AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.6.1.2

Properties of waves

Past-paper questions

Tier	**Higher**
Question groups	**14**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

6.6.1.2 Properties of waves

Question 01

June 2018 | 8464/P/2H | Original Q5

0 5 A car aerial receives radio waves from a radio transmitter.

Radio waves are transverse waves.

Sound waves are longitudinal waves.

0 5 . 1 Describe the difference between transverse waves and longitudinal waves.

[2 marks]

0 5 . 2 The radio waves have a frequency of 4.8×10^9 Hz

Wave speed of electromagnetic waves = 3.0×10^8 m/s

Calculate the wavelength of the radio waves.

Give your answer to 2 significant figures.

[3 marks]

Wavelength = _____ m

Question 5 continues on the next page

6.6.1.2 Properties of waves

Question 01 · continued

0 5 . 3 Describe how the radio waves reaching the car aerial produce signals in the electrical circuit of the car radio.

[3 marks]

8

6.6.1.2 Properties of waves

Question 02

June 2019 | 8464/P/2H | Original Q1

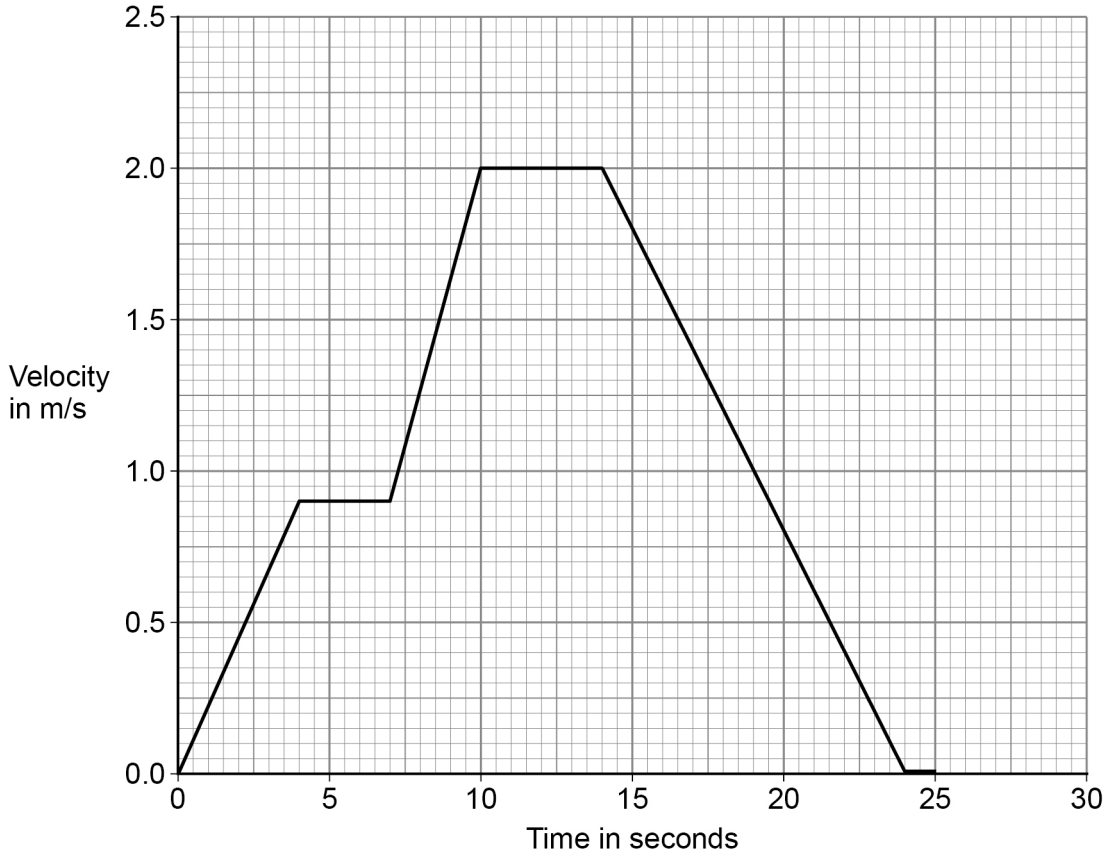
0 1 **Figure 1** shows a runner using a smart watch and a mobile phone to monitor her run.

