AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.2.4.2

Uses of nanoparticles

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**12**
Available paper years	**2008–2025**

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.

4.2.4.2 Uses of nanoparticles

Answer 01 · Mark scheme

January 2008 | CHY2H | Original Q2 | Legacy

The full source mark scheme begins on page 26. Follow original question 2 in that document.

4.2.4.2 Uses of nanoparticles

Answer 02 · Mark scheme

June 2008 | CHY2H | Original Q6 | Legacy

question	answers	extra information	mark
6(a)	nanoparticles / they are small(er)	accept 1–100 nm or a few atoms in size	1
	so can easily pass through pores / skin / cell / membranes / arteries / veins / capillaries / into blood stream owtte	must be a comparative statement can be inferred from smaller particles allow absorbed for pass through	1
6(b)	any **one** from: • may be toxic (to cells / specific cells) • to ensure safety **or** reduce risk **or** risk of litigation • nanoparticles may have different properties • to see if they pass into the body	allow may harm / damage / kill cells / organs / tissues **or** may cause cancer allow may cause allergies / side effects ignore harmful / dangerous unqualified eg harmful to body / people	1

Question 6 continued on the next page...

4.2.4.2 Uses of nanoparticles

COMPONENT NUMBER: CHY2H

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

Question 6 continued...

question	answers	extra information	mark
6(c)	any **two** sensible ideas from eg: • testing is expensive **or** testing costs money • testing is time consuming • don't see any reason to test since normal sized particles (of titanium oxide) do not cause harm • don't want to risk not producing a popular product (owtte) • testing process / unfavourable results might cause alarm / reduce sales / reduce profit (less money) • do not want to be seen doing animal testing	allow it costs money ignore litigation accept normal sun cream does **not** cause harm owtte eg if unsafe will have to stop production **or** have to remove product if toxic	2
Total			**5**

4.2.4.2 Uses of nanoparticles

Answer 02 · Mark scheme

June 2008 | CHY2H | Original Q6 | Legacy

COMPONENT NUMBER: CHY2H

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

4.2.4.2 Uses of nanoparticles

Answer 03 · Mark scheme

January 2010 | CHY2H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)	any **four** from: • giant structure / lattice • positive ions • sea of electrons **or** delocalised / free electrons • awareness of outer shell / highest energy level electrons are involved • (electrostatic) attractions / bonds between electrons and positive ions • bonds / attractions (between atoms/ ions) are strong • a lot of energy / heat is needed to break these bonds / attractions	max **3** marks if any reference made to covalent / ionic bonding / molecules **or** intermolecular forces **or** graphite / diamond **or** forces of attraction between electrons and then ignore throughout ignore layers ignore electrons can move allow hard to break for strong ignore forces unqualified ignore high temperature	4

Question 4 continues on next page

CHY2H

Question 4 continued

question	answers	extra information	mark
4(b)(i)	that they are very small **or** 1–100 nanometres **or** a few (hundred) atoms	accept tiny / really small / a lot smaller / any indication of very small eg microscopic, smaller than the eye can see ignore incorrect numerical values if very small is given	1
4(b)(ii)	any **2** from: • one (non-bonded) electron from each atom • delocalised / free electrons • electron carry / form / pass current / charge	 allow sea of electrons ignore electrons can move ignore carry electricity	2
Total			**7**

4.2.4.2 Uses of nanoparticles

Answer 03 · Mark scheme

January 2010 | CHY2H | Original Q4 | Legacy

CHY2H

4.2.4.2 Uses of nanoparticles

Answer 04 · Mark scheme

June 2011 | CHY2H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)	kills <u>bacteria</u> **or** stops growth of <u>bacteria</u>	allow destroys bacteria ignore attacks / reacts with bacteria ignore 'traps the smell' ignore microbes	1
1(b)	small<u>er</u> / <u>very</u> small / tiny	assume they are referring to nanoparticles unless they state otherwise accept 1 – 100nm in size accept a few hundred atoms in size accept normal size particles are (much) larg<u>er</u>	1
1(c)	any **one** from: • big(ger) surface area • react fast(er)	 accept more reactive ignore kill faster	1
1(d)	so they do not get released during washing **or** so they do not get into rivers / ecosystem / environment because this could harm fish / aquatic life **or** so the socks keep their odour – preventing properties (owtte)		1 1
Total			**5**

4.2.4.2 Uses of nanoparticles

Answer 04 · Mark scheme

June 2011 | CHY2H | Original Q1 | Legacy

CHY2H

4.2.4.2 Uses of nanoparticles

Answer 05 · Mark scheme

June 2012 | CH2HP | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	because calcium is +2 and hydroxide is –1 **or** to make the compound neutral (in terms of charges)	accept to balance the charges allow calcium needs to lose 2 electrons and hydroxide needs to gain one electron	1
6(b)	particles of size 1-100 nm **or** particles with a few hundred atoms / ions **or** particles with a high surface area (to volume ratio) **or** as different properties to 'normal' size particles of the same substance	allow clear comparison to 'normal' size particles	1
6(c)	M_r CaO = 56 **and** M_r $Ca(OH)_2$= 74 2/56 (x74) **or** 0.036 (x74) **or** 74/56 (x2) **or** 1.3(214…) (x2) 2.6(428…) in range 2.6 to 2.96	 allow ecf from step 1 correct answer with or without working gains **3** marks allow ecf carried through from step 1 ignore final rounding to 3	1 1 1
Total			**5**

