AQA GCSE Physics | 8463

SPECIFICATION POINT 4.6.2.4

Uses and applications of electromagnetic waves

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**151**
Available paper years	**2003–2024**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.6.2.4 Uses and applications of electromagnetic waves

Answer 01 · Mark scheme June 2003 | 3451H | Original Q3 | Legacy

The full source mark scheme begins on page 142. Follow original question 3 in that document.

Answer 02 · Mark scheme June 2003 | 3451H | Original Q9 | Legacy

The full source mark scheme begins on page 142. Follow original question 9 in that document.

Answer 03 · Mark scheme June 2003 | 3451H | Original Q14 | Legacy

The full source mark scheme begins on page 142. Follow original question 14 in that document.

Answer 04 · Mark scheme June 2003 | 3462H3 | Original Q3 | Legacy

The full source mark scheme begins on page 164. Follow original question 3 in that document.

Answer 05 · Mark scheme June 2003 | 3462H3 | Original Q7 | Legacy

The full source mark scheme begins on page 164. Follow original question 7 in that document.

4.6.2.4 Uses and applications of electromagnetic waves

Answer 06 · Mark scheme June 2003 | 3462H3 | Original Q12 | Legacy

The full source mark scheme begins on page 164. Follow original question 12 in that document.

Answer 07 · Mark scheme June 2004 | 3451H | Original Q2 | Legacy

The full source mark scheme begins on page 181. Follow original question 2 in that document.

Answer 08 · Mark scheme June 2004 | 3462H3 | Original Q2 | Legacy

The full source mark scheme begins on page 202. Follow original question 2 in that document.

Answer 09 · Mark scheme June 2005 | 3451 | Original Q9 | Legacy

The full source mark scheme begins on page 219. Follow original question 9 in that document.

Answer 10 · Mark scheme June 2005 | 3451 | Original Q10 | Legacy

The full source mark scheme begins on page 219. Follow original question 10 in that document.

4.6.2.4 Uses and applications of electromagnetic waves

Answer 11 · Mark scheme June 2005 | 3462 | Original Q7 | Legacy

The full source mark scheme begins on page 237. Follow original question 7 in that document.

Answer 12 · Mark scheme June 2005 | 3462 | Original Q8 | Legacy

The full source mark scheme begins on page 237. Follow original question 8 in that document.

Answer 13 · Mark scheme June 2006 | 3451 | Original Q10 | Legacy

The full source mark scheme begins on page 251. Follow original question 10 in that document.

Answer 14 · Mark scheme June 2006 | 3462 | Original Q8 | Legacy

The full source mark scheme begins on page 271. Follow original question 8 in that document.

Answer 15 · Mark scheme November 2006 | PHY1B | Original Q1 | Legacy

One	**A**	infra red rays	**1**
	B	ultraviolet waves	**3**
	C	visible light	**2**
	D	X-rays	**4**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 16 · Mark scheme November 2006 | PHY1B | Original Q5 | Legacy

Five	**A**	a distant galaxy	**3**
	B	a satellite	**1**
	C	the Earth	**2**
	D	the Universe	**4**

Answer 17 · Mark scheme November 2006 | PHY1B | Original Q6 | Legacy

Six	**A**	bar	**3**
	B	categoric	**1**
	C	dependent	**2**
	D	reliable	**4**

	A	**B**	**C**	**D**

Answer 18 · Mark scheme November 2006 | PHY1B | Original Q9 | Legacy

Nine	**3**	**3**	**3**	**1**

4.6.2.4 Uses and applications of electromagnetic waves

PHY1B (Radiation and the Universe) Higher Tier

Question	Key		
One	**A**	bar	**3**
	B	categoric	**1**
	C	dependent	**2**
	D	reliable	**4**
Two	**A**	current	**3**
	B	energy	**2**
	C	frequency	**4**
	D	substance	**1**

	A	B	C	D
Three	**3**	**2**	**3**	**3**
Four	**3**	**3**	**3**	**1**
Five	**3**	**2**	**4**	**4**
Six	**4**	**4**	**1**	**1**
Seven	**2**	**1**	**2**	**2**
Eight	**4**	**4**	**4**	**2**
Nine	**2**	**2**	**2**	**2**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 19 · Mark scheme

January 2007 | PHY1H | Original Q1 | Legacy

No matching mark scheme was available in the supplied archive for this question.

Answer 20 · Mark scheme

January 2007 | PHY1H | Original Q4 | Legacy

No matching mark scheme was available in the supplied archive for this question.

Answer 21 · Mark scheme

January 2007 | PHY1H | Original Q5 | Legacy

No matching mark scheme was available in the supplied archive for this question.

Answer 22 · Mark scheme

March 2007 | PHY1B | Original Q1 | Legacy

Question	Key		
One	**A**	infra red	**3**
	B	radio waves	**4**
	C	ultraviolet	**2**
	D	visible light	**1**

Answer 23 · Mark scheme

March 2007 | PHY1B | Original Q2 | Legacy

Two	**A**	electron	**1**
	B	nucleus	**4**
	C	neutron	**3**
	D	proton	**2**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 24 · Mark scheme March 2007 | PHY1B | Original Q4 | Legacy

Four	**A**	away from	**2**
	B	beyond	**4**
	C	furthest	**3**
	D	towards	**1**

Answer 25 · Mark scheme March 2007 | PHY1B | Original Q5 | Legacy

Five	**A**	6	**3**
	B	8	**2**
	C	12	**4**
	D	19	**1**

Answer 26 · Mark scheme March 2007 | PHY1B | Original Q7 | Legacy

Seven	**4**	**1**	**1**	**2**

Answer 27 · Mark scheme June 2007 | PHY1B | Original Q2 | Legacy

Two	**A**	alpha (α)	**4**
	B	beta (β)	**2**
	C	gamma (γ)	**3**
	D	alpha (α), beta (β) and gamma (γ)	**1**

	A	**B**	**C**	**D**

Answer 28 · Mark scheme June 2007 | PHY1B | Original Q3 | Legacy

Three	**1**	**4**	**3**	**1**

Answer 29 · Mark scheme June 2007 | PHY1B | Original Q5 | Legacy

Five	**2**	**4**	**4**	**4**

Answer 30 · Mark scheme June 2007 | PHY1B | Original Q7 | Legacy

Seven	**3**	**1**	**1**	**4**

Answer 31 · Mark scheme June 2007 | PHY1B | Original Q8 | Legacy

Eight	**3**	**4**	**4**	**4**

4.6.2.4 Uses and applications of electromagnetic waves

Question 1 continued

	answers	extra information	mark
(c)(i)	idea of testing food on humans / animals		1
	no (measured) ill effects **or** monitor their health	accept monitor people that have eaten the food accept a measurement / comparison for **1** mark eg measure the amount of radiation in treated food comparison plus a reason for the comparison would get **2** marks eg idea of measuring level of radiation in treated food **with** no measurable increase in level = **2** marks **or** comparing it to untreated food = **2** marks	1
(ii)	so can make own decision about eating or not eating treated food	accept may be against their religious / moral views accept some people prefer food that hasn't been tampered with ignore in case they don't like the idea of eating treated food accept don't want to eat treated food ignore might be allergic to the food eg think it will give them cancer = **0** marks think it will give you cancer so I need to know so that I can choose = **1** mark	1
total			8

4.6.2.4 Uses and applications of electromagnetic waves

PHY1H Question 2

	answers	extra information	mark
(a)	the outside colour of the cans		1
(b)(i)	18 (°C) **or** 88 to 70	ignore negative sign	1
(ii)	8 (°C) **or** 70 to 62	ignore negative sign	1
(c)	greater temperature difference between water and surroundings (at start)	must mention temperature difference ignore just water hotter accept energy used to heat cans initially	1
(d)	black temperature falls the fastest (in L) black is a good / the best / better emitter (of heat / radiation)	 accept (can L) loses more heat / cools quicker accept heat for temperature accept converse ignore black is best absorber	1 1 1
total			7

4.6.2.4 Uses and applications of electromagnetic waves

PHY1H Question 3

	answers	extra information	mark
(a)(i)	national grid		1
(ii)	increases voltage / potential difference	accept decrease current accept step-up / boosts the voltage do **not** accept increases energy / power / current ignore reference to voltage going through	1
(iii)	any **two** from: • reduce current • reduces energy loss / power loss (from cables) • increases efficiency (of distribution)	 ignore increased voltage / pd accept reduces heat loss do **not** accept stops energy loss	2
(b)	any **one** from: • produces pollutant gases • produces solid waste / ash / smoke	 accept produces carbon dioxide / sulfur dioxide / nitrogen oxides accept global warming / greenhouse effect / carbon emissions / air pollution / acid rain ignore ozone layer do **not** accept carbon monoxide accept global dimming ignore produces pollution	1

Continued on next page

4.6.2.4 Uses and applications of electromagnetic waves

Question 5 continued

	answers	extra information	mark
(b)(i)		any mention of alpha, beta, gamma waves scores **0** marks	
	emit / uses / transmit / receive microwaves	accept radiation for microwaves throughout ignore radio waves	1
	some microwave / energy absorbed by / enters the body	ecf for their given electromagnetic wave do **not** accept goes through the body	1
	raises temperature of (body) cells / tissue / water	accept reference to water molecules vibrating faster accept it could cause mutation / harm / kill cells do **not** accept answers in terms of ionisation ignore references to cancer	1
(ii)	any **two** from: • research (may be) biased **or** may have been misled in the past • some research suggests a link • long-term effect not proven / studied • residents may not have seen the research	accept not independent **or** may be lying accept not studied for long enough	2
total			8

4.6.2.4 Uses and applications of electromagnetic waves

PHY1H Question 6

	answers	extra information	mark
(a)	four calculations correctly shown	200 × 10 – 1800 = £200 100 × 10 – 2400 = –£1400 50 × 10 – 600 = –£100 20 × 10 – 75 = 125 accept four final answers only **or** obvious rejection of solar water heater and underfloor heating, with other two calculations completed any 1 complete calculation correctly shown **or** showing each saving × 10 of all four calculations = **1** mark answers in terms of savings as a percentage of installation cost **may** score savings mark only	2
	hot water boiler	correct answers only	1
(b)	less electricity / energy to be generated / needed from power stations	accept less demand	1
	reduction in (fossil) fuels being burnt	accept correctly named fuel accept answer in terms of: fewer light bulbs required because they last longer (1 mark) less energy used / fuels burnt in production / transport etc. (1 mark) ignore reference to CO_2 or global warming ignore reference to conservation of energy	1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

Answer 34 · Mark scheme November 2007 | PHY1B | Original Q1 | Legacy

One	**A**	analogue electrical signal	**2**
	B	digital light signal	**3**
	C	microwaves	**4**
	D	sound waves	**1**

Answer 35 · Mark scheme November 2007 | PHY1B | Original Q2 | Legacy

Two	**A**	infra red radiation	**1**
	B	ultraviolet radiation	**3**
	C	visible light	**2**
	D	X-rays	**4**

	A	**B**	**C**	**D**

Answer 36 · Mark scheme November 2007 | PHY1B | Original Q4 | Legacy

Four	**4**	**4**	**3**	**3**

Answer 37 · Mark scheme November 2007 | PHY1B | Original Q5 | Legacy

Five	**4**	**2**	**1**	**1**

Answer 38 · Mark scheme November 2007 | PHY1B | Original Q7 | Legacy

Seven	**1**	**2**	**2**	**4**

4.6.2.4 Uses and applications of electromagnetic waves

Question 4

question	answers	extra information	mark
(a)(i)	beta and gamma	both answers required accept correct symbols	1
(ii)	alpha and beta	both answers required accept correct symbols	1
(iii)	gamma	accept correct symbol	1
(b)	nothing *(*you do to a radioactive substance / source*)* changes the count rate / activity / rate of decay / radiation (emitted) **or** *(*reducing*)* the temperature does not change the activity / count rate / rate of decay / radiation (emitted)	accept it = radiation emitted	1
(c)(i)	has <u>one</u> more neutron	correct answer only	1
(ii)	14 days	no tolerance allow **1** mark for showing a correct method on the graph	2

Question 4 continues on the next page

PHY1H

Question 4 continued

question	answers	extra information	mark
(iii)	any **two** from: • beta particles / radiation can be detected externally • beta particles / radiation can pass out of / through the plant • long half-life gives time for phosphorus to move through the plant / be detected / get results • phosphorus-32 is chemically identical to phosphorus-31 • phosphorus-32 is used in the same way by a plant as phosphorus-31		2
total			9

4.6.2.4 Uses and applications of electromagnetic waves

Answer 39 · Mark scheme

January 2008 | PHY1H | Original Q4 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 40 · Mark scheme January 2008 | PHY1H | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
(a) E	C or 0.18 mm		1
(b) E	0.6 m	allow **1** mark for correct transformation and substitution allow **1** mark for changing frequency to Hz answer 600 gains **1** mark	2
(c) E	creates an alternating current with the same frequency as the radio wave **or** it gets hotter	accept 'ac' for alternating current accept alternating voltage accept signal for radio wave	1 1
(d) E	X-rays cannot penetrate the atmosphere **or** X-rays are absorbed *(*by the atmosphere*)*	accept atmosphere stops X-rays do **not** accept atmosphere in the way before reaching Earth ignore explanations	1
total			6

4.6.2.4 Uses and applications of electromagnetic waves

Answer 40 · Mark scheme January 2008 | PHY1H | Original Q5 | Legacy

PHY1H

Answer 41 · Mark scheme March 2008 | PHY1BP | Original Q2 | Legacy

Two	**A**	gamma rays	**2**		
	B	radio waves	**3**		
	C	ultraviolet waves	**4**		
	D	visible light	**1**		
	A		**B**	**C**	**D**

Answer 42 · Mark scheme March 2008 | PHY1BP | Original Q3 | Legacy

Three	**4**	**1**	**1**	**1**

Answer 43 · Mark scheme March 2008 | PHY1BP | Original Q4 | Legacy

Four	**4**	**1**	**3**	**4**

Answer 44 · Mark scheme March 2008 | PHY1BP | Original Q9 | Legacy

Nine	**4**	**4**	**4**	**3**

Answer 45 · Mark scheme June 2008 | PHY1BP | Original Q3 | Legacy

Three	**1**	**4**	**2**	**4**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 46 · Mark scheme June 2008 | PHY1BP | Original Q4 | Legacy

Four	**4**	**3**	**4**	**3**

Answer 47 · Mark scheme June 2008 | PHY1BP | Original Q5 | Legacy

Five	**4**	**2**	**3**	**1**

Answer 48 · Mark scheme June 2008 | PHY1BP | Original Q7 | Legacy

Seven	**2**	**2**	**3**	**3**

Answer 49 · Mark scheme June 2008 | PHY1BP | Original Q9 | Legacy

Nine	**4**	**1**	**2**	**4**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 50 · Mark scheme

June 2008 | PHY1H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
(a)(i)	soil		1
(a)(ii)	type of surface is a categoric (variable)	accept surface is not a continuous (variable) do **not** accept data is discrete	1
(a)(iii)		mark is for a feasible reason linked to either the skier or golfer accept radiation for UV	1
	skier		
	exposed to high(er) level reflected UV	accept snow is a good reflector of UV do **not** accept snow reflects UV	
	or		
	less UV absorbed by the atmosphere	accept snow is a poor absorber of UV do **not** accept snow absorbs UV	
	golfer		
	out when Sun's intensity is highest	accept when Sun is stronger / hotter	
	or		
	larger area of skin / body exposed	accept golfer is outside for longer	
(a)(iv)	any **one** from: • (skin) cancer	accept kills / damages cells	1
	• premature skin ageing	accept a correct description do **not** accept suntan accept burn (it)	

Question 2 continues on the next page

PHY1H

Question 2 continued

question	answers	extra information	mark
(b)(i)	level of UV **transmitted** is very low	accept energy / rays for UV	1
		accept answers in terms of absorbed / blocked	
	for all wavelengths shown / up to 400 nm	only scores if first mark scores	1
		accept an answer in terms of cannot support 95 % claim as measurements cannot be taken from the graph **or** an attempted calculation	
(b)(ii)	glass transmitted most / a lot of UV	accept energy / rays for UV do **not** accept light for UV do **not** accept all UV	1
		accept results (almost) same as no absorbing material	
	or		
	glass absorbed little UV	accept blocks / stops for absorbed do **not** accept no UV	
(c)(i)	Publicity and education ….		1
(c)(ii)	implication of financial gain	accept to promote the product	1
		sunglasses cost a lot of money is insufficient	
total			9

4.6.2.4 Uses and applications of electromagnetic waves

Answer 50 · Mark scheme June 2008 | PHY1H | Original Q2 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 51 · Mark scheme June 2008 | PHY1H | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
(a)	Hubble telescope is above the (Earth's) atmosphere	accept no / little atmosphere	1
	atmosphere distorts image **or** atmosphere scatters light	do **not** accept light / waves distorted accept picture for image accept no clouds (to block light) accept no light pollution answers in terms of closer to stars neutral	1
(b)	to check it works (correctly) **or** less risk of a fault (once in space)		1
	too far away (for astronauts) to travel to / to fix	accept its difficult to send astronauts to repair / maintain it dangerous / expensive is insufficient	1
(c)	to test the design works	accept idea of fault finding or modifying the design	1
(d)	(visible) light can pass through the atmosphere		1
	X-rays are absorbed by the atmosphere **or** X-rays cannot pass through the atmosphere		1
total			7

4.6.2.4 Uses and applications of electromagnetic waves

Answer 51 · Mark scheme June 2008 | PHY1H | Original Q3 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 52 · Mark scheme

Question 6

question	answers	extra information	mark
(a)(i)	3 fewer neutrons	accept fewer neutrons accept different number of neutrons do **not** accept different number of electrons	1
(a)(ii)	electron from the nucleus	both points needed	1
(a)(iii)	32 (days)	allow **1** mark for clearly obtaining 4 half-lives	2
(a)(iv)	has a **much** longer half-life little decay happened / still in the atmosphere	accept converse answers in terms of iodine-131 accept it has not reached one half-life yet accept it is still decaying	1 1
(b)	any **two** from: • some children developed TC before 1986 • some children (after 1986) that developed TC did not live in highly contaminated areas • the (large) increase can (only) be explained by (a large increase in) radiation as caused by Chernobyl • all areas would be contaminated (and raise the risk of TC) • no evidence (of effect) of other variables	marks are for reasons	2
(c)	People not exposed (to the radiation but who were otherwise similar)	accept people not affected (by the radiation)	1

Question 6 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

PHY1H

Question 6 continued

question	answers	extra information	mark
(d)	any **two** from: • produce no pollutant / harmful gases • produces a lot of energy for a small mass (of fuel) **or** is a concentrated energy source • it is reliable **or** it can generate all of the time • produces only a small volume of (solid) waste	answers should be in terms of nuclear power and **not** why we should not use other fuels accept named gas or greenhouse gases do **not** accept no pollution accept amount for mass accept high energy density accept amount for volume	2
total			11

4.6.2.4 Uses and applications of electromagnetic waves

Answer 53 · Mark scheme November 2008 | PHY1AP | Original Q9 | Legacy

Nine	**4**	**2**	**3**	**1**

* The whole of question two was removed from the mark scheme and this test was marked out of 32.

Answer 54 · Mark scheme November 2008 | PHY1BP | Original Q1 | Legacy

Question	Key		
One	**A**	alpha radiation	**3**
	B	beta radiation	**4**
	C	gamma radiation	**2**
	D	visible light	**1**

Answer 55 · Mark scheme November 2008 | PHY1BP | Original Q5 | Legacy

Five	**3**	**2**	**1**	**2**

Answer 56 · Mark scheme November 2008 | PHY1BP | Original Q6 | Legacy

Six	**4**	**1**	**3**	**2**

Answer 57 · Mark scheme November 2008 | PHY1BP | Original Q7 | Legacy

Seven	**1**	**3**	**3**	**1**

Answer 58 · Mark scheme November 2008 | PHY1BP | Original Q8 | Legacy

Eight	**1**	**3**	**3**	**3**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 59 · Mark scheme

Question 5

question	answers	extra information	mark
5(a)(i)	radio(waves)		1
5(a)(ii)	energy	correct answer only	1
5(b)(i)	0.0125 (m)	allow **1** mark for correct transformation and substitution	2
5(b)(ii)	make it hot(ter)	do **not** accept cook it accept (air) particles inside ball will move faster accept water in the ball gets hotter	1
5(b)(iii)	wavelength decreases frequency increases	ignore reference to speed	1 1
5(c)(i)	both variables are continuous	accept the data is continuous	1

Question 5 continues on the next page

PHY1H

Question 5 continued

question	answers	extra information	Mark
5(c)(ii)	digital data can be (easily) processed by a computer **or** digital analogue data cannot (easily) be processed by a computer	both parts needed do **not** accept answers in terms of interference / quality / clearer signals	1
5(c)(iii)	digital a signal that has only two states / discrete values analogue a signal that varies continuously	accept can only be on or off accept made up of 1 and 0 only allow both marks for two correct diagrams correctly labelled digital and analogue allow **1** mark for two correct diagrams but not labelled	1 1
Total			**11**

4.6.2.4 Uses and applications of electromagnetic waves

Question 6

question	answers	extra information	mark
6(a)	146		1
6(b)	atomic number		1
6(c)(i)	alpha		1
6(c)(ii)	number of protons changes	accept atomic number changes accept loses or gains protons do **not** accept protons with any other particle e.g. number of protons and neutrons changes incorrect do **not** accept any reference to mass number	1
Total			**4**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 60 · Mark scheme January 2009 | PHY2H | Original Q6 | Legacy

PHY2H

Answer 61 · Mark scheme March 2009 | PHY1BP | Original Q2 | Legacy

Two	**A**	alpha particles	**4**
	B	beta particles	**2**
	C	gamma rays	**3**
	D	alpha, beta and gamma radiation	**1**

	A	**B**	**C**	**D**

Answer 62 · Mark scheme March 2009 | PHY1BP | Original Q3 | Legacy

Three	**1**	**3**	**2**	**1**

Answer 63 · Mark scheme March 2009 | PHY1BP | Original Q4 | Legacy

Four	**2**	**3**	**2**	**3**

Answer 64 · Mark scheme March 2009 | PHY1BP | Original Q5 | Legacy

Five	**4**	**2**	**3**	**3**

Answer 65 · Mark scheme March 2009 | PHY1BP | Original Q6 | Legacy

Six	**3**	**4**	**4**	**3**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 66 · Mark scheme

March 2009 | PHY1BP | Original Q9 | Legacy

Nine	**2**	**3**	**4**	**3**

Answer 67 · Mark scheme

June 2009 | PHY1BP | Original Q1 | Legacy

Question	Key		
One	**A**	microwaves	**3**
	B	X-rays	**1**
	C	visible light	**2**
	D	radio waves	**4**

Answer 68 · Mark scheme

June 2009 | PHY1BP | Original Q2 | Legacy

Two	**A**	alpha only	**1**		
	B	beta only	**2**		
	C	gamma only	**3**		
	D	alpha and gamma	**4**		
	A		**B**	**C**	**D**

Answer 69 · Mark scheme

June 2009 | PHY1BP | Original Q4 | Legacy

Four	**1**	**1**	**3**	**4**

Answer 70 · Mark scheme

June 2009 | PHY1BP | Original Q5 | Legacy

Five	**2**	**3**	**4**	**3**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 71 · Mark scheme June 2009 | PHY1BP | Original Q6 | Legacy

Six	**3**	**4**	**2**	**2**

Answer 72 · Mark scheme June 2009 | PHY1BP | Original Q7 | Legacy

Seven	**4**	**1**	**3**	**4**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 73 · Mark scheme

June 2009 | PHY1H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)(i)	HESS	accept gamma	1
1(a)(ii)	infra red	accept IR accept answers written in table do **not** accept heat	1
1(b)	clearer / more detailed / sharper / less distorted image any **one** from: • no light pollution • light is not scattered by the atmosphere	do **not** accept image is bigger accept no clouds to prevent observations accept light is scattered by the atmosphere (implies William Herschel) accept light does (not have to) pass through the atmosphere accept air for atmosphere do **not** accept answers in terms of distance	1 1

Question 1 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

PHY1H

Question 1 continued . . .

question	answers	extra information	mark
1(c)	any **two** from: • microwaves absorbed by water (molecules) • signal strength greater (in dry environment) • more sensitive (in dry environment) • detect weaker signals (in dry environment) • more detailed / clearer image (in dry environment)	accept more microwaves reach telescope accept harder to detect signals in a humid environment accept image contains more information do **not** accept better image	2
1(d)	a fourth / extra galaxy / star	accept a planet / another object / source	1
Total			**7**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 73 · Mark scheme

June 2009 | PHY1H | Original Q1 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 74 · Mark scheme

June 2009 | PHY1H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)(i)	any **one** from: • less (prone to) interference • can be (easily) processed by computers • better (quality) signal • signal can be restored	accept interference causes less / no permanent damage accept no interference accept noise / distortion for interference accept can be processed without an analogue to digital converter accept clearer signal do **not** accept faster / sends more information	1
2(a)(ii)	cooking **or** satellite communication	do **not** accept microwave (oven) accept radar accept (microwave) telescopes accept Wi-Fi do **not** accept radio	1
2(b)(i) **E**	compare (the health of) mobile phone users with non-mobile phone users	must be an implied comparison between users and non-users any idea of doing an experiment negates the mark	1
2(b)(ii) **E**	increase the sample size	accept use more people accept have a large sample size repeat the research / test is neutral	1

Question 2 continues on the next page . . .

PHY1H

Question 2 continued . . .

question	answers	extra information	mark
2(b)(iii)	ethical		1
2(c)(i)	so the phones can be compared (fairly)	a fair test is insufficient accept different tests (may) give different results do **not** accept to make the results reliable, unless qualified eg all variables are controlled do **not** accept bias unless qualified	1
2(c)(ii)	yes all are below the legal limit / 2 (W/kg) **or** no and any **one** from: • even absorbing a small amount of energy may be harmful • no proof that small amounts of energy are not harmful	 accept microwaves for energy accept emits energy absorbed by head / other parts of body accept because the SAR value is not 0 (W/kg)	1
2(d)	any **one** from: • to get an independent opinion • company scientists may be biased	 accept company scientists may manipulate results	1
Total			**8**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 74 · Mark scheme

June 2009 | PHY1H | Original Q2 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 75 · Mark scheme

Question 3

question	answers	extra information	mark
3(a)(i)	0.6	accept 60% allow **1** mark for useful energy = 480 answer 0.6 with any unit or 60 gains **1** mark only	2
3(a)(ii)	transferred to surroundings	accept goes into the air accept heats the surroundings up accept gets spread out accept transferred into heat (only) do **not** accept wasted / lost unless qualified destroyed negates mark transferred into light / sound negates mark	1
3(b)(i)	1.75	allow **1** mark for converting to kW answers of 0.7, 0.525, 0.35, 0.875, 1.05, 5.25 gains **1** mark answers of 1750 or 17.5 gains **1** mark	2
3(b)(ii)	21p or £0.21 or their (b)(i) × 12		1

Question 3 continues on the next page . . .

PHY1H

Question 3 continued . . .

question	answers	extra information	mark
3(c)	any **two** from: • (more) electricity needs to be generated • (more) power stations needed • (more) fossil fuels burnt • (more) pollutant gases emitted	(more) electricity is being used accept named fossil fuel accept named gas accept harmful for pollutant accept greenhouse gases accept atmospheric pollution accept answer in terms of any form of electricity generation and an associated environmental problem	2
Total			**8**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 75 · Mark scheme

June 2009 | PHY1H | Original Q3 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 76 · Mark scheme

June 2009 | PHY1H | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)(i)	gamma hardly ionises the air	accept does not ionise accept gamma radiation is not charged do **not** accept answers in terms of danger of gamma or other properties	1
6(a)(ii)	half-life (too) short	accept need frequent replacement 'it' refers to curium-242	1
6(a)(iii)	(two) fewer neutrons	accept different numbers of neutrons if a number is specified it must be correct do **not** accept more neutrons unless curium-244 is specified	1
6(b)(i)	gamma	accept correct symbol	1
6(b)(ii)	both absorbed by the metal / steel / weld	only scores if (b)(i) is correct accept cannot pass through the metal / steel / weld	1
6(c)(i)	put source into water at **one** point on bank see if radiation is detected in polluted area	accept the idea of testing different parts of the river bank at different times accept idea of tracing	1 1
6(c)(ii)	2.7 (days)	allow **1** mark for showing correct use of the graph	2
Total			**9**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 77 · Mark scheme November 2009 | PHY1AP | Original Q9 | Legacy

Nine	**1**	**1**	**2**	**4**

Answer 78 · Mark scheme November 2009 | PHY1BP | Original Q3 | Legacy

Three	**2**	**4**	**2**	**2**

Answer 79 · Mark scheme November 2009 | PHY1BP | Original Q4 | Legacy

Four	**2**	**1**	**2**	**3**

Answer 80 · Mark scheme November 2009 | PHY1BP | Original Q5 | Legacy

Five	**3**	**2**	**3**	**1**

Answer 81 · Mark scheme November 2009 | PHY1BP | Original Q7 | Legacy

Seven	**4**	**1**	**3**	**3**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 82 · Mark scheme

November 2009 | PHY1BP | Original Q9 | Legacy

Nine	**3**	**2**	**4**	**3**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 83 · Mark scheme

Question 3

question	answers	extra information	mark
3(a)(i)	microwaves		1
3(a)(ii)	can pass through the ionosphere	accept travels in a straight line accept atmosphere for ionosphere do **not** accept air for ionosphere	1
3(b)	any **two** from: • analogue is continuously varying • digital has only discrete values • digital is less prone to interference (than analogue) • digital can be processed more easily (than analogue) by a computer	 do **not** accept analogue has many values accept digital is on or off accept digital is 1 or 0 accept digital is binary accept digital is easier to restore	2
3(c)	higher the frequency, further the wave travels (into the atmosphere before reflection)		1
3(d)	15 000	allow **1** mark for correct transformation and substitution ie $\frac{300\,000\,000}{20}$ an answer of 15 000 000 only gains **1** mark allow both marks for an answer of 15 MHz (unit must be changed) an answer of 15 gains no credit	2
Total			**7**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 83 · Mark scheme

January 2010 | PHY1H | Original Q3 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 84 · Mark scheme

Question 3

question	answers	extra information	mark
3(a)(i)	**K** and **L**	both answers required either order	1
3(a)(ii)	(1) same number of protons (2) different numbers of neutrons	accept same number of electrons accept same atomic number	1 1
3(b)(i)	90		1
3(b)(ii)	140		1
3(c)	alpha (particle) mass number goes down by 4 **or** number of protons and neutrons goes down by 4 **or** number of neutrons goes down by 2 atomic / proton number goes down by 2 **or** number of protons goes down by 2	reason may score even if beta or gamma is chosen candidates that answer correctly in terms of why gamma **and** beta decay are not possible gain full credit accept an alpha particle consists of 2 neutrons and 2 protons for **1** mark accept alpha equals $^{4}_{2}He$ or $^{4}_{2}\alpha$ for **1** mark an alpha particle is a helium nucleus is insufficient for this mark	1 1 1
Total			**8**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 84 · Mark scheme January 2010 | PHY2H | Original Q3 | Legacy

PHY2H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 85 · Mark scheme

Question 3

question	answers	extra information	mark
3(a)	sound / mechanical / longitudinal (wave) any **one** from: • above 20 000 hertz / 20kHz • above (human) audible range • cannot be heard by humans		1 1
3(b)	**either** particles / molecules / fluid vibrate(s) (1) (and) knock particles of dirt off the jewellery (1) **or** by the process of cavitation (1) which breaks up / releases dirt from the surface (1)	 accept ‘formation and collapse of tiny bubbles’	2

Question 3 continues on the next page . . .