Figure 1



Figure 2 is a velocity–time graph for part of the runner's warm-up.

Figure 2



6.6.1.2 Properties of waves

Question 02 · continued

0 1 . 1 Determine the total time for which the velocity of the runner was increasing.

[2 marks]

Time = _____ s

0 1 . 2 Determine the deceleration of the runner.

[2 marks]

Deceleration = _____ m/s^2

Question 1 continues on the next page

6.6.1.2 Properties of waves

Question 02 · continued

The smart watch and mobile phone are connected to each other by a system called Bluetooth.

Bluetooth is wireless and uses electromagnetic waves for communication.

0 1 . 3 Suggest why the phone and watch being connected by a wireless system is an advantage when running.

[1 mark]

0 1 . 4 Write down the equation that links frequency, wave speed and wavelength.

[1 mark]

0 1 . 5 The electromagnetic waves have a frequency of 2 400 000 000 Hz

The speed of electromagnetic waves is 300 000 000 m/s

Calculate the wavelength of the electromagnetic waves.

[3 marks]

Wavelength = _____ m

6.6.1.2 Properties of waves

Question 02 · continued

0 1 . 6 **Table 1** shows some information about four types of Bluetooth.

Table 1

Type	Power in milliwatts	Range in metres
1	100	100
2	2.50	10.0
3	1.00	1.00
4	0.50	0.50

Mobile phones use type **2** Bluetooth to communicate with other devices.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

11

6.6.1.2 Properties of waves

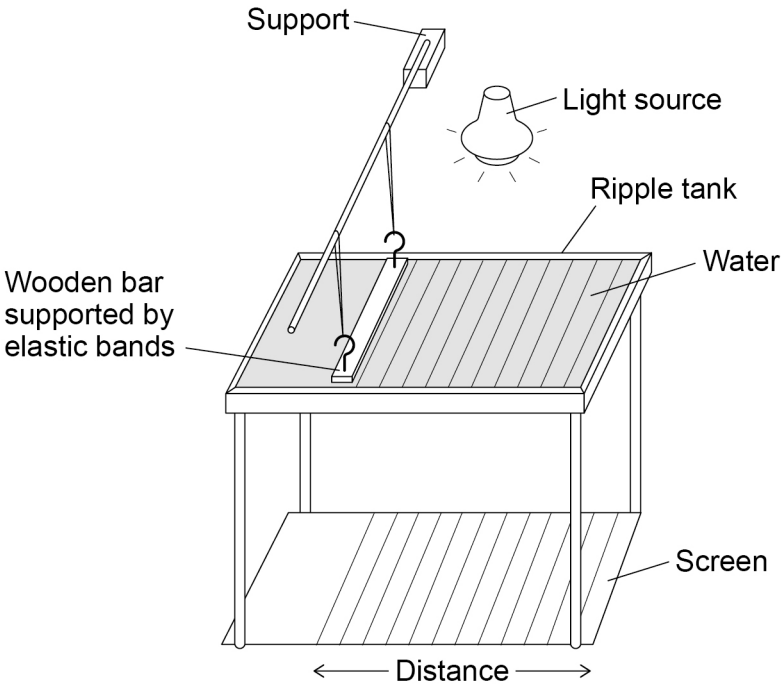
Question 03

0 2 **Figure 3** shows the equipment a teacher used to determine the speed of a water wave.

The equipment includes:

- a ripple tank filled with water
- a wooden bar that creates ripples on the surface of the water
- a light source which causes a shadow of the ripples on the screen.

Figure 3



0 2 . 1 Describe how equipment in **Figure 3** can be used to measure the wavelength, frequency and speed of a water wave.

[6 marks]

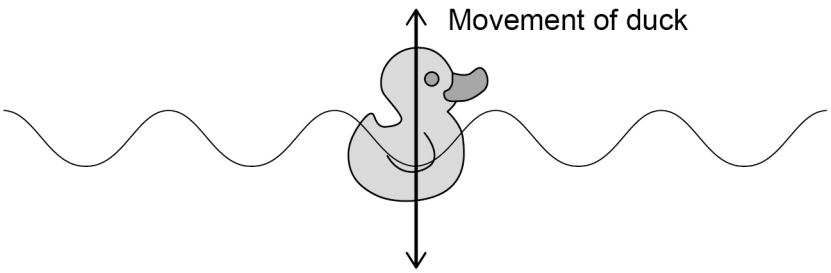
6.6.1.2 Properties of waves

Question 03 · continued

The teacher put a plastic duck in the ripple tank as shown in **Figure 4**.