4.2.4.2 Uses of nanoparticles

Answer 05 · Mark scheme

June 2012 | CH2HP | Original Q6 | Legacy

CH2HP

4.2.4.2 Uses of nanoparticles

Answer 06 · Mark scheme

June 2014 | CH2HP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
5(a)	nanotubes can slide (over each other) because no (covalent) bonds between the nanotubes	allow nanotubes can roll (over each other) *accept weak forces between the nanotubes **or** weak intermolecular forces* *allow layers for nanotubes throughout*	1 1	1 / 2.2.3d	E
5(b)	delocalised electrons *so (delocalised) electrons* can move through the graphite	*accept free electrons* *accept so (delocalised) electrons can carry charge through the graphite*	1 1	1 + 2 / 2.2.3c/e	E
Total			**4**		

4.2.4.2 Uses of nanoparticles

Answer 06 · Mark scheme

June 2014 | CH2HP | Original Q5 | Legacy



4.2.4.2 Uses of nanoparticles

Answer 07 · Mark scheme June 2014 | CH2HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
6(a)(i)	any **two** from: • *100% of (type 1 and type 2) bacteria are killed with a particle size of 7.5 to 8.5 nm* • *as the size increases (beyond 8.5 nm), nanoparticles are less effective at killing (type 1 and type 2) bacteria* • *type 1 shows a linear relationship **or** type 2 is non-linear* • type 1 bacteria more susceptible than type 2 (at all sizes of nanoparticles shown on the graph)	*ignore any conclusion drawn referring to data below 7.5 nm or above 20 nm* *accept nanoparticles in the range of 7.5 to 8.5 nm are most effective at killing (type 1 and type 2) bacteria* *allow type 2 bacteria are harder to kill*	2	3 / 2.2.6a	E
6(a)(ii)	(yes) because you *could confirm the pattern that has been observed* **or** (no) because trend/*conclusion* is already clear	*allow would reduce the effect of anomalous points / random errors* *allow would give better line of best fit* *ignore references to reliability / precision / accuracy / reproducibility / repeatability / validity*	1	3 / 2.2.6a	E

4.2.4.2 Uses of nanoparticles

Answer 07 · Mark scheme

June 2014 | CH2HP | Original Q6 | Legacy

6(b)		reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **3**		1 / 2.1.1c/f	E
	magnesium loses electron(s)		1		
	oxygen gains electron(s)		1		
	<u>two</u> electrons (per atom)		1		
	gives full outer shells (of electrons) ***or*** *eight electrons in highest energy level*	*accept noble gas structure*	1		
	or				
	(electrostatic) attraction between ions **or** forms ionic bonds				
Total			**7**		

4.2.4.2 Uses of nanoparticles

Answer 07 · Mark scheme

June 2014 | CH2HP | Original Q6 | Legacy



4.2.4.2 Uses of nanoparticles

Answer 08 · Mark scheme

June 2016 | CH2HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
3(a)(i)	(mass number = 16) because there are 8 protons and 8 neutrons (in the nucleus)	accept mass number is total number of protons and neutrons for **1** mark	2	AO1/AO2 2.3.1a,b,c
3(a)(ii)	same number of protons **or** both have 6 protons	numbers, if given, must be correct accept same atomic number	1	2AO1 / 1AO2 2.3.1d
	^{12}C has 6 neutrons	accept different number of neutrons for **1** mark	1	
	^{14}C has 8 neutrons		1	
		incorrect reference to electrons = **max 2** marks		
3(b)(i)	2 bonding pairs	accept dot, cross or e or – or any combination additional unbonded electrons negates this mark	1	AO1 2.1
	4 unbonded electrons around oxygen		1	
3(b)(ii)	covalent		1	AO1 2.1.1g

Question 3 continues on the next page

4.2.4.2 Uses of nanoparticles

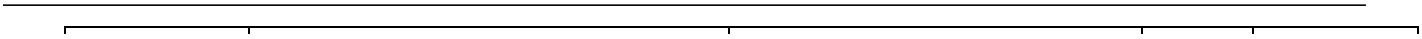
Question 3 continued

3(b)(iii)	any **one** from: • no delocalised / free electrons • no overall electric charge • no ions	do **not** accept any implications of the presence of ions ignore mobile electrons accept no charge (carriers)	1	AO1 2.2.1c
3(c)(i)	larger	accept the size of a few hundred atoms accept atoms are smaller (than nanoparticles) allow up to 1000 atoms	1	AO1 2.2.6a
3(c)(ii)	(nanoparticles have) large(r) surface area		1	AO2 2.2.6a
Total			**11**	

4.2.4.2 Uses of nanoparticles

Answer 08 · Mark scheme

June 2016 | CH2HP | Original Q3 | Legacy



Answer 09 · Mark scheme

June 2017 | CH2HP | Original Q3 | Legacy

The full source mark scheme begins on page 41. Follow original question 3 in that document.