PHY3H

Question 3 continued . . .

question	answers	extra information	mark
3(c)	**either** two appropriate points gain **1** mark each **or** one appropriate point (and) appropriate qualification / amplification	**either** both pro **or** both con **or** one of each examples other mammals (sufficiently) similar to humans (1) so results appropriate (1) unethical to experiment on humans (1) so it is better to experiment on mice (1) knowledge / techniques will benefit humans (1) and also other animals (1) experiments were justified because ultrasound has proved useful (1)	2
Total			**6**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 85 · Mark scheme January 2010 | PHY3H | Original Q3 | Legacy

PHY3H

Answer 86 · Mark scheme March 2010 | PHY1BP | Original Q4 | Legacy

Four	**2**	**4**	**2**	**1**

Answer 87 · Mark scheme March 2010 | PHY1BP | Original Q5 | Legacy

Five	**4**	**2**	**1**	**1**

Answer 88 · Mark scheme March 2010 | PHY1BP | Original Q6 | Legacy

Six	**2**	**2**	**3**	**2**

Answer 89 · Mark scheme March 2010 | PHY1BP | Original Q7 | Legacy

Seven	**1**	**2**	**2**	**3**

Answer 90 · Mark scheme March 2010 | PHY1BP | Original Q9 | Legacy

Nine	**1**	**4**	**4**	**3**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 91 · Mark scheme June 2010 | PHY1BP | Original Q2 | Legacy

Two	**A**	Source gives off alpha radiation only.		**3**
	B	Source gives off alpha and beta radiation only.		**2**
	C	Source gives off alpha, beta and gamma radiation.		**4**
	D	Source gives off beta radiation only.		**1**

	A	**B**	**C**	**D**

Answer 92 · Mark scheme June 2010 | PHY1BP | Original Q3 | Legacy

Three	3	3	4	2

Answer 93 · Mark scheme June 2010 | PHY1BP | Original Q6 | Legacy

Six	2	2	2	2

Answer 94 · Mark scheme June 2010 | PHY1BP | Original Q7 | Legacy

Seven	1	2	2	1

Answer 95 · Mark scheme June 2010 | PHY1BP | Original Q9 | Legacy

Nine	2	4	4	2

4.6.2.4 Uses and applications of electromagnetic waves

Answer 96 · Mark scheme

June 2019 | PHY1H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)	gamma will pass through the body **or** alpha will not pass through the body	it refers to gamma answers must relate to the body accept skin for body	1
	gamma is only slightly ionising **or** alpha is heavily ionising	accept gamma causes less damage to cells / tissue do **not** accept gamma causes no damage to cells less harmful is insufficient	1
2(b)(i)	(both graphs show an initial) increase in count-rate	accept both show an increase	1
2(b)(ii)	only the right kidney is working correctly		1
	any **two** from: • count-rate / level / line for right kidney decreases (rapidly) • count-rate / level / line for <u>left</u> kidney does not change • radiation is being passed out / into urine - if referring to right kidney • radiation is not being passed out - if referring to the left kidney	if incorrect box chosen maximum of **1** mark can be awarded reference to named kidney can be inferred from the tick box it decreases is insufficient it does not change is insufficient	2

Question 2 continues on the next page . . .

PHY1H

Question 2 continued . . .

question	answers	extra information	mark
2(c)(i)	time taken for number of nuclei to halve **or** time taken for the count-rate to halve		1
2(c)(ii)	short half-life - the level of radiation (in the body) decreases rapidly to a safe / very small level **or** a long half-life - the radiation remains in the body / for a long time level of radiation remains high	it refers to short life isotope answers in terms of damage eg cancer are insufficient	1 1
Total			**9**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 96 · Mark scheme June 2010 | PHY1H | Original Q2 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 97 · Mark scheme

June 2010 | PHY1H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)(i)	any **two** from: • travel at the same speed (through a vacuum) • can travel through a vacuum / space • transfer energy • can be reflected • can be refracted • can be diffracted • can be absorbed • can be transmitted • transverse	 accept travel at the speed of light accept air for vacuum do **not** accept air for vacuum accept any other property common to electromagnetic waves accept travel at the same speed through a vacuum for both marks do **not** accept both radiated from the Sun	2
4(a)(ii)	infra red radio(waves)	**both** required for the mark accept IR for infra red	1

Question 4 continues on the next page . . .

PHY1H

Question 4 continued . . .

question	answers	extra information	mark
4(b)	2400000000	correct transformation and substitution gains **1** mark ie $\frac{300000000}{0.125}$ **or** $\frac{300000000}{12.5}$ an answer of 24000000 gains **1** mark **either** 2400000 kHz **or** 2400 MHz scores **3** marks but the symbol only scores the 3rd mark if it is correct in every detail	2
	hertz	accept Hz do **not** accept hz	1
4(c)(i)	presented (scientific) evidence / data	do an experiment / investigation is insufficient	1
4(c)(ii)	to find out if there is a hazard (or not)	accept to find out if it is safe accept not enough evidence to make a decision not enough evidence is insufficient	1
Total			**8**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 97 · Mark scheme June 2010 | PHY1H | Original Q4 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 98 · Mark scheme

June 2010 | PHY2H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)(i)	2.5		1
2(a)(ii)	The radiation dose from natural sources is much greater than from artificial sources.		1
2(b)(i)	other factors may be involved	accept a specific suggestion eg they may be exposed to other types of radiation accept cannot be sure (in many cases) that the cause of death is radon (poisoning)	1
2(b)(ii)	any **one** from: • different concentrations in different rooms • to average out daily fluctuations	accept to find an average accept to make the result (more) reliable / valid do **not** accept to make more accurate on its own	1
2(b)(iii)	average level (much) higher (in **C** and **D**) some homes have very high level (in **C** and **D**) **or** maximum level in some homes (in **C** and **D**) is very high	accept converse accept maximum level in **A** and **B** is low accept higher radiation levels (in **C** and **D**) for **1** mark	1 1
Total			**6**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 98 · Mark scheme June 2010 | PHY2H | Original Q2 | Legacy

PHY2H

Answer 99 · Mark scheme November 2010 | PHY1BP | Original Q2 | Legacy

Two	**A**	categoric	**3**
	B	continuous	**1**
	C	dependent	**2**
	D	reliable	**4**

	A	B	C	D

Answer 100 · Mark scheme November 2010 | PHY1BP | Original Q5 | Legacy

Five	**3**	**3**	**1**	**4**

Answer 101 · Mark scheme November 2010 | PHY1BP | Original Q6 | Legacy

Six	**3**	**2**	**1**	**2**

Answer 102 · Mark scheme November 2010 | PHY1BP | Original Q7 | Legacy

Seven	**2**	**3**	**2**	**4**

Answer 103 · Mark scheme November 2010 | PHY1BP | Original Q8 | Legacy

Eight	**2**	**2**	**4**	**2**

Answer 104 · Mark scheme November 2010 | PHY1BP | Original Q9 | Legacy

Nine	**3**	**3**	**4**	**4**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 105 · Mark scheme

Question 1

question	answers	extra information	mark
1(a)	higher frequency **or** shorter wavelength **or** greater energy	general properties / uses are neutral do **not** accept different frequency / wavelength / energy	1
1(b)	the same (speed)	accept they travel at the speed of light	1
1(c)	pass through / transmitted by the plastic / casing <u>reflected</u> by the metal / plates	 do **not** accept bounce / deflected etc for reflected if neither marking point scores an answer reflected (back to boat / from the device) scores **1** mark	1 1
1(d)(i)	waves are not <u>reflected</u> from the walls **or** only waves (reflected) from the device are detected	accept microwaves / radar for waves do **not** accept bounce / deflected etc for reflected accept to stop reflected waves affecting results	1

Question 1 continues on the next page . . .

PHY1H

Question 1 continued . . .

question	answers	extra information	mark
1(d)(ii)	different types (of device) can be compared	fair test is insufficient accept idea that only one variable is then changed	1
1(d)(iii)	so (measurements / results / scientists) are not biased towards one type / manufacturer of device/s	accept to avoid bias accept so they are not biased	1
1(e)(i)	any **two** from: • (for any angle) **A** values < **B** values • **A** values increase with (increasing) angle • **B** values decrease with (increasing) angle • **A** values do not vary as much (as **B** values)	if temperature is mentioned rather than angle a maximum of **1** mark can be scored **or** converse eg **B** values are higher / better / stronger accept weakest at 0° strongest at 15° values go up is insufficient accept strongest at 0° weakest at 15° values go down is insufficient	2
1(e)(ii)	**D** values are always over 2(.0)	mark is for the reason reason cannot score if **D** is not chosen	1
Total			**10**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 105 · Mark scheme January 2011 | PHY1H | Original Q1 | Legacy

PHY1H

4.6.2.4 Uses and applications of electromagnetic waves

Answer 106 · Mark scheme

Question 7

question	answers	extra information	mark
7(a)	beta		1
	alpha: would not pass through (the aluminium / foil)		1
	gamma: no change in count rate when thickness changes	must be a connection between detection / count rate / passing through and change in thickness	1
7(b)	foil thickness increases then decreases (then back to normal / correct thickness)	a description of count rate changes is insufficient	1
	gap between rollers decreases, then increases (then back to correct size) **or** pressure from rollers increases then decreases	accept tightness for pressure answers may link change in thickness and gap width for full credit ie: foil thickness increases so gap between rollers decreases (1) foil thickness decreases so gap between rollers increases (1)	1

Question 7 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

PHY1H

Question 7 continued . . .

question	answers	extra information	mark
7(c)	56 (years)	accept any value between 55-57 inclusive allow **1** mark for correct calculation of mass remaining as 1.5 (micrograms) allow **1** mark for a mass of 4.5 micrograms plus correct use of graph with an answer of 12 maximum of **1** compensation mark can be awarded	2
Total			**7**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 107 · Mark scheme

January 2011 | PHY2H | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)(i)	any **one** from: • food / drink • rocks / building materials • cosmic rays / rays from space	accept correctly named example	1
3(a)(ii)	any **one** from: • nuclear power / coal power (stations) • nuclear accidents • nuclear weapons testing	accept nuclear waste accept named accident eg Chernobyl accept named medical procedure which involves a radioactive source accept radiotherapy nuclear activity / radiation is insufficient do **not** accept CT scans	1
3(a)(iii)	different number of / fewer protons **or** different atomic number	accept does not have 86 protons accept only has 84 protons do **not** accept bottom number different reference to mass number negates this mark	1

Question 3 continues on the next page . . .

PHY2H

Question 3 continued . . .

question	answers	extra information	mark
3(b)	168	accept 169 if clear, correct method is shown allow **1** mark for a correct dose ratio involving the spine eg 2:140 etc **or** ratio of days to dose is 1.2 **or** ratio of dose to days is 0.83	2
3(c)(i)	**Group A**: **J M O**; **Group B**: **K L N**	all correct any order within each group	1
3(c)(ii)	similar (number) / same (number) / large (number)	accept the same specific number in each group eg three reference to other factors such as age is neutral	1
3(c)(iii)	how many people in each group developed cancer	a clear comparison is required	1

Question 3 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

PHY2H

Question 3 continued . . .

question	answers	extra information	mark
3(c)(iv)	**Yes** the benefit of having the scan is greater than the risk **or** the risk is (very) small (compared to the chance from natural causes) **No** no additional risk is acceptable	there are no marks for **Yes** or **No** the mark is for the reason accept the risk is much greater from natural causes	1
Total			**9**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 107 · Mark scheme January 2011 | PHY2H | Original Q3 | Legacy

PHY2H

Answer 108 · Mark scheme March 2011 | PHY1AP | Original Q2 | Legacy

Two	**A**	conduction	**1**
	B	convection	**2**
	C	insulation	**4**
	D	radiation	**3**

Answer 109 · Mark scheme March 2011 | PHY1BP | Original Q2 | Legacy

Two	**A**	infra red	**3**
	B	microwaves	**2**
	C	visible light	**1**
	D	X-rays	**4**

Answer 110 · Mark scheme March 2011 | PHY1BP | Original Q3 | Legacy

Three	**A**	bacteria	**3**
	B	cells	**2**
	C	isotopes	**1**
	D	particles	**4**

Answer 111 · Mark scheme March 2011 | PHY1BP | Original Q4 | Legacy

Four	**A**	gamma rays	**1**
	B	infra red rays	**3**
	C	radio waves	**4**
	D	ultraviolet rays	**2**

Answer 112 · Mark scheme March 2011 | PHY1BP | Original Q7 | Legacy

Seven	**1**	**4**	**1**	**2**

Answer 113 · Mark scheme March 2011 | PHY1BP | Original Q9 | Legacy

Nine	**4**	**1**	**2**	**2**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 113 · Mark scheme

March 2011 | PHY1BP | Original Q9 | Legacy

GCSE

SCIENCE A (4461) / PHYSICS (4451)

Objective Test Answer Key

PHY1BP (Radiation and the Universe)

March 2011

Higher Tier

Question	Key		
One	**A**	a belief that science cannot disprove	**1**
	B	a conclusion based on observations of red-shift	**3**
	C	a theory supported by scientific evidence but not direct observations	**4**
	D	a theory that science has disproved	**2**
Two	**A**	Isotope **A**	**4**
	B	Isotope **B**	**1**
	C	Isotope **C**	**3**
	D	Isotope **D**	**2**

	A	**B**	**C**	**D**
Three	**1**	**3**	**2**	**1**
Four	**4**	**1**	**2**	**2**
Five	**4**	**3**	**4**	**3**
Six	**2**	**3**	**2**	**4**
Seven	**1**	**2**	**3**	**4**
Eight	**3**	**2**	**4**	**2**
Nine	**2**	**3**	**4**	**3**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 114 · Mark scheme June 2011 | PHY1BP | Original Q4 | Legacy

Four	**2**	**3**	**4**	**1**

Answer 115 · Mark scheme June 2011 | PHY1BP | Original Q5 | Legacy

Five	**1**	**4**	**2**	**3**

Answer 116 · Mark scheme June 2011 | PHY1BP | Original Q6 | Legacy

Six	**1**	**4**	**4**	**3**

Answer 117 · Mark scheme June 2011 | PHY1BP | Original Q8 | Legacy

Eight	**3**	**4**	**2**	**3**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 118 · Mark scheme

June 2011 | PHY1H | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)(i)	radio waves pass through the atmosphere	accept it is cheaper / easier to maintain	1
5(a)(ii)	computers process digital signals (more easily)	accept read for process accept computers cannot (easily) process analogue signals ignore references to interference	1
5(b)(i)	wavelength (of waves appears to) increase **or** wavelength moves to longer / red end of spectrum	accept answers in terms of frequency decrease accept wavelength stretched but not just wave is stretched answers involving planets negates mark	1
5(b)(ii)	can measure change 20 times smaller	accept can measure (much) smaller change accept detects with greater precision accept can show more detail / stars accept can detect weaker signals can see things more clearly is insufficient	1

Question 5 continues on the next page

PHY1H

Question 5 continued

question	answers	extra information	mark
5(b)(iii)	Universe had a start point Universe is (still) changing / expanding	mention of Earth / planets etc exploding / expanding negates answer	1 1
5(c)	any **one** from: • share ideas • can justify large development costs • makes new investigations possible	accept cost shared saves money is insufficient accept any sensible suggestion	1
Total			**7**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 118 · Mark scheme June 2011 | PHY1H | Original Q5 | Legacy

PHY1H

Answer 119 · Mark scheme November 2011 | PHY1BP | Original Q1 | Legacy

Question	Key		
One	**A**	gamma rays	**1**
	B	infra red rays	**3**
	C	radio waves	**2**
	D	ultraviolet rays	**4**

Answer 120 · Mark scheme November 2011 | PHY1BP | Original Q3 | Legacy

Three	**2**	**1**	**2**	**2**

Answer 121 · Mark scheme November 2011 | PHY1BP | Original Q7 | Legacy

Seven	**3**	**2**	**3**	**4**

Answer 122 · Mark scheme November 2011 | PHY1BP | Original Q9 | Legacy

Nine	**4**	**4**	**3**	**3**

The AQA UMS Conversion Calculator can be found at the following web address:

http://www.aqa.org.uk/umsconversion

4.6.2.4 Uses and applications of electromagnetic waves

Answer 123 · Mark scheme

June 2012 | PH1HP | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)	any **two** from: • black is a good emitter of (infrared radiation) • large surface (area) • matt surfaces are better emitters (than shiny surfaces)	accept heat for radiation ignore reference to absorbing radiation accept matt surfaces are good emitters ignore reference to good conductor	2
1(b)	90 % or 0.9(0)	efficiency = useful energy out / total energy in (×100%) allow **1** mark for correct substitution ie 13.5 / 15 provided no subsequent step shown an answer of 90 scores **1** mark an answer of 90 / 0.90 with a unit scores **1** mark	2
1(c)	(producing) light	allow (producing) sound	1

Question 1 continues on the next page

PH1HP

Question 1 continued

question	answers	extra information	mark
1(d)	any **two** from: • wood is renewable • (using wood) conserves fossil fuels • wood is carbon neutral	 accept wood grows again / quickly accept wood can be replanted accept doesn't use fossil fuels accept a description cheaper / saves money is insufficient	2
1(e)	2 550 000 joules /J	$E = m \times c \times \theta$ allow **1** mark for correct substitution ie 100 × 510 x 50 provided no subsequent step shown answers of 1 020 000, 3 570 000 gain **1** mark accept kJ / MJ do **not** accept j for full credit the unit and numerical answer must be consistent	 2 1
Total			**10**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 123 · Mark scheme

June 2012 | PH1HP | Original Q1 | Legacy

PH1HP

4.6.2.4 Uses and applications of electromagnetic waves

Answer 124 · Mark scheme

June 2012 | PH1HP | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)	any **two** from: • travel (at same speed) through a vacuum / space • transverse • transfer energy • can be reflected • can be refracted • can be diffracted • can be absorbed • travel in straight lines	do **not** accept air for vacuum	2
5(b)	can pass through the ionosphere	accept atmosphere for ionosphere do **not** accept air for ionosphere accept travel in straight lines accept not refracted / reflected / absorbed by the ionosphere	1
5(c)	diffraction (of waves around hills) wavelength needs to be similar size to the obstacle / gap radio has a long enough wavelength **or** TV doesn't have a long enough wavelength	an answer TV (waves / signals) have short wavelengths so do not diffract (around the hill) scores **2** marks	1 1 1

Question 5 continues on the next page

4.6.2.4 Uses and applications of electromagnetic waves

Answer 124 · Mark scheme

June 2012 | PH1HP | Original Q5 | Legacy

PH1HP

Question 5 continued

question	answers	extra information	mark
5(d)		$v = f \times \lambda$	
	1.2×10^6 / 1200 000	allow **1** mark for correct substitution ie $3.0 \times 10^8 = f \times 2.5 \times 10^2$	2
	hertz / Hz	do **not** accept hz **or** HZ accept kHz **or** MHz answers 1.2 MHz **or** 1200 kHz gain all **3** marks for full credit the unit and numerical value must be consistent	1
Total			**9**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 124 · Mark scheme June 2012 | PH1HP | Original Q5 | Legacy

PH1HP

4.6.2.4 Uses and applications of electromagnetic waves

Answer 125 · Mark scheme

June 2012 | PH1HP | Original Q8 | Legacy

Question 8

question	answers	extra information	mark
8(a)	any **three** from: • red-shift shows galaxies are moving away (from each other / the Earth) • more distant galaxies show bigger red-shift **or** more distant galaxies show a greater increase in wavelength • (in all directions) more distant galaxies are moving away faster • suggests single point of origin (of the universe)	accept correct reference to frequency in place of wavelength accept (suggests) universe is expanding	3
8(b)(i)	(radiation produced shortly after) 'Big Bang'	accept beginning of time / beginning of the universe for 'Big Bang'	1
8(b)(ii)	any **one** from: • can only be explained by 'Big Bang' • existence predicted by 'Big Bang' • provides (further) evidence for 'Big Bang'	ignore proves 'Big Bang' (theory) ignore reference to red-shift	1

Question 8 continues on the next page

PH1HP

Question 8 continued

question	answers	extra information	mark
8(b)(iii)	increase universe continues to accelerate outwards **or** greater red-shift	accept becomes radio waves accept as universe continues to expand	1 1
Total			**7**

UMS Conversion Calculator www.aqa.org.uk/umsconversion

4.6.2.4 Uses and applications of electromagnetic waves

Answer 126 · Mark scheme

June 2012 | PH2HP | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)(i)	1.25 (mSv)		1
2(a)(ii)	any **two** from: • (frequent) flying • living at altitude • living in areas with high radon concentrations • living in a building made from granite (blocks) • having more than the average number of X-rays or having a CT scan • working in a nuclear power station	accept stated occupation that involves flying accept a specific area, eg Cornwall accept more medical treatments accept any suggestion that could reasonably increase the level from a specific source	2
2(b)(i)	to be able to see the effect of exposure (to radon gas) **or** as a control	accept to compare (the effect of) exposure (with no exposure)	1
2(b)(ii)	increased levels of exposure increases the risk (of developing cancer) smoking increases the (harmful) effect of radon	accept exposure (to radon gas) increases the risk answers that simply reproduce statistics are insufficient	1 1
2(c)	LNT model – risk increases with increasing radiation (dose) level Radiation hormesis – low radiation (dose) levels reduce the risk	accept in (direct) proportion accept low doses increase the risk	1 1

Question 2 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

PH2HP

Question 2 continued

question	answers	extra information	mark
2(d)	two valid points made – examples: • animals have no choice and so should not be used • should not make animals suffer • better to experiment on animals than humans • experiments lead to a better understanding / new knowledge • experiments may lead to health improvement / cures for humans	results for animals may not apply to humans is insufficient	2
Total			**10**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 126 · Mark scheme

June 2012 | PH2HP | Original Q2 | Legacy

PH2HP

4.6.2.4 Uses and applications of electromagnetic waves

Answer 127 · Mark scheme

January 2013 | PH1HP | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)(i)	gamma	accept correct symbol	1
5(a)(ii)	any **one** from: • (ultraviolet has a) higher frequency • (ultraviolet has a) greater energy • (ultraviolet has a) shorter wavelength	ultraviolet cannot be seen is insufficient ignore ultraviolet causes cancer etc	1
5(b)	1.2×10^7 / 12 000 000 hertz / Hz / kHz / MHz	allow **1** mark for correct substitution, ie $3 \times 10^8 = f \times 25$ do **not** accept hz **or** HZ answers 12 000 kHz **or** 12 MHz gain **3** marks for full credit the numerical answer and unit must be consistent	2 1
5(c)(i)	away (from each other)	accept away (from the Earth) accept receding	1
5(c)(ii)	distance (from the Earth) speed galaxy is moving	accept how far away (it is)	1 1
5(c)(iii)	(Universe is) expanding		1
Total			**9**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 127 · Mark scheme

January 2013 | PH1HP | Original Q5 | Legacy

PH1HP

4.6.2.4 Uses and applications of electromagnetic waves

Answer 128 · Mark scheme

June 2013 | PH1HP | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)	10^{-15} metres to 10^{4} metres		1
7(b)(i)	any **one** from: • (TV / video / DVD) remote controls • (short range) data transmission • optical fibre (signals)	mobile phones is insufficient accept specific example, eg linking computer peripherals do **not** accept Bluetooth	1
7(b)(ii)	0.17	an answer 17 cm gains **3** marks an answer given to more than 2 significant figures that rounds to 0.17 gains **2** marks allow **1** mark for correct substitution, ie $3 \times 10^{8} = 1.8 \times 10^{9} \times \lambda$	3
7(c)	(maybe) other factors involved	accept a named 'sensible' factor, eg higher stress / sedentary lifestyle / overweight / smoking more / diet / hot office / age not testing enough people is insufficient unreliable data is insufficient	1
Total			**6**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 128 · Mark scheme

June 2013 | PH1HP | Original Q7 | Legacy

PH1HP

4.6.2.4 Uses and applications of electromagnetic waves

Answer 129 · Mark scheme

June 2013 | PH1HP | Original Q8 | Legacy

Question 8

question	answers	extra information	mark
8(a)(i)	origin of the Universe	accept (why) the Universe is expanding do **not** accept origin of the Earth	1
8(a)(ii)	provided more evidence to support the 'Big Bang' theory		1
8(b)(i)	red-shift	accept Doppler (shift)	1
8(b)(ii)	(at the point in time shown the observed spectrum from) star A (shows it) is moving away from the Earth light from star B shows a decrease in wavelength so star B is moving towards Earth	accept star A is moving away star A shows red-shift is insufficient accept light from star B shows blue-shift accept light from star B shows an increase in frequency	1 1 1
Total			**6**

UMS Conversion Calculator: www.aqa.org.uk/umsconversion

4.6.2.4 Uses and applications of electromagnetic waves

Answer 130 · Mark scheme

June 2013 | PH3HP | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.		6

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant / correct content.	There is a basic description of either wave **OR** What happens to either wave when they enter the body. However there is little other detail.	There is either: A clear description of BOTH waves **OR** A clear description as to what happens to BOTH waves inside the body **OR** A clear description of ONE of the waves with clear detail as to what happens to either wave inside the body.	There is a detailed description of BOTH of the waves **AND** A detailed description as to what happens to EITHER wave inside the body.

Question 3 continues on the next page . . .

PH3HP

Question 3 continued . . .

Examples of the points made in the response: **<u>Description of an X-ray</u>** • X-rays are electromagnetic waves / part of the electromagnetic spectrum • X-rays are (very) high frequency (waves) • X-rays are (very) high energy (waves) • X-rays have a (very) short wavelength • Wavelength (of X-rays) is of a similar size to (the diameter of) an atom • X-rays are a transverse wave • X-rays are ionising radiation **<u>Description of ultrasound</u>** • ultrasound has a <u>frequency</u> above 20 000 (hertz) **OR** ultra sound is above 20 000 hertz • ultrasound is above / beyond the human (upper) limit (of hearing) • ultrasound is a longitudinal wave **<u>Statement(s) as to what happens to X-rays inside the human body:</u>** • X-rays are absorbed by bone • X-rays travel through / are transmitted by tissue / skin **<u>Statement as to what happens to ultrasound inside body:</u>** • ultrasound is (partially) reflected at / when it meets a boundary between two different media • travel at different speeds through different media	do **not** allow a description of a property – eg X-rays travel through a vacuum / at the speed of light correct description acceptable – oscillations / vibrations are perpendicular (at 90°) to direction of energy transfer accept ultrasound cannot be heard by humans correct description acceptable – oscillations / vibrations (of particles) are parallel (in same direction) to direction of energy transfer	

Question 3 continues on the next page . . .

PH3HP

Question 3 continued . . .

question	answers	extra information	mark
3(b)	(because the X-rays) are ionising	accept a description of what ionising is	1
	(they will) damage cells **or** mutate cells / cause mutations / increase chances of mutations **or** turn cells cancerous / produce abnormal growths / produce rapidly growing cells **or** kill cells	instead of cell, any of these words can be used: DNA / genes / chromosomes / nucleus do **not** accept they can be dangerous (to human health) do **not** accept damage to soft tissue	1
3(c)	any **one** from: • removal / destruction of kidney / gall stones		1
	• repair of damaged tissue / muscle	accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation accept physiotherapy accept curing prostate cancer **or** killing prostate cancer cells	
	• removing plaque from teeth	cleaning teeth is insufficient	
Total			**9**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 130 · Mark scheme

June 2013 | PH3HP | Original Q3 | Legacy

PH3HP

4.6.2.4 Uses and applications of electromagnetic waves

Answer 131 · Mark scheme

6(a)	(same) number of protons	same atomic number is insufficient	1	AO1 2.5.1e
6(b)(i)	nuclei split	do **not** accept atom for nuclei / nucleus	1	AO1 2.6.1b
6(b)(ii)	(nuclear) reactor		1	AO1 2.6.1a
6(c)	beta any **one** from: • atomic / proton number increases (by 1) • number of neutrons decreases / changes by 1 • mass number does not change • a neutron becomes a proton	 accept atomic / proton number changes by 1 (total) number of protons and neutrons does not change	1 1	AO2 2.5.2d
6(d)	(average) time taken for number of nuclei to halve **or** (average) time taken for count-rate / activity to halve		1	AO1 2.5.2h

Question 6 continues on the next page . . .

Question 6 continued . . .

Question	Answers	Extra information	Mark	AO spec ref
6(e)(i)	6.2 (days)	Accept 6.2 to 6.3 inclusive allow **1** mark for correctly calculating number remaining as 20 000 **or** allow **1** mark for number of 80 000 plus correct use of the graph (gives an answer of 0.8 days)	2	AO2 2.5.2h
6(e)(ii)	radiation causes ionisation that may then harm / kill healthy cells	allow radiation can be ionising accept specific examples of harm, eg alter DNA / cause cancer	1 1	AO3 2.5.2g
6(e)(iii)	benefit (of diagnosis / treatment) greater than risk (of radiation)	accept may be the only procedure available	1	AO3 2.5.2g
Total			**11**	

4.6.2.4 Uses and applications of electromagnetic waves

Answer 131 · Mark scheme

June 2014 | PH2HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO spec ref

4.6.2.4 Uses and applications of electromagnetic waves

Answer 132 · Mark scheme

June 2014 | PH3HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO spec ref
1(a)	(sound waves) which have a frequency higher than the upper limit of hearing for humans **or** a (sound) wave (of frequency) above 20 000 Hz	sound waves that cannot be heard is insufficient a wave of frequency 20 000 Hz is insufficient	1	AO1 3.1.2a
1(b)	640	an answer of 1280 gains **2** marks allow **2** marks for the correct substitution ie 1600 × 0.40 provided no subsequent step allow **2** marks for the substitution $\frac{1600 \times 0.80}{2}$ provided no subsequent step allow **1** mark for the substitution 1600 × 0.80 provided no subsequent step allow **1** mark for the identification that time (boat to bed) is 0.4	3	AO2 3.1.2c
1(c)	any **one** from: • pre-natal scanning / imaging • imaging of a named organ (that is not surrounded by bone), eg stomach, bladder, testicles • Doppler scanning blood flow	accept heart do **not** allow brain **or** lungs (either of these negates a correct answer)	1	AO1 3.1.2d

Question 1 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

Question 1 continued . . .

Question	Answers	Extra information	Mark	AO spec ref
1(d)	advantage any **one** from: • (images are) high quality or detailed or high resolution • (scan) produces a slice through the body • image can be viewed from any direction • an image can be made of <u>any</u> part (inside the body) • easier to diagnose **or** see a problem (on the image) disadvantage any **one** from: • (the X-rays used **or** scans) are ionising • mutate cells **or** cause mutations **or** increase chances of mutations • turn cells cancerous **or** produce abnormal growths **or** produce rapidly growing cells • kill cells • metal/lead/glass/concrete shielding is needed	clearer / better image is sufficient allow images are (always) 3D / 360° allow whole body can be scanned allow a description of what ionising is allow for cells: DNA / genes / chromosomes / nucleus / tissue damage cells is insufficient can be dangerous (to human health) unqualified, is insufficient	1 1	AO1 3.1
Total			**7**	

4.6.2.4 Uses and applications of electromagnetic waves

Answer 133 · Mark scheme

June 2015 | PH1HP | Original Q6 | Legacy

The full source mark scheme begins on page 285. Follow original question 6 in that document.

4.6.2.4 Uses and applications of electromagnetic waves

Answer 134 · Mark scheme June 2015 | PH3HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. ref.
3(a)	20,000	accept 20 kilo **or** 20 k **or** 20 001	1	AO1 P3.1.2a
	an atom		1	AO1 P3.1.1a

Question 3 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

Answer 134 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(b)			6	AO1 P3.1 P3.1.1c

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 4 and apply a 'best-fit' approach to the marking.