The plastic duck moved up and down as the waves in the water passed.

Figure 4



0 2 . 2 How does the movement of the plastic duck in **Figure 4** demonstrate that water waves are transverse?

[1 mark]

Question 2 continues on the next page

6.6.1.2 Properties of waves

Question 03 · continued

0 2 . 3 The teacher measured the maximum height and the minimum height of the plastic duck above the screen as the wave passed.

The teacher repeated his measurements.

Table 2 shows the teacher's measurements.

Table 2

Maximum height in mm	509	513	511
Minimum height in mm	503	498	499

Calculate the mean amplitude of the water wave.

[3 marks]

Mean amplitude = _____ mm

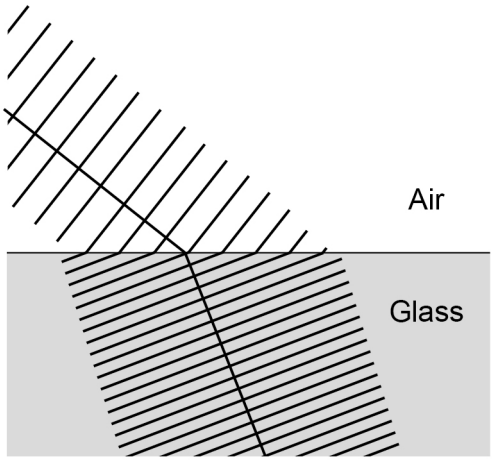
10

6.6.1.2 Properties of waves

Question 04

0 7 Wave front diagrams are used to explain why light refracts when it passes from air into glass.

Figure 10



0 7 . 1 Explain why the light refracts as it passes from air into glass.

[3 marks]

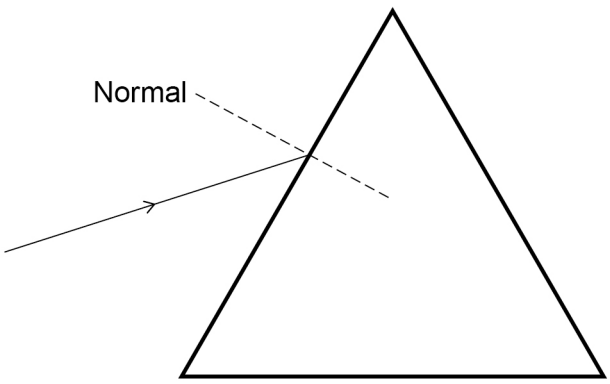
Question 7 continues on the next page

6.6.1.2 Properties of waves

Question 04 · continued

0 7 . 2 **Figure 11** shows a ray of red light entering a glass prism.

Figure 11



Complete the ray diagram to show the ray emerging from the glass prism.

[3 marks]

6.6.1.2 Properties of waves

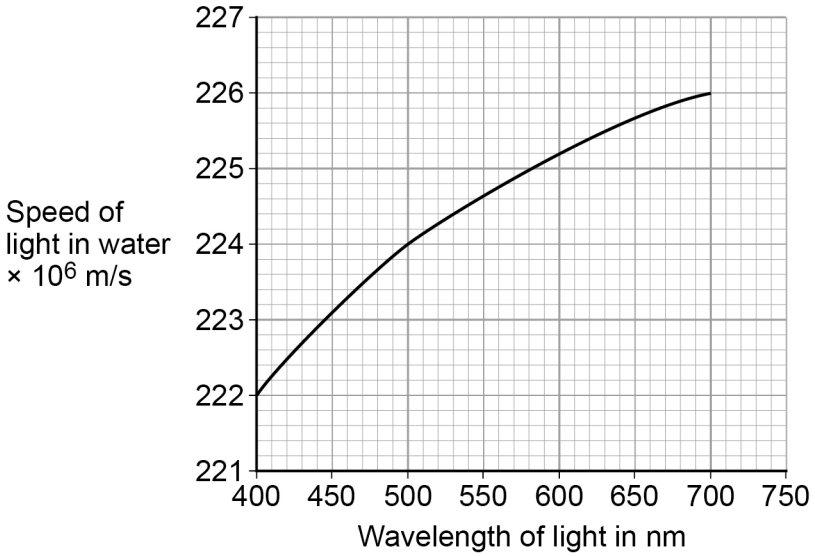
Question 04 · continued

0 7 . 3 White light is made up of a continuous spectrum of different wavelengths that all travel at 3×10^8 m/s in air.