4.2.4.2 Uses of nanoparticles

Answer 10 · Mark scheme

June 2019 | 8462/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	contain delocalised electrons (so) electrons can move through the structure / nanotube	allow contain free electrons allow (so) electrons can carry charge through the structure / nanotube ignore throughout for through ignore current / electricity for charge	1 1	AO1 4.2.3.3

Question	Answers	Mark	AO / Spec. Ref.
03.2	**Level 2:** Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3 4.2.2.7 4.2.3.3
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content • wood is the least dense so lightest to use • aluminium is the most dense so will make the racket too heavy • carbon nanotube is the strongest so least likely to break • wood / aluminium are too weak so the racket will break more easily • carbon nanotube is the stiffest so least likely to bend out of shape • wood / aluminium are not very stiff so could bend out of shape • justified conclusion		

Answer 10 · Mark scheme

Question 3 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3		an answer of 4.0 x 10^4 (nm^2) scores **3** marks an answer of 40344 (nm^2) scores **2** marks		AO2 4.2.4.1
	(82^2 =) 6724 (nm^2)		1	
	(6 x 6724 =) 40344 (nm^2)	allow 40344 (nm^2) correctly rounded to any number of significant figures allow correct calculation using incorrectly calculated value of area of one face from step 1	1	
	= 4.0 x 10^4 (nm^2)	allow 4.0344 x 10^4 (nm^2) correctly rounded to 1 or more significant figures allow a correctly calculated and rounded conversion to standard form of an incorrect calculation of surface area	1	
03.4	any **one** from: • less can be used (for the same effect) • greater surface area (to volume ratio)	allow converse statements about fine particles ignore nanoparticles are smaller	1	AO3 4.2.4.2
Total			**10**	

4.2.4.2 Uses of nanoparticles

Answer 11 · Mark scheme

June 2023 | 8462/1H | Original Q10

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	(nanoparticles) any **two** from: • have a higher surface area to volume ratio • less (material) needed (for the same effect) • more light gets through	allow converse arguments for fine particles allow a thinner coating is needed	2	AO3 4.2.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	(M_r TiO_2 =) 80		1	AO2 4.3.1.2
	(conversion 100 kg =) 100 000 (g)		1	4.3.2.1 4.3.2.2 4.3.5
	$\left(\text{moles } TiO_2 = \frac{100\,000}{80} = \right)$ 1250	allow correct use of an incorrectly determined M_r allow correct use of an incorrect / no conversion of mass	1	
	(moles Cl_2 = 1250 × 2 =) 2500	allow correct use of an incorrectly determined number of moles of TiO_2	1	
	(volume Cl_2 =) 2500 x 24	allow correct use of an incorrectly determined number of moles of Cl_2	1	
	= 60 000 (dm^3)		1	

Total Question 10	8

Answer 12 · Mark scheme

June 2025 | 8462/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	a ball of positive charge	allow a positive(ly charged) ball do **not** accept references to protons, nuclei, neutrons	1	AO1 4.1.1.3
	with (negative) electrons embedded		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	any **two** from: • the mass of the atom is concentrated at the centre / nucleus • the nucleus is positive / charged • most of the atom is empty space • electrons orbit the nucleus	do **not** accept references to shells	2	AO1 4.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	electrons orbit the nucleus at specific distances	allow electrons orbit the nucleus in energy levels allow electrons orbit the nucleus in shells	1	AO1 4.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	~100 000 times larger		1	AO2 4.1.1.5

4.2.4.2 Uses of nanoparticles

Answer 12 · Mark scheme

June 2025 | 8462/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(surface area = 6×1.2^2 =) 8.64 (nm^2)		1	AO2 4.2.4.1
	(volume = 1.2^3 =) 1.728 (nm^3)		1	
	(ratio = 8.64 : 1.728 =) $\frac{8.64}{1.728}$ (: 1)	allow (ratio = 1.728 : 8.64 =) (1 :) $\frac{1.728}{8.64}$ allow correct use of incorrectly determined values of surface area and / or volume	1	
	= 5 : 1	allow = 1 : 0.2	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6		allow converse arguments in terms of fine particles		AO3 4.2.4.2
	(nanoparticles) have a higher surface area to volume ratio		1	
	(so) less coating is used	(so) a thinner layer can be used	1	
	OR			
	(with nanoparticles) a thinner layer can be used (1)	allow less coating is used		
	(so) more light gets through the lenses (1)	allow (so) visibility is not reduced (as much)		

Total Question 5	12

4.2.4.2 Uses of nanoparticles

Version 1.0: 0108

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Additional Science 4463 / Chemistry 4421

CHY2H Unit 2 Chemistry

Mark Scheme

2008 examination – January series

4.2.4.2 Uses of nanoparticles

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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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4.2.4.2 Uses of nanoparticles

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 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 / ; eg allow smooth / free movement.)