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
no relevant content	At least one relevant statement is given for either type of wave	**Either** a use, risk and precaution is given for one type of wave **Or** A medical use is given for both types of wave **plus** a risk or precaution for one type of wave	At least one medical use is given for both types of wave linked to the risks and any precautions necessary

examples of the points made in the response	extra information
Medical use of X-rays Any one from: • Detecting bone fractures • Detecting dental problems • Killing cancer cells • CT scanning	Ignore details about how X-rays/ultrasound work accept any specific use of X-rays, eg • detecting heart/lung disorders (with chest X-rays) • mammograms / breast cancer detection • detecting stones / bowel disease (with abdominal X-rays)
Risks with X-rays X-rays pose a risk / danger / hazard	accept are harmful
X-rays cause ionisation / damage to cells **or** mutate cells / cause mutations / increase chances of mutations **or** turn cells cancerous / produce abnormal growths / produce rapidly growing cells **or** kill cells	accept a description of what ionising is instead of cell, any of these words can be used: DNA / genes / chromosomes / nucleus accept (may) cause cancer

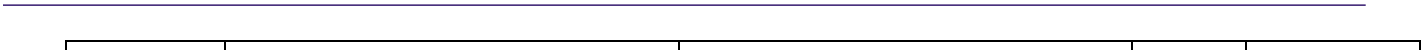
Answer 134 · Mark scheme

Operator precautions with X-rays The X-ray operator should go behind a (metal / glass) screen / leave the room when making an X-ray / wear a lead lined apron	accept appropriate precautions for the patient e.g. limit the total exposure/dose (in one year) wear a radiation badge is insufficient	
Medical use of ultrasound Any one from: • Pre-natal scanning • Imaging (a named body part). • removal / destruction of kidney / gall stones • removing plaque from teeth • repair of damaged tissue / muscle	cleaning teeth is insufficient accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation accept physiotherapy accept curing prostate cancer **or** killing prostate cancer cells	
Risks with ultrasound Ultrasound poses no risk / danger / hazard (to the user / patient). Ultrasound is not ionising or Ultrasound does not damage (human) cells	accept ultrasound is safer than using X-rays.	
Precautions with ultrasound The operator needs to take no precautions when making an ultrasound scan.	this can be assumed if it is stated that ultrasound is harmless or it is safer than using x-rays or it is non-ionising	

Total		**8**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 134 · Mark scheme June 2015 | PH3HP | Original Q3 | Legacy



Answer 135 · Mark scheme June 2016 | PH1HP | Original Q3 | Legacy

The full source mark scheme begins on page 301. Follow original question 3 in that document.

Answer 136 · Mark scheme June 2016 | PH1HP | Original Q4 | Legacy

The full source mark scheme begins on page 301. Follow original question 4 in that document.

4.6.2.4 Uses and applications of electromagnetic waves

Answer 137 · Mark scheme

June 2016 | PH2HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)	2 protons and 2 neutrons	accept 2p and 2 n accept (the same as a) helium nucleus symbol is insufficient do not accept 2 protons and neutrons	1	AO1 2.5.2c
2(b)(i)	gamma rays		1	AO1 2.5.2e
2(b)(ii)	loses/gains (one or more) electron(s)		1	AO1 2.5.1d
2(c)	any **one** from: • wear protective clothing • work behind lead/concrete/glass shielding • limit time of exposure • use remote handling	accept wear mask/gloves wear goggles is insufficient wear protective equipment/gear is insufficient accept wear a film badge accept handle with (long) tongs accept maintain a safe distance accept avoid direct contact	1	AO2 2.5

4.6.2.4 Uses and applications of electromagnetic waves

Answer 137 · Mark scheme

June 2016 | PH2HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(d)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 4 and apply a 'best-fit' approach to the marking.		6	AO1 2.5.2e 2.5.2f

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant information	There is a description of at least one type of radiation in terms of one or more properties.	There is a description of at least two types of radiation in terms of some properties **or** a full description of one type of radiation in terms of all three properties **or** the same property is described for all three radiations	There is a description of all three types of radiation in terms of at least two of their properties **or** a full description of two types of radiation in terms of all three properties.

examples of physics points made in the response	extra information
alpha particles • are least penetrating • are stopped by paper / card • have the shortest range • can travel (about) 5cm in air • are (slightly) deflected by a magnetic field • alpha particles are deflected in the opposite direction to beta particles by a magnetic field	
beta particles • (some are) stopped by (about) 2mm (or more) of aluminium/metal • can travel (about) 1 metre in air • are deflected by a magnetic field • beta particles are deflected in the opposite direction to alpha particles by a magnetic field	accept (some are) stopped by aluminium foil
gamma rays • are the most penetrating • are stopped by (about) 10cm of lead • have the longest range • can travel at least 1 km in air • are not deflected by a magnetic field	

Total			10

4.6.2.4 Uses and applications of electromagnetic waves

Answer 137 · Mark scheme

June 2016 | PH2HP | Original Q2 | Legacy



4.6.2.4 Uses and applications of electromagnetic waves

Answer 138 · Mark scheme June 2016 | PH2HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(a)(i)	(enough) dust and gas (from space) is pulled together by: gravitational attraction **or** gravitational forces **or** gravity	accept nebula for dust and gas accept hydrogen for gas accept gas on its own dust on its own is insufficient mention of air negates this mark ignore any (correct) stages beyond this	1 1	AO1 2.6.2c
6(a)(ii)	joining of two (atomic) nuclei (to form a larger one)	do not accept atoms for nuclei	1	AO1 2.6.2a
6(a)(iii)	more sensitive astronomical instruments / telescopes **or** infrared telescopes developed	accept better technology more knowledge is insufficient	1	AO3 2.6
6(b)(i)	(other) planets / solar systems	do not accept galaxy moons is insufficient	1	AO3 2.6
6(b)(ii)	provided evidence to support theory	accept proves the theory	1	AO1 2.6
6(c)	elements heavier than iron are formed only when a (massive) star explodes	accept materials for elements accept supernova for star explodes accept stars can only fuse elements up to (and including) iron	1	AO1 2.6.2f
Total			**7**	

4.6.2.4 Uses and applications of electromagnetic waves

Answer 138 · Mark scheme

June 2016 | PH2HP | Original Q6 | Legacy



4.6.2.4 Uses and applications of electromagnetic waves

Answer 139 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)	ultrasound is not ionising but X-rays are ionising so X-rays increase the health risk to the (unborn) baby	allow ultrasound does not harm the (unborn) baby accept specific examples of health risks, eg cancer, stunted growth, impaired brain function etc X-rays are dangerous is insufficient	1 1 1	AO1 3.1
3(b)	ultrasound/waves are partially <u>reflected</u> (when they meet a boundary) (between two different media / substances / tissues) the time taken is measured (and is used to determine distances)	must be clear that not all of the wave is reflected 	1 1	AO1 3.1.2b
3(c)	1600 (m/s)	800 (m/s) gains **2** marks 160 000 (m/s) gains **2** marks 0.0016 (m/s) gains **2** marks allow **2** marks for $\frac{0.04}{25 \times 10^{-6}}$ or $\frac{0.08}{50 \times 10^{-6}}$ 80 000 (m/s) gains **1** mark 0.0008 (m/s) gains **1** mark allow **1** mark for $\frac{0.04}{25}$ or $\frac{0.08}{50}$ allow **1** mark for evidence of doubling the distance or halving the time	3	AO2 3.1.2c

Question 3 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

Answer 139 · Mark scheme

June 2016 | PH3HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(d)(i)	they are absorbed by bone	allow stopped for absorbed X-rays are reflected negates this mark	1	AO1 3.1.1a
	they are transmitted by soft tissue	allow pass through for transmitted allow flesh / muscle / fat accept less (optically) dense material for soft tissue	1	
	(the transmitted) X-rays are detected		1	
3(d)(ii)	short	accept small	1	AO1 3.1.1a
Total			12	

4.6.2.4 Uses and applications of electromagnetic waves

Answer 139 · Mark scheme

June 2016 | PH3HP | Original Q3 | Legacy



4.6.2.4 Uses and applications of electromagnetic waves

Answer 140 · Mark scheme

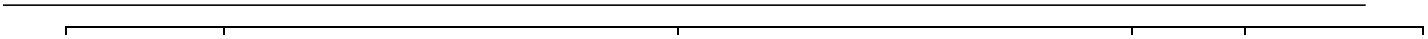
June 2017 | PH1HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)	Doppler		1	AO1 1.5.4a
4(b)(i)	A frequency has increased	 accept frequency is higher (compared to the emitted frequency) accept wavelength has decreased reason only scores if A is chosen	1 1	AO2 AO3 1.5.4a
4(b)(ii)	C greater change in frequency	 accept greater change in wavelength reason only scores if C chosen	1 1	AO2 AO3 1.5.4a
Total			**5**	

4.6.2.4 Uses and applications of electromagnetic waves

Answer 140 · Mark scheme

June 2017 | PH1HP | Original Q4 | Legacy



4.6.2.4 Uses and applications of electromagnetic waves

Answer 141 · Mark scheme

June 2018 | 8463/1H | Original Q6

Question	Answers	Extra information	Mark	AO/ Spec. Ref
06.1	smoke absorbs / stops alpha radiation	allow alpha particles for alpha radiation alpha radiation does not reach the detector is insufficient	1	AO2 4.4.2.1
06.2	alpha radiation is not very penetrating **or** alpha radiation does not penetrate skin	allow alpha particles for alpha radiation allow alpha radiation does not travel very far (in air)	1	AO1 4.4.2.1
06.3	beta and gamma radiation will penetrate smoke no change (in the count rate) would be detected	allow beta and gamma radiation will not be stopped by smoke allow the change detected (in the count rate) would be too small	1 1	AO2 4.4.2.1
06.4	(a long half-life means) the count rate is (approximately) constant **or** a short half-life means the count rate decreases quickly until 1.3 half-lives the count rate is above 80 per second **or** until 1.3 half-lives the count rate is above the threshold for the smoke alarm to be activated **or** after 1.3 half-lives the smoke alarm will be activated all the time	allow activity of source is (approximately) constant allow after 1.3 half-lives the count rate is below 80 per second so don't have to replace source or smoke detector is insufficient	1 1	AO3 4.4.2.3

4.6.2.4 Uses and applications of electromagnetic waves

Answer 141 · Mark scheme

June 2018 | 8463/1H | Original Q6

Question	Answers	Mark	AO/ Spec. Ref
06.5	**Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO2 4.4.3.3
	Level 1: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	1–2	AO1 4.4.3.3
	No relevant content	0	
	Indicative content • short half-life or half-life of a few hours • (short half-life means) less damage to cells / tissues / organs / body • low ionising power • (low ionising power means) less damage to cells / tissues / organs / body • highly penetrating • (highly penetrating means) it can be detected outside the body • emits gamma radiation		
Total			**10**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 142 · Mark scheme

June 2018 | 8463/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	any **one** from: • too few turns / coils on the secondary • p.d. across the primary was reduced	allow number of turns / coils on the primary was increased ignore human error	1	AO3 4.7.3.4
07.2	the p.d. (across the secondary) goes above 2V	allow p.d. across secondary is higher than p.d. across primary after 20 turns	1	AO3 4.7.3.4
07.3	it increases (until the nails reach a constant temperature)		1	AO1 4.6.3.1

4.6.2.4 Uses and applications of electromagnetic waves

Answer 142 · Mark scheme

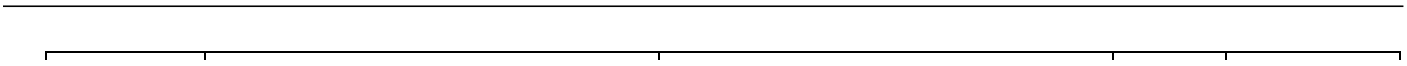
June 2018 | 8463/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4		an answer of 1.2 (A) scores **5** marks		AO2 4.7.3.4
	$\frac{640}{4} = \frac{V_p}{1.75}$		1	
	$V_p = \frac{640 \times 1.75}{4}$		1	
	$V_p = 280$ (V)		1	
	$280 \times I_p = 336$	allow their calculated $V_p \times I_p = 336$	1	
	$I_p = 1.2$ (A)	allow an answer that is consistent with their calculated value of V_p	1	
	or			
	$336 = I_s \times 1.75$ (1)			
	$I_s = \frac{336}{1.75}$ (1)			
	$I_s = 192$ (A) (1)			
	$I_p = 192 \times \frac{4}{640}$ (1)	allow I_p= their calculated $I_s \times \frac{4}{640}$		
	$I_p = 1.2$ (A) (1)	allow an answer that is consistent with their calculated value of I_s		
Total			**8**	

4.6.2.4 Uses and applications of electromagnetic waves

Answer 142 · Mark scheme

June 2018 | 8463/2H | Original Q7



4.6.2.4 Uses and applications of electromagnetic waves

Answer 143 · Mark scheme

June 2019 | 8463/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7.1	The frequency increases and the wave speed in air stays the same		1	AO1/1 4.6.2.1 iso
7.2	pass through soft tissue (but) absorbed by bone	allow penetrate for pass through allow skin/muscle/etc… for soft tissue pass through tissue is insufficient allow do not pass through bone do not accept reflected by bone	1 1	AO1/1 4.6.2.4
7.3	accept a sensible practical suggestion eg • complete the investigation standing up • use (slightly) cooler water • do not touch the hot cube	do not accept use cold water pour water in carefully is insufficient ignore wear safety goggles or gloves	1	AO2/2 4.6.2.2 WS2.4
7.4	distance between each side (of the cube) and the (infrared) detector	allow distance between cube and detector	1	AO1/2 4.6.2.2 WS2.2
7.5	measurements (for each surface) have not been repeated (to show that they cluster closely)	do not accept any answer for measurement should be repeated for any reason other than to show they cluster eg to show accuracy / average / anomalies would be wrong	1	AO3/3b 4.6.2.2 WS3.7
7.6	(the student) could not conclude that black surfaces always emit more (infrared) than a white surface (as) the reading for the matt white and shiny black would both be 66 (°C)	a (matt) white surface (appears to) emit(s) the same amount (of infrared) as a (shiny) black surface the conclusion is wrong is insufficient allow (as) the reading for the matt white and shiny black would be the same	1 1	AO3/1a/2b 4.6.2.2 WS2.2
7.7	0.0	allow 0 allow zero	1	AO1/1 4.6.3.1

4.6.2.4 Uses and applications of electromagnetic waves

Answer 143 · Mark scheme

June 2019 | 8463/2H | Original Q7

7.8	at night, more radiation is emitted from the Earth than absorbed from space cloud reflects radiation (towards the Earth) at A, (there is no cloud cover so) a larger proportion of radiation will be emitted into space	 allow solar radiation for radiation 	1 1 1	AO1/1 4.6.3.2
Total			**12**	

Answer 144 · Mark scheme

November 2020 | 8463/2H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	320 MHz = 3.2×10^8 Hz	allow 320 000 000	1	AO2
	$3.0 \times 10^8 = 3.2 \times 10^8 \times \lambda$	this mark may be awarded if frequency is incorrectly/not converted	1	AO2
	$\lambda = \frac{3.0 \times 10^8}{3.2 \times 10^8}$	this mark may be awarded if frequency is incorrectly/not converted	1	AO2
	wavelength = 0.9375	allow correct calculation using an incorrectly/not converted frequency allow an answer that rounds to 0.94	1	AO2
	metres **or** m		1	AO1 4.6.1.2
06.2	(alternating) current <u>induced</u> (in the electrical circuit)	allow <u>electrons</u> vibrate / oscillate (in the electrical circuit)	1	AO1 4.6.2.3
	with the same frequency as the radio wave		1	
06.3	Any **two** from: • (radio waves are) transverse	allow sound waves are longitudinal allow a description of transverse/longitudinal waves	2	AO1 4.6.1.1 4.6.1.2
	• (radio waves) travel at a higher speed • (radio waves) don't need a medium • (radio waves are) electromagnetic	allow (only) radio waves travel through a vacuum allow sound waves are mechanical		
06.4	accelerating	allow speeding up	1	AO3 4.5.6.1.4

Answer 144 · Mark scheme

06.5	appropriate tangent drawn correct reading from graph for change in distance and change in time (eg 5.6 (m) and 20 (s)) gradient of tangent shown (eg 5.6/20) 0.28 (m/s)	 allow correct reading from their tangent for change in distance and change in time allow correct gradient from their tangent this answer only allow 0.25 to 0.30 (m/s) if the tangent is appropriate allow 2.8 / 20 = 0.14 (m/s) for **1** mark	1 1 1 1	AO2 4.5.6.1.4
06.6	$0.52^2 - 0.12^2 = 2 \times 0.04 \times s$ $s = \frac{0.52^2 - 0.12^2}{2 \times 0.04}$ s = 3.2 (m) 0.48 = F x 3.2 $F = \frac{0.48}{3.2}$ F = 0.15 (N) **OR**	 this mark may be awarded if the displacement is incorrectly calculated this mark may be awarded if the displacement is incorrectly calculated allow a correctly calculated F using an incorrectly calculated displacement	1 1 1 1 1 1	AO2 4.5.2 4.5.6.1.5

	Alternative method 1 $t = \frac{0.52 - 0.12}{0.04}$ (1) t = 10 (s) (1) s = 0.32 × 10 = 3.2 (m) (1) 0.48 = F x 3.2 (1) $F = \frac{0.48}{3.2}$ (1) F = 0.15 (N) (1) **OR** Alternative method 2 0.48 = (0.5 x m x 0.52^2) – (0.5 x m x 0.12^2) (1) 0.48 = 0.1352m – 0.0072m (1) 0.48 = 0.128m (1) m = 3.75 (1) F = 3.75 x 0.040 (1) F = 0.15 (N) (1)	allow a correctly calculated displacement from an incorrectly calculated t this mark may be awarded if the displacement is incorrectly calculated this mark may be awarded if the displacement is incorrectly calculated allow a correctly calculated F from incorrectly calculated values for displacement and / or t allow their calculated m allow correctly calculated F using an incorrectly calculated m		

4.6.2.4 Uses and applications of electromagnetic waves

Answer 144 · Mark scheme

November 2020 | 8463/2H | Original Q6

06.7	there is a maximum forward force (provided by the motor) as the speed of the car increases air resistance increases until air resistance is equal in size to forward force so the car can no longer accelerate	allow driving force for forward force - throughout the car has a maximum acceleration is insufficient allow friction / drag for air resistance - throughout allow (until) the resultant force is zero allow forces are in equilibrium / balanced allow the car travels at terminal velocity	1 1 1 1	AO1 4.5.6.1.5
Total			**24**	

4.6.2.4 Uses and applications of electromagnetic waves

Answer 145 · Mark scheme

November 2021 | 8463/2H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **one** from: • (sun) tan • energy efficient lamps	allow • (invisible) security coding • detecting forged bank notes • kill microbes • attract insects • sterilise (surgical) equipment • cause the body to produce vitamin D • increasing the growth rate of plants • water purification	1	AO1 4.6.2.4
05.2	3×10^{-7} m		1	AO1 4.6.2.1
05.3	$3.0 \times 10^{8} = \text{frequency} \times 3 \times 10^{-7}$ $\text{frequency} = \frac{3.0 \times 10^{8}}{3 \times 10^{-7}}$ frequency = 1×10^{15} (Hz)	allow ecf from question **05.2**	1 1 1	AO2 4.6.1.2
05.4	**Wave** / **Name** Wave E → Infrared Wave F → Visible light Wave G → X-rays all three lines correct for **1** mark		1	AO3 4.6.2.1

4.6.2.4 Uses and applications of electromagnetic waves

Answer 145 · Mark scheme

November 2021 | 8463/2H | Original Q5

05.5	in a transverse wave, the oscillations / vibrations are perpendicular to the direction of energy transfer in a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer	allow direction of wave travel for direction of energy transfer	1 1	AO1 4.6.1.1

Total			**8**

Answer 146 · Mark scheme

June 2022 | 8463/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	two protons and two neutrons	allow helium nucleus ignore symbols	1	AO1 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	85 37	this order only	1 1	AO1 4.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	alpha radiation has a low penetrating ability		1	AO1 4.4.2.4
	(so externally) alpha radiation is stopped by skin (so is low risk)	allow absorbed for stopped ignore reference to range of alpha particles through other materials	1	
	internally, alpha radiation is absorbed by living tissue / organs	allow (internal) contamination will increase the radiation dose	1	
	(as) alpha radiation is highly ionising		1	
	(internal) contamination will cause greater (risk of) harm to cells / tissues / organs / DNA / genes	allow contamination causes greater chance of developing cancer allow greater chance of mutations	1	

Total Question 7		**8**

4.6.2.4 Uses and applications of electromagnetic waves

Answer 147 · Mark scheme

June 2023 | 8463/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	perpendicular		1	AO1 4.6.1.1

Question	Answers	Mark	AO / Spec. Ref.
01.2	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5-6	AO3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3-4	AO1
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1-2	AO1
	No relevant content	0	
	Indicative content **Method:** • heat the water / kettle • add an equal volume of (hot) water to each flask • insert a thermometer into each flask • record the initial temperature from both flasks OR • place an IR detector near each flask • the distance between the IR detector and the flask should be the same each time • record initial reading from IR detectors • (and) start a stop clock • record the temperatures / readings after 10 minutes from both flasks • calculate the change in temperatures / readings during the 10 minutes • compare the results to test the hypothesis to access level 3 the method must allow the correct consideration of a temperature decrease for both flasks or the correct comparison of IR detected from both flasks		4.6.2.2

Answer 147 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	during the 1st minute there is the greatest temperature difference (between the hot water and the surroundings)	 allow highest temperature or hottest MP 2 dependent on scoring MP 1	1 1	AO2 AO1 4.6.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	the temperature (increase / change after 10 minutes)	allow the final temperature do not allow temperature decrease	1	AO1 4.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	black surfaces absorb more (infrared than white surfaces) matt surfaces absorb more (infrared) than shiny surfaces of the same colour	allow black surfaces have a greater temperature increase (than white surfaces) allow matt surfaces have a greater temperature increase than shiny surfaces of the same colour if no other marks scored, allow 1 mark for matt black surface is the best absorber and shiny white surface is the worst absorber if no other marks scored, allow 1 mark for matt black has the greatest temperature increase and shiny white has the smallest temperature increase	1 1	AO3 4.6.2.2 4.6.3.1

4.6.2.4 Uses and applications of electromagnetic waves

Answer 147 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	pressure = $\frac{\text{force}}{\text{area}}$		1	AO1 4.5.5.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	area of base = 0.0144 (m^2)	do not allow this or subsequent marks unless base area is used	1	AO2 4.5.5.1.1
	$1500 = \frac{F}{0.0144}$	this mark may be awarded if base area is incorrectly calculated	1	
	$F = 1500 \times 0.0144$	this mark may be awarded if base area is incorrectly calculated	1	
	$F = 21.6$ (N)	this mark may be awarded if base area is incorrectly calculated allow 22 (N)	1	

Total Question 1	17

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	satellite	allow moon	1	AO1 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	12.5 cm = 0.125 m		1	AO2 4.6.1.2
	$3 \times 10^8 = f \times 0.125$	this mark may be awarded for an incorrectly / not converted value for wavelength	1	
	$f = \frac{3 \times 10^8}{0.125}$	this mark may be awarded for an incorrectly / not converted value for wavelength	1	
	$f = 2\,400\,000\,000$ (Hz)	this mark may be awarded for an incorrectly / not converted value for wavelength	1	
	$f = 2.4 \times 10^9$ (Hz)	this mark may be awarded for an incorrectly calculated value for frequency in standard form using the given data	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	gravitational force causes the Hubble Space Telescope to accelerate towards the Earth		1	AO1 4.5.1.1 4.5.6.1.3 4.8.1.3
	this changes the direction of motion (but not the speed)		1	
	so changes the velocity of the Hubble Space Telescope	if no other marks awarded, allow 1 mark for gravitational force maintains circular orbit	1	

4.6.2.4 Uses and applications of electromagnetic waves

Answer 148 · Mark scheme

June 2023 | 8463/2H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	galaxy A has the greater red shift (so) A is travelling (away from us) faster (than B) (because) A is further away (from us than B)	if no other marks awarded, allow 1 mark for galaxy A and galaxy B are moving away from us	1 1 1	AO3 4.8.2

Total Question 6	12

Answer 149 · Mark scheme

June 2024 | 8463/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	nuclei neutrons gamma (rays)	this order only	1 1 1	AO1 4.4.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	energy = power × time **or** $E = P \times t$		1	AO1 4.2.4.2 4.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	P = 500 000 000 (W) E = 500 000 000 × 3600 E = 1 800 000 000 000 (J) **or** $E = 1.8 \times 10^{12}$ (J)	 allow a correct substitution of an incorrectly / not converted value of P allow an answer consistent with an incorrectly / not converted value of P	1 1 1	AO2 4.2.4.2 4.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	any **one** from: • bury the radioactive waste • put the radioactive waste in cooling ponds • transport the radioactive waste in secure vessels • store the radioactive waste in metal containers • cover the radioactive waste in concrete	allow store it for (at least) one half-life ignore references to high / medium / low level waste ignore label the waste as hazardous	1	AO3 4.4.2.4

4.6.2.4 Uses and applications of electromagnetic waves

Answer 149 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	number of days = $\frac{92}{100} \times 365$		1	AO2 4.1.3
	number of days = 335.8	allow answers of 335 and 336 days allow an answer of 29.2 (days) for 1 mark	1	

Total Question 2	10

Answer 150 · Mark scheme

June 2024 | 8463/1H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	radiation (from source **A**) travels (approximately) 3 cm (in air) (after which) count rate decreases to background radiation (because) alpha radiation has a short range (in air)	 allow alpha radiation has (very) low penetrating ability allow beta and gamma radiation have a (much) longer range in air	1 1 1	AO1 4.4.2.1 4.4.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	use an aluminium sheet (which) beta radiation will not penetrate but gamma will **or** (which) only gamma will penetrate	allow other materials that beta would be stopped by e.g. brick, sheets of iron / lead, etc. ignore sheet(s) of metal foil unless thickness is given MP2 dependent on scoring MP1	1 1	AO1 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	any **one** from: • increase distance between source and teacher • limit exposure time • use tongs / forceps • wear a lead apron • keep source in box unless in use • stand behind safety screen • point source away from teacher	allow any reasonable precaution that increases distance between the source and the teacher, or limits exposure time ignore wear PPE unqualified ignore examples of additional clothing	1	AO1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	wear gloves / apron **or** wear a lab coat **or** handle source with tongs / forceps	allow no eating / drinking (while radioactive source is in the lab) allow do not touch the source (with bare hands) ignore wear a mask ignore wear safety glasses ignore protective clothing unqualified ignore wear a hazmat suit ignore wear PPE unqualified	1	AO1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	tangent drawn on line at 300 s	do not allow a line drawn that crosses the graph line	1	AO2
	attempt to calculate gradient of the tangent	allow missing power for Δy	1	AO2
	activity = 7.1×10^{20}	allow a value between 6.5 and 7.6×10^{20}	1	AO1
	becquerel / Bq	ignore decays/second	1	4.4.2.1

Total Question 9	**11**

Answer 151 · Mark scheme

June 2024 | 8463/2H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	any **three** from: • they travel at the same speed (in a vacuum / air) • they can travel through a vacuum • they are transverse (waves) • they are electromagnetic (waves)	allow they travel at the speed of light allow they do not need a medium (to travel) ignore they can be reflected / refracted / absorbed / transmitted / diffracted.	3	AO1 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	any **one** from: • (medical) imaging • (medical) treatments	allow correctly named method eg PET scan, tracer, gamma camera do not accept ultrasound, CT scan, X-rays, MRI scan allow correctly named treatment eg radiotherapy, brachiotherapy, gamma knife do not accept chemotherapy allow sterilising medical equipment	1	AO1 4.6.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	gamma rays are (weakly) ionising but radio waves are <u>not</u> (ionising) (so gamma rays) can cause mutations in genes / DNA **or** (so gamma rays) can increase the risk of cancers	allow can cause cancer allow damages / kills cells	1 1	AO1 4.6.2.3

4.6.2.4 Uses and applications of electromagnetic waves

Answer 151 · Mark scheme

June 2024 | 8463/2H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(radio waves are produced by) oscillations in electrical circuits (of the scanner)	allow (radio waves are produced by) alternating current allow (radio waves are produced by) oscillating electrons (in an aerial)	1	AO1 4.6.2.3
	the radio waves have the same frequency as the oscillations	MP2 dependent on MP1	1	

Total Question 6	8

4.6.2.4 Uses and applications of electromagnetic waves

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2003

GCSE

Physics

3451

Foundation

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Kathleen Tattersall: *Director General*

4.6.2.4 Uses and applications of electromagnetic waves

INFORMATION FOR EXAMINERS

1. General

The mark scheme for each question shows:

- the marks available for each part of the question;
- the total marks available for the question;
- the typical answer or answers which are expected;
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example:
where consequential marking needs to be considered in a calculation;
or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; e.g. allow smooth / free movement.)

3. Marking points

3.1 Marking of Quality of Written Communication

Examiners are reminded of the need to assess QoWC by the following statement appearing in the appropriate parts of the mark scheme:

The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.

The maximum marks available to a candidate whose answer is not well expressed will be (the number of marks available –1).

4.6.2.4 Uses and applications of electromagnetic waves

3.2 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.3 Use of chemical symbols/formulae

If a candidate writes a chemical symbol/formula instead of a required chemical name, full credit can be given if the symbol/formula is correct and if, in the context of the question, such action is appropriate.

3.4 The marking of quantitative relationships

Full credit can be given for a correct quantitative relationship expressed in:

- named units;
- physical quantities;
- standard symbols;
- a combination of physical quantities and units.

No credit can be given for any quantitative relationship expressed in terms of:

- a combination of physical quantities, units and symbols;
- a diagram, e.g. the ohm's law triangle, unless the rest of the answer shows clearly that the candidate understands the relationships involved.

3.5 Marking procedure for calculations

3.5.1 Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown. However, if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column.

3.5.2 Where calculations are based on incorrectly recalled relationships, neither the incorrectly recalled relationship, nor the resulting calculation based on the incorrect relationship, will be credited.

3.6 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.7 Errors carried forward

There should be no error carried forward from a previous answer which has been based on wrong science. Any error in the answers to a structured question should be penalised once only.

Examples

(a) A candidate who calculates average speed using speed = time/distance **and** then proceeds to use this incorrect answer to calculate an acceleration based on the correct quantitative relationship should be given credit for the use of the correct acceleration relationship but none for either numerical answer.