Rainbows are produced because different wavelengths of light travel at different speeds in water.

Figure 12 shows the speed of different wavelengths of light in water.

Figure 12



Explain why violet light is refracted the most as it enters water.

[3 marks]

9

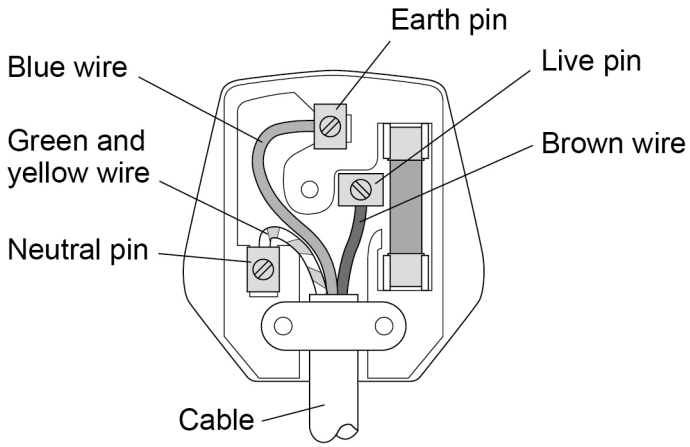
6.6.1.2 Properties of waves

Question 05

November 2020 | 8464/P/1H | Original Q1

0 1 **Figure 1** shows the inside of a plug.

Figure 1



0 1 . 1 The plug is **not** wired correctly.

What should be done to connect the wires in the plug correctly?

[1 mark]

Question 05 · continued

The correctly wired plug and cable connects a washing machine to the mains electricity supply.

0 1 . 2 Give the potential difference and frequency of the mains electricity supply in the UK.

[2 marks]

The potential difference is _____ V

The frequency is _____ Hz

0 1 . 3 The washing machine is switched on.

What is the potential difference between the neutral wire and the earth wire?

[1 mark]

Potential difference = _____ V

0 1 . 4 The plug has a fuse.

Draw the circuit symbol for a fuse in the space below.

[1 mark]

Question 1 continues on the next page

6.6.1.2 Properties of waves

Question 05 · continued

The washing machine has a metal case.

A fault causes the live wire to make an electrical connection with the metal case of the washing machine.

0 1 . 5 The earth wire is **not** connected to the metal case of the washing machine.

Explain why it would not be safe for a person to touch the metal case.

[2 marks]

0 1 . 6 The earth wire is now connected to the metal case of the washing machine.

Explain why it would now be safe for a person to touch the metal case, even if the live wire touches the metal case.

[2 marks]

9

6.6.1.2 Properties of waves

Question 06

November 2021 | 8464/P/2H | Original Q3

0 3 A student made water waves in a ripple tank.

0 3 . 1 Describe how the frequency and wavelength of the water waves in the ripple tank can be measured accurately.

[4 marks]

The student recorded values for the frequency and the wavelength of waves in the ripple tank.

Table 1 and **Table 2** show the results.

Table 1

Reading	**1**	**2**	**3**
Frequency in hertz	9.8	9.4	9.3

Table 2

Reading	**1**	**2**	**3**
Wavelength in cm	1.7	2.2	2.1

6.6.1.2 Properties of waves

Question 06 · continued

0 3 . 2 Determine the mean wave speed.

[4 marks]

Mean wave speed = _____ m/s

0 3 . 3 What is the advantage of taking repeat readings and then calculating a mean?

[1 mark]

0 3 . 4 The speed of the wave is affected by the depth of the water in the ripple tank.

The deeper the water the faster the wave.

Explain how the depth of the water affects the wavelength of the wave if the frequency is constant.