3. Marking points

3.1 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.

4.2.4.2 Uses of nanoparticles

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

3.2 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.

3.3 Marking procedure for calculations

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;

3.4 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 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.

3.6 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 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.

4.2.4.2 Uses of nanoparticles

CHY2H

Question 1

question	answers	extra information	mark
(a)	sensible line of best fit which goes through or close to all the points **except** the anomalous point	allow wobbly / short double lines ± ½ square	1
(b)	loss of gas / loss of CO_2	idea of gas produced / formed	1
(c)	7		1
(d)(i)	steeper line from around the same starting point and left of the points levelling off at 99	allow crosses if they are fully correct for **1** mark accept short level line at 99 ± ½ square	1 1
(d)(ii)	any **three** from: • particles / molecules / atoms/ ions have more energy • move faster • collide <u>more</u> often **or** <u>more</u> chance of collisions **or** bump into each other <u>more</u> • collide with <u>more</u> force / energy **or** <u>more</u> particles have the activation energy **or** <u>more</u> collisions result in reaction **or** <u>more</u> collisions are successful	 allow given / gain / get energy ignore move about more ignore vibrate more / faster ignore collide quicker / faster	3
total			8

4.2.4.2 Uses of nanoparticles

CHY2H

Question 2

question	answers	extra information	mark
(a)	any **one** from: • they are made of layers • atoms / ions / particles / layers (of atoms) can slide over each other	 do **not** accept line / rows / lattice	1
(b)	any **one** from: • smaller / tiny **or** very small • correct size range 1 to 100 nanometres • a few hundred atoms in size	 do **not** allow small alone if they state smaller and give a size outside range ignore size if it is less than 20,000	1
(c)	harder plus **one** from: • so does not wear as quickly / erode as quickly • less vulnerable to damage owtte • because they have a high surface area to volume ratio **or** stronger (1) plus **one** from: (1) • less likely to break / do not break • not as vulnerable to damage owtte • do not bend out of shape • because they have a high surface area to volume ratio	 ignore corrode harder to wear down = **1** mark accept withstand pressure harder and stronger alone gains **1** mark	1 1
total			4

4.2.4.2 Uses of nanoparticles

CHY2H

Question 3

question	answers	extra information	mark
(a)	N_2O		1
(b)	13.8 to 14	gains full marks without working if answer incorrect 13 gains **1** mark **or** 14/101 × 100 gains **1** mark	2
total			3

4.2.4.2 Uses of nanoparticles

CHY2H

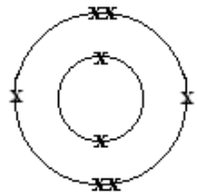
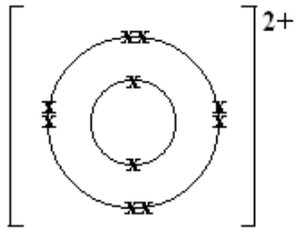
Question 4

question	answers	extra information	mark
(a)	electric current / electricity		1
	plus **one** from:		1
	• is passed through ionic compound / substance / electrolyte • passed through molten/aqueous compound / substance	must be linked to electricity allow liquid compound / substance do **not** allow solution / liquid alone	
	• causing decomposition	accept split up / breakdown / breaking up owtte ignore separated accept elements are formed ignore new substances form	
(b)	hydrogen	accept H_2 do **not** accept H / H^2	1
(c)	one electron from each atom	accept each carbon is bonded to three other carbon atoms leaving one (unbonded) electron owtte	1
	is delocalised / free (to move)	must be linked to electrons answers of delocalised / free electrons only, gains **1** mark accept each carbon is bonded to three other carbon atoms leaving delocalised / free electrons = **2** marks **maximum 1** mark if graphite described as a metal / giant ionic lattice	1
total			5

4.2.4.2 Uses of nanoparticles

CHY2H

Question 5

question	answers	extra information	mark
(a)	any **one** from: • gives out heat / energy • transfers energy from a substance to the surroundings • ΔH / energy change / enthalpy change is negative	accept releases / gives off owtte ignore references to light	1
(b)	$2Mg + O_2 \rightarrow 2MgO$	accept correct multiples / fractions	1
(c)		electrons do not need to be paired accept dots / circles / e instead of crosses do **not** allow 2.6 without diagram	1
(d)		electrons do not need to be paired allow without brackets must have the charge accept dots / circles / e instead of crosses ignore extra empty outer shells ignore nucleus do **not** allow $[2.8]^{2+}$ without diagram	1

continued…

4.2.4.2 Uses of nanoparticles

CHY2H

Question 5 continued…

question	answers	extra information	mark
(e)	oppositely charged (ions / atoms)	allow positive and negative(ions / atoms)	1
	(they) attract	must be in correct context accept held by electrostatic forces ignore ionic bonding **maximum 1** if they refer to intermolecular forces / attractions / covalent bonds	1
(f)	magnesium chloride	accept $MgCl_2$ (if correctly written)	1
total			7