(b) A candidate who incorrectly calculates average speed using speed = distance/time and then proceeds to use this incorrect value to calculate an acceleration based on the correct quantitative relationship, should be given credit for the use of both correct quantitative relationships **and** for the correct substitution and use of the incorrect value in the calculation of the rate of acceleration.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.8 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.9 Brackets

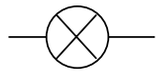
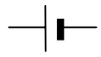
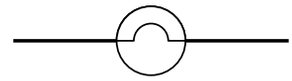
(…..) is used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.10 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q1

question	answers	extra information	mark
(a)	circuit symbol for a lamp correct   circuit symbol for a cell correct	accept  accept any standard of drawing providing circuit would work	1 1
	2 lamps drawn in parallel with 3 cells	polarity of cells must be correct (+ to –) but cells may be either way around	1
(b)	4.5		1
(c)	the same as	accept any clear indication of the correct answer	1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q2

question	answers	extra information	mark
(a)	gas		1
(b)	fuel burning stations produce electricity at any time / all the time wind generator can only produce when the wind is strong enough	accept fuel available all the time accept it's not always windy	1 1
(c)	no fuel is burnt **or** no fuel is used **or** uses only energy from wind **or** does not emit harmful gases / soot / smoke	do **not** accept wind is natural / environmentally friendly / renewable answer must be in terms of wind, **not** negative of fuel burning specific examples of gases CO_2, SO_2, acid rain and greenhouse gases can be accepted ozone negates credit	1
total			4

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q3

question	answers	extra information	mark
(a)(i)	microwaves		1
(ii)	infra red		1
(iii)	ultrasonic		1
(b)(i)	B		1
(ii)	A		1
(c)	disturbance / vibration / movement direction	accept motion / force do **not** accept energy	1 1
(d)	sound wave	accept any clear indication of the correct answer	1
total			8

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q4

question	answers	extra information	mark
(a)(i)	heat		1
(ii)	temperature increases **or** (cause) convection (currents)	accept gets warmer accept gets hotter	1
(iii)	60% **or** 0.6	60 without % scores **1** mark 0.6 with a unit scores **1** mark 60 with incorrect unit scores **1** mark **or** correct substitution $\frac{120}{200}$ for **1** mark	2
(b)	street more (energy transferred as) light **or** less (energy transferred as) heat **or** useful energy output the highest	 can only score this mark if first mark scored all efficiencies calculated correctly score 2nd mark point	1 1
total			6

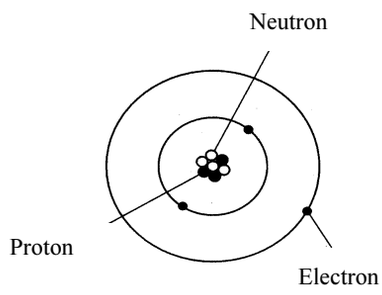
4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q5

question	answers	extra information	mark
(a)	MN	accept 5.8, 8 seconds must include unit	1
(b)	LM	accept 0.8, 5.8 seconds must include unit	1
(c)(i)	0.8		1
(ii)	drinking alcohol		1
(d)	straight (by eye) line starting at 0.8 seconds line drawn steeper than LM starting before L	 ignore lines going beyond 2 seconds but line must exceed 2.5 metres per second before terminating	1 1
total			6

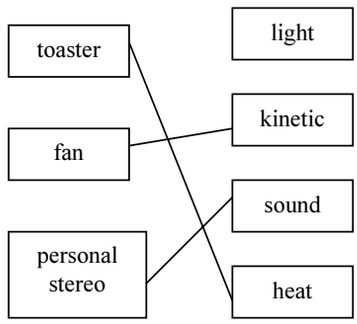
4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q6

question	answers	extra information	mark
(a)(i)	each correct label scores 1 mark  		3
(ii)	neutron		1
(iii)	7 number of protons and neutrons **or** number of nucleons **or** number of particles in the nucleus	 accept number of particles in the centre only if first answer = 7	1 1
(b)(i)	50 ± 5		1
(ii)	50 ± 5	accept their (b)(i)	1
(iii)	less	accept any way of indicating the correct answer	1
total			9

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q7

question	answers	extra information	mark
(a)	each correct line scores 1 mark  	if more than 3 lines are drawn mark incorrect ones first, to a maximum of 3 lines	3
(b)	toaster	accept 1.2 kW	1
(c)(i)	400		1
(ii)	£24 **or** 2400p	full credit for their (c)(i) × 6p for full credit the correct numerical answer must have the correct unit an answer of 24 or 2400 with no unit or the incorrect unit scores **1** mark (c)(i) × 6 incorrectly evaluated scores **1** mark	2
(d)	6	allow 6000 for **1** mark allow 3 × 2 for **1** mark	2
total			9

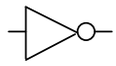
4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q8

question	answers	extra information	mark
(a)(i)	point where the rays cross	do not credit if ambiguous	1
(ii)	converging (lens)	do **not** accept convex	1
(b)(i)	point where the rays appear to diverge from	this should appear to be within 10mm in front of the back of the arrows on the approximate centre line need not be accurately constructed using a ruler	1
(ii)	diverging (lens)	do **not** accept concave	1
(c)	converging film smaller than nearer to	accept any clear indication of the correct response e.g. ticking, ringing, writing in after a mistake	1 1 1 1
(d)(i)	(image) bigger than object / enlarge	accept just 'made bigger'	1
(ii)	it / real image can be put on a screen **or** real image on the opposite side of the lens to the object	accept 'not an imaginary or virtual image' assume 'it' refers to a real image do **not** credit 'it can be seen'	1
(e)	**either** (the converging lens is) thick in the middle thin(ner) at the edge **or** (both) sides bend outwards (1) in the middle (1) **or** one side bends in the middle (1) more than the other side bends inwards (in the middle) (1)	thickest in the middle gains **2** marks convex gains **2** marks suitable diagrams gains **2** marks	1 1
total			12

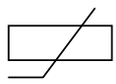
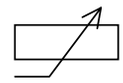
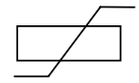
4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q9

question	answers	extra information	mark
(a)(i)	off off on	all correct	1
(ii)	AND (gate)	accept and (gate)	1
(iii)	on on on	all correct	1
(iv)	OR (gate)	accept or (gate)	1
(b)(i)	1 0 **or** 0 1 0 1 1 0	do **not** credit on / off responses	1
(ii)		accept mirror image accept  accept with either or both parts shaded accept line through as shading	1
(c)		accept off for 0 and on for 1 throughout	
	0 0	both correct	1
	0 1	both correct	1
	1 1	both correct	1
	1 1	both correct	1

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q9 continued

(d)(i)		accept mirror image **or** inverted do **not** credit  **or**  or similar	1
(ii)	resistance decreases / increases / changes current (through it) increases / decreases / changes **or** temperature changes / increases / decreases (1) resistance changes / decreases / increases (1) (NTC thermistor) both marks independent but must be compatible to score **2** marks	accept 'voltage across it decreases' for **2** marks but only if it is made clear that this refers to a thermistor in series	1 1
total			13

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q10

question	answers	extra information	mark
(a)(i)	friction	accept any way of indicating the correct answer	1
(ii)	gravity	accept any way of indicating the correct answer	1
(b)(i)	accelerates **or** speed / velocity increases	accept faster and faster (**1** mark) do **not** accept faster pace / falls faster or suggestions of a greater but constant speed	1
	downwards / falls	accept towards the Earth / ground this may score in part (b)(ii) if it does not score here and there is no contradiction between the two parts	1
(ii)	constant speed / velocity **or** terminal velocity / speed **or** zero acceleration	stays in the same place negates credit	1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q11

question	answers	extra information	mark
(a)(i)	X – mantle		1
	Y – inner core	do **not** accept solid core	1
(ii)	different to the crust **or** contains a lot of (heavy) metals	accept iron and nickel for metals	1
	higher (average) density **or** denser	density higher than 5500 (kg/m^3) gets **2** marks	1
(b)	animals were able to move from one continent to the other		1
	(when bridge broke) animals evolved differently	accept animals adapted differently	1
(c)(i)	earthquakes occur at the boundary between plates **or** earthquakes occur where plates push against each other		1
	there are no plate boundaries running through Britain	accept Britain is not near the edge of a plate	1
(ii)	convection currents (in the mantle) **or** heat released by (natural) radioactive processes		1
total			9

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q12

question	answers	extra information	mark
(a)(i)	outside the Earth **or** not from the Earth	accept alien accept life from / on another planet / space accept our planet for Earth	1
(ii)	radio telescope(s)	do **not** accept telescopes do **not** accept satellite dishes do **not** accept radio receivers **or** transmitters	1
(b)(i)	galaxies	do **not** accept stars	1
(ii)	any **one** from: the pulses were regular pulses from space are usually random (scientists) thought technology had been used to produce the pulses neutron stars were unknown signals from a single point	 accept signals / beats for pulses accept noise for random pulses idea of regular but not continuous	1
(iii)	neutron star is (the matter / mass) left behind after a star / red giant explodes (as a super nova)	 accept after a super nova (explosion) neutron star causing super nova gets no credit	1 1
(c)(i)	carried on the balloon / equipment	accept carried by a rocket / aircraft / satellite birds negates credit	1
(ii)	on comets or meteors	accept meteorites / shooting stars accept returning space craft accept solar wind ignore asteroids accept ufo do **not** accept solar flares do **not** accept satellites	1
total			8

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q13

question	answers	extra information	mark
(a)	silver is a (good) reflector of <u>heat</u> (radiation) **or** silver reflects the heat (radiation)	fact heat = infra red ignore references to light accept shiny for silver good radiator negates the mark ignore references to good conductor do **not** accept bounce back	1
	less heat is lost through the board **or** more heat is retained by the shirt	explanation accept both sides of shirt heated reflects heat back up gets **1** mark only ignore mention of friction	1
(b)	metal soleplate	accept soleplate / bottom / metal do **not** accept outside / case	1
(c)	plastic **or** rubber	accept any named plastic do **not** accept wood	1
	it is a (good) insulator **or** it is a poor conductor	ignore mention of heat if in conjunction with electricity	1
(d)	**Quality of written communication** *The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.*	*Maximum of **2** marks if ideas not well expressed.*	
	pulls iron bolt down **or** attracts the iron bolt **or** moves bolt out of plunger	answers in terms of charges attracting or repelling gain no credit	1
	plunger pushed / moved to the right (by spring) **or** plunger released		1
	push switch opens / goes to off / goes to right	accept circuit is broken for maximum credit the points must follow a logical sequence 3 correct points but incorrect sequence scores **2** marks only ignore reset action	1
total			8

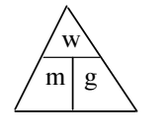
4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q14

question	answers	extra information	mark
(a)(i)	any **one** from: the ground the air radon (gas) building materials buildings rocks / granite food cosmic rays **or** solar rays X-rays nuclear weapons testing nuclear power stations / accidents	 do **not** accept mobile phones accept from outer space accept sun but **not** sunlight accept medical uses	1
(ii)	2	allow $\frac{1200}{60\times10}$ **or** $\frac{1200}{600}$ **or** 120 for **1** mark	2
(b)	 alpha: the count rate is (greatly) reduced by the card **or** the card absorbs alphas but not betas beta: the count rate is (greatly) reduced by the metal **or** the thin metal absorbs alphas and betas **or** the thin metal absorbs all of the radiation (from the source) gamma: would pass through the thin metal but count rate is background **or** no radiation passing through **or** a higher reading would be recorded **or** to reduce the count to 2 would require much more than 3 mm of metal	answers must be comparative accept converse answers throughout accept paper for the card accept aluminium for the metal accept aluminium for the metal accept lead / aluminium for the metal	 1 1 1
total			6

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q15

question	answers	extra information	mark
(a)(i)	weight = mass × g.f.s.	accept w = m × g accept gravity for gfs accept  provided subsequent use of Δ correct do **not** accept N = kg × N/kg	1
(ii)	675	75 × 9 for **1** mark	2
(iii)	g.(f.s.) is higher (on Earth than Venus)	accept gravity for g.f.s. do **not** accept g.f.s. is lower unless answer states on Venus	1
(iv)	orbit time for Jupiter is <u>longer</u> / longest (than for the other planets)	do **not** give any credit for an answer that includes a comparison of diameter **or** a comparison of g.f.s.	1
(b)	**Quality of written communication** *The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.* any **two** from: dust <u>and</u> gas **or** remnants of a super nova pulled together by (force of) <u>gravity</u> nuclear fusion starts	*Maximum of **1** mark if ideas not well expressed.* accept hydrogen for dust and gas do **not** accept hydrogen burns although candidates may include more detail these points are essential to score the credit	2
total			7

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q16

question	answers	extra information	mark
(a)(i)	upright with the contacts at the bottom and still in place and unbent	no need for labels but incorrect label(s) cancel the mark accept a freehand drawing no need for details such as correct dimensions	1
	one blob of mercury touching <u>both</u> contacts	do **not** award mark if contacts bent to touch	1
(b)(i)	(X is a) battery	do **not** credit cell accept (set of) cells accept power supply do **not** accept power pack	1
	(Y is a) LED	**or** light emitting diode	1
(ii)	longer (time)	do **not** accept 'slower time'	1
(iii)	any **two** from: current less (so) rate of flow of charge less **or** less coulombs per second (so) discharge is slower	 do **not** accept current slower accept capacitor has charge for longer **or** charge lasts longer **or** (so total of) electrons take longer to travel round circuit	2
(c)	4200	 translation correct (= 4000) but percentage addition incorrect gains **1** mark translation incorrect but 5% addition is correct gains **1** mark accept 422.1 **or** 42.2 **or** 6.3 for **1** mark	2
	ohms **or** Ω	 4.2 kilohms **or** 4.2 kΩ gains all **3** marks	1
total			10

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q17

question	answers	extra information	mark
(a)	point at which its mass (seems to) act **or** point at which gravity (seems to) act	accept …its weight acts accept correct statements if the intent is clear e.g. … if suspended, the centre of gravity will be directly under the point of suspension e.g. … (if the object is symmetrical), the centre of gravity is on the **or** an axis (of symmetry) do **not** credit just 'it is a point'	1
(b)	**Quality of written communication** *The answer to this question requires good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.* any **five** from: clamp (steel) rod (horizontally) hang plastic / sheet by rod through (one) hole hang plumb line from rod mark ends of plumb line on the sheet and use the ruler to draw a straight line repeat with other hole centre of mass is where the lines cross check by balancing at this point	*maximum of **4** marks if ideas not well expressed* **no** marks if method quite unworkable maximum of **3** marks if no 'repeat with other hole'	5
(c)(i)	(turning) effect **or** moment force distance	all three correct accept weight accept length	1
(ii)	17.6 Nm **or** newton metre(s)	allow 44 × 0.4 **or** 0.4 × 44 for **1** mark do **not** accept N/m **or** N/cm 1760 Ncm gains all **3** marks	2 1
total			10

4.6.2.4 Uses and applications of electromagnetic waves

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2003

GCSE

Science: Double Award Co-ordinated

3462

Paper 3F

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Kathleen Tattersall: *Director General*

4.6.2.4 Uses and applications of electromagnetic waves

INFORMATION FOR EXAMINERS

1. General

The mark scheme for each question shows:

- the marks available for each part of the question;
- the total marks available for the question;
- the typical answer or answers which are expected;
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example:
where consequential marking needs to be considered in a calculation;
or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; e.g. allow smooth / free movement.)

3. Marking points

3.1 Marking of Quality of Written Communication

Examiners are reminded of the need to assess QoWC by the following statement appearing in the appropriate parts of the mark scheme:

The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.

The maximum marks available to a candidate whose answer is not well expressed will be (the number of marks available –1).

3.2 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.3 Use of chemical symbols/formulae

If a candidate writes a chemical symbol/formula instead of a required chemical name, full credit can be given if the symbol/formula is correct and if, in the context of the question, such action is appropriate.

3.4 The marking of quantitative relationships

Full credit can be given for a correct quantitative relationship expressed in:

- named units;
- physical quantities;
- standard symbols;
- a combination of physical quantities and units.

No credit can be given for any quantitative relationship expressed in terms of:

- a combination of physical quantities, units and symbols;
- a diagram, e.g. the ohm's law triangle, unless the rest of the answer shows clearly that the candidate understands the relationships involved.

3.5 Marking procedure for calculations

3.5.1 Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown. However, if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column.

3.5.2 Where calculations are based on incorrectly recalled relationships, neither the incorrectly recalled relationship, nor the resulting calculation based on the incorrect relationship, will be credited.

3.6 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.7 Errors carried forward

There should be no error carried forward from a previous answer which has been based on wrong science. Any error in the answers to a structured question should be penalised once only.

Examples

(a) A candidate who calculates average speed using speed = time/distance **and** then proceeds to use this incorrect answer to calculate an acceleration based on the correct quantitative relationship should be given credit for the use of the correct acceleration relationship but none for either numerical answer.

(b) A candidate who incorrectly calculates average speed using speed = distance/time and then proceeds to use this incorrect value to calculate an acceleration based on the correct quantitative relationship, should be given credit for the use of both correct quantitative relationships **and** for the correct substitution and use of the incorrect value in the calculation of the rate of acceleration.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.8 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.9 Brackets

(…..) is used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

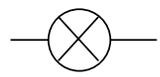
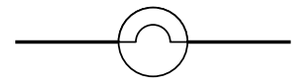
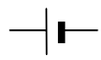
3.10 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

4.6.2.4 Uses and applications of electromagnetic waves

Double Award
Foundation Tier 3462/3F

3462/3F Q1

question	answers	extra information	mark
(a)	circuit symbol for a lamp correct 	accept  accept any standard of drawing providing circuit would work	1
	circuit symbol for a cell correct 		1
	2 lamps drawn in parallel with 3 cells	polarity of cells must be correct (+ to –) but cells may be either way around	1
(b)	4.5		1
(c)	the same as	accept any clear indication of the correct answer	1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q2

question	answers	extra information	mark
(a)	gas		1
(b)	fuel burning stations produce electricity at any time / all the time wind generator can only produce when the wind is strong enough	accept fuel available all the time accept it's not always windy	1 1
(c)	no fuel is burnt **or** no fuel is used **or** uses only energy from wind **or** does not emit harmful gases / soot / smoke	do **not** accept wind is natural / environmentally friendly / renewable answer must be in terms of wind, **not** negative of fuel burning specific examples of gases CO_2, SO_2, acid rain and greenhouse gases can be accepted ozone negates credit	1
total			4

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q3

question	answers	extra information	mark
(a)(i)	microwaves		1
(ii)	infra red		1
(iii)	ultrasonic		1
(b)(i)	B		1
(ii)	A		1
(c)	disturbance / vibration / movement direction	accept motion / force do **not** accept energy	1 1
(d)	sound wave	accept any clear indication of the correct answer	1
total			8

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q4

question	answers	extra information	mark
(a)(i)	heat		1
(ii)	temperature increases **or** (cause) convection (currents)	accept gets warmer accept gets hotter	1
(iii)	60% **or** 0.6	60 without % scores **1** mark 0.6 with a unit scores **1** mark 60 with incorrect unit scores **1** mark **or** correct substitution $\frac{120}{200}$ for **1** mark	2
(b)	street more (energy transferred as) light **or** less (energy transferred as) heat **or** useful energy output the highest	 can only score this mark if first mark scored all efficiencies calculated correctly score 2nd mark point	1 1
total			6

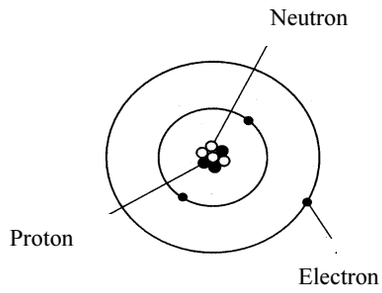
4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q5

question	answers	extra information	mark
(a)	MN	accept 5.8, 8 seconds must include unit	1
(b)	LM	accept 0.8, 5.8 seconds must include unit	1
(c)(i)	0.8		1
(ii)	drinking alcohol		1
(d)	straight (by eye) line starting at 0.8 seconds		1
	line drawn steeper than LM starting before L	ignore lines going beyond 2 seconds but line must exceed 2.5 metres per second before terminating	1
total			6

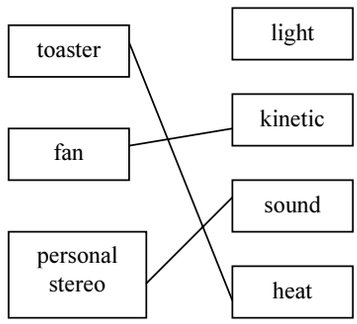
4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q6

question	answers	extra information	mark
(a)(i)	each correct label scores 1 mark  		3
(ii)	neutron		1
(iii)	7 number of protons and neutrons **or** number of nucleons **or** number of particles in the nucleus	 accept number of particles in the centre only if first answer = 7	1 1
(b)(i)	50 ± 5		1
(ii)	50 ± 5	accept their (b)(i)	1
(iii)	less	accept any way of indicating the correct answer	1
total			9

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q7

question	answers	extra information	mark
(a)	each correct line scores 1 mark  	if more than 3 lines are drawn mark incorrect ones first, to a maximum of 3 lines	3
(b)	toaster	accept 1.2 kW	1
(c)(i)	400		1
(ii)	£24 **or** 2400p	full credit for their (c)(i) × 6p for full credit the correct numerical answer must have the correct unit an answer of 24 or 2400 with no unit or the incorrect unit scores **1** mark (c)(i) × 6 incorrectly evaluated scores **1** mark	2
(d)	6	allow 6000 for **1** mark allow 3 × 2 for **1** mark	2
total			9

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q8

question	answers	extra information	mark
(a)(i)	friction	accept any way of indicating the correct answer	1
(ii)	gravity	accept any way of indicating the correct answer	1
(b)(i)	accelerates **or** speed / velocity increases	accept faster and faster (**1** mark) do **not** accept faster pace / falls faster or suggestions of a greater but constant speed	1
	downwards / falls	accept towards the Earth / ground this may score in part (b)(ii) if it does not score here and there is no contradiction between the two parts	1
(ii)	constant speed / velocity **or** terminal velocity / speed **or** zero acceleration	stays in the same place negates credit	1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q9

question	answers	extra information	mark
(a)(i)	X – mantle		1
	Y – inner core	do **not** accept solid core	1
(ii)	different to the crust **or** contains a lot of (heavy) metals	accept iron and nickel for metals	1
	higher (average) density **or** denser	density higher than 5500 (kg/m^3) gets **2** marks	1
(b)	animals were able to move from one continent to the other		1
	(when bridge broke) animals evolved differently	accept animals adapted differently	1
(c)(i)	earthquakes occur at the boundary between plates **or** earthquakes occur where plates push against each other		1
	there are no plate boundaries running through Britain	accept Britain is not near the edge of a plate	1
(ii)	convection currents (in the mantle) **or** heat released by (natural) radioactive processes		1
total			9

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q10

question	answers	extra information	mark
(a)(i)	outside the Earth **or** not from the Earth	accept alien accept life from / on another planet / space accept our planet for Earth	1
(ii)	radio telescope(s)	do **not** accept telescopes do **not** accept satellite dishes do **not** accept radio receivers **or** transmitters	1
(b)(i)	galaxies	do **not** accept stars	1
(ii)	any **one** from: the pulses were regular pulses from space are usually random (scientists) thought technology had been used to produce the pulses neutron stars were unknown signals from a single point	 accept signals / beats for pulses accept noise for random pulses idea of regular but not continuous	1
(iii)	neutron star is (the matter / mass) left behind after a star / red giant explodes (as a super nova)	 accept after a super nova (explosion) neutron star causing super nova gets no credit	1 1
(c)(i)	carried on the balloon / equipment	accept carried by a rocket / aircraft / satellite birds negates credit	1
(ii)	on comets or meteors	accept meteorites / shooting stars accept returning space craft accept solar wind ignore asteroids accept ufo do **not** accept solar flares do **not** accept satellites	1
total			8

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q11

question	answers	extra information	mark
(a)	silver is a (good) reflector of heat (radiation) **or** silver reflects the heat (radiation)	fact heat = infra red ignore references to light accept shiny for silver good radiator negates the mark ignore references to good conductor do **not** accept bounce back	1
	less heat is lost through the board **or** more heat is retained by the shirt	explanation accept both sides of shirt heated reflects heat back up gets **1** mark only ignore mention of friction	1
(b)	metal soleplate	accept soleplate / bottom / metal do **not** accept outside / case	1
(c)	plastic **or** rubber	accept any named plastic do **not** accept wood	1
	it is a (good) insulator **or** it is a poor conductor	ignore mention of heat if in conjunction with electricity	1
(d)	**Quality of written communication** *The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.*	*Maximum of **2** marks if ideas not well expressed.*	
	pulls iron bolt down **or** attracts the iron bolt **or** moves bolt out of plunger	answers in terms of charges attracting or repelling gain no credit	1
	plunger pushed / moved to the right (by spring) **or** plunger released		1
	push switch opens / goes to off / goes to right	accept circuit is broken for maximum credit the points must follow a logical sequence 3 correct points but incorrect sequence scores **2** marks only ignore reset action	1
total			8

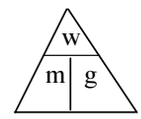
4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q12

question	answers	extra information	mark
(a)(i)	any **one** from: the ground the air radon (gas) building materials buildings rocks / granite food cosmic rays **or** solar rays X-rays nuclear weapons testing nuclear power stations / accidents	 do **not** accept mobile phones accept from outer space accept sun but **not** sunlight accept medical uses	1
(ii)	2	allow $\frac{1200}{60\times10}$ **or** $\frac{1200}{600}$ **or** 120 for **1** mark	2
(b)	 alpha: the count rate is (greatly) reduced by the card **or** the card absorbs alphas but not betas beta: the count rate is (greatly) reduced by the metal **or** the thin metal absorbs alphas and betas **or** the thin metal absorbs all of the radiation (from the source) gamma: would pass through the thin metal but count rate is background **or** no radiation passing through **or** a higher reading would be recorded **or** to reduce the count to 2 would require much more than 3 mm of metal	answers must be comparative accept converse answers throughout accept paper for the card accept aluminium for the metal accept aluminium for the metal accept lead / aluminium for the metal	 1 1 1
total			6

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q13

question	answers	extra information	mark
(a)(i)	weight = mass × g.f.s.	accept w = m × g accept gravity for gfs accept  provided subsequent use of Δ correct do **not** accept N = kg × N/kg	1
(ii)	675	75 × 9 for **1** mark	2
(iii)	g.(f.s.) is higher (on Earth than Venus)	accept gravity for g.f.s. do **not** accept g.f.s. is lower unless answer states on Venus	1
(iv)	orbit time for Jupiter is <u>longer</u> / longest (than for the other planets)	do **not** give any credit for an answer that includes a comparison of diameter **or** a comparison of g.f.s.	1
(b)	**Quality of written communication** *The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.* any **two** from: dust <u>and</u> gas **or** remnants of a super nova pulled together by (force of) <u>gravity</u> nuclear fusion starts	*Maximum of **1** mark if ideas not well expressed.* accept hydrogen for dust and gas do **not** accept hydrogen burns although candidates may include more detail these points are essential to score the credit	2
total			7

GCSE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics Specification B
3451/F

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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4.6.2.4 Uses and applications of electromagnetic waves

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4.6.2.4 Uses and applications of electromagnetic waves

GCSE PHYSICS

INFORMATION FOR EXAMINERS

1. General

The mark scheme for each question shows:

- the marks available for each part of the question;
- the total marks available for the question;
- the typical answer or answers which are expected;
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example:
where consequential marking needs to be considered in a calculation;
or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; e.g. allow smooth / free movement.)

3. Marking points

3.1 Marking of Quality of Written Communication

Where *Quality of written communication* appears in the mark scheme, one mark is to be awarded for either of the following points:

- Using correct scientific terms
- Correct sequencing or linking of ideas or points

The mark scheme will specify which of the points is to be awarded in a particular question. A QoWC mark can be awarded for a scientific answer, even if it is not accurate. It cannot be awarded for a nonsensical or non-scientific answer.
On the script, the QoWC tick should be identified by a 'q' written next to it.

3.2 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

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Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.3 Use of chemical symbols/formulae

If a candidate writes a chemical symbol/formula instead of a required chemical name, full credit can be given if the symbol/formula is correct and if, in the context of the question, such action is appropriate.

3.4 The marking of quantitative relationships

Full credit can be given for a correct quantitative relationship expressed in:

- named units;
- physical quantities;
- standard symbols;
- a combination of physical quantities and units.

No credit can be given for any quantitative relationship expressed in terms of:

- a combination of physical quantities, units and symbols;
- a diagram, e.g. the ohm's law triangle, unless the rest of the answer shows clearly that the candidate understands the relationships involved.

3.5 Marking procedure for calculations

3.5.1 Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown.
However:

- if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column;
- if the answer is correct, but an incorrect relationship is written in the working, then no marks can be awarded (see 3.5.2).

3.5.2 Where calculations are based on incorrectly recalled relationships, neither the incorrectly recalled relationship, nor the resulting calculation based on the incorrect relationship, will be credited.

3.6 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

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4.6.2.4 Uses and applications of electromagnetic waves

3.7 Errors carried forward

There should be no error carried forward from a previous answer which has been based on wrong science. Any error in the answers to a structured question should be penalised once only.

Examples

(a) A candidate who calculates average speed using speed = time/distance **and** then proceeds to use this incorrect answer to calculate an acceleration based on the correct quantitative relationship should be given credit for the use of the correct acceleration relationship but none for either numerical answer.

(b) A candidate who incorrectly calculates average speed using speed = distance/time and then proceeds to use this incorrect value to calculate an acceleration based on the correct quantitative relationship, should be given credit for the use of both correct quantitative relationships **and** for the correct substitution and use of the incorrect value in the calculation of the rate of acceleration.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.8 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.9 Brackets

(…..) is used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.10 Interpretation of marginal points

There will be times when the answer is almost, but not quite, correct. Some examiners would award a mark while others would not. In any one script, an attempt should be made to balance these nearly correct answers by giving the mark on some occasions but not on others. If this is not done, the marking would end up being too lenient or too harsh.