[2 marks]

11

6.6.1.2 Properties of waves

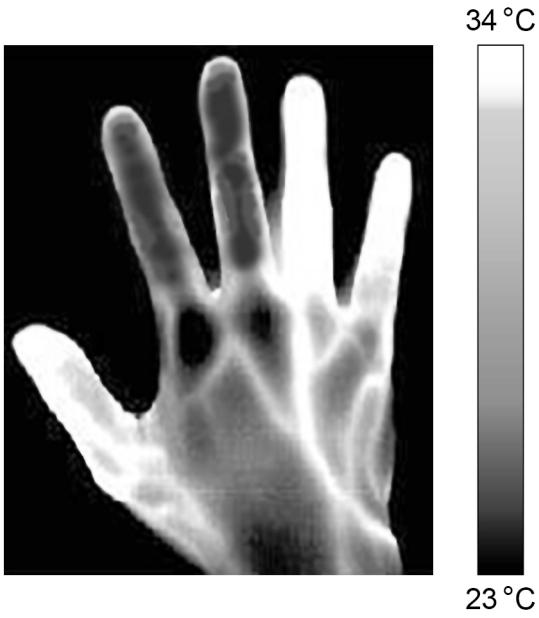
Question 07

November 2021 | 8464/P/2H | Original Q5

0 5 Different parts of the electromagnetic spectrum are used in medical imaging.

Figure 8 shows an image of a person's hand taken with an infrared camera.

Figure 8



0 5 . 1 Explain why the infrared camera is able to show that parts of the hand are at different temperatures.

[2 marks]

Question 5 continues on the next page

6.6.1.2 Properties of waves

Question 07 · continued

0 5 . 2 Infrared has a range of wavelengths from 700 nm to 1 mm.

Which part of the electromagnetic spectrum would have waves with a wavelength of 6.5×10^{-7} m?

[1 mark]

Tick (✓) **one** box.

- Infrared ☐
- Microwaves ☐
- Radio waves ☐
- Visible light ☐

0 5 . 3 **Figure 9** shows X-rays and gamma rays being used for medical imaging.

Figure 9

X-rays **Gamma rays**



To use X-rays for medical imaging, a machine produces a very brief burst of X-rays.

To use gamma rays for medical imaging, a radioactive isotope is injected into the patient's blood. The isotope is circulated around the body in the blood. The isotope emits gamma rays.

Compare the potential risks to a patient of using X-rays and gamma rays for medical imaging.

[4 marks]

Question 5 continues on the next page

Question 07 · continued

X-rays are produced by colliding high-energy electrons into a metal target.

The electrons have high energy because they are accelerated to high speeds.

Only a small proportion of the kinetic energy of an electron is converted into an X-ray when it collides with the metal target.

0 5 . 4 An electron is accelerated through a distance of 15 mm.

The work done on the electron is 1.2×10^{-13} J.

Calculate the force on the electron.

[3 marks]

Force = _____ N

0 5 . 5 The metal target is made from tungsten.

Tungsten has the highest melting point of any metal.

Explain why using tungsten as the metal target enables the X-ray machine to be more powerful.

[3 marks]

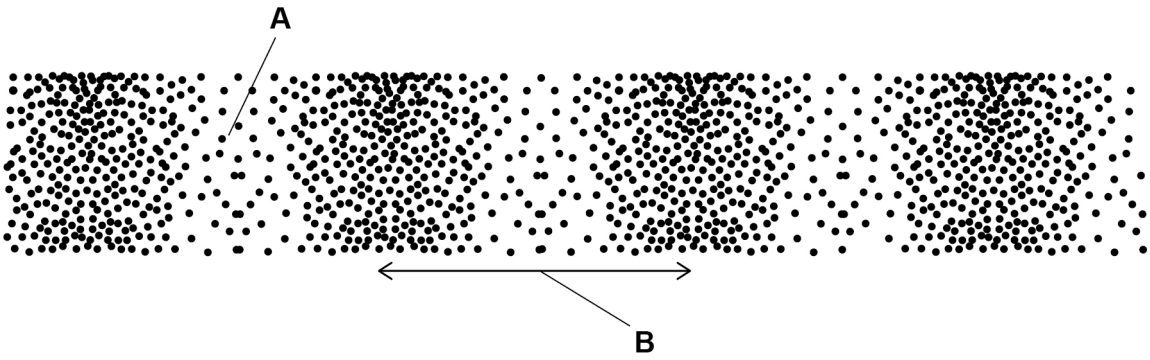
13

6.6.1.2 Properties of waves

Question 08

0 1 **Figure 1** shows a longitudinal wave.