4.2.4.2 Uses of nanoparticles

CHY2H

Question 6

question	answers	extra information	mark
(a)	**Compound A** any **one** from: • sodium bromide • potassium bromide • ammonium bromide • hydrogen bromide • any metal bromide except silver and lead. **Compound B** silver nitrate	accept correct formulae accept silver sulfate	1 1
(b)	the silver compound will decompose / silver ions be reduced to silver (owtte)	accept film would darken owtte accept any idea of light changing silver bromide / silver ions / silver nitrate / silver sulfate allow 'forms a black solid' / it would turn black	1
(c)	precipitation	accept descriptions of precipitation reactions accept double decomposition accept precipitate do **not** allow displacement	1
(d)	electrons are gained	 the second mark **must** be linked to electrons accept it / silver / silver ions gains electrons for **both** marks ignore references to oxygen	1 1
total			6

4.2.4.2 Uses of nanoparticles

CHY2H

Question 7

question	answers	extra information	mark
(a)	1213.8 to 1214.3 correct answer not given then check working 1) moles of $N_2 = \frac{1000}{28}$ $= 35.7$ mol 2) moles of $NH_3 = 2 \times$ (answer from (1)) $= 71.4$ mol 3) mass of NH_3 = (answer from 2) × 17 $= 71.4 \times 17 = 1214$ g **or** • 28g of $N_2 \rightarrow 34$g of NH_3 • 1g of $N_2 \rightarrow \frac{34}{28}$ $= 1.214$g NH_3 • 1000 g of $N_2 \rightarrow 1000 \times 1.214$ $= 1214$g **or** • $1000 \times \frac{34}{28}$ **or** **other correct methods**	gains **3** marks without working **1** mark for each correct step do **not** penalise rounding errors in this part **1** mark for each correct step do **not** penalise rounding errors in this part allow error carried forward eg gains **2** marks if correct answer not given $1000 \times \frac{28}{34}$ gains **1** mark, **2** marks if correctly calculated (823.5g) $1000 \times \frac{28}{17}$ gains **1** mark if calculated correctly (1647.05g) look for the key ideas in the methods above	3

continued…

4.2.4.2 Uses of nanoparticles

CHY2H

Question 7 continued…

question	answers	extra information	mark
(b)	25 / 25.035 **or** ecf from (a)	gains **2** marks even when there is no working incorrect answer then 304/(their answer from (a)) × 100 gains **1** mark	2
	or using figures from part (b)		
	27.6 / 28	gains **2** marks even when there is no working accept 27 for **1** mark if answers incorrect then304/1100 × 100 gains **1** mark	
(c)(i)	increase yield		1
	reaction is exothermic		1
	or		
	allow decreased yield because rate of reaction is slower / fewer collisions for **2** marks	**must** get both points for **2** marks	
(c)(ii)	increase yield		1
	plus **one** from: • more (gaseous) reactant molecules than (gaseous) product molecules (owtte) • increased rate of reaction / more collisions	accept greater volume on the left than the right owtte	1

continued…

4.2.4.2 Uses of nanoparticles

CHY2H

Question 7 continued…

question	answers	extra information	mark
(d)	any **one** from: **economic** • large town provides workforce • workers do not have to travel far to the factory. (owtte) • transport infrastructure already in place for large town. (owtte) • factory brings prosperity to town (owtte) • factory provides employment • reduced tourism • reduction in local house prices • any other sensible economic factor linked to town		1
	any **one** from: **safety** • escape of dangerous / harmful chemicals / gases (owtte) • danger of increased traffic • risk of explosion.(owtte) /danger of high pressure • consequences of an accident could be severe if the town is close • any other sensible safety idea	do **not** allow polluting gases unqualified	1

continued…

4.2.4.2 Uses of nanoparticles

CHY2H

Question 7(d) continued…

question	answers	extra information	mark
	any **one** from: **environmental** • factory might be unsightly (owtte) • screening of factory (owtte) • loss of habitats (owtte) • plant trees/ hedges etc on and around plant site • pollution of water / air / soil could harm plants / animals **or** noise pollution • CO_2 is produced by burning fuels / heating • CO_2 causes global warming / any effect of global warming • eye sore • any other sensible environmental factor	must be explained	1
total			12

4.2.4.2 Uses of nanoparticles

GCSE

Additional Science / Chemistry

CH2HP
Final Mark scheme

4408 / 4402
June 2017

Version/Stage: v1.0

4.2.4.2 Uses of nanoparticles

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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4.2.4.2 Uses of nanoparticles

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 and underlining

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 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]

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

4.2.4.2 Uses of nanoparticles

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, 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 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 'ecf' 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 or insufficient is used when the information given is irrelevant to the question or not enough to gain a 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 Written Communication and levels marking

In Question 2 students are required to produce extended written material in English, and will be assessed on the quality of their written 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.