3.11 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

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4.6.2.4 Uses and applications of electromagnetic waves

GCSE Physics
Foundation Tier 3451/F

3451F Q1

question	answers	extra information	mark
(a)	comet	correct order only	1
	elliptical		1
	Milky Way		1
	Universe		1
(b)(i)	D A C B	allow **2** marks for two letters in the correct place allow **1** mark for one letter in the correct place	3
(ii)	A		1
total			8

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q2

question	answers	extra information	mark
(a)	95		1
(b)	alpha	accept correct symbol	1
(c)	any **two** from: • radiation is outside the body • radiation will not reach (living) cells • radiation absorbed by the air	 accept detector is on ceiling or high up the wall accept radiation cannot pass through the body / skin accept cannot pass through the plastic casing do **not** accept because it is alpha radiation – unless qualified do **not** accept does not give off harmful substance do **not** accept cannot pass through building materials etc.	2
(d)	less (than)		1
total			5

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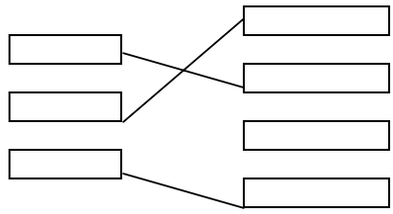
4.6.2.4 Uses and applications of electromagnetic waves

3451F Q3

question	answers	extra information	mark
(a)	generator	accept dynamo accept alternator	1
(b)(i)	1400	ignore units	1
(ii)	0.3 or 30%	any incorrect unit penalise **1** mark allow **1** mark for the correct use of 600 **or** 0.3% **or** 30	2
(c)	**1** mark for each correct link 	if more than 3 lines are drawn, mark only 3 lines starting with those that are incorrect	3
(d)(i)	110	no tolerance	1
(ii)	12	no tolerance	1
(iii)	wind speed may be too low to operate the generator	accept wind may not always blow accept power depends on wind speed accept does not generate if wind speed is too high accept does not generate if wind speed is above 12 (m/s) accept does not generate if wind speed is below 1.6 (m/s) accept it is unreliable do **not** accept answers referring to cost only	1
total			10

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q4

question	answers	extra information	mark
(a)	B E A D	allow **1** mark for each letter in the correct place, to a maximum of **3** marks	3
(b)	(a spark) may cause the (petrol vapour) to explode / ignite	accept petrol for (petrol vapour) accept catch fire for explode	1
	connect tanker to earth with a (conducting) wire / chain **or** earth the tanker	accept ground for earth	1
(c)	**Quality of written communication**	for a logical sequence	1
	any **two** from:		2
	• when current greater than fuse rating / value	accept when current too great for appliance do **not** accept 'if there is too much current' do **not** accept voltage or electricity	
	• fuse (becomes hot and) melts / burns out	accept fuse blows / breaks	
	• circuit is broken	accept circuit switched off this cannot score credit on its own	
total			8

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q5

question	answers	extra information	mark
(a)(i)	crust		1
(ii)	inner core is solid outer core is liquid	do **not** accept just rock inner core is denser / hotter than outer core gets **2** marks accept one is solid and one is liquid for **1** mark accept they are different densities for **1** mark wrong way round = **0** marks	1 1
(b)	seismograph		1
(c)	difficult to measure (slow) movement (1) of plates (1) dependent mark **or** difficult to measure friction / forces (1) between plates (1) dependent mark		1 1
(d)	geothermal		1
(e)(i)	5000		1
(ii)	2500		1
total			9

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q6

	answers	extra information	mark
(a)	converging image object image object shorter		1 1 1 1 1 1
(b)(i)	(Earth's) gravity	accept centripetal accept minor misspellings, however, do **not** credit any response which could be 'centrifugal'	1
(ii)	to(wards) (the centre of the) Earth	allow inwards do **not** accept downwards	1
(c)(i)	**either** friction (force) **or** centripetal force between the tyres / wheels and (the surface of) the road	 allow grip allow on the tyres / wheels **or** towards the centre of the bend / arc / circle	 1 1
(ii)	mass **or** speed **or** momentum radius / diameter	allow weight allow velocity do **not** credit 'curvature' or 'circumference'	1 1
(d)	centripetal	accept minor misspellings (see above)	1
total			13

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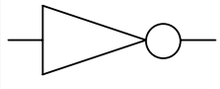
4.6.2.4 Uses and applications of electromagnetic waves

3451F Q7

	answers	extra information	mark
(a)(i)	two switches in series **and** circuit complete	ignore small imperfections	1
(ii)	two switches in parallel **and** circuit complete	ignore small imperfections	1
(iii)	one switch in parallel with the cell / lamp (but **not** both)	ignore small imperfections	1
(iv)	(i) AND (ii) OR (iii) NOT	accept 'and' accept 'or' accept 'not'	1 1 1
(b)(i)	when it is light the sensor sends on / high / 1 signal to the gate off / low / 0 sent to the lamp **or** when it is dark the sensor sends off / low / 0 signal to the gate (1) on / high / 1 sent to the lamp (1)		1 1
(ii)	any suitable application	e.g. to switch a security light on (and off) e.g. to switch a light on when it is dark do **not** credit just '… to switch a light on / off'	1
(c)(i)		accept shading-in of either or both parts end connections are not required accept any orientation	1
(ii)	1 0 **or** 0 1 0 1 1 0	all correct	1
(iii)	truth (table)		1
total			12

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q8

question	answers	extra information	mark
(a)	60		1
(b)	$5\frac{1}{2}$ hours	must include unit	1
(c)	30		1
(d)	30 minutes or $\frac{1}{2}$ hour	must include unit	1
(e)	D **and** E least steep part of the graph	accept finish for E accept correct numbers from axes with units accept covers smallest distance in a set time accept only moves 5 km in $1\frac{1}{2}$ hours (accept anything between 5 and 6) ignore horse is tired	1 1
total			6

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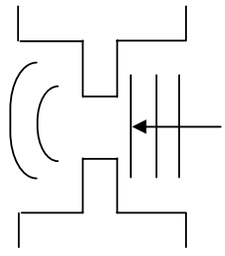
4.6.2.4 Uses and applications of electromagnetic waves

3451F Q9

question	answers	extra information	mark
(a)(i)	any **one** from: • (doctors) to see inside a patients body **or** endoscope • telephone cables • optical fibre / fibre optic lamps **or** (artificial) Christmas trees • data transfer **or** internet connection	 accept keyhole surgery do **not** accept flex **or** wires for cable accept decorative / ornamental lighting accept any feasible practical suggestion for taking light to a difficult to access place do **not** accept lighting unqualified do **not** accept lamp unqualified do **not** accept communications unless clarified	1
(ii)	(incident) ray angle greater than critical angle total internal reflection occurs	either order accept (incident) ray greater than 42° accept TIR do **not** accept just description of TIR	1 1
(b)(i)	waves shown diffracting in the correct direction 	ignore wavelength	1
(ii)	diffraction	accept diffract / diffracted	1
total			5

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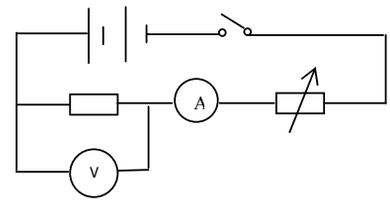
4.6.2.4 Uses and applications of electromagnetic waves

3451F Q10

question	answers	extra information	mark
(a)	all symbols correct	 accept push switch symbol switch may be open or closed any lines through symbols = **0** marks	1
	correct circuit drawn voltmeter must be across resistor only	polarity of cells not relevant provided they are joined correctly two cells are required in the diagram ignore the order of the components allow small gaps in circuit omission of any component = **0** marks	1
(b)(i)	potential difference = current × resistance	accept voltage or p.d. for potential difference accept $V = I \times R$ accept  provided subsequent use correct do **not** accept C for current	1
(ii)	2	 allow **1** mark for correct substitution wrong working loses both marks	2
(iii)	straight line drawn <u>through the origin</u> straight line passes through $I = 0.4, V =$ their (b)(ii) / 2 **and** 0.0	judge by eye this mark may be awarded if all points shown including these points are correct even if no line is drawn N.B. a curve scores **0** marks	1 1 dep
(c)	temperature <u>increases</u>	accept filament lamp / it gets <u>hotter</u> allow heat for temperature	1
total			8

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q11

question	answers	extra information	mark
(a)(i)	gamma rays	accept gamma accept correct symbol	1
(ii)	infra red	accept IR	1
(b)	ultraviolet <u>absorbed</u> by ink (energy) given out as light	 accept glows / luminous accept for **both** marks the ink is fluorescent do **not** accept answers in terms of uv being reflected	1 1
(c)	any **two** from: • UV can damage / kill / ionise / alter (normal) cells • change DNA structure **or** mutate • (normal) cells may become cancerous	 do **not** accept attacks cells **or** burns skin accept may cause (skin) cancer accept abnormal cell multiplication	2
(d)(i)	microwaves **and** infra red	both answers needed in either order do **not** accept heat for IR	1
(ii)	0.9	allow **1** mark for the <u>correct</u> use of 1.8 (kW) ($1.8 \times \frac{1}{2}$ or 1.8×30) i.e. adding the correct 2 power values	2
total			9

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q12

question	answers	extra information	mark
(a)(i)	accelerating	accept getting faster accept speed / velocity increasing	1
(ii)	acceleration <u>increases</u>	accept velocity / speed increases <u>more</u> rapidly do **not** accept velocity / speed increases	1
(b)(i)	$\text{acceleration} = \frac{\text{change in velocity}}{\text{time (taken)}}$	accept $a = \frac{v - u}{t}$ **or** $a = \frac{v_1 - v_2}{t}$ do **not** accept velocity for change in velocity do **not** accept change in speed do **not** accept $a = \frac{v}{t}$	1
(ii)	15	allow **1** mark for an answer of 900 **or** for <u>correct</u> use of 540 seconds	2
(iii)	velocity includes direction	accept velocity is a vector (quantity) accept converse answer	1
(c)	force of gravity (between <u>shuttle</u> and Earth) plus correct orbital speed (makes <u>shuttle</u> move in a curve)	accept gravitational pull if used correctly accept forward motion **or** constant speed for orbital speed accept it is travelling fast enough accept for **2** marks the force of gravity provides the <u>centripetal</u> force	1 1
(d)	black is a good emitter of radiation **or** to limit the temperature rise inside the shuttle	accept heat for radiation accept the tiles are good insulation do **not** accept black absorbs heat on its own do **not** accept tiles are heat proof	1
total			9

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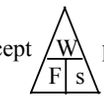
4.6.2.4 Uses and applications of electromagnetic waves

3451F Q13

question	answers	extra information	mark
(a)(i)	work (done) = force (applied) × distance (moved)	accept W = F × s or W = F × d accept  provided subsequent method is correct	1
(ii)	240 000 joules	allow **1** mark for correct substitution **or** correct use of 1200 (N) accept J do **not** accept j / Nm	2 1
(b)	800 (watts)	accept 0.8 kW accept their (a)(ii) ÷ 300 correctly evaluated for **2** marks allow **1** mark for correct substitution (a)(ii) ÷ 5 correctly evaluated for **1** mark	2
(c)(i)	any **one** from: • needs to raise the chair / lift • lifting more than one chair • energy transfer to the surroundings correctly qualified	 allow lifting more than 2 people implication of a heavier weight accept loss for transfer do **not** accept motor inefficient do **not** accept motor gets hot do **not** accept friction unless the location is specified as external to the motor	1
(ii)	electrical potential	accept electric **both** answers required for the mark	1
total			8

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q14

	answers	extra information	mark
(a)(i)	current		1
(ii)	resistance decreases	 accept 'the flow of electrons / current (through it) increases' for **1** mark do **not** credit just '… it will get warmer'	1 1
(b)	input sensor → controlled by the processor processor → detects changes in the environment output device → decides what action is needed	all pairs correct one pair correct for **1** mark	2
(c)(i)	potential divider	accept voltage divider	1
(ii)	4 (volts)	$6 \times \frac{30}{45}$ for **1** mark	2
(iii)	across the new resistor…(will) increase across R_2 … (will) decrease	 N.B. independent marks	1 1
total			10

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q15

	answers	extra information	mark
(a)	relay (normally open) (switch)	each mark is independent	1
	… switch on a (larger) current (in another circuit) **or** switch on a higher voltage circuit	do **not** accept switch on another circuit **or** smaller / equal current	1
	light emitting diode / LED	do **not** credit LDR	1
	… in one / direct / certain direction **or** from left to right	**or** when the cathode is connected to the negative terminal / side **or** when the left-hand side is connected to the positive terminal / side do **not** credit just '… is big enough' do **not** accept 'positive direction'	1
	AND gate	accept 'and' gate	1
	… (both) inputs are on / high / 1 **or** current flows in both inputs	do **not** accept numerical values unless expanded	1
(b)	**Quality of written communication**	If in a sensible order which clearly indicates advantages or disadvantages, including answers in the form of a table **or** as bullet points Q ✓ Q X	1
	any **three** from: • advantage of mobile phones • drawback of mobile phones • benefit of the Internet • drawback of the Internet	 e.g. more convenient for service engineers e.g. calls can be received away from base e.g. privacy can be more easily invaded e.g. drivers can be distracted e.g. microwaves / radio waves can / may cause damage to the brain e.g. access to educational material e.g. some material is salacious e.g. spam (on external e-mail) these are examples candidates may be credited for a variety of responses	3
total			10

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4.6.2.4 Uses and applications of electromagnetic waves

3451F Q16

question	answers	extra information	mark
(a)	**Y** and **Z** they have the same number of protons **or** same atomic number	 accept they have the same number of electrons **or** same number of protons **and** electrons allow only different in number of neutrons N.B. independent marks	1 1
(b)	**Quality of written communication** A – alpha particle passes straight through the empty space of the atom **or** it is a long way from the nucleus B – alpha particle deflected / repelled / repulsed by the (positive) nucleus C – alpha particle heading straight for the nucleus is deflected / repelled / repulsed backwards	for correct use of terms underlined in B **or** C Q ✓ Q X describes 3 tracks correctly for **2** marks describes 2 or 1 track correctly for **1** mark do **not** accept hits the nucleus do **not** accept answers referring to refraction do **not** accept answers in terms of reflected backwards unless qualified in terms of repulsion mention of difference in charge on nucleus negates that track	1 max 2
total			5

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GCSE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Science: Double Award
Specification B (Co-ordinated)
3462/3F

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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4.6.2.4 Uses and applications of electromagnetic waves

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4.6.2.4 Uses and applications of electromagnetic waves

SCIENCE: DOUBLE AWARD CO-ORDINATED

INFORMATION FOR EXAMINERS

1. General

The mark scheme for each question shows:

- the marks available for each part of the question;
- the total marks available for the question;
- the typical answer or answers which are expected;
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example:
where consequential marking needs to be considered in a calculation;
or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; e.g. allow smooth / free movement.)

3. Marking points

3.1 Marking of Quality of Written Communication

Where *Quality of written communication* appears in the mark scheme, one mark is to be awarded for either of the following points:

- Using correct scientific terms
- Correct sequencing or linking of ideas or points

The mark scheme will specify which of the points is to be awarded in a particular question. A QoWC mark can be awarded for a scientific answer, even if it is not accurate. It cannot be awarded for a nonsensical or non-scientific answer.
On the script, the QoWC tick should be identified by a 'q' written next to it.

3.2 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

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Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.3 Use of chemical symbols/formulae

If a candidate writes a chemical symbol/formula instead of a required chemical name, full credit can be given if the symbol/formula is correct and if, in the context of the question, such action is appropriate.

3.4 The marking of quantitative relationships

Full credit can be given for a correct quantitative relationship expressed in:

- named units;
- physical quantities;
- standard symbols;
- a combination of physical quantities and units.

No credit can be given for any quantitative relationship expressed in terms of:

- a combination of physical quantities, units and symbols;
- a diagram, e.g. the ohm's law triangle, unless the rest of the answer shows clearly that the candidate understands the relationships involved.

3.5 Marking procedure for calculations

3.5.1 Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown.
However:

- if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column;
- if the answer is correct, but an incorrect relationship is written in the working, then no marks can be awarded (see 3.5.2).

3.5.2 Where calculations are based on incorrectly recalled relationships, neither the incorrectly recalled relationship, nor the resulting calculation based on the incorrect relationship, will be credited.

3.6 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

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4.6.2.4 Uses and applications of electromagnetic waves

3.7 Errors carried forward

There should be no error carried forward from a previous answer which has been based on wrong science. Any error in the answers to a structured question should be penalised once only.

Examples

(a) A candidate who calculates average speed using speed = time/distance **and** then proceeds to use this incorrect answer to calculate an acceleration based on the correct quantitative relationship should be given credit for the use of the correct acceleration relationship but none for either numerical answer.

(b) A candidate who incorrectly calculates average speed using speed = distance/time and then proceeds to use this incorrect value to calculate an acceleration based on the correct quantitative relationship, should be given credit for the use of both correct quantitative relationships **and** for the correct substitution and use of the incorrect value in the calculation of the rate of acceleration.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.8 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.9 Brackets

(…..) is used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.10 Interpretation of marginal points

There will be times when the answer is almost, but not quite, correct. Some examiners would award a mark while others would not. In any one script, an attempt should be made to balance these nearly correct answers by giving the mark on some occasions but not on others. If this is not done, the marking would end up being too lenient or too harsh.

3.11 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

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4.6.2.4 Uses and applications of electromagnetic waves

Double Award
Foundation Tier 3462/3F

3462/3F Q1

question	answers	extra information	mark
(a)	comet	correct order only	1
	elliptical		1
	Milky Way		1
	Universe		1
(b)(i)	D A C B	allow **2** marks for two letters in the correct place allow **1** mark for one letter in the correct place	3
(ii)	A		1
total			8

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4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q2

question	answers	extra information	mark
(a)	95		1
(b)	alpha	accept correct symbol	1
(c)	any **two** from: • radiation is outside the body • radiation will not reach (living) cells • radiation absorbed by the air	 accept detector is on ceiling or high up the wall accept radiation cannot pass through the body / skin accept cannot pass through the plastic casing do **not** accept because it is alpha radiation – unless qualified do **not** accept does not give off harmful substance do **not** accept cannot pass through building materials etc.	2
(d)	less (than)		1
total			5

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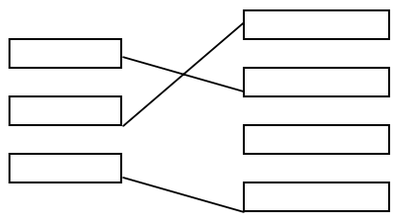
4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q3

question	answers	extra information	mark
(a)	generator	accept dynamo accept alternator	1
(b)(i)	1400	ignore units	1
(ii)	0.3 or 30%	any incorrect unit penalise **1** mark allow **1** mark for the correct use of 600 **or** 0.3% **or** 30	2
(c)	**1** mark for each correct link 	if more than 3 lines are drawn, mark only 3 lines starting with those that are incorrect	3
(d)(i)	110	no tolerance	1
(ii)	12	no tolerance	1
(iii)	wind speed may be too low to operate the generator	accept wind may not always blow accept power depends on wind speed accept does not generate if wind speed is too high accept does not generate if wind speed is above 12 (m/s) accept does not generate if wind speed is below 1.6 (m/s) accept it is unreliable do **not** accept answers referring to cost only	1
total			10

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4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q4

question	answers	extra information	mark
(a)	B E A D	allow **1** mark for each letter in the correct place, to a maximum of **3** marks	3
(b)	(a spark) may cause the (petrol vapour) to explode / ignite	accept petrol for (petrol vapour) accept catch fire for explode	1
	connect tanker to earth with a (conducting) wire / chain **or** earth the tanker	accept ground for earth	1
(c)	**Quality of written communication**	for a logical sequence	1
	any **two** from:		2
	• when current greater than fuse rating / value	accept when current too great for appliance do **not** accept 'if there is too much current' do **not** accept voltage or electricity	
	• fuse (becomes hot and) melts / burns out	accept fuse blows / breaks	
	• circuit is broken	accept circuit switched off this cannot score credit on its own	
total			8

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4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q5

question	answers	extra information	mark
(a)(i)	crust		1
(ii)	inner core is <u>solid</u> outer core is liquid	do **not** accept just rock inner core is denser / hotter than outer core gets **2** marks accept one is solid and one is liquid for **1** mark accept they are different densities for **1** mark wrong way round = **0** marks	1 1
(b)	seismograph		1
(c)	difficult to measure (slow) movement (1) of plates (1) dependent mark **or** difficult to measure friction / forces (1) between plates (1) dependent mark		1 1
(d)	geothermal		1
(e)(i)	5000		1
(ii)	2500		1
total			9

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4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q6

question	answers	extra information	mark
(a)	60		1
(b)	$5\frac{1}{2}$ hours	must include unit	1
(c)	30		1
(d)	30 minutes or $\frac{1}{2}$ hour	must include unit	1
(e)	D **and** E least steep part of the graph	accept finish for E accept correct numbers from axes with units accept covers smallest distance in a set time accept only moves 5 km in $1\frac{1}{2}$ hours (accept anything between 5 and 6) ignore horse is tired	1 1
total			6

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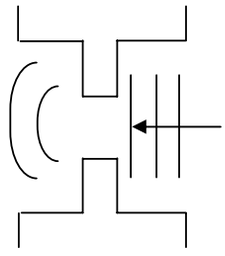
4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q7

question	answers	extra information	mark
(a)(i)	any **one** from: • (doctors) to see inside a patients body **or** endoscope • telephone cables • optical fibre / fibre optic lamps **or** (artificial) Christmas trees • data transfer **or** internet connection	 accept keyhole surgery do **not** accept flex **or** wires for cable accept decorative / ornamental lighting accept any feasible practical suggestion for taking light to a difficult to access place do **not** accept lighting unqualified do **not** accept lamp unqualified do **not** accept communications unless clarified	1
(ii)	(incident) ray angle greater than critical angle total internal reflection occurs	either order accept (incident) ray greater than 42° accept TIR do **not** accept just description of TIR	1 1
(b)(i)	waves shown diffracting in the correct direction 	ignore wavelength	1
(ii)	diffraction	accept diffract / diffracted	1
total			5

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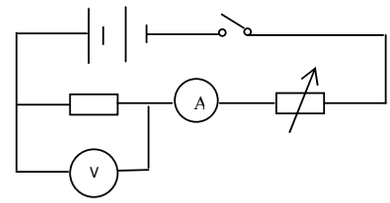
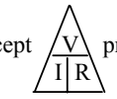
4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q8

question	answers	extra information	mark
(a)	all symbols correct	 accept push switch symbol switch may be open or closed any lines through symbols = **0** marks	1
	correct circuit drawn voltmeter must be across resistor only	polarity of cells not relevant provided they are joined correctly two cells are required in the diagram ignore the order of the components allow small gaps in circuit omission of any component = **0** marks	1
(b)(i)	potential difference = current × resistance	accept voltage or p.d. for potential difference accept $V = I \times R$ accept  provided subsequent use correct do **not** accept C for current	1
(ii)	2	allow **1** mark for correct substitution wrong working loses both marks	2
(iii)	straight line drawn <u>through the origin</u> straight line passes through $I = 0.4, V =$ their (b)(ii) / 2 **and** 0.0	judge by eye this mark may be awarded if all points shown including these points are correct even if no line is drawn N.B. a curve scores **0** marks	1 1 dep
(c)	temperature <u>increases</u>	accept filament lamp / it gets <u>hotter</u> allow heat for temperature	1
total			8

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4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q9

question	answers	extra information	mark
(a)(i)	gamma rays	accept gamma accept correct symbol	1
(ii)	infra red	accept IR	1
(b)	ultraviolet absorbed by ink (energy) given out as light	 accept glows / luminous accept for **both** marks the ink is fluorescent do **not** accept answers in terms of uv being reflected	1 1
(c)	any **two** from: • UV can damage / kill / ionise / alter (normal) cells • change DNA structure **or** mutate • (normal) cells may become cancerous	 do **not** accept attacks cells **or** burns skin accept may cause (skin) cancer accept abnormal cell multiplication	2
(d)(i)	microwaves **and** infra red	both answers needed in either order do **not** accept heat for IR	1
(ii)	0.9	allow **1** mark for the correct use of 1.8 (kW) $(1.8 \times \frac{1}{2}$ or $1.8 \times 30)$ i.e. adding the correct 2 power values	2
total			9

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4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q10

question	answers	extra information	mark
(a)(i)	accelerating	accept getting faster accept speed / velocity increasing	1
(ii)	acceleration increases	accept velocity / speed increases more rapidly do **not** accept velocity / speed increases	1
(b)(i)	$\text{acceleration} = \frac{\text{change in velocity}}{\text{time (taken)}}$	accept $a = \frac{v - u}{t}$ **or** $a = \frac{v_1 - v_2}{t}$ do **not** accept velocity for change in velocity do **not** accept change in speed do **not** accept $a = \frac{v}{t}$	1
(ii)	15	allow **1** mark for an answer of 900 **or** for correct use of 540 seconds	2
(iii)	velocity includes direction	accept velocity is a vector (quantity) accept converse answer	1
(c)	force of gravity (between shuttle and Earth) plus correct orbital speed (makes shuttle move in a curve)	accept gravitational pull if used correctly accept forward motion **or** constant speed for orbital speed accept it is travelling fast enough accept for **2** marks the force of gravity provides the centripetal force	1 1
(d)	black is a good emitter of radiation **or** to limit the temperature rise inside the shuttle	accept heat for radiation accept the tiles are good insulation do **not** accept black absorbs heat on its own do **not** accept tiles are heat proof	1
total			9

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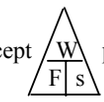
4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q11

question	answers	extra information	mark
(a)(i)	work (done) = force (applied) × distance (moved)	accept W = F × s or W = F × d accept  provided subsequent method is correct	1
(ii)	240 000 joules	allow **1** mark for correct substitution **or** correct use of 1200 (N) accept J do **not** accept j / Nm	2 1
(b)	800 (watts)	accept 0.8 kW accept their (a)(ii) ÷ 300 correctly evaluated for **2** marks allow **1** mark for correct substitution (a)(ii) ÷ 5 correctly evaluated for **1** mark	2
(c)(i)	any **one** from: • needs to raise the chair / lift • lifting more than one chair • energy transfer to the surroundings correctly qualified	 allow lifting more than 2 people implication of a heavier weight accept loss for transfer do **not** accept motor inefficient do **not** accept motor gets hot do **not** accept friction unless the location is specified as external to the motor	1
(ii)	electrical potential	accept electric **both** answers required for the mark	1
total			8

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4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q12

question	answers	extra information	mark
(a)	**Y** and **Z**		1
	they have the same number of protons **or** same atomic number	accept they have the same number of electrons **or** same number of protons **and** electrons allow only different in number of neutrons N.B. independent marks	1
(b)	**Quality of written communication**	for correct use of terms underlined in B **or** C Q ✓ Q X	1
	A – alpha particle passes straight through the empty space of the atom **or** it is a long way from the nucleus B – alpha particle deflected / repelled / repulsed by the (positive) nucleus C – alpha particle heading straight for the nucleus is deflected / repelled / repulsed backwards	describes 3 tracks correctly for **2** marks describes 2 or 1 track correctly for **1** mark do **not** accept hits the nucleus do **not** accept answers referring to refraction do **not** accept answers in terms of reflected backwards unless qualified in terms of repulsion mention of difference in charge on nucleus negates that track	max 2
total			5

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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Physics 3451/F
Specification B

Mark Scheme

2005 examination – June series

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Physics (Specification B)
Foundation Tier 3451/F

3451/F Q1

question	answers	extra information	mark
(a)(i)	less than	accept any correct indication	1
(ii)	more than	accept any correct indication	1
(b)	any **two** from: stays above the same place above the equator one orbit takes 24 hours	 do **not** accept stays in the same place do **not** accept goes around equator unless qualified do **not** accept orbit at same speed as Earth do **not** accept orbit at a constant speed accept has same angular speed / velocity as Earth	2
total			4

3451/F Q2

question	answers	extra information	mark
(a)	comet		1
(b)	large group / number / collection of stars	ignore reference to planets accept millions of stars do **not** accept thousands of stars do **not** accept loads of stars	1
(c)	giant supernova neutron		1 1 1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q3

question	answers	extra information	mark
(a)(i)	radio		1
(ii)	gamma	accept microwave accept infrared	1
(iii)	ultra violet		1
(iv)	microwaves		1
(b)	the same as		1
(c)	X-rays do not go through lead	references to gamma rays are incorrect accept lead protects them from the X-rays accept not exposed to X-rays	1
	lead stops / reduces risk of X-rays harming / damaging / killing (persons) <u>cells</u>	accept X-rays (may) cause cancer accept organs for cell do **not** accept references to electric shock do **not** accept stops bones of people showing on X-ray answers involving the horse wearing an apron are incorrect	1
	Quality of written communication	award for a sensible sequence of **two** points	1
total			8

4.6.2.4 Uses and applications of electromagnetic waves

Physics B – AQA GCSE Mark Scheme, 2005 June series

3451/F Q4

question	answers	extra information	mark
(a)	light electrical		1 1
(b)	15% **or** 0.15	correct substitution gains **1** mark only an answer of 15 with no unit **or** an incorrect unit gains **1** mark an answer of 0.15 given with a unit gains **1** mark	2
(c)	the ticket machine is a long way from other electricity supplies		1
(d)	any figure between 5 and 10 inclusive	unit not required but if given must match numerical answer	1
total			6

3451/F Q5

question	answers	extra information	mark
(a)(i)	radon (gas)	do **not** accept gas	1
(ii)	background		1
(b)	bigger	accept any word which means bigger	1
(c)	**Z** alpha will not pass through aluminium or lead	if Z is not given, the reason does not score accept alpha cannot go through metals / dense material accept there is nothing to stop the radiation accept alpha will not pass through aluminium do **not** accept alpha will not pass through lead do **not** accept alpha stopped by air	1 1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q6

question	answers	extra information	mark
(a)	loses negative charge / electrons	do **not** accept positive charge transfers to the comb do **not** accept friction	1
(b)	**A** attract		1
	B repel		1
	C attract		1
(c)	**F A D E**	allow **2** marks for 2 letters in the correct place allow **1** mark for 1 letter in the correct place	3
total			7

4.6.2.4 Uses and applications of electromagnetic waves

Physics B – AQA GCSE Mark Scheme, 2005 June series

3451/F Q7

question	answers	extra information	mark
(a)	all points correctly plotted	tolerance ± $\frac{1}{2}$ square on y axis only allow **1** mark for 3 correctly plotted points	2
	attempt made to draw a smooth curve	do **not** accept dot-to-dot line	1
(b)(i)	3 days ± 0.2 **or** any value correctly obtained using their graph line	if no line drawn in (a), answer must be exactly 3	1
(ii)	3 days or their (b)(i)		1
(c)	radon-222	accept radon **or** 222 accept alpha or 3.8 correct isotope required for reason to score	1
	has the shortest half-life	accept the others have longer half-lives	1
total			7

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q8

question	answers	extra information	mark
(a)	fossils of Cynognathus are found in Africa and South America		1
	the shapes ……. almost fit together	only two boxes should be ticked deduct **1** mark for each additional box to a minimum mark of **0**	1
(b)	continental		1
	crust		1
	tectonic		1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

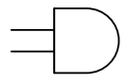
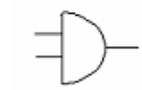
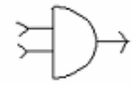
3451/F Q9

question	answers	extra information	mark
(a)	capacitor	accept condenser	1
	LDR	**or** light dependent resistor accept 'ldr', 'Ldr' etc.	1
	relay (normally open)	do **not** accept 'relay normally closed'	1
(b)(i)	battery	accept '(battery of) cells' do **not** accept 'battery / cell'	1
(ii)	LED	**or** light emitting diode accept 'led' or 'Led' do **not** accept just 'diode'	1
(iii)	B will light (but C will not)	accept '(only) B will work' accept 'one is on the other is off' do **not** accept 'C is on and B is off'	1
(iv)	any **one** from: B is connected the right way round (and C is not) a (light emitting) diode only allows (a significant) current to flow in one direction B's anode is connected to the positive side of the supply B's cathode is connected to the negative terminal	N.B. the candidate's answer to part (b)(iii) may include this mark but do **not** credit if the response to part (b)(iii) is incorrect or there is any other contradiction if (iv) is completely consistent with (iii) which is wrong, allow **1** mark	1
(c)(i)	first input / second input / output 0 / 0 / **0** 1 / 0 / **0** 0 / 1 / **0** 1 / 1 / **1**	**all** correct allow: OFF NO OFF NO OFF NO ON YES	1
(ii)	truth (table)		1

cont…

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q9 cont…

(iii)		a Roman upper case D in any orientation without contacts is acceptable but if contacts are shown do **not** give the mark if there is any ambiguity or contradiction allow  	1
(d)	light sensor	**or** light dependent resistor **or** LDR accept 'ldr', Ldr' etc allow solar cell, photo cell	1
	NOT gate	accept 'Not gate' **or** 'not gate' if both correct but in the wrong order credit with **1** mark	1
total			12

4.6.2.4 Uses and applications of electromagnetic waves

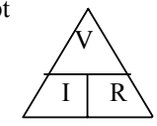
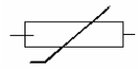
Physics B – AQA GCSE Mark Scheme, 2005 June series

3451/F Q10

question	answers	extra information	mark
(a)(i)	rays continued to meet on the right hand side of the lens and beyond	must be straight lines from the right hand side of the lens ignore details through the lens allow if no arrows	1
	meet exactly on the axis	negate mark if contradictory arrow(s) added do not need to go beyond the focus for this mark	1
(ii)	(principal) focus	**or** focal (point)	1
(iii)	converging	**or** convex	1
(b)(i)	**A**		1
(ii)	rays seem to come from this point	**or** words to this effect **or** shows this on the diagram	1
(iii)	diverging	**or** concave	1
(c)	film	accept any unambiguous method of showing the correct response	1
	smaller than		1
	further away from		1
(d)	any **three** from: • real image can be put on a screen • virtual image cannot be put on a screen / film • virtual image is imaginary • real image is formed where (real) rays cross / converge • virtual image is where virtual / imaginary rays (seem to) come from • virtual image formed where virtual rays intersect / cross	allow film allow real image has light travelling through it **or** virtual image is where rays seem to come from	3
total			13