Figure 1



0 1 . 1 What do the labels **A** and **B** on **Figure 1** represent?

Choose answers from the box.

[2 marks]

amplitude	**frequency**	**rarefaction**	**reflection**	**wavelength**

A _____

B _____

6.6.1.2 Properties of waves

Question 08 · continued

0 1 . 2 The wave shown in **Figure 1** has a frequency of 4.0 kHz

Calculate the period of the wave.

Use the Physics Equations Sheet.

Give the unit.

[4 marks]

Period = _____ Unit _____

Question 1 continues on the next page

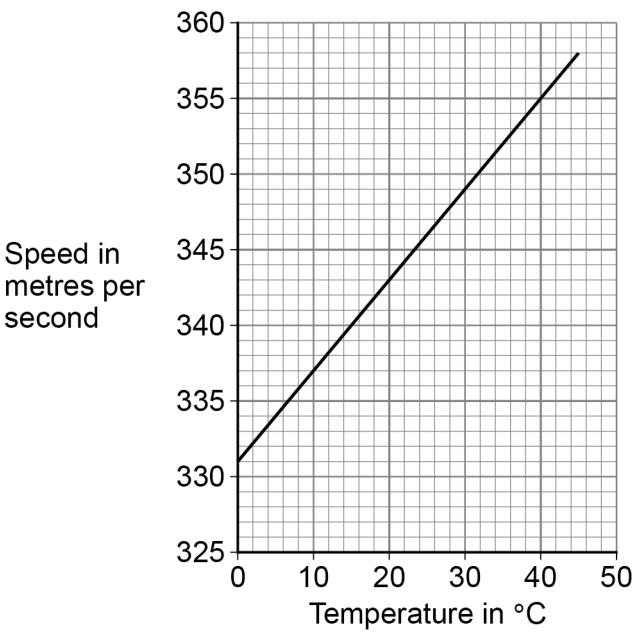
6.6.1.2 Properties of waves

Question 08 · continued

Sound waves are longitudinal.

Figure 2 shows how the speed of sound varies with the temperature of the air.

Figure 2



6.6.1.2 Properties of waves

Question 08 · continued

Use the Physics Equations Sheet to answer questions **01.3** and **01.4**.

0 1 . 3 Write down the equation that links frequency (f), wavelength (λ) and wave speed (v).

[1 mark]

0 1 . 4 A sound wave with a frequency of 300 Hz travels through the air.

The air has a temperature of 28.0 °C

Determine the wavelength of the sound wave.

Use **Figure 2**.

[4 marks]

Wavelength = _____ m

11

6.6.1.2 Properties of waves

Question 09

June 2023 | 8464/P/2H | Original Q1

0 1 The Sun emits a continuous spectrum of electromagnetic waves.

Figure 1 names some of the groups of waves in the electromagnetic spectrum.

Figure 1

A	**B**	Infrared	Visible light	Ultraviolet	**C**	Gamma rays

0 1 . 1 Name groups **A**, **B** and **C** in **Figure 1**.

[2 marks]

A _____

B _____

C _____

0 1 . 2 Give **one** similarity and **one** difference between the properties of ultraviolet waves and gamma rays.

[2 marks]

Similarity _____

_____

Difference _____

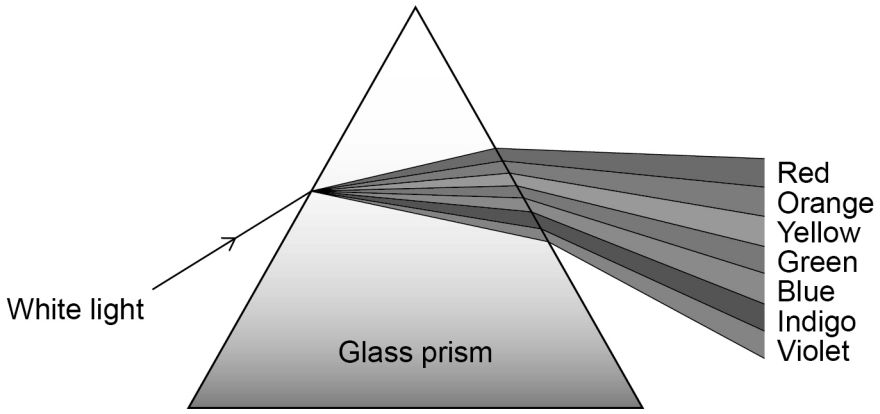
_____

6.6.1.2 Properties of waves

Question 09 · continued

Figure 2 shows white light split into a spectrum of different colours by a glass prism.