4.2.4.2 Uses of nanoparticles

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	a smooth curve through or close to all points except (30,12)		1	AO2 2.4
1(a)(ii)	correct reading from the curve in 1(a)(i) (cm^3)	allow a tolerance of +/- 0.5 cm^3	1	AO2 2.4
1(a)(iii)	45-50 (seconds)		1	AO3 2.4
1(a)(iv)	line becomes less steep because gas is produced more slowly	ignore line levels out or plateaus allow examples with figures, eg 12 cm^3 gas from 0 to 20s but 1.5 cm^3 gas in last 20s ignore reaction has stopped or no more gas produced	1 1	AO3 2.4
1(a)(v)	0.6 (cm^3 per second)	allow 0.55 to 0.65	1	AO2 2.4
1(b)(i)	 temperature volume (of hydrogen peroxide)	concentration of hydrogen peroxide = max **1** ignore amount (of hydrogen peroxide)	 1 1	AO3 2.4
1(b)(ii)	 rate increases because more particles (in the same volume) so frequency of collisions increases	incorrect reference to energy = max **2** accept particles closer together allow greater chance of collisions ignore more collisions	 1 1 1	AO1 2.4.1e

4.2.4.2 Uses of nanoparticles

1(c)	(increasing the amount of catalyst) increases rate same final volume of gas	accept steeper graph or graph levels off earlier	1 1	**AO2** 2.4.1g
Total			**13**	

4.2.4.2 Uses of nanoparticles

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>2</td><td></td><td></td><td>6</td><td rowspan="6">AO1
2.1.1h
2.2.4b,c
2.2.5a,b</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="4"><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 given</td><td>a statement about the structure or a property of a metal
or
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer
and
at least one statement linking structure and property</td></tr>
</table></td></tr>
<tr><td colspan="4">Statements shown as HT only are credited on both FT and HT.
However, HT only means that these statements are not expected in a FT answer.</td></tr>
<tr><td colspan="4">Examples of chemistry points made in response

Metal:

Properties
shiny
hardness
(tensile) strength
melting point/boiling point
density
malleable/flexible
ductile
conduct electricity or thermal energy</td></tr>
</table>

4.2.4.2 Uses of nanoparticles

Structure • metals contain atoms /((positive) ions HT only) • (the atoms/(positive) ions/particles are) closely packed / in a regular pattern / in a giant structure/in layers / in a lattice • strong bonds/(electrostatic attractions HT only) • (metal has delocalised electrons HT only) **Polymer:** **Properties** • flexible • melting/boiling point • density • can be shaped/moulded • poor conductor of electricity or thermal energy **Structure** • polymer consists of chains • polymer chains may be tangled • polymer has no cross links. • (polymer has weak intermolecular forces HT only) **Level 3:** **Examples of linked statements:** • metal can be bent and shaped because the layers can slide • some metals are soft because layers can slide • some metals are hard because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure/ in a lattice • metal has high melting/boiling point because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure / in a lattice • metal is strong because of strong bonds • some metals are dense because the atoms are closely packed • (metal can conduct thermal energy and electricity because metal has delocalised electrons HT only) • thermosoftening polymer melts when heated because it has no cross-links (or has weak intermolecular forces HT only) • thermosoftening polymer is flexible because the chains can move over each other	

Total			**6**

4.2.4.2 Uses of nanoparticles

Question	Answers	Extra Information	Mark	AO / Spec. Ref
3(a)(i)	2 bonding pairs 4 unbonded electrons on each atom	accept dots, crosses, e, - or any combination ignore any electrons on any inner shells if no other mark awarded allow **1** mark for 1 bonding pair and 6 unbonded electrons on each atom	1 1	**AO2** 2.1.1g
3(a)(ii)	covalent	allow convalent and covelant ignore single or double ignore shared, shared bond or sharing	1	**AO1** 2.1.1g
3(a)(iii)	weak intermolecular forces require little energy to overcome	reference to weak covalent or weak ionic bonds = **0** accept weak intermolecular bonds MP2 dependent on MP1 if no other mark awarded allow 1 mark for simple/small molecules	1 1	**AO1** **AO2** 2.2.1a,b

4.2.4.2 Uses of nanoparticles

3(b)(i)	**2** Mg + O_2 → **2** MgO	accept multiples	1	**AO2** 2.2.2
3(b)(ii)		reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **2**		**AO1** **AO2** 2.1.1a,b,c,f
	magnesium loses (electrons) **and** oxygen gains (electrons)		1	
	two (electrons transferred)		1	
	noble gas structure **or** 8 electrons in outer shells **or** (electrostatic) attraction between ions **or** forms ionic bonds	accept full outer shell (of electrons)	1	
3(b)(iii)	particles 1-100 nm in size	accept contain a few hundred atoms/ions accept have a high surface area to volume ratio ignore reference to (very) small particles do **not** accept smaller than an atom/ion	1	**AO1** 2.2.6a