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q11

question	answers	extra information	mark
(a)(i)	$A_1 = 0.5$ $A_4 = 0.5$	ignore any units allow **1** mark for $A_1 = A_4 \neq 0.5$	1 1
(ii)	the resistance of **P** is more than 20 Ω a smaller current goes through P / A_2 (than 20 Ω)	 dependent on getting 1st mark correct accept converse	1 1
(b)(i)	potential difference = current × resistance	accept pd / voltage for potential difference accept V = I × R, correct symbols and correct case only accept volts = amps × ohms accept  provided subsequent method is correct allow combination of physical quantities and named units allow voltage = I × R	1
(ii)	6	allow **1** mark for correct substitution	2
(iii)	6	accept their (b)(ii)	1
(c)	thermistor or  resistance goes down (as temperature of thermistor goes up)	accept correct circuit symbol allow phonetic spelling do **not** accept changes for goes down do **not** accept an answer in terms of current only answers in terms of other components are incorrect	1 1
total			10

4.6.2.4 Uses and applications of electromagnetic waves

Physics B – AQA GCSE Mark Scheme, 2005 June series

3451/F Q12

question	answers	extra information	mark
(a)(i)	larger the distance, greater the time	accept 'they are proportional' accept converse	1
(ii)	any value between 6 and 9 years inclusive		1
(b)(i)	carbon dioxide		1
(ii)	(Venus) has high**er** temperature (than Mercury)	accept has the high**est** temperature accept Venus is hotter / hottest do **not** accept has a high / very high temperature	1
	(Venus) further from the Sun than Mercury	accept 'Venus is not the closest planet to the Sun' answer in terms of greenhouse effect only, scores **0** marks	1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q13

question	answers	extra information	mark
(a)(i)	20		1
(ii)	convection		1
(iii)	fit draughtproof strips	accept lay carpet accept fit curtains accept close doors / windows / curtains accept any reasonable suggestion for reducing a draught 'double glazing' alone is insufficient	1
(b)	air is (a good) insulator **or** air is a poor conductor	accept air cavity / 'it' for air	1
	reducing heat transfer by <u>conduction</u>	accept stops for reduces ignore convection do **not** accept radiation do **not** accept answers in terms of heat being trapped	1
(c)(i)	most cost effective	accept it is cheaper or low<u>est</u> cost accept shortest payback time accept in terms of reducing heat loss by the largest amount do **not** accept it is easier ignore most heat is lost through the roof	1
(ii)	4		1
total			7

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q14

question	answers	extra information	mark
(a)(i)	constant speed	do **not** accept normal speed do **not** accept it is stopped / stationary	1
	in a straight line	accept any appropriate reference to a direction constant velocity gains **2** marks 'not accelerating' gains **2** marks terminal velocity alone gets **1** mark	1
(ii)	goes down owtte	accept motorbike (it) slows down	1
(b)(i)	20 (m/s)	ignore incorrect units	1
(ii)	acceleration = change in velocity / time (taken)	do **not** accept velocity for change in velocity accept change in speed accept $a = \frac{v-u}{t}$ **or** $a = \frac{v_1 - v_2}{t}$ **or** a = $\frac{\Delta v}{t}$ do **not** accept $a = \frac{v}{t}$	1
(iii)	4 **or** their (b)(i) ÷ 5	allow **1** mark for correct substitution	2
	m/s^2	m/s/s **or** ms^{-2} **or** metres per second squared **or** metres per second per second	1
(c)	vehicle may skid / slide	loss of control / brakes lock / wheels lock accept greater stopping distance **or** difficult to stop	1
	due to reduced friction (between tyre(s) and road)	accept due to less grip do **not** accept no friction	1

cont…

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q14 cont…

(d)	any **three** from: • <u>increased</u> speed • <u>reduced</u> braking force • <u>slower</u> (driver) reactions • <u>poor</u> vehicle maintenance • <u>increased</u> mass / weight of vehicle • <u>poor</u> road surface • <u>more</u> streamlined	do **not** accept night time / poor vision N.B. specific answers may **each** gain credit eg tiredness (1), drinking alcohol (1), using drugs (1), driver distracted (1) etc specific examples may **each** gain credit eg worn brakes or worn tyres etc accept large mass / weight of vehicle if candidates give three answers that affect stopping distance but not specific to <u>increase</u> award **1** mark only	3
total			13

4.6.2.4 Uses and applications of electromagnetic waves

Physics B – AQA GCSE Mark Scheme, 2005 June series

3451/F Q15

question	answers	extra information	mark
(a)(i)	arrow from centre of the ball **and** at right angles to the string **and** in the correct direction	arrow should point to the student's belt accept free-hand 'straight' line do **not** accept curved line	1
(ii)	increase increase increase	accept 'be stronger / bigger' accept 'be stronger / bigger' accept 'be stronger / bigger'	1 1 1
(b)	speed velocity direction	all **three** correct any two correct for **1** mark otherwise **0** marks	2
(c)(i)	centripetal	accept 'centripedal' and other minor misspellings do **not** accept anything which could be 'centrifugal'	1
(ii)	gravity	accept 'weight' accept 'force of attraction due to mass(es) (of the Moon and the Earth)'	1
(iii)	electron(s)		1
(iv)	electrostatic	accept 'electrical' do **not** accept just 'centripetal'	1
total			10

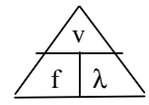
4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q16

question	answers	extra information	mark
(a)(i)	**X** at the centre of the lifebelt	measuring from the centre of **X**, allow 2 mm tolerance in any direction	1
(ii)	any **two** from: below the point of suspension at the centre (of the lifebelt) (because) the lifebelt / it is symmetrical	if X is on vertical line below the hanger (but not at centre) can gain the first point only accept '(vertically) below **Y**' accept 'in the middle' **or** (because) the mass / weight is evenly distributed	2
(b)	Nm **or** newton metre(s) 750	accept Newton metre(s) do **not** accept any ambiguity in the symbol ie NM, nM or nm (moment) = force × (perpendicular) distance (between line of action and pivot) **or** (moment) = 500 × 1.5 gains **1** mark	1 2
(c)	**Quality of written communication**: any **three** connected points from: low(er) <u>centre of mass / gravity</u> (more) <u>stable</u> less likely to fall over the <u>turning effect / moment</u> (of the weight of case) is less so the pull on her arm is less	for **2** of the underlined terms used in the correct context **or** <u>centre of mass / gravity</u> will be close(r) to the wheels / axle / ground **or** less <u>unstable</u> accept 'less likely to overturn' do **not** accept 'will not fall over' **or** so less effort is needed to hold the case ignore references to pulling the case	1 3
total			10

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q17

question	answers	extra information	mark
(a)	any **two** from: • **amplitude** decreasing • **wavelength** increasing • **frequency** decreasing **Quality of written communication**	accept siren / sound getting quieter do **not** accept sound decreases accept pitch decreasing ignore reference to transverse wave ignore reference to speed contradictory statements within each point lose the mark all emboldened terms in candidate's answer used correctly	2 1
(b)(i)	ultrasound **or** ultrasonic		1
(ii)	wave speed = frequency × wavelength	accept speed / velocity for wave speed accept $v = f \times \lambda$ do **not** accept w for λ do **not** accept s for v accept  provided subsequent calculation shows a correct method	1
(iii)	339.2 **or** 340 **or** 339	allow **1** mark for using 212 000 allow **1** mark for correct substitution an answer of 0.3392 **or** 0.34 **or** 0.339 gains **1** mark only award full credit for a correct numerical answer with the unit changed to km/s	3
total			8

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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Science: Double Award 3462/3F
Specification B (Co-ordinated)

Mark Scheme

2005 examination - June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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4.6.2.4 Uses and applications of electromagnetic waves

Double Award
Foundation Tier 3462/3F

3462/3F Q1

question	answers	extra information	mark
(a)(i)	less than	accept any correct indication	1
(ii)	more than	accept any correct indication	1
(b)	any **two** from: stays above the same place above the equator one orbit takes 24 hours	 do **not** accept stays in the same place do **not** accept goes around equator unless qualified do **not** accept orbit at same speed as Earth do **not** accept orbit at a constant speed accept has same angular speed / velocity as Earth	2
total			4

3462/ 3F Q2

question	answers	extra information	mark
(a)	comet		1
(b)	large group / number / collection of stars	ignore reference to planets accept millions of stars do **not** accept thousands of stars do **not** accept loads of stars	1
(c)	giant supernova neutron		1 1 1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q3

question	answers	extra information	mark
(a)(i)	radio		1
(ii)	gamma	accept microwave accept infrared	1
(iii)	ultra violet		1
(iv)	microwaves		1
(b)	the same as		1
(c)	**Quality of written communication**	award for a sensible sequence of **two** points	1
	X-rays do not go through lead	accept lead protects them from the X-rays accept not exposed to X-rays	1
	lead stops / reduces risk of X-rays harming / damaging / killing (persons) <u>cells</u>	accept X-rays (may) cause cancer accept organs for cell do **not** accept references to electric shock do **not** accept stops bones of people showing on X-ray answers involving the horse wearing an apron are incorrect references to gamma rays are incorrect	1
total			8

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2005 June series

3462/3F Q4

question	answers	extra information	mark
(a)	light electrical		1 1
(b)	15% **or** 0.15	correct substitution gains **1** mark only an answer of 15 with no unit **or** an incorrect unit gains **1** mark an answer of 0.15 given with a unit gains **1** mark	2
(c)	the ticket machine is a long way from other electricity supplies		1
(d)	any figure between 5 and 10 inclusive	unit not required but if given must match numerical answer	1
total			6

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q5

question	answers	extra information	mark
(a)(i)	radon (gas)	do **not** accept gas	1
(ii)	background		1
(b)	bigger	accept any word which means bigger	1
(c)	**Z** alpha will not pass through aluminium or lead	if Z is not given, the reason does not score accept alpha cannot go through metals / dense material accept there is nothing to stop the radiation accept alpha will not pass through aluminium do **not** accept alpha will not pass through lead do **not** accept alpha stopped by air	1 1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2005 June series

3462/3F Q6

question	answers	extra information	mark
(a)	loses negative charge / electrons	do **not** accept positive charge transfers to the comb do **not** accept friction	1
(b)	**A** attract		1
	B repel		1
	C attract		1
(c)	**F A D E**	allow **2** marks for 2 letters in the correct place allow **1** mark for 1 letter in the correct place	3
total			7

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q7

question	answers	extra information	mark
(a)	all points correctly plotted	tolerance ± $\frac{1}{2}$ square on y axis only allow **1** mark for 3 correctly plotted points	2
	attempt made to draw a smooth curve	do **not** accept dot-to-dot line	1
(b)(i)	3 days ± 0.2 **or** any value correctly obtained using their graph line	if no line drawn in (a), answer must be exactly 3	1
(ii)	3 days or their (b)(i)		1
(c)	radon-222	accept radon **or** 222 accept alpha or 3.8 correct isotope required for reason to score	1
	has the shortest <u>half-life</u>	accept the others have longer <u>half-lives</u>	1
total			7

4.6.2.4 Uses and applications of electromagnetic waves

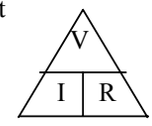
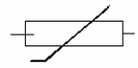
Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2005 June series

3462/3F Q8

question	answers	extra information	mark
(a)	fossils of Cynognathus are found in Africa and South America		1
	the shapes ……. almost fit together	only two boxes should be ticked deduct **1** mark for each additional box to a minimum mark of **0**	1
(b)	continental		1
	crust		1
	tectonic		1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q9

question	answers	extra information	mark
(a)(i)	$A_1 = 0.5$ $A_4 = 0.5$	ignore any units allow **1** mark for $A_1 = A_4 \neq 0.5$	1 1
(ii)	the resistance of **P** is more than 20 Ω a smaller current goes through P / A_2 (than 20 Ω)	 dependent on getting 1st mark correct accept converse	1 1
(b)(i)	potential difference = current × resistance	accept pd / voltage for potential difference accept V = I × R, correct symbols and correct case only accept volts = amps × ohms accept  provided subsequent method is correct allow combination of physical quantities and named units allow voltage = I × R	1
(ii)	6	allow **1** mark for correct substitution	2
(iii)	6	accept their (b)(ii)	1
(c)	<u>thermistor</u> or  <u>resistance</u> goes down (as temperature of thermistor goes up)	accept correct circuit symbol allow phonetic spelling do **not** accept changes for goes down do **not** accept an answer in terms of current only answers in terms of other components are incorrect	1 1
total			10

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2005 June series

3462/3F Q10

question	answers	extra information	mark
(a)(i)	larger the distance, greater the time	accept 'they are proportional' accept converse	1
(ii)	any value between 6 and 9 years inclusive		1
(b)(i)	carbon dioxide		1
(ii)	(Venus) has high**er** temperature (than Mercury)	accept has the high**est** temperature accept Venus is hotter / hottest do **not** accept has a high / very high temperature	1
	(Venus) further from the Sun than Mercury	accept 'Venus is not the closest planet to the Sun' answer in terms of greenhouse effect only, scores **0** marks	1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q11

question	answers	extra information	mark
(a)(i)	20		1
(ii)	convection		1
(iii)	fit draughtproof strips	accept lay carpet accept fit curtains accept close doors / windows / curtains accept any reasonable suggestion for reducing a draught 'double glazing' alone is insufficient	1
(b)	air is (a good) insulator **or** air is a poor conductor	accept air cavity / 'it' for air	1
	reducing heat transfer by <u>conduction</u>	accept stops for reduces ignore convection do **not** accept radiation do **not** accept answers in terms of heat being trapped	1
(c)(i)	most cost effective	accept it is cheaper or low<u>est</u> cost accept shortest payback time accept in terms of reducing heat loss by the largest amount do **not** accept it is easier ignore most heat is lost through the roof	1
(ii)	4		1
total			7

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2005 June series

3462/3F Q12

question	answers	extra information	mark
(a)(i)	constant speed	do **not** accept normal speed do **not** accept it is stopped / stationary	1
	in a straight line	accept any appropriate reference to a direction constant velocity gains **2** marks 'not accelerating' gains **2** marks terminal velocity alone gets **1** mark	1
(ii)	goes down owtte	accept motorbike (it) slows down	1
(b)(i)	20 (m/s)	ignore incorrect units	1
(ii)	acceleration = change in velocity / time (taken)	do **not** accept velocity for change in velocity accept change in speed accept $a = \frac{v-u}{t}$ **or** $a = \frac{v_1 - v_2}{t}$ **or** $a = \frac{\Delta v}{t}$ do **not** accept $a = \frac{v}{t}$	1
(iii)	4 **or** their (b)(i) ÷ 5	allow **1** mark for correct substitution	2
	m/s^2	m/s/s **or** ms^{-2} **or** metres per second squared **or** metres per second per second	1
(c)	vehicle may skid / slide	loss of control / brakes lock / wheels lock accept greater stopping distance **or** difficult to stop	1
	due to reduced friction (between tyre(s) and road)	accept due to less grip do **not** accept no friction	1

cont…

4.6.2.4 Uses and applications of electromagnetic waves

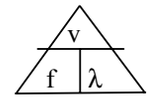
3462/3F Q12 cont…

(d)	any **three** from: • <u>increased</u> speed • <u>reduced</u> braking force • <u>slower</u> (driver) reactions • <u>poor</u> vehicle maintenance • <u>increased</u> mass / weight of vehicle • <u>poor</u> road surface • <u>more</u> streamlined	do **not** accept night time / poor vision NB specific answers may **each** gain credit eg tiredness (1), drinking alcohol (1), using drugs (1), driver distracted (1) etc specific examples may **each** gain credit eg worn brakes or worn tyres etc accept large mass / weight of vehicle if candidates give three answers that affect stopping distance but not specific to <u>increase</u> award **1** mark only	3
total			13

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2005 June series

3462/3F Q13

question	answers	extra information	mark
(a)	**Quality of written communication**	all emboldened terms in candidate's answer used correctly	1
	any **two** from: • **amplitude** decreasing • **wavelength** increasing • **frequency** decreasing	accept siren / sound getting quieter do **not** accept sound decreases accept pitch decreasing ignore reference to transverse wave ignore reference to speed contradictory statements within each point lose the mark	2
(b)(i)	ultrasound **or** ultrasonic		1
(ii)	wave speed = frequency × wavelength	accept speed / velocity for wave speed accept $v = f \times \lambda$ do **not** accept w for λ do **not** accept s for v accept  provided subsequent calculation shows a correct method	1
(iii)	339.2 **or** 340 **or** 339	allow **1** mark for using 212 000 allow **1** mark for correct substitution an answer of 0.3392 **or** 0.34 **or** 0.339 gains **1** mark only award full credit for a correct numerical answer with the unit changed to km/s	3
total			8

Version 1.0: 0906

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Physics 3451/F
Specification B

Mark Scheme

2006 examination - June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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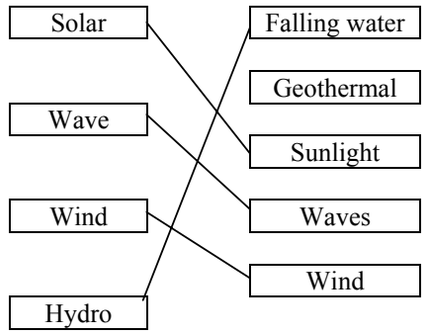
4.6.2.4 Uses and applications of electromagnetic waves

Physics (Specification B)
Foundation Tier 3451/F

3451/F Q1

question	answers	extra information	mark
(a)	4 correct lines drawn  	**1** mark for each correct line if more than 4 lines are drawn mark incorrect ones first. Mark only 4 lines	4
(b)	4		1
(c)(i)	nuclear		1
(ii)	(natural) gas	do **not** accept natural	1
total			7

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q2

question	answers	extra information	mark
(a)(i)	ultra violet		1
(ii)	kill the cells	accept destroys the cells accept makes cells cancerous accept damage cells accept harms cells accept changes DNA accept cause cells to mutate accept skin cells for cells accept cause cancer do **not** accept skin for cells do **not** accept burns the cells	1
(b)(i)	the sunbed uses an alternating current (a.c.) supply		1
(ii)	10.8	accept **1** mark for correct substitution of power in W or kW and time in hours or seconds	2
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q3

question	answers	extra information	mark
(a)(i)	M		1
(ii)	K		1
(iii)	J		1
(iv)	O		1
(b)(i)	billions of years		1
(ii)	red giant	any answer in terms of explosion or supernova is **incorrect**	1
	contracts / shrinks to	incorrect reference to black hole negates **1** mark	1
	white dwarf		1
total			8

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q4

question	answers	extra information	mark
(a)(i)	A and C	**both** answers must be correct in either order	1
(ii)	A and B	**both** answers must be correct in either order	1
(iii)	same number of protons plus neutrons **or** same number of nucleons	accept number of particles in nucleus the same do **not** accept they add up to 6 unless qualified	1
(b)(i)	any **two** from: • boron - 12 • carbon - 14 • oxygen - 15 • lead - 209	**both** required both name **and** number must be given	1
(ii)	any **two** from: • boron - 11 • carbon - 12 • oxygen - 16 • lead - 207	**both** required both name **and** number must be given	1
(c)	alpha		1
total			6

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q5

question	answers	extra information	mark
(a)	(good) insulator	accept does not conduct (electricity) accept does not conduct heat or electricity do **not** accept does not conduct heat outside is tough is insufficient	1
(b)	fuse		1
(c)	connect the green and yellow / earth wire	accept wires must be connected to screws	1
	swap the brown and blue wires round		1
total			4

3451/F Q6

question	answers	extra information	mark
(a)	fossils	answers can be in either order	1
	water		1
(b)	increased		1
(c)	radio telescope		1
total			4

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q7

question	answers	extra information	mark
(a)(i)	electrical		1
	kinetic	accept movement	1
(ii)	heat	answers can be in either order	1
	sound		1
(b)(i)	360	accept **1** mark for correct substitution	2
(ii)	watt		1
(c)	the stairlift is not moving the stairlift is moving at constant speed	**both** answers are required for the mark	1
total			8

3451/F Q8

question	answers	extra information	mark
(a)(i)	(up) further **or** (up) faster	any reference to downwards movement loses credit accept <u>with</u> more force accept motion would increase	1
(ii)	down	accept the opposite way accept drop	1
(b)(i)	direct current		1
(ii)	Z		1
total			4

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q9

question	answers	extra information	mark
(a)	level of radiation (detected) will not change	ignore reference to particles	1
	if thickness of aluminium changes	accept for **both** marks a specific example eg if the aluminium gets thicker the level of radiation detected stays the same. accept for **1** mark gamma will pass through aluminium	1
	QoWC for 2 points in a sensible sequence		1
(b)	S W T V	all in correct order accept **2** marks for 2 correct accept **1** mark for 1 correct	3
total			6

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q10

question	answers	extra information	mark
(a)	thermistor(s) LDR(s) switch(es) LED(s) buzzer(s) motor(s)	**1** mark each or light dependent resistor(s) or light emitting diode(s)	6
(b)(i)	1st input / 2nd input / Output 0 / 0 / **0** 1 / 0 / **0** 0 / 1 / **0** 1 / 1 / 1	all correct	1
(ii)	Input / Output 0 / **1** 1 / **0**	**both** correct	1
(iii)	1st input / 2nd input / Output 0 / 0 / 0 1 / 0 / **1** 0 / 1 / **1** 1 / 1 / **1**	all correct	1
(c)(i)		do **not** credit any attempt which could equally well be a poorly drawn attempt at the symbol for a cell	1
(ii)	charge increases	accept 'electrons' accept 'energy **or** gets bigger/larger	1 1
total			12

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q11

question	answers	extra information	mark
(a)(i)	A		1
(ii)	B		1
(iii)	mass is larger	credit if the response is clear by some other means e.g. it is ringed	1
	wire is shorter	credit if the response is clear by some other means e.g. it is ringed	1
(b)	moment		1
	distance		1
(c)(i)	1		1
(ii)	5		1
(iii)	any **two** from • remove slotted mass(es) • slide (slotted) masses / weights nearer pivot • slide forcemeter away from the pivot • slide rod to the left	 **or** ….. to the left **or** ….. to the right **or** …. so that the slotted masses side is shorter **or** …. so that the forcemeter side is longer	2
(d)	centre of the rectangle	accept *2*mm tolerance any direction	1
	centre of the circle	accept *2*mm tolerance any direction	1
	on centre line and 10mm above base	accept *2*mm tolerance any direction	1
total			13

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q12

question	answers	extra information	mark
(a)	0.05 (A)	ignore incorrect units if given accept 'the same' / 'the same as K' / 'the same as the other ammeter' do **not** accept 'same as the other meter'	1
(b)(i)	any **two** from: • two cells are joined + to +	answers in terms of current gain no marks accept one cell in the wrong way accept two cells are joined back-to-back accept two cells are joined – to – accept battery for cell do **not** accept answers in terms of all the cells or in terms of energy only	2
	• some of the cells potential difference is across the diode / ammeters / wires **or** the pd of the cells is shared by all components	accept voltage for pd do **not** accept using up pd	
	• the other components have a resistance	accept a named component / components / wire has a resistance	
	• cells not fully charged **or** cells partially run down	do **not** accept voltage of cells is less than 1.5 unless explained do **not** accept cells are not as powerful unless explained	
	• cells have an internal resistance		
(ii)	the diode has a (very) high resistance (in the reverse direction)		1
	a diode only conducts / allows current to flow in one direction	accept little / no current flows do **not** accept blocks / cuts flow	1

Continued

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q12

question	answers	extra information	mark
(c)	**QoWC** for the use of the word resistance	annotate Q✓ Q✗ accept resistant	1
	accept increase / change / decrease throughout question but a contradiction loses **one** mark with change as neutral		
	as the pd / current increases / changes	accept voltage for pd must be correctly linked to at least one of the following points accept	1
	the temperature of the filament increases / changes	lamp / bulb for filament accept filament becomes hotter	1
	increasing / changing the **resistance** of the lamp	accept for **1** mark only the filament lamp does not obey Ohm's law	1
total			9

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q13

question	answers	extra information	mark
(a)	0.5		1
	hertz	accept Hz but **not** HZ / hz / hZ accept (waves) per second **or** / sec **or** / s **or** s^{-1} **or** sec^{-1}	1
(b)	any **one** from: • any named part of the electromagnetic spectrum • S – waves / secondary waves • wave on a rope	 do **not** accept seismic waves / earthquake do **not** accept slinky unless clearly described	1
(c)	transverse – disturbance / vibration is perpendicular to the direction of energy transfer / wave travel	accept a correctly labelled diagram	1
	longitudinal – disturbance / vibration is parallel to the direction of energy transfer / wave travel	accept a correctly labelled diagram part explanation of the difference between transverse **and** longitudinal gains **1** mark	1
(d)(i)	TIR shown	needs to stay inside water jet ignore number of reflections **or** arrow heads lines straight by eye	1
(ii)	bigger than	any indication of correct answer	1
total			7

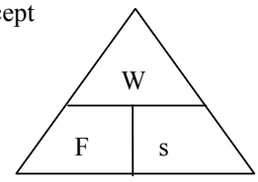
4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q14

question	answers	extra information	mark
(a)	W		1
	has only two states **or** is either on or off	accept discrete values only do **not** credit answer purely in terms of shape	1
(b)	any **one** from:		1
	• higher quality	accept clearer do **not** accept easier to read ignore faster accept <u>less</u> distortion **or** <u>less</u> weakening of signal strength do **not** accept no distortion / weakening on its own	
	• increased carrying capacity	accept more information can be sent **or** more channels	
	• errors can be rectified		
total			3

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q15

question	answers	extra information	mark
(a)(i)	all points plotted accurately	accept **1** mark for 5 correct plots ± ½ small square on stopping distance	2
	line of best fit must be continuous	accept attempt at a reasonable curve does not need to go through 0 0 do **not** accept a straight line do **not** accept dot-to-dot	1
(ii)	4 to 6 (metres)	accept ecf from (a)(i) accept **1** mark for value taken correctly from graph at 25mph **or** correct method shown	2
(b)(i)	0.7 (s)	incorrect unit = 0 marks	1
(ii)	constant speed / velocity	accept (continued as) 30mph accept did not change / stayed the same accept no acceleration	1
(iii)	3.3(s)	penalise incorrect unit once only	1
(iv)	reaction time <u>increases</u> / is <u>longer</u> **or** thinking distance <u>increases</u>	do **not** accept reaction time slower **or** reactions are slower	1
	stopping distance / it <u>increases</u>	do **not** accept travels at constant speed for longer	1
(c)(i)	work done = force (applied) × distance (moved)	accept W = F × s or W = F × d accept  provided subsequent method is correct	1

Continued

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q15

question	answers	extra information	mark
(ii) **E**	2100	accept 2.1 kilo accept **1** mark for using 7000 N	2
(iii)	2100 (joules)	accept their (c)(ii)	1
total			14

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q16

question	answers	extra information	mark
(a)(i)	refraction		1
(ii)	it changes speed **or** change in density	accept it speeds up do **not** accept it slows down do **not** accept air is more dense than glass	1
(b)(i)	sound / waves <u>diffract</u> through the gap (in the wall) **or** over the wall **or** because the gate is open	do **not** accept reflection this only scores if first marking point is given accept for **1** mark only sound / waves go through the gap and <u>spread out</u> **or** diagram showing wave fronts spreading out from open gates if diagram is labelled as diffraction both marks can be scored	1 1
(ii)	less diffraction	accept no diffraction accept gates <u>absorb</u> sound / noise / waves accept gates <u>reflect</u> sound / noise / waves do **not** accept rebounds / stops / blocks out	1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q17

question	answers	extra information	mark
(a)	both rays brought to a focus at F on the right	do **not** have to be continued beyond F	1
	lines have been drawn **accurately** with a ruler	only credit if 1st mark credited do **not** credit if contradictory arrow(s) added	1
(b)	rays seem to come from a focus at G on the left and continued to the right of the lens	this mark is for the current idea of divergence	1
	lines have been drawn **accurately** with a ruler	only credit if 1st mark credited do **not** credit if contradictory arrow(s) added	1
(c)	…lens… …image… …object… …image… ...object… …lens…	lens as 1st and 6th words (1) image and object in the correct order 2nd and 3rd words (1) image and object in correct order 4th and 5th words (1)	max 3
(d)(i)	correct statement about real image real rays intersect / cross to form a real image **or** a real image can be formed on a screen **or** real image is (always) on the opposite side (of the lens) **or** real image is (always) upside down (to the object)	may be credited from a correct diagram	1
	correct statement about virtual / imaginary image virtual / imaginary rays intersect / cross to form a virtual image **or** a virtual / imaginary image cannot **or** virtual / imaginary image is (always) on the same side (of the lens) **or** virtual / imaginary image is (always) same way up (as the object)	may be credited from a correct diagram	1

Continued

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q17

question	answers	extra information	mark
(ii)	**either** image needs to fall on / affect the film **or** image needs to fall on / affect the light sensors / charged coupled devices (CCDs) (in a digital camera / mobile phone) **or** image needs to cause a chemical reaction (in / on the film)		1
total			10

4.6.2.4 Uses and applications of electromagnetic waves

3451/F Q18

<table>
<tr><th>question</th><th>answers</th><th>extra information</th><th>mark</th></tr>
<tr><td>(a)</td><td>AND (gate)

OR (gate)

NOT (gate)

LED or light emitting diode</td><td>accept ‘and’

accept ‘or’

accept ‘not’ or invert gate

accept ‘led’</td><td>1

1

1

1</td></tr>
<tr><td>(b)(i)</td><td>NOT (gate) and AND (gate)</td><td>both in either order or ‘(the) gates’

any additions lose the mark</td><td>1</td></tr>
<tr><td>(ii)</td><td><table><tr><th>Switch for fire</th><th>Tilt switch</th><th>Signal to relay</th></tr><tr><td>0</td><td>0</td><td>…0…</td></tr><tr><td>0</td><td>1</td><td>…0…</td></tr><tr><td>1</td><td>0</td><td>…1…</td></tr><tr><td>1</td><td>1</td><td>…0…</td></tr></table></td><td>all correct

allow off or no
off no
on yes
off no</td><td>1</td></tr>
<tr><td>(iii)</td><td>(relay) acts as / is a switch

either
small current from the electronic / control circuit / system (1)

large current through the output / (electric) fire (1)

or

full current through electronic control system (1)

may damage components / lead to overheating / electric shock (1)

QoWC for correct use of the scientific term ‘current’</td><td>accept implication that it works as a switch e.g. ‘turns on fire’

or ‘small current through the coil (of the relay)’

do not accept small current is turned into a large current

annotate Q✓ Q×

if answer in terms of voltage isolation / voltage/ p.d. accept QoWC mark for correct use</td><td>1

1

1

1</td></tr>
<tr><td>total</td><td></td><td></td><td>10</td></tr>
</table>

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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Science: Double Award 3462/3F
Specification B

Mark Scheme

2006 examination - June series

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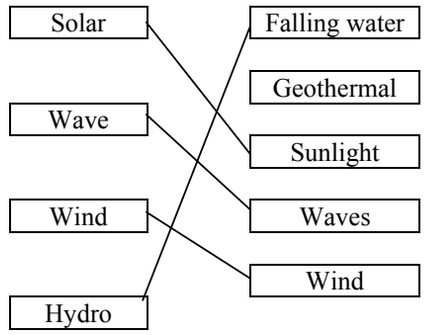
4.6.2.4 Uses and applications of electromagnetic waves

Double Award (Co-ordinated)
Foundation Tier 3462/3F

3462/3F Q1

question	answers	extra information	mark
(a)	4 correct lines drawn  	**1** mark for each correct line if more than 4 lines are drawn mark incorrect ones first. Mark only 4 lines	4
(b)	4		1
(c)(i)	nuclear		1
(ii)	(natural) gas	do **not** accept natural	1
total			7