Figure 2



0 1 . 3 Light changes direction when it enters the glass prism.

What name is given to this process?

[1 mark]

Question 1 continues on the next page

6.6.1.2 Properties of waves

Question 09 · continued

Use the Physics Equations Sheet to answer questions **01.4** and **01.5**.

0 1 . 4 Write down the equation that links frequency (f), wavelength (λ) and wave speed (v).

[1 mark]

0 1 . 5 The wave in the middle of the spectrum has a wavelength of 5.0×10^{-7} m.

wave speed of light = 3.0×10^{8} m/s

Calculate the frequency of the wave.

[3 marks]

Frequency = _____ Hz

9

6.6.1.2 Properties of waves

Question 10

June 2023 | 8464/P/2H | Original Q3

0 3 A teacher used a ripple tank to demonstrate water waves.

The teacher used a lamp to project a shadow of the water waves onto a screen below the ripple tank.

0 3 . 1 **Figure 4** represents the shadow of the water waves seen on the screen.

Figure 4



1.0 mm on **Figure 4** represents 5.0 mm on the screen.

Determine an **accurate** value for the wavelength of the waves on the screen.

Give your answer in mm.

Show how you work out your answer.

[3 marks]

Wavelength = _____ mm

Question 10 · continued

The teacher adjusted the frequency of the waves produced in the ripple tank.

The teacher measured the wavelength five times.

Table 2 shows the results.

Table 2

Measurement	1	2	3	4	5	**Mean**
Wavelength in millimetres	96	99	97	**X**	97	97

0 3 . 2 Calculate value **X** in **Table 2**.

[2 marks]

X = _____ mm

0 3 . 3 The teacher states that the results are very precise.

Which of the following supports the statement made by the teacher?

[1 mark]

Tick (✓) one box.

- The mean value is very close to the true value. ☐
- The spread of values about the mean is very small. ☐
- The values are all given to the nearest millimetre. ☐
- The wavelength measurement was taken five times. ☐

6.6.1.2 Properties of waves

Question 10 · continued

0 3 . 4 Describe the difference between longitudinal waves and transverse waves.

[2 marks]

8

6.6.1.2 Properties of waves

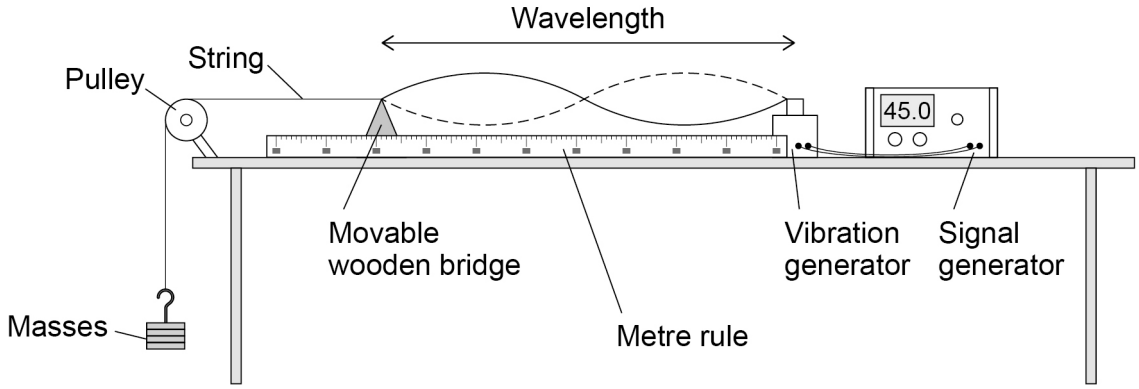
Question 11

June 2024 | 8464/P/2H | Original Q1

0 1 A teacher demonstrated how the frequency of a wave on a string affects the wavelength of the wave.