4.2.4.2 Uses of nanoparticles

3(c)	has a high melting point	allow will not melt allow a lot of energy needed to melt ignore boiling point reference to incorrect particles or incorrect bonding or incorrect structure = max **1** from MP2 and MP3	1	**AO1** **AO2** 2.2.3a
	because all atoms linked to other atoms	allow giant structure/lattice ignore many bonds	1	
	by covalent bonds	allow strong bonds allow a lot of energy needed to break bonds accept giant covalent structure for MP2 and MP3	1	
Total			**13**	

4.2.4.2 Uses of nanoparticles

Question	Answers	Extra Information	Mark	AO / Spec. Ref
4(a)	add copper oxide and (sulfuric) acid		1	**AO1** **AO2** 2.6.1b,c
	excess (copper oxide)		1	
	filter (to remove excess)	ignore impurities	1	
	heat /boil / evaporate / leave (to crystallise)	do **not** accept to dryness	1	
4(b)	(M_r CuO =) 79.5		1	**AO2** 2.3.3c
	24.95/249.5 **or** 0.1 **OR** 79.5/249.5 **or** 0.3186…	allow ecf for M_r CuO from step 1 allow correct rounding to min 2SF	1	
	(24.95/249.5 x 79.5=) 7.95	allow ecf for M_r CuO from step 1 allow ecf from step 2 of incorrect calculation/ rounding of correct ratio allow correct rounding to min 2SF correct answer with or without working gains 3 marks	1	
4(c)(i)	as wealth decreases, ethene production decreases (with the exception of country C or D)	accept converse	1	**AO2** **AO3** 2.6
	sulfuric acid production is not linked to wealth		1	

4.2.4.2 Uses of nanoparticles

4(c)(ii)	use of products of ethene has increased	allow use of polymers / plastics / ethanol / poly(ethene) has increased ignore use of ethene as a (bio)fuel ignore cost	1	**AO3** 2.2.5
Total			**10**	

4.2.4.2 Uses of nanoparticles

Question	Answers	Extra Information	Mark	AO / Spec. Ref
5(a)(i)	draw line on paper put (dots of) inks on line place (bottom of) paper in solvent / water any **one** from: line drawn in pencil allow dots of ink to dry line above solvent lid		1 1 1 1	**AO1** 2.3.2b
5(a)(ii)	any **two** from: • A has 3 colours **and** B has 4 colours • 2 colours are the same • **A** has 1 colour not in **B and B** has 2 colours not in **A**	accept 3 colours are different if no other mark awarded allow **one** more colour in ink **B** than in ink **A** (or converse)	2	**AO3** 2.3.2b
5(b)(i)	substances carried by gas through column / tube / coil (packed with solid) (different substances move through the column) at different speeds	 accept (different) substances come out at different times or have different retention times	1 1 1	**AO1** 2.3.2c
5(b)(ii)	(relative) molecular mass	allow (relative) formula mass allow RFM, RMM, M_r	1	**AO1** 2.3.2c
Total			**10**	

4.2.4.2 Uses of nanoparticles

Question	Answers	Extra Information	Mark	AO / Spec. Ref
6(a)(i)	tick (✓) by: the initial temperature reading was too low		1	**AO3** 2.5
6(a)(ii)	the reaction is exothermic	allow energy is given out	1	**AO3** 2.5.1b
6(b)(i)	(positive/hydrogen) ions gain electrons hydrogen is below sodium in the reactivity series so hydrogen / H_2 is produced	accept (positive/hydrogen) ions are reduced accept reference to high reactivity of sodium If no other mark awarded allow hydrogen (and sodium) ions **or** positive ions are attracted to negative electrode for **1** mark	1 1 1	**AO1** **AO2** 2.7.1c,f,i
6(b)(ii)	**2** (Cl^-) → **Cl_2 + 2e^-**	must be completely correct allow multiples	1	**AO1** 2.7.1g
6(b)(iii)	solution is alkaline because sodium hydroxide / NaOH is produced **or** sodium hydroxide / NaOH is left over	accept hydroxide (ions) / OH^- is produced **or** hydroxide (ions) / OH^- is left over	1 1	**AO1** **AO2** 2.7.1i; 2.6.2d
Total			**8**	

4.2.4.2 Uses of nanoparticles

Answer 10 · Examiner comments

June 2019 | 8462/1H | Original Q3

Question 3 (standard demand)

03.1 Most students scored a mark for referring to the presence of delocalised electrons in carbon nanotubes.

Only a small proportion scored the mark for explaining the role of these electrons in the conduction of electricity.
Some students only referred to the delocalised electrons being able to carry charge without further qualification.
Others were not sufficiently precise in describing the movement of electrons through the structure. This implies movement in a particular direction as opposed to random movement, for example, around the structure.

03.2 Almost all students made an attempt at comparing the properties of the three materials.

Most achieved a Level 2 mark by giving a consequence of one of the stated differences in properties. Many gave a justified conclusion in referencing the most suitable material for the racket frame.

4.2.4.2 Uses of nanoparticles

Answer 10 · Examiner comments

June 2019 | 8462/1H | Original Q3

03.3 Almost 70% of students scored full marks. Of those that didn't, most scored 2 marks for calculating the surface area as 40344 nm^2 but incorrectly converting or not converting this answer to standard form.