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q2

question	answers	extra information	mark
(a)(i)	ultra violet		1
(ii)	kill the cells	accept destroys the cells accept makes cells cancerous accept damage cells accept harms cells accept changes DNA accept cause cells to mutate accept skin cells for cells accept cause cancer do **not** accept skin for cells do **not** accept burns the cells	1
(b)(i)	the sunbed uses an alternating current (a.c.) supply		1
(ii)	10.8	accept **1** mark for correct substitution of power in W or kW and time in hours or seconds	2
total			5

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2006 June series

3462/3F Q3

question	answers	extra information	mark
(a)(i)	M		1
(ii)	K		1
(iii)	J		1
(iv)	O		1
(b)(i)	billions of years		1
(ii)	red giant	any answer in terms of explosion or supernova is **incorrect**	1
	contracts / shrinks to	incorrect reference to black hole negates **1** mark	1
	white dwarf		1
total			8

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q4

question	answers	extra information	mark
(a)(i)	A and C	**both** answers must be correct in either order	1
(ii)	A and B	**both** answers must be correct in either order	1
(iii)	same number of protons plus neutrons **or** same number of nucleons	accept number of particles in nucleus the same do **not** accept they add up to 6 unless qualified	1
(b)(i)	any **two** from: • boron - 12 • carbon - 14 • oxygen - 15 • lead - 209	**both** required both name **and** number must be given	1
(ii)	any **two** from: • boron - 11 • carbon - 12 • oxygen - 16 • lead - 207	**both** required both name **and** number must be given	1
(c)	alpha		1
total			6

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2006 June series

3462/3F Q5

question	answers	extra information	mark
(a)	(good) insulator	accept does not conduct (electricity) accept does not conduct heat or electricity do **not** accept does not conduct heat outside is tough is insufficient	1
(b)	fuse		1
(c)	connect the green and yellow / earth wire	accept wires must be connected to screws	1
	swap the brown and blue wires round		1
total			4

3462/3F Q6

question	answers	extra information	mark
(a)	fossils	answers can be in either order	1
	water		1
(b)	increased		1
(c)	radio telescope		1
total			4

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q7

question	answers	extra information	mark
(a)(i)	electrical		1
	kinetic	accept movement	1
(ii)	heat	answers can be in either order	1
	sound		1
(b)(i)	360	accept **1** mark for correct substitution	2
(ii)	watt		1
(c)	the stairlift is not moving the stairlift is moving at constant speed	**both** answers are required for the mark	1
total			8

3462/3F Q8

question	answers	extra information	mark
(a)(i)	(up) further **or** (up) faster	any reference to downwards movement loses credit accept <u>with</u> more force accept motion would increase	1
(ii)	down	accept the opposite way accept drop	1
(b)(i)	direct current		1
(ii)	Z		1
total			4

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2006 June series

3462/3F Q9

question	answers	extra information	mark
(a)	level of radiation (detected) will not change	ignore reference to particles	1
	if thickness of aluminium changes	accept for **both** marks a specific example eg if the aluminium gets thicker the level of radiation detected stays the same. accept for **1** mark gamma will pass through aluminium	1
	QoWC for 2 points in a sensible sequence		1
(b)	S W T V	all in correct order accept **2** marks for 2 correct accept **1** mark for 1 correct	3
total			6

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q10

question	answers	extra information	mark
(a)	0.05 (A)	ignore incorrect units if given accept 'the same' / 'the same as K' / 'the same as the other ammeter' do **not** accept 'same as the other meter'	1
(b)(i)	any **two** from: • two cells are joined + to +	answers in terms of current gain no marks accept one cell in the wrong way accept two cells are joined back-to-back accept two cells are joined – to – accept battery for cell do **not** accept answers in terms of all the cells or in terms of energy only	2
	• some of the cells potential difference is across the diode / ammeters / wires **or** the pd of the cells is shared by all components	accept voltage for pd do **not** accept using up pd	
	• the other components have a resistance	accept a named component / components / wire has a resistance	
	• cells not fully charged **or** cells partially run down	do **not** accept voltage of cells is less than 1.5 unless explained do **not** accept cells are not as powerful unless explained	
	• cells have an internal resistance		
(ii)	the diode has a (very) high resistance (in the reverse direction)		1
	a diode only conducts / allows current to flow in one direction	accept little / no current flows do **not** accept blocks / cuts flow	1

Continued

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2006 June series

3462/3F Q10

question	answers	extra information	mark
(c)	**QoWC** for the use of the word resistance	annotate Q✓ Q✗ accept resistant	1
	accept increase / change / decrease throughout question but a contradiction loses **one** mark with change as neutral		
	as the pd / current increases / changes	accept voltage for pd must be correctly linked to at least one of the following points accept	1
	the temperature of the filament increases / changes	lamp / bulb for filament accept filament becomes hotter	1
	increasing / changing the **resistance** of the lamp	accept for **1** mark only the filament lamp does not obey Ohm's law	1
total			9

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q11

question	answers	extra information	mark
(a)	0.5		1
	hertz	accept Hz but **not** HZ / hz / hZ accept (waves) per second **or** / sec **or** / s **or** s^{-1} **or** sec^{-1}	1
(b)	any **one** from: • any named part of the electromagnetic spectrum • S – waves / secondary waves • wave on a rope	 do **not** accept seismic waves / earthquake do **not** accept slinky unless clearly described	1
(c)	transverse – disturbance / vibration is perpendicular to the direction of energy transfer / wave travel	accept a correctly labelled diagram	1
	longitudinal – disturbance / vibration is parallel to the direction of energy transfer / wave travel	accept a correctly labelled diagram part explanation of the difference between transverse **and** longitudinal gains **1** mark	1
(d)(i)	TIR shown	needs to stay inside water jet ignore number of reflections **or** arrow heads lines straight by eye	1
(ii)	bigger than	any indication of correct answer	1
total			7

4.6.2.4 Uses and applications of electromagnetic waves

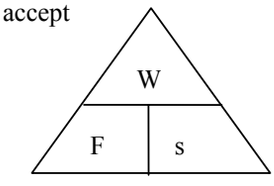
Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2006 June series

3462/3F Q12

question	answers	extra information	mark
(a)	W		1
	has only two states **or** is either on or off	accept discrete values only do **not** credit answer purely in terms of shape	1
(b)	any **one** from:		1
	• higher quality	accept clearer do **not** accept easier to read ignore faster accept <u>less</u> distortion **or** <u>less</u> weakening of signal strength do **not** accept no distortion / weakening on its own	
	• increased carrying capacity	accept more information can be sent **or** more channels	
	• errors can be rectified		
total			3

4.6.2.4 Uses and applications of electromagnetic waves

3462/3F Q13

question	answers	extra information	mark
(a)(i)	all points plotted accurately	accept **1** mark for 5 correct plots ± ½ small square on stopping distance	2
	line of best fit must be continuous	accept attempt at a reasonable curve does not need to go through 0 0 do **not** accept a straight line do **not** accept dot-to-dot	1
(ii)	4 to 6 (metres)	accept ecf from (a)(i) accept **1** mark for value taken correctly from graph at 25mph **or** correct method shown	2
(b)(i)	0.7 (s)	incorrect unit = 0 marks	1
(ii)	constant speed / velocity	accept (continued as) 30mph accept did not change / stayed the same accept no acceleration	1
(iii)	3.3(s)	penalise incorrect unit once only	1
(iv)	reaction time increases / is longer **or** thinking distance increases	do **not** accept reaction time slower **or** reactions are slower	1
	stopping distance / it increases	do **not** accept travels at constant speed for longer	1
(c)(i)	work done = force (applied) × distance (moved)	accept W = F × s or W = F × d accept  provided subsequent method is correct	1
(ii)	2100	accept 2.1 kilo accept **1** mark for using 7000 N	2
(iii)	2100 (joules)	accept their (c)(ii)	1
total			14

4.6.2.4 Uses and applications of electromagnetic waves

Science: Double Award (Co-ordinated) – AQA GCSE Mark Scheme, 2006 June series

3462/3F Q14

question	answers	extra information	mark
(a)(i)	refraction		1
(ii)	it changes speed **or** change in density	accept it speeds up do **not** accept it slows down do **not** accept air is more dense than glass	1
(b)(i)	sound / waves <u>diffract</u> through the gap (in the wall) **or** over the wall **or** because the gate is open	do **not** accept reflection this only scores if first marking point is given accept for **1** mark only sound / waves go through the gap and <u>spread out</u> **or** diagram showing wave fronts spreading out from open gates if diagram is labelled as diffraction both marks can be scored	1 1
(ii)	less diffraction	accept no diffraction accept gates <u>absorb</u> sound / noise / waves accept gates <u>reflect</u> sound / noise / waves do **not** accept rebounds / stops / blocks out	1
total			5

4.6.2.4 Uses and applications of electromagnetic waves

PMT

AQA

GCSE

Science A / Physics

PH1HP

Mark scheme

4405/4403
June 2015

Version/Stage: 1.0 Final

4.6.2.4 Uses and applications of electromagnetic waves

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

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4.6.2.4 Uses and applications of electromagnetic waves

Mark Scheme

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.1 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.2 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.3 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.4 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.5 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.6 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.2 Ignore / Insufficient / Do not allow

Ignore of insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

4. Quality of Communication and levels marking

In Question **2a** students are required to produce extended written material in English, and will be assessed on the quality of their communication as well as the standard of the scientific response.

Students will be required to:
- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: basic
- Knowledge of basic information
- Simple understanding
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail
- The spelling, punctuation and grammar are very weak.

Level 2: clear
- Knowledge of accurate information
- Clear understanding
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: detailed
- Knowledge of accurate information appropriately contextualised
- Detailed understanding, supported by relevant evidence and examples
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar

4.6.2.4 Uses and applications of electromagnetic waves

Question	Answers	Extra information	Mark	AO / Spec. ref.
1(a)	chemical kinetic sound	correct order only	1 1 1	AO1 P1.2.1a
1(b)	37.5% or 0.375	an answer rounded to 0.38 or 38% scores both marks an answer of 0.375 with a unit gains **1** mark an answer of 0.375% gains **1** mark an answer of 37.5 with or without a unit gains **1** mark allow **1** mark for an answer 3/8 3/8 with a unit scores 0	2	AO2 P1.2.1d
Total			**5**	

4.6.2.4 Uses and applications of electromagnetic waves

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th><th>ID</th></tr>
<tr><td>2 (a)</td><td colspan="2">Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 4 and apply a ‘best-fit’ approach to the marking.</td><td>6</td><td>AO2
AO3
P1.2
HSW</td><td>E</td></tr>
<tr><td colspan="6">
<table>
<tr><th>0 marks</th><th>Level 1 (1-2 marks)</th><th>Level 2 (3-4 marks)</th><th>Level 3 (5-6 marks)</th></tr>
<tr><td>No relevant information</td><td>There is a relevant statement about an energy saving method</td><td>There is at least one clear comparison of energy saving methods and their cost effectiveness with an appropriate calculation</td><td>There is a comparison of energy saving methods and their cost effectiveness with appropriate calculations. Comparison to include further detail.</td></tr>
</table>
<table>
<tr><th>examples of physics points made in the response</th><th>extra information</th></tr>
<tr><td>examples of relevant statements
• energy efficient boiler saves the most (energy / money) per year
• loft insulation costs the least to install
• double-glazing costs the most to install
examples of statements that include cost effectiveness
• loft insulation is the most cost effective in the long term
• double-glazing is the least cost effective
• loft insulation has the shortest payback time
• double-glazing has the longest payback time
• payback time calculated for any method
examples of further detail
• for cost effectiveness install in the following order: loft, cavity wall, boiler, double-glazing
• for reducing energy use install in the following order: boiler, loft, cavity wall, double glazing
• don’t install double-glazing for insulation purposes
• double-glazing won’t pay for itself in your lifetime
• justified choice of best / worst method</td><td>payback times:
energy efficient boiler: 6.25 years
loft insulation: 2 years
double glazing: 100 years
cavity wall insulation: 2.86 years</td></tr>
</table>
</td></tr>
</table>

Question 2 continued . . .

Question	Answers	Extra information	Mark	AO / Spec. ref.
2(b)(i)	how effective a material is as an insulator	accept 'heat' for energy accept how effective a material is at keeping energy in accept the lower the U-value the better the insulator accept the lower the U-value the lower the rate of energy transfer	1	AO1 P1.1.4a
2(b)(ii)	(the U-value) decreases		1	AO1 P1.1.4b
Total			**8**	

4.6.2.4 Uses and applications of electromagnetic waves

Question	Answers	Extra information	Mark	AO / Spec. ref.
3(a)(i)	0.5 °C		1	AO3 P1.1
3(a)(ii)	data is continuous **or** both variables are continuous **or** independent variable is continuous **or** time is continuous	accept results / measurements for data accept data is not categoric one variable is continuous is insufficient air temperature is continuous is insufficient	1	AO3 P1.1
3(b)(i)	20.5 (°C)		1	AO2 P1.1
3(b)(ii)	60 (minutes)	accept 1 hour	1	AO2 P1.1
3(c)(i)	so a comparison can be made **or** outside temperature is a control variable	accept: (outside) temperature would affect energy required (to maintain temperature of the house) **or** (outside) temperature would affect internal temperature (of the house) **or** heat loss will be faster on a cold day outside temperature will affect the results is insufficient fair test is insufficient	1	AO3 P1.1

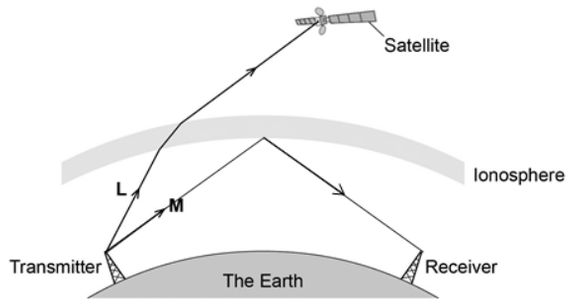
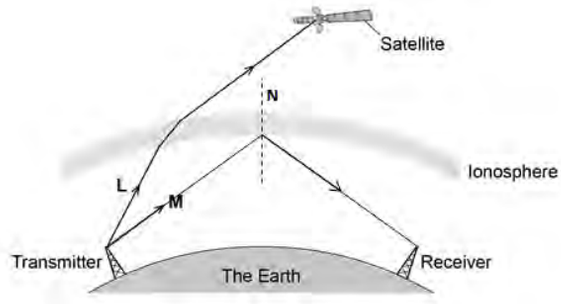
Question 3 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

Question	Answers	Extra information	Mark	AO / Spec. ref.
3(c)(ii)	the cost is equal to the number of kWh x the cost per kWh calculation 0.8 / 8.0 = 0.1 or 10%	accept (heating) bill depends on (number of) kWh used accept energy for kWh allow 7.2 / 8.0 = 0.9 or 90%	1 1	AO3 AO2 P1.1
3(c)(iii)	heating is on for more / less time (than anticipated) because some days it is cooler / warmer (than anticipated)	 accept other sensible suggestions an answer giving two sensible situations gains **2** marks possible examples: • some houses have different amounts of insulation • there are different styles of house temperature (inside / outside) is always changing is insufficient	1 1	AO3 P1.1
Total			**9**	

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP – JUNE 2015

Question	Answers	Extra information	Mark	AO / Spec. ref.
4(a)(i)	microwave		1	AO1 P1.5.1k
4(a)(ii)	refraction		1	AO1 P1.5.1g
4(b)(i)	wave M continues as a straight line to the ionosphere and shown reflected correctly reflected wave shown as a straight line reaching the top of the receiver  	accept reflection at or within the ionosphere if more than 2 rays shown 1 mark maximum ignore arrows	1 1	AO2 P1.5.2b
4(b)(ii)	normal drawn at point where their **M** meets the ionosphere  		1	AO1 P1.5.2a

Question 4 continues on the next page. . .

Question 4 continued…

Question	Answers	Extra information	Mark	AO / Spec. ref.
4(c)	any **two** from: • transverse • same speed (through air) • can be reflected • can be refracted • can be diffracted • can be absorbed • transfer energy • can travel through a vacuum • can be polarised • show interference	accept speed of light **or** 3 x 10^8 m/s an answer travel at the same speed though a vacuum scores **2** marks travel in straight lines is insufficient	2	AO1 P1.5.1a,bc,d,g
Total			**7**	

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP – JUNE 2015

Question	Answers	Extra information	Mark	AO / Spec. ref.
5(a)(i)	infrared (radiation)	accept IR (radiation)	1	AO1 P1.1.1b
5(a)(ii)	(heated) water turns to steam steam turns a turbine turbine turns a generator	ignore reference to fossil fuels do **not** accept water evaporates to steam accept turbine connected to a generator	1 1 1	AO1 P1.4.1a
5(b)(i)	(so the molten salts) can store large amounts of energy	accept there is a small temperature change for a large energy transfer accept heat for energy	1	AO2 P1.1.4d
5(b)(ii)	16 (hours)	an answer that rounds to 16 gains **2** marks eg 15.71 allow **1** mark for a correct substitution ie 2 200 000 = 140 000 x t	3	AO2 AO1 P1.3.1c
5(b)(iii)	the number of daylight hours varies the (mean) power (received from the Sun per square metre) varies	less sunlight is insufficient accept an answer in terms of maximum possible electrical output only possible during Summer for **1** mark	1 1	AO2 AO3 P1.4

Question 5 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

Question 5 continued . . .

Question	Answers	Extra information	Mark	AO / Spec. ref.
5(c)(i)	non-renewable power stations have higher Capacity Factors than renewable power stations		1	AO1 AO3 P1.4
	fuel (for non-renewable power stations) is always available	reference to non-renewable power stations operating all the time is insufficient non-renewable energy sources are reliable is insufficient	1	
	(most) renewable energy sources are unpredictable / unreliable	accept (most) renewable energy sources depend on the weather	1	
5(c)(ii)	the (proportion of) time that solar storage power stations can generate electricity is greater (than for other renewable energy sources)		1	AO1 P1.4
Total			**14**	

4.6.2.4 Uses and applications of electromagnetic waves

Question	Answers	Extra information	Mark	AO/Spec ref.
6(a)	Doppler (effect)		1	AO1 P1.5.4a
6(b)	(reflected microwaves) wavelength decreased (reflected microwaves) frequency increased (reflected microwaves) have same speed		1 1 1	AO1 P1.5.4a P1.5.1d
Total			4	

4.6.2.4 Uses and applications of electromagnetic waves

Question	Answers	Extra information	Mark	AO / Spec. ref.
7(a)	4200	allow **2** marks for correct substitution ie 6930 = 0.330 x c x 5.0 answers of 1050 **or** 840 **or** correctly calculated answer from correct substitution of incorrect temperature change **or** identification of temperature change ie 5 ˚C gain **1** mark	3	AO2 AO1 P1.1.4d
	J/kg˚C	accept J/kg K	1	
7(b)	(in a metal) free electrons	to gain full credit the answer must be in terms of free electrons	1	AO1 P1.1.3a
	gain kinetic energy	accept move faster	1	
	(free electrons) transfer energy to other electrons / ions / atoms	do **not** accept particles	1	
	by collision		1	
		allow a maximum of **2** marks for answers in terms of atoms / ions / particles • gaining kinetic energy or vibrating faster / more • transferring energy by collisions		
7(c)	(air) particles spread out		1	AO1 P1.1.3a
	(which causes the) air to become less dense / expand	do **not** accept particles become less dense	1	
	(so the) warm air rises	do **not** accept heat rises particles rise is insufficient	1	
7(d)	large surface area	ignore references to type of metal or external conditions	1	AO1 P1.1.3c
	black / dark (colour)		1	
Total			**13**	

4.6.2.4 Uses and applications of electromagnetic waves

AQA

GCSE

Science A / Physics

PH1HP

Mark scheme

4405/4403
June 2016

Version 1.0: Final Mark Scheme

4.6.2.4 Uses and applications of electromagnetic waves

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2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Accept / allow

Accept is used to indicate an equivalent answer to that given on the left-hand side of the mark scheme. Allow is used to denote lower-level responses that just gain credit.

3.9 Ignore / Insufficient / Do not allow

Ignore of insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

4. Quality of Communication and levels marking

In Question **2(b)** students are required to produce extended written material in English, and will be assessed on the quality of their communication as well as the standard of the scientific response.

Students will be required to:
- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: basic
- Knowledge of basic information
- Simple understanding
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail
- The spelling, punctuation and grammar are very weak.

Level 2: clear
- Knowledge of accurate information
- Clear understanding
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: detailed
- Knowledge of accurate information appropriately contextualised
- Detailed understanding, supported by relevant evidence and examples
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar.

4.6.2.4 Uses and applications of electromagnetic waves

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)	frequency		1	AO1 1.5.3b
1(b)	echo(es)		1	AO1 1.5.3c
1(c)	spreading (out) equal to	changing direction is insufficient moving apart is insufficient bending is insufficient accept: similar to same (order of magnitude) as slightly smaller than slightly larger than	1 1	AO1 1.5.1g
1(d)	340 (m/s)	allow **1** mark for correct substitution ie 25 000 x 0.0136 provided no subsequent step **or** allow **1** mark for a correct calculation showing an incorrect value from conversion to hertz x 0.0136 an answer of 0.34 gains **1** mark	2	AO2 1.5.1j
1(e)	(a wave where the) oscillations are parallel to the direction of energy transfer causing (areas of) compression and rarefaction	both marking points may appear as labels on a diagram accept vibrations for oscillations accept in same direction as for parallel to allow direction of wave (motion) for direction of energy transfer accept correct description in terms of particles mechanical wave is insufficient needs a medium to travel through is insufficient	 1 1	AO1 1.5.1b
Total			**8**	

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)	any **one** from: • high cost of installing overhead power lines or underground cables or pylons • high cost as (very) long cables needed • amount of electricity required is too low	allow not enough (surplus) electricity would be generated	1	AO1 1.4.1e

Question 2 continues on the next page . . .

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(b)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.		6	3 AO1 2 AO2 1 AO3 1.4.1b

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant information	at least **one** advantage **or one** disadvantage of either method	at least **one** advantage **and one** disadvantage is stated for **one** method **and** a different advantage **or** disadvantage is stated for the other method	clear comparison of advantages **and** disadvantages of **each** method

examples of physics points made in the response	extra information
Advantages of both methods:	
• both renewable sources of energy	
• both have no fuel (cost)	accept carbon neutral
• both have very small (allow 'no') running costs	accept no greenhouse gases
• no carbon dioxide produced	accept doesn't contribute to global warming
Advantages of wind:	
• higher average power output	produces more energy is insufficient
Advantages of hydroelectric:	
• constant / reliable power (output)	
• lower (installation) cost	
Disadvantages of wind:	
• higher (installation) cost	
• variable / unreliable power output	
• (may) kill birds / bats	
Disadvantages of hydroelectric:	
• lower power output	
• (may) kill fish or (may) damage habitats	
• more difficult to set up (within river)	
Disadvantages of both methods	
• (may be) noisy	
• visual pollution	ignore payback time unless no other relevant points made ignore time to build for both

Total			7

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)	a proportion / percentage of the energy is wasted	allow heat for energy allow some energy is wasted	1	AO2 1.2.1b 1.2.1c
	(wasted) energy is transferred to surroundings **or** energy is needed to heat pan (before food is heated)		1	
3(b)	(fins have a) large(r) surface area	accept fins increase the surface area	1	AO1 1.1.1c 1.1.1e 1.1.3c
	(black metal surface is a) good / better absorber of infrared radiation	allow 'heat' or 'energy' for infrared radiation ignore good emitter of infrared radiation not a good reflector is insufficient	1	
3(c)	the higher the temperature (of the saucepan) the greater the rate at which infrared radiation is emitted	accept converse answer allow the higher the temperature the more infrared radiation is emitted allow there is a positive correlation	1	AO2 1.1.1b
Total			**5**	

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)(i)	**use of infrared:** remote controls fibre optic (communications) **use of microwaves:** mobile/cell phones satellite (communications/TV) wi-fi Bluetooth	 accept mobiles accept phone signals	1 1	AO1 1.5.1k
4(a)(ii)	any **two** from • same speed **or** travel at the speed of light (in a vacuum) • transverse • transfer energy (from one place to another) • can be reflected • can be refracted • can be diffracted • can be absorbed / transmitted • can travel through a vacuum/space • can be polarised	 accept a full description of a transverse wave travels in straight lines is insufficient	2	AO1 1.5.1c 1.5.1d 1.5.1e 1.5.1g
4(b)(i)	Cosmic Microwave Background (Radiation)	accept CMBR	1	AO1 1.5.4d
4(b)(ii)	 the Big Bang (theory) predicted the existence of CMBR **or** only the Big Bang (theory) supports the existence of CMBR	allow microwave radiation for CMBR throughout allow it supports / proves the Big Bang (theory) accept CMBR disproved other theories, eg steady state	 1	AO1 1.5.4e
Total			**6**	

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5(a)	no particles (in a vacuum) (so) no / reduced conduction and no / reduced convection	 both energy transfer methods needed for the mark	1 1	AO1 1.1.3a
5(b)(i)	78 (°C)	allow **2** marks for correct temperature change ie 22 ˚C allow **1** mark for correct substitution ie 46 200 = 0.5 x 4200 x θ **or** $\frac{46200}{0.5\times4200}=\theta$	3	AO2 1.1.4d
5(b)(ii)	6.4 (W)	allow **2** marks for an answer that rounds to 6.4 allow **1** mark for correct substitution ie 46 200 = P x 7200 an answer of 23 000 or 23 100 or 385 gains 1 mark	2	AO2 1.3.1c
Total			**7**	

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(a)	any **two** from: • cost per kWh is lower (than all other energy resources) • infrastructure for nuclear power already exists • more reliable (than renewable energy resources)	allow it is cheaper ignore fuel cost ignore energy released per kg of nuclear fuel accept cost of setting up renewable energy resources is high accept many renewable power stations would be needed to replace one nuclear power station accept (France in 2011 already had a) surplus of nuclear energy, so less need to develop more renewable capacity for increased demand in the future accept France benefits economically from selling electricity accept (nuclear) fuel is readily available ignore destruction of habitats for renewables	2	AO1 AO2 1.4
6(b)	any **two** from: • non-renewable • high decommissioning costs • produces radioactive / nuclear waste • long start-up time • nuclear accidents have widespread implications	allow nuclear fuel is running out accept high commissioning costs allow waste has a long half-life allow for nuclear accident a named nuclear accident eg Fukushima, Chernobyl ignore visual pollution	2	AO1 1.4.1f

Question 6 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(c)	0.48 (kW)	allow **1** mark for correct substitution ie 0.15 = P / 3.2 an answer of 480 W gains **2** marks an answer of 48 or 480 scores **1** mark	2	AO2 1.2.1d
6(d)	the higher the efficiency, the higher the cost (per m^2 to manufacture)	accept a specific numerical example	1	AO2 AO3 1.4.1c
	more electricity could be generated for the same (manufacturing) cost using lower efficiency solar panels **or** (reducing the cost) allows more solar panels to be bought	accept a specific numerical example	1	
Total			**8**	

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7(a)	surface area **or** duration of experiment	accept shape of beaker size of beaker is insufficient	1	AO3 1.1.3b
7(b)	any **two** from: • takes readings automatically • takes readings more frequently • reduces / no instrument reading error • higher resolution • don't need to remove probe to take reading • more accurate	ignore easier **or** takes readings for you ignore human error allow better resolution	2	AO3 1.1.3
7(c)(i)	0.07 (°C/s)	allow **1** mark for obtaining a temperature drop of 7(ºC) allow **1** mark for an answer between 0.068 and 0.069 (°C/s)	2	AO2 1.1.3d
7(c)(ii)	rate of temperature change is greater at the start **or** rate of temperature change decreases	accept rate of evaporation is greater at the start allow rate of evaporation decreases allow temperature decreases faster at the start	1	AO3 1.1.3b

Question 7 continues on the next page . . .

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7(c)(iii)	A lower temperature decrease (over 200 seconds)	reason only scores if A is chosen accept lower gradient	 1	AO3 1.1.3b
7(c)(iv)	no effect (as rate of evaporation is unchanged)	allow larger temperature change (per second as mass of liquid is lower)	1	AO3 1.1.3b
7(d)	particles with more energy leave the (surface of the) liquid (which) reduces the average (kinetic) energy (of the remaining particles)	accept particles with higher speeds allow reference to the total energy of the liquid reducing	1 1 1	AO1 1.1.3b
Total			11	

4.6.2.4 Uses and applications of electromagnetic waves

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
8(a)	any **two** factors: • surface area (of mug in contact with cup warmer) • thickness of mug • temperature of heater / coffee • power of the heater	 accept temperature difference (between heater and coffee) accept power of the laptop ignore efficiency of the heater	2	AO3 1.1.3c
8(b)	atoms (gain kinetic energy and) vibrate faster / more energy is passed on from atom to atom by collision	allow particles / molecules for atoms allow bigger / faster vibrations do not accept start to vibrate accept vibrations for energy an answer in terms of free electrons scores zero	1 1	AO1 1.1.3a
8(c)	the particles spread out (so) coffee becomes less dense (so) the heated coffee rises (and) cooler / denser coffee falls	allow fluid / liquid / water for coffee throughout answer allow particles move further apart allow (coffee) expands particles rise is insufficient particles fall is insufficient	1 1 1 1	AO1 1.1.3a
Total			**8**	

4.6.2.4 Uses and applications of electromagnetic waves

Answer 142 · Examiner comments June 2018 | 8463/2H | Original Q7

Question 7 (Standard/high and High demand)

07.1 Many students had the correct idea, but imprecise detail such as ‘wrong number of turns’ or ‘number of turns was miscounted’ were insufficient to score the mark.

07.2 Many students tried to answer the question from a general knowledge about transformers, rather than using information from the graph, and so did not gain credit.

07.3 Most of the answers were correct. A very small number of students wrote ‘hotter’ but made no reference to infrared or thought it was just a temperature increase.

07.4 This question involved a two stage calculation, a new feature of the examination. Nearly 33 % of students knew the equations to use and how to use them, scoring all five marks. A further 35% of students correctly used one equation to give a partially correct answer, scoring three marks.

Answer 143 · Examiner comments June 2019 | 8463/2H | Original Q7

Question 7 (Standard and standard/high and high demand)

07.1 Around 42% of the students scored this mark. Many students seem to think that the wave speed changes.

07.2 About 35% of the students scored both marks. Some students did not specify ‘soft’ tissue or a named soft tissue, which was required as bone is a tissue. Many students incorrectly described bones as reflecting X-rays rather than absorbing them. Some students appeared to confuse X-rays with gamma rays or even alpha particles.

07.3 A large number of the students failed to appreciate that the hot cube was the main hazard rather than the kettle. The majority gave an answer in terms of ‘wear safety goggles and/or

Answer 143 · Examiner comments

June 2019 | 8463/2H | Original Q7

gloves. Less than a quarter of the students gave a correct answer, these appeared to be evenly distributed across the alternatives given in the mark scheme.

07.4 Only a quarter of the students scored this mark, with most incorrect answers giving the temperature or volume of the water as the control variable.

07.5 There appeared to be some confusion of the term precise with either accuracy or resolution. The lack of repeat readings was sometimes given but then incorrectly linked to the idea of calculating a mean or identifying anomalies. About 10% of the students scored this mark.

07.6 About 64% of the students realised that two of the surfaces would give the same temperature reading and therefore undermine the conclusion. However most of these students then simply wrote that the conclusion would not be valid without then going on to explain why.

07.7 Just over 70% of the students gave the correct answer.

07.8 Only a small number of the students scored any marks on this question. Those that did usually scored the mark for ‘clouds reflect radiation’. Virtually no students related their answer to night time. Marking points 1 and 3 were rarely awarded. Many of the students wrote about insulation with a few mentioning the cloud as a ‘blanket’ keeping the ground warm. These answers did not score any marks.

4.6.2.4 Uses and applications of electromagnetic waves

Answer 144 · Examiner comments November 2020 | 8463/2H | Original Q6

Question 6 (Standard and standard/high and high demand)

06.1 The majority of the students were able to convert MHz to Hz correctly. A large number of the students did not know the unit of wavelength with the symbol 'λ' being a common incorrect answer.

06.2 Only 3% of students were able to write a complete answer to this question. Many of the students described the final movement of the car rather than what happens in the electrical circuit. A significant number of the students thought that absorbing radio waves would result in sound being produced. Some of the students realised that there would be a current in the aerial but used terms such as 'produce a current' and 'produce an electrical signal' which were insufficient for credit to be awarded.

06.3 The most frequent correct answer was to state that radio waves are transverse and sound waves are longitudinal. Another popular correct answer was the idea of radio waves being able to travel through a vacuum / space. Comparisons of wavelength / frequency did not gain any marks due to the overlapping range of wavelength and frequency of radio waves and sound waves.

06.4 83% of students correctly described the motion of the car during the first 30 seconds.

06.5 The majority of the students knew how to calculate velocity from a straight line graph but failed to realise the significance of the curved line. Those few students that drew an appropriate tangent to the line at 20s generally went on to score all four marks.

06.6 Whilst 25% of the students gained all six marks for this calculation, a significant number of the remaining students gained partial credit for clearly showing the working out, part of which was correct.

06.7 There were very few complete and correct answers to this question. A significant number of the students correctly referred to air resistance increasing with speed but then went on to state that air resistance becomes equal to speed. It was common for answers to be in terms of real cars, the effect of speed on braking distances or the likely increase in accidents.

Answer 145 · Examiner comments November 2021 | 8463/2H | Original Q5

Question 5

Although a number of correct uses were given for ultraviolet a number of the students appeared to confuse UV with ultrasound. The meaning of the prefix 'nano' was not well known. However the students that knew the correct equation for part **05.3** (about 35% did not) did go on to use the value chosen in **05.2** to calculate a correct answer. Only about half of the students could use the data presented in Table 1 to correctly answer part **05.4.** Most of the students scored no marks for part **05.5**, with many either simply giving an example of each type of wave, or failing to link the direction of oscillation to either direction of energy transfer or direction of wave travel.

4.6.2.4 Uses and applications of electromagnetic waves

Answer 147 · Examiner comments — June 2023 | 8463/2H | Original Q1

01.1

72% scored a mark on this question. The most frequent incorrect response was ‘parallel’.

01.2

Most responses were levels 1 and 2. Many failed to gain marks because they did not think it was necessary to explain the need for additional equipment. Very few students explained the need to calculate the temperature change or to compare the readings on infrared detectors, which was a requirement to get into level 3. A number of students suggested using cold water, or even described a different practical. Students were not penalised for using tiny volumes of water, but it is clear that students have no concept of how much 50 ml is, for example. There was a lot of confusion relating to use of infra red detectors and what they measured.
Many students stated they would take readings every minute, and lots suggested repeating to get averages, or producing graphs. This was not required by the question.
There were some pleasing summaries referring to the evidence and the hypothesis.

01.3

80 % of students scored the first mark, but only 47% scored both marks. Some students simply reworded the stem. There was a small amount of confusion with radioactivity, because of the use of the word radiation, and a number who seemed to think a chemical reaction was taking place.

01.4

A majority of students gained this mark, but there seemed to be some confusion as to what is meant by the dependent variable.

01.5

The most common response related to the matt black surface and the shiny white surface. This was awarded 1 mark. Some did mention that black was the best absorber but failed to adequately describe the relative absorbance of matt versus shiny surfaces, as they did not explain this only applied for the same colour surface. In addition, some gave their response in terms of emission or reflection of IR radiation, both of which scored zero. Only 3% of students successfully gave both conclusions.

01.6

99% of students identified the equation for calculating pressure.

Answer 147 · Examiner comments — June 2023 | 8463/2H | Original Q1

01.7

78% of students scored all 4 marks for this calculation. Some scored zero, as they calculated the total surface area, the volume or used the length of the cube.

4.6.2.4 Uses and applications of electromagnetic waves

Answer 148 · Examiner comments June 2023 | 8463/2H | Original Q6

06.1

88% of students scored this mark. The vast majority of responses seen said ‘satellite’, with a small number giving the alternative ‘moon’.

06.2

61% of students were able to achieve full marks for this calculation. Those that did not, didn't convert the wavelength into metres, or converted incorrectly. Most students were able to give their answer in standard form.

06.3

Many students only scored the compensation mark and it was rare to see answers where acceleration towards Earth was included. Few students linked a change in direction to a change in velocity, with some describing the converse.

06.4

6% of students gained full marks for this explanation. students scored a mark for the 2nd or 3rd marking point, and it was unusual to have to consider the award of the compensation mark. A significant number of students thought that galaxies A and B were emitting radiation with a greater wavelength than that emitted by the Sun.

Answer 150 · Examiner comments June 2024 | 8463/1H | Original Q9

Question 9 (High Demand)

09.1 Students needed to refer to the graph, and factual recall about alpha radiation, to score the 1st and 3rd mark points.,. The 2nd mark point was much more unlikely to score, as students often stated the graph went to zero, rather than being just above zero. A number of students confused the graph with a half-life graph, believing the *x*-axis showed time, not distance. 8% of students scored 3 marks, while 45% scored 2 marks and 35% scored 1 mark.

09.2 A lot of students thought it was enough to say ‘an absorbing material’ without specifying what the absorbing material should be made from. Any suitable absorbing material was creditworthy, a block of wood for example. However, reference to any metal foil was not creditworthy unless students referred to a certain thickness eg 5 mm thick aluminium foil. A ‘foil’ was taken to be the same thickness as kitchen foil, whereas a ‘metal sheet’ was taken to be thick enough to absorb

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4.6.2.4 Uses and applications of electromagnetic waves

Answer 150 · Examiner comments June 2024 | 8463/1H | Original Q9

beta radiation, provided students did not contradict their earlier statements. Paper and cardboard were not creditworthy as suitable absorbing materials. 51% of students scored 2 marks, while 7% of students scored 1 mark.

09.3 65% of students scored this mark by suggesting a suitable safety precaution. Hazmat suits and PPE were insufficient to score.

09.4 64% of students scored this mark by suggesting a suitable precaution to avoid contamination. Hazmat suits and PPE were insufficient to score.

09.5 Students at GCSE find the idea of rate of change to be a difficult one, hence linking the change in the number of atoms to activity was a difficult question in this exam series. 7% of students scored 4 marks, while 12% of students scored 3 marks. If students failed to draw a tangent, they were very unlikely to score any marks except the unit mark. A common incorrect choice of unit for activity for many students was sieverts, Sv. Examiners were looking for becquerel or Bq. Decays per second or decays/second were insufficient to score.

Answer 151 · Examiner comments June 2024 | 8463/2H | Original Q6

06.1
Some students displayed a good factual knowledge in answering this item, although a good number thought electromagnetic waves are both transverse and longitudinal. Some students tried to answer this question in terms of the uses of the waves rather than their properties and scored few marks as a result.

06.2
72% of students (scored the mark for this item, displaying a good factual knowledge in giving a wide range of medical uses for gamma rays. However, there were students who did not focus on gamma rays, incorrectly giving MRI scans, X-ray imaging or ultrasound as their response and hence failing to score the mark.

06.3
Only 20% of students scored both marks on this question, comparing the dangers of gamma rays compared with radio waves. The most common errors were not stating that radio waves are not ionising, saying gamma rays are more ionising than radio waves or that gamma rays are highly ionising. Many stated that gamma rays cause cancer or kill cells, but those who mentioned mutations did not always link them to genes / DNA.

06.4
Many students could not explain how radio waves of a specific frequency are produced. Students that achieved the first mark point usually mentioned alternating current. Only 15% scored any marks here.

4.6.2.4 Uses and applications of electromagnetic waves

AQA

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4.6.2.4 Uses and applications of electromagnetic waves

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4.6.2.4 Uses and applications of electromagnetic waves

General

Grade 4-5 calculation questions ask for students to recall an equation, before using it in a subsequent calculation. In the 2022 series, students were given an Equations Sheet which had all the equations printed on it. Subsequently, the performance on the more straightforward calculations has improved on previous years.

The multistep calculations targeted at candidates working at grades 8-9, questions **09.1** and **10.1**, were well attempted with many students answering correctly. Of these two questions, students were slightly more successful on question **09.1** with about 55% of students scoring full marks, whereas for question **10.1** approximately 45% of students scored full marks.

Question **02.1** was generally well attempted and students who had carried out the density required practical had an advantage over those who hadn't. For this question, about 35% of students scored 6 marks and approximately 25% of students scored 5 marks.

Handwriting continues to be a problem for a number of students, making it very difficult for examiners to read what has been written. Students who have handwriting that is difficult to read may benefit from a scribe or from word processing their answers in exams.

Question 11

Due to incorrect Advance Information guidance being issued for this question, and to avoid students being disadvantaged, Question 11 was discounted and all students were awarded full (9) marks.

Levels of demand

Questions are set at three levels of demand for this paper:

- **Standard demand** questions are designed to broadly target grades 4–5.
- **Standard/high demand** questions are designed to broadly target grades 6–7.
- **High demand** questions are designed to broadly target grades 8–9.

A student's final grade, however, is based on their attainment across the qualification as a whole, not just on questions that may have been targeted at the level at which they are working.

4.6.2.4 Uses and applications of electromagnetic waves

Question 1 (Standard demand)

01.1 About 55% of students scored 2 marks. The unit conversion caused a problem for many students and powers of 10 errors were frequently seen. A correct calculation using an incorrectly or not converted value for power would score 1 mark.

01.2 Students were generally successful at answering this question with approximately 40% scoring 2 marks and about 50% scoring 1 mark. Most students wrote variations of the first and third bullet points in the markscheme. A number of students wrote that the turbines may be broken, which was enough to score a mark for the idea of maintenance.

01.3 'Turbine will rotate faster' was insufficient to score a mark. 'Rotate more smoothly' was not enough to score the 'less friction' mark. Students who stated that 'no energy was wasted' did not score the second marking point. Approximately 35% of students scored 3 marks, 35% of students scored 2 marks and 20% of students scored 1 mark.

01.4 About 30% of students scored 2 marks, while approximately 50% of students scored 1 mark. Many students answered in terms of 'saving energy' which was insufficient. Other students answered in terms of absolute statements which did not score, 'energy efficient appliances waste no energy' for example.

Question 2 (Standard demand)

02.1 Generally very well answered with about 35% of students gaining 6 marks and 25% scoring 5 marks. Students were told that this required practical would appear in the 2022 series via the Advance Information. A number of students quoted the density equation incorrectly, although this was given on the Equations Sheet for the 2022 series. There were extremely few students who didn't attempt the question and less than 1% of students who attempted the question scored zero.

02.2 Approximately 85% of students answered this question correctly. Of the incorrect answers seen, a significant proportion gave the maximum and minimum values the wrong way round. Another common mistake was to write maximum: 2.55 and minimum 0.10, which showed a clear misunderstanding of expressing an uncertainty.

02.3 About 95% of students answered this question correctly.

02.4 Approximately 45% of students scored 2 marks and 40% scored 1 mark. 'In case an error / mistake was made the first time' was insufficient. 'To check the repeatability of the data' was ignored, as this wouldn't improve the accuracy of the data. 'Get rid of anomalies' was assumed to mean 'remove anomalies', but 'stops anomalies from occurring' did not score. Likewise 'stops random errors' did not score.

4.6.2.4 Uses and applications of electromagnetic waves

Question 3 (Standard demand)

03.1 Over 99% of students answered this question correctly as they had all the Physics equations on the Equations Sheet for the 2022 series.

03.2 Nearly 95% of students answered this question correctly. In this series all students were given all the equations on the Equations Sheet. The first mark is for the substitution into the equation as it appears on the equations sheet. Some students failed to score any marks by incorrectly rearranging the equation, then substituting into the incorrectly rearranged equation.

03.3 Over 99% of students answered this question correctly as they had all the Physics equations on the Equations Sheet for the 2022 series.

03.4 95% of students answered this question correctly. In this series all students were given all the equations on the Equations Sheet. The first mark is for the substitution into the equation as it appears on the Equations Sheet. Some students failed to score any marks by incorrectly rearranging the equation, then substituting into the incorrectly rearranged equation.

Question 4 (Standard/High demand)

04.1 A large number of students found it difficult to identify the independent and dependent variables in the investigation that was described. Control variables appeared often in students' answers. 'Temperature change' seemed to be the most common incorrect answer for the dependent variable. About 50% of students scored 2 marks and approximately 35% of students scored 1 mark.

04.2 65% of students answered correctly. The most common incorrect answer was 87.4 °C.

04.3 About 35% of students answered this question correctly. Common incorrect answers referred to the resolution, or just repeated the question and said 'difficult to read' which was insufficient.

04.4 Approximately 75% of students scored 3 marks and about 10% of students scored 2 marks. Power of 10 errors were common and usually resulted in 2 marks being scored for an incorrectly or not converted value of energy.

04.5 Many students found relating the time for the temperature to decrease to thermal conductivity difficult. About 15% of students scored 2 marks, while 40% scored 1 mark. Answers in terms of good / bad insulators were insufficient to score a mark.

Question 5 (Standard/High demand)

05.1 Approximately 45% of students scored 1 mark, with about 5% of students scored 3 marks. Around 30% of students scored no marks. The first marking point of this explanation was most likely to score, the third marking point was least likely to score.

05.2 About 30% of students scored all 3 marks for this explanation. 10% of students scored 2 marks and 10% scored 1 mark. A lot of student answers were not creditworthy, with mixed up descriptions of ion transfer, electron transfer, proton transfer, protons weighing more than electrons and transfer of electrons increasing the mass of the rod on the balance. As a result about 50% of students scored zero.

05.3 Approximately 60% of students scored the mark. Some students evidently did not know what a zero error was. Answers like 'it means there is no error' being a good example of this. Some answers were insufficient, 'the actual mass of the rod is not required' being not enough to score the mark. 'Weight' was allowed for 'mass' when used correctly as the reading on the balance does depend on the weight of the object. An answer of 'only the change in weight was needed' would have scored the mark.

05.4 Some very good explanations were seen and about 10% of students scored all 3 marks. The first marking point was least likely to score. The third marking point needed to be linked to the second marking point before it could be scored.

Question 6 (Standard/High demand)

06.1 This question discriminated well between students. About 15% scored 4 marks with 20% gaining 3 marks. The first two marking points were most commonly scored. Students who said that 'no energy was lost' as a consequence of the step-up transformer's effect did not score the third marking point.

06.2 Approximately 55% of students scored 2 marks, while 15% of students scored 1 mark. Students who scored no marks usually confused the quantity that was decreased (pd) with the quantity that increased (current). Some student answers lacked technical accuracy referring to energy, power or charge incorrectly.

06.3 Two thirds of students scored 4 marks for this calculation, whereas about 20% of students scored 3 marks. A common mistake was to try to multiply the answer by the number of seconds in a day, which would probably only score the significant figure mark if correct, as the Physics equations were applied incorrectly.
Common mistakes were to round the answer to 1 400 000 000 C, which would score 3 marks if the full s.f. answer was seen, or round the answer to 141, which would score 3 marks for the supporting calculations if seen. A common error was to miscount the number of zeroes, so would only score 3 marks.

4.6.2.4 Uses and applications of electromagnetic waves

Question 7 (Standard/High demand)

07.1 54% of students could state what an alpha particle consists of. The list principle was applied when students wrote '2 protons and 2 neutrons – a helium atom', which did not score.

07.2 65% of students completed the nuclear equation correctly, scoring 2 marks, whereas 24% scored just 1 mark.

07.3 Students generally made good attempts to answer this question and marking points 1, 2 and 4 were seen most often. To score the 5th marking point students need to make a comparative statement, internal versus external damage. The third marking point was least likely to score, as students rarely referred to dose or the living cells / tissues / organs inside the body. Some students incorrectly thought that ionisation was a process that happened to cells, rather than atoms, so often didn't score the fifth marking point for this reason. Very few students scored 5 marks and the question discriminated well between students of differing ability.

Question 8 (Standard/High demand)

08.1 About 90% of students gave the correct measuring instrument. While it wasn't seen often, an answer of a 'volumetric pipette' was also creditworthy. 'Pipette' was insufficient.

08.2 Around 90% of students correctly identified the hazard in the investigation.

08.3 For this calculation, about 45% of students scored 5 marks and 20% of students scored 4 marks. A common mistake was to calculate *L* using one of the masses given in the question, rather than the change in mass. The resulting numerical answer would score zero as the equation was not being used correctly.

08.4 About 15% of students scored 2 marks for this explanation and 10% of students scored 1 mark. Many students reached incorrect conclusions and many students simply reworded the information given in the question.

08.5 7% of students scored 2 marks and 3% of students scored 1 mark. Many students reached incorrect conclusions and many students reworded the information given in the question without adding to it.

4.6.2.4 Uses and applications of electromagnetic waves

Question 9 (High demand)

09.1 Approximately 55% of students scored 5 marks, but in the 2022 series students were provided with an Equations Sheet with all the equations. A commonly seen answer was 73 500, which scored 4 marks for not converting the height into metres.

09.2 5% scored 2 marks and about 30% scored 1 mark. Many students failed to score a mark by pointing to the 'inaccuracy of the measured mass / height / gravitational field strength', or referring to the measurements as being 'low resolution'. 'Mass may have been greater than 60 kg' or 'time may have been longer / shorter than 1.40 seconds' were other common incorrect answers.

09.3 About 75% of students identified the correct conclusion.

Question 10 (High demand)

10.1 About 45% of students scored 6 marks for this extended calculation, but in the 2022 series students were provided with an Equations Sheet with all the equations. Therefore, students were supported when it came to attempting this question. With an alternative approach using equations from paper 2, students' answers were marked on whichever approach brought them closest to the correct final answer. An answer of 6 m/s with no supporting working did not score full marks as students could achieve this answer by multiplying the spring constant and the extension together, which would give them the maximum force acting on the toy aeroplane.

10.2 About 65% of students scored the mark. The most common incorrect answers seen were gravitational potential or elastic potential.

10.3 Approximately 20% of students scored a mark. Many students failed to score a mark because they gave a factor without a specific change e.g. 'extension of spring', rather than 'increase the extension of the spring'.

Question 11 (High demand)

Due to incorrect Advance Information guidance being issued for this question, and to avoid students being disadvantaged, Question 11 was discounted and all students were awarded full (9) marks.

4.6.2.4 Uses and applications of electromagnetic waves

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account of how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

4.6.2.4 Uses and applications of electromagnetic waves

Questions matter

GCSE

Physics

8463/1H Paper 1 Higher Tier

Report on the Examination

8463
June 2024

Version: 1.0

4.6.2.4 Uses and applications of electromagnetic waves

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4.6.2.4 Uses and applications of electromagnetic waves

General

Grade 4-5 calculation questions ask for students to recall an equation first before using it in a subsequent calculation, however in the 2024 series, students were given a Physics Equations Sheet which had all the equations printed on it. Subsequently, the performance on straightforward calculations has improved compared with years when equations have needed to be recalled from memory.

The grade 8-9 multistep calculations, question **05.5** and **06.2**, were well attempted. Question **05.5** had 18% of students scoring 5 marks, while question **06.2** had 14% of students scoring 6 marks.

Question **03.1** was well attempted and students who had carried out the resistance of a wire required practical would have had a material advantage over those who hadn't. For this question, 44% of students scored 5 or 6 marks and 37% of students scored 3 or 4 marks.

Handwriting continues to be a problem for a number of students, making it very difficult for examiners to read what has been written. An increasing number of students are using computers to word process their answers for extended response questions, which is helpful for examiners in awarding credit for student responses. However, students must use the question number as printed in the question paper eg 4.3 rather than 4(c) to ensure that their work is marked with the corresponding question part.

Levels of demand

Questions are set at three levels of demand for this paper:

- **Standard demand** questions are designed to broadly target grades 4–5.
- **Standard/high demand** questions are designed to broadly target grades 6–7.
- **High demand** questions are designed to broadly target grades 8–9.

A student's final grade, however, is based on their attainment across the qualification as a whole, not just on questions that may have been targeted at the level at which they are working.

Question 1 (Standard Demand)

01.1 98% of students scored this mark, identifying the energy store which increases when water is heated.

01.2 93% of students scored this mark. Some incorrect answers seen were 'method A' or 'method B' students thinking they were linking a method to the energy transfer. Another common answer was 'hydroelectric energy' which didn't score. The word 'potential' was needed for an answer of 'gravitational potential.' As the question was worded it seemed reasonable to credit 'kinetic' since the water moving uphill would have kinetic energy before it reached its destination and stored only gravitational potential energy.

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01.3 55% of students scored 4 marks. Some students failed to realise that the calculations needed were to show the amount of stored energy wasted or the amount of stored energy usefully transferred. Simple subtractions were insufficient to score the calculation marks. To score 4 marks, two comparisons were needed in addition to a comparative calculation. Although the comparative calculation performed by a minority of students involved dividing 33 600 kJ by 490 kJ and getting an answer of 68.6, which is the number of times more energy stored by method A compared to B. This single calculation was enough to score 4 marks with the two simple comparisons. The installation comparison only scored if value was added to the information eg Method A is easier to install or is likely to cost less money.

01.4 To score marks for this question, students needed to say what activity should be stopped (or reduced) and what should be done instead for both transport and electricity generation. At its simplest this could be use electric cars instead of petrol cars and use renewable methods instead of fossil fuels to generate electricity. As well as the examples on the mark scheme other valid methods were also creditworthy: car sharing, for example, or limiting the distance that goods could be shipped across country. 39% of students scored 4 marks, while 35% of students scored 3 marks.

Question 2 (Standard Demand)

02.1 A sentence completion question about nuclear fission which discriminated well between students. 72 % of students scored 3 marks, 21% scored 2 marks and 5% scored 1 mark.

02.2 99.5% of students scored the mark for writing down the correct equation. However, in this exam series all equations were provided for the students on the Physics Equations Sheet.

02.3 A standard demand calculation of energy question. 48% of students scored 3 marks, while 41% of students scored 2 marks. Not converting or incorrectly converting the unit will have allowed many students to only score 2 marks.

02.4 44% of students scored a mark. ‘Wear protective clothing’ or ‘hazmat suits’ were common incorrect answers. Any idea of ‘burying it’ was credited, so ‘bury it in a field’ was ok, as was ‘bury it in landfill,’ which from a student’s perspective is equivalent to burying it underground. ‘Keeping it away from people’ was insufficient.

02.5 96% of students scored 2 marks. The answer of 29.2 days was worth 1 mark as this could only have been calculated by doing the correct calculation and then subtracting the result from 365.

Question 3 (Standard/High Demand)

03.1 Students who had completed the investigation found this question straightforward, especially as the circuit was shown in a photo. It was not necessary for the circuit connections to be described. The mean mark for the question was 4 marks. 44% of students scored 5 or 6 marks, while 37% of students scored 3 or 4 marks.

03.2 83% of students identified the graph showing the relationship between length of wire and resistance.

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03.3 28% of students scored 2 marks, while 50% scored 1 mark. The converse of 'low p.d.' was the bare minimum to score the first mark, so 'not a high p.d.' was taken to mean the p.d. was low. Similarly, 'not enough to give you a shock' and 'not enough to electrocute you' were creditworthy for the second mark.

Question 4 (Standard/High Demand)

04.1 Students answers were generally very confused with this question and statements about transfer of positive electrons or protons or even neutrons were commonly seen. Students struggled to understand that when you are in contact with a charged object you have the same charge as that object. It was common to see statements about the dome being negative so the student (and her hair) are positively charged. If a student said that the student was positively charged they could not score mark points 1 and 2, but they could still score mark point 3 if they said that like / same charges repel. 10% of students scored 3 marks, while 15% scored 2 marks and 32% scored 1 mark.

04.2 Only 8% of students scored a mark on this question. An answer of 'the area / space / region where an electron experiences a force' was creditworthy as were other examples of charged particles or ions. 'The area where other charged particles experience repulsion or attraction' was also creditworthy. Neither of these examples were seen often, however.

04.3 92% scored a mark for this question. A surprisingly large number of students made statements like 'as you get closer to the dome, the field strength increases' answering the question in the opposite way to the way it was set out. They scored a mark but would have saved a lot of time by writing 'it decreases.'

04.4 Some students did not convert, or incorrectly converted, the unit of charge and scored 3 marks.. Some students incorrectly converted the unit for charge and also spuriously converted the energy by multiplying or dividing by a power of ten. These students made two mistakes, so scored a maximum of 2 marks on this question. 36% of students scored all 4 marks, while 56% of students scored 3 marks for this calculation of potential difference.

04.5 80% of students identified the factor that would increase the distance a spark can jump between two objects.

Question 5 (Standard/High Demand)

05.1 72% of students scored 2 marks, while 15% of students scored 1 mark. A number of students thought mains p.d. was 240 V. It was officially changed to 230 V in 1987 and this is the value given in the specification. However, it was more common for students to get the p.d. correct and the frequency incorrect.

05.2 A grade 6-7 calculation of resistance, which discriminated well between students. The conversion of milliwatts to watts proved a problem for the vast majority of students. 53% scored all 4 marks, while 36% scored 3 marks.

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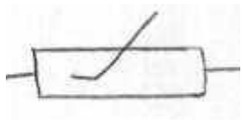
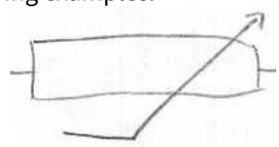
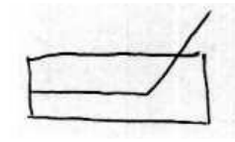
05.3 64% of students scored a mark for suggesting why dirty coins are not recognised by the machine. Answers which were insufficient, but ignored, included 'Can't measure resistance' and 'Dirt is an insulator'..

05.4 63% of students scored a mark for drawing the thermistor symbol. Answers that were not acceptable included the following examples.

05.5 This grade 8-9 calculation, worth 5 marks, question discriminated well between students of different abilities. If a student did not calculate the total resistance and then use that value to calculate the current in the circuit, then they didn't score the first 3 marks. If a student calculated the current in the circuit using just the 400 Ω resistor, then they could use that value to score the 4th and 5th marks for the calculation of the p.d. across the thermistor, using $V = IR$.
Answers with a p.d. greater 12 V usually scored zero marks, due to fundamental Physics errors.
18% of students scored 5 marks, while 31% of students scored 2 marks. 46% of students scored 0 marks. In this exam series all equations were provided for the students on the Physics Equations Sheet.

Question 6 (High Demand)

06.1 90% of students scored this mark, for identifying that the elastic potential energy store increases as the bungee cords are stretched.

06.2 A challenging grade 8-9 calculation question. A common incorrect answer was '10' which scored 5 marks because the only mistake the student made was not doubling the elastic potential energy calculated for one bungee cord. Due to the various ways students approached the question it discriminated well between different abilities. 14% of students scored 6 marks, while 34% scored 5 marks and 28% scored 4 marks. As long as a student had used the elastic potential energy equation calculating a value of E_e using a value of k and e^2 they could score the marks for using the E_p equation.

06.3 12% of students scored 2 marks, while 46% of students scored 1 mark, in this question for identifying the ways in which energy was dissipated.

Question 7 (Standard/High Demand)

07.1 52% of students scored this mark. The question states that the student's eye is not in line with the level of the water. The position of the eye is likely to remain in the same (incorrect) position as the water level changes when the ring is inserted. This will cause a random error as both volume measurements will be incorrect, but not by the same amount.

07.2 63% of students scored this mark. Additional mass or absorbing extra water were ignored. The answer needed to make a comparison, rather than just state that 'volume of string affects the measurement of volume.'

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07.3 33% of students scored the mark for this question about resolution. Comments on low / high resolution were insufficient to score. Statements needed to refer to the resolution value itself or the number of decimal places the measurement could be read to. As measuring cylinders often have large gaps between markings, a statement that the resolution was 0.1 cm^3 was allowed.

07.4 71% of students scored a mark for this question about zero error. Common incorrect answers said, 'take repeat readings and calculate a mean.'

07.5 A grade 6-7 calculation question, but the unit conversion made this question more difficult than other similar calculations in the exam, with only 33% of students scoring all 4 marks. 57% of students scored 3 marks.

Question 8 (High Demand)

08.1 Questions about the microscopic causes of pressure are difficult for GCSE students and this question was no exception. Many students repeated information given in the question which did not score any marks. A minority of students scored the first mark point, many students simply stating that the volume decreased which was insufficient. Students made a good attempt at explaining that there were more collisions between the particles and the container walls, but failed to score because they didn't refer to a specified time period e.g. per second, or rate or more frequent, etc. Some students stated that the kinetic energy of the particles had increased, which stopped them from scoring the second mark point. Very few students scored the third mark point which was the most demanding of the three. 9% of students scored 2 or 3 marks, while 43% of students scored 1 mark.

08.2 94% of students scored this mark, linking temperature increase to mean kinetic energy of particles.

08.3 A grade 6-7 calculation question which discriminated well between students. Many students failed to convert the specific heat capacity so scored 3 marks instead of 4. Some students tried to convert the energy into kJ but very few did this successfully, usually ending with a 'power of 10' error. 22% of students scored 3 marks while 62% of students scored 4 marks.

Question 9 (High Demand)

09.1 Students needed to refer to the graph, and factual recall about alpha radiation, to score the 1st and 3rd mark points.,. The 2nd mark point was much more unlikely to score, as students often stated the graph went to zero, rather than being just above zero. A number of students confused the graph with a half-life graph, believing the *x*-axis showed time, not distance. 8% of students scored 3 marks, while 45% scored 2 marks and 35% scored 1 mark.

09.2 A lot of students thought it was enough to say 'an absorbing material' without specifying what the absorbing material should be made from. Any suitable absorbing material was creditworthy, a block of wood for example. However, reference to any metal foil was not creditworthy unless students referred to a certain thickness eg 5 mm thick aluminium foil. A 'foil' was taken to be the same thickness as kitchen foil, whereas a 'metal sheet' was taken to be thick enough to absorb

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beta radiation, provided students did not contradict their earlier statements. Paper and cardboard were not creditworthy as suitable absorbing materials. 51% of students scored 2 marks, while 7% of students scored 1 mark.

09.3 65% of students scored this mark by suggesting a suitable safety precaution. Hazmat suits and PPE were insufficient to score.

09.4 64% of students scored this mark by suggesting a suitable precaution to avoid contamination. Hazmat suits and PPE were insufficient to score.

09.5 Students at GCSE find the idea of rate of change to be a difficult one, hence linking the change in the number of atoms to activity was a difficult question in this exam series. 7% of students scored 4 marks, while 12% of students scored 3 marks. If students failed to draw a tangent, they were very unlikely to score any marks except the unit mark. A common incorrect choice of unit for activity for many students was sieverts, Sv. Examiners were looking for becquerel or Bq. Decays per second or decays/second were insufficient to score.

Question 10 (Standard/High Demand)

10.1 72% of students correctly identified the colour of the live wire insulation.

10.2 66% of students scored the mark on this question. Students who made the box for the answer into a fuse symbol did not score the mar nor did a fuse symbol added to any side of the box .

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10.3 A grade 6-7 calculation of current. 57% of students scored all 4 marks. 36% of students scored 3 marks, usually for incorrectly converting, or not converting, the unit.

10.4 A grade 6-7 calculation of mass. 61% of students scored 4 marks. 31% of students scored 3 marks for either incorrectly converting, or not converting, the unit.

10.5 40% of students scored 2 marks on this question recognising that the time would be longer because more energy in total would need to be transferred. An answer of ‘less energy is melting the wire’ was just enough to score the second mark. 15% of students scored zero on this question.

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4.6.2.4 Uses and applications of electromagnetic waves

Mark Ranges and Award of Grades

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