Even if the answer to their calculation was incorrect, a mark could still be scored for correctly converting this answer to standard form, provided that an attempt to calculate the surface area had been made.

03.4 Almost half of students scored this mark.

The most common correct response referred to nanoparticles having a greater surface area to volume ratio (compared to fine particles).

Some students linked the greater surface area to less zinc oxide being needed for the same effect. This covered both alternative bullet points in the mark scheme.

Common responses seen that were not credited included:

- nanoparticles are smaller
- nanoparticles are easier to manufacture
- less energy is required.

4.2.4.2 Uses of nanoparticles

Answer 11 · Examiner comments

June 2023 | 8462/1H | Original Q10

Question 10 (standard/high and high demand)

10.1 About a third of students scored one mark, but far fewer scored a second mark. Many students did not give comparative answers. Many referred to nanoparticles having a larger surface area, but failed to realise that this depends on the amount used. A higher surface area to volume ratio, or a higher surface area for the same mass of material was creditworthy and was the most common correct answer. This leads on to other creditworthy answers, such as a thinner coating being needed, and hence, more light getting through the window, but these answers were rarely seen. References to cost were ignored.

10.2 This question discriminated well. The great majority of students scored at least one mark, with nearly a half scoring five or six marks. The most common error was not converting 100 kilograms to grams in order to calculate the moles, or converting incorrectly. Another common error was to calculate a spurious volume of TiO_2. Some converted the number of moles of chlorine to a mass first, before converting to a volume; whilst unnecessary, this did give the correct answer and gained full credit. Students who gained one or two marks usually calculated the relative formula mass of TiO_2 and/or converted 100 kilograms to grams. A few seemed to be concerned by the large value of the answer and introduced a division by 1000 into what would have been a correct answer.

Students sometimes tried more than one method and did not cross out the one they did not want to be marked. This led to confusion and contradictions, sometimes meaning that marks could not be awarded. Students should always cross out discarded methods; examiners will not make the choice for the student.

4.2.4.2 Uses of nanoparticles

Answer 11 · Examiner comments

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

4.2.4.2 Uses of nanoparticles

Answer 12 · Examiner comments

June 2025 | 8462/1H | Original Q5

Question 5 (standard/high and high demand)

05.1 Over half of students scored both marks by giving the description in the specification. For the first marking point, the idea of both the shape and the charge were needed. Common errors were to refer to a positive 'cloud' or a ball of positive 'energy'. Other errors were to refer to protons, which had not been discovered, or to imply that there was an overall positive charge on the atom as a whole; atoms were known to be neutral in terms of charge. For the second marking point the electrons needed to be referred to as such, not just negative charge. Common errors were to imply that electrons were on the surface rather than embedded, or that they were moving.

05.2 This was well answered, with four fifths of students scoring at least one mark. Many referred to the mass being concentrated at the centre and also the positive charge but

4.2.4.2 Uses of nanoparticles

Answer 12 · Examiner comments

failed to refer to the centre as the nucleus. Many referred to most of the atom being empty space, but some simply said that there is empty space in the atom which is not quite the same. Fewer referred to electrons orbiting the nucleus, and many of those who did referred incorrectly to shells.

05.3 Whilst many students knew that Bohr's contribution to the model of the atom was electron shells, many did not mention that the electrons were orbiting the nucleus in these shells. Even fewer referred to specific distances from the nucleus. Many confused Bohr with Chadwick and stated that Bohr discovered neutrons. Only one third of students gave a fully correct answer.

05.4 More than four fifths of students gave the correct response, with 10 000 times larger being the most popular distractor.

05.5 Two thirds of students gave fully correct answers. Most students could calculate the volume correctly, although some incorrectly gave the units as nm instead of nm^3. They had more difficulty with the surface area, with some forgetting to multiply the area of one face by 6 and others miscounting the number of faces. The marks for calculating the ratio could be obtained from incorrect values for the surface area and / or volume. The simplest ratio was required, so this needed to be either a whole number ratio or with one of the values reduced to 1. Dividing one value by the other was by far the simplest way of finding the ratio. A few students unnecessarily decided to change the units from nm to m, mm or even μm. As this ratio is not dimensionless, this approach gave different values depending on the units chosen. Full marks could be obtained if the conversions were correct, but many were not. If students are not instructed to give an answer in particular units, they should stick with the ones provided.

05.6 Students found this question more difficult than expected, with fewer than half scoring one mark and about one in ten scoring both. Many students gave the general answer; that nanoparticles have a greater surface area to volume ratio. However, fewer were able to express clearly the idea that a thinner coating could be used, with many using ambiguous phrases such as 'less nanoparticles needed' rather than less of the coating or another description of less material in bulk. Fewer concentrated on the specific use in glasses. Although many said that visibility would not be reduced as much if nanoparticles were used, many thoughts this would be because the particles themselves could be seen if fine particles were used, which is not the case. Some students did not give answers in comparative terms, for example referring to a high (rather than higher) surface area to volume ratio.