Figure 1 shows the equipment used.

Figure 1



The frequency of the signal generator is adjusted so that the wave shown in **Figure 1** is seen.

At this frequency the string vibrates between the two positions shown in **Figure 1**.

0 1 . 1 Describe a method the teacher could use to investigate how the frequency of the wave affects the wavelength.

[4 marks]

6.6.1.2 Properties of waves

Question 11 · continued

Use the Physics Equations Sheet to answer questions **01.2** and **01.3**.

0 1 . 2 Which equation links frequency (f), wavelength (λ) and wave speed (v)?

[1 mark]

Tick (✓) **one** box.

$f = \lambda \times v$ ☐

$\lambda = f \times v$ ☐

$v = f \times \lambda$ ☐

0 1 . 3 The wave on the string has a frequency of 45.0 Hz.

The wave speed is 35.1 m/s.

Calculate the wavelength of the wave.

[3 marks]

Wavelength = _____ m

8

6.6.1.2 Properties of waves

Question 12

June 2024 | 8464/P/2H | Original Q3

0 3 Electromagnetic waves are grouped according to their wavelength and frequency.

Electromagnetic waves are transverse waves and can travel through a vacuum.

0 3 . 1 Give one **other** property that is the same for all types of electromagnetic wave.

[1 mark]

0 3 . 2 What is meant by 'transverse wave'?

[1 mark]

0 3 . 3 Which group of electromagnetic waves is used for satellite communications?

[1 mark]

0 3 . 4 Visible light is the only group of electromagnetic waves that the human eye can detect.

Which colour of visible light has the shortest wavelength?

[1 mark]

6.6.1.2 Properties of waves

Question 12 · continued

0 3 . 5 The three highest frequency groups of electromagnetic waves are hazardous.

Describe a risk linked to each group of high frequency electromagnetic wave.

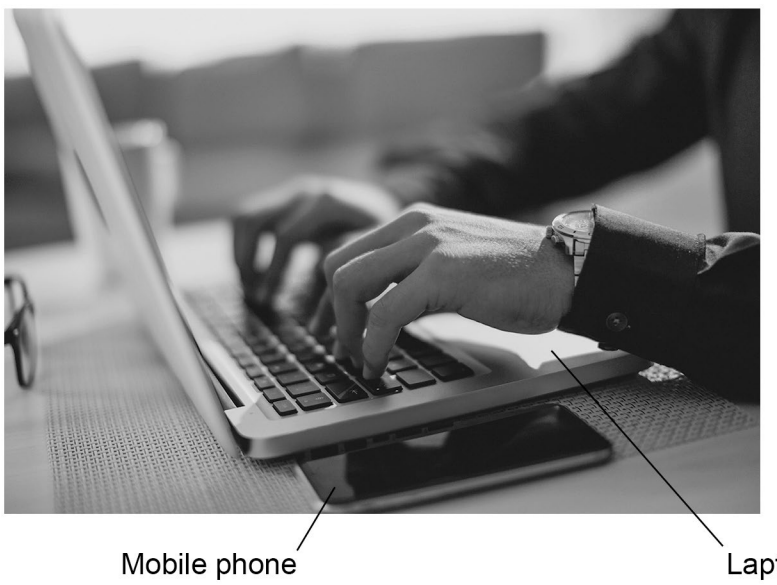
[2 marks]

Question 3 continues on the next page

Question 12 · continued

Figure 5 shows a person using a mobile phone to allow a laptop to access the Internet.

Figure 5



The electromagnetic waves emitted by the mobile phone send information to the laptop.

0 3 . 6 The electromagnetic waves emitted by the mobile phone have a period of 4.0×10^{-10} s.

Calculate the frequency of the waves.

Use the Physics Equations Sheet.

Give your answer in standard form.

[3 marks]

Frequency (in standard form) = _____ Hz

6.6.1.2 Properties of waves

Question 12 · continued

0 3 . 7 The electromagnetic waves are produced by oscillations in the transmitter of the mobile phone.

Explain how oscillations in the transmitter enable information to be transferred to the detector in the laptop.

[4 marks]

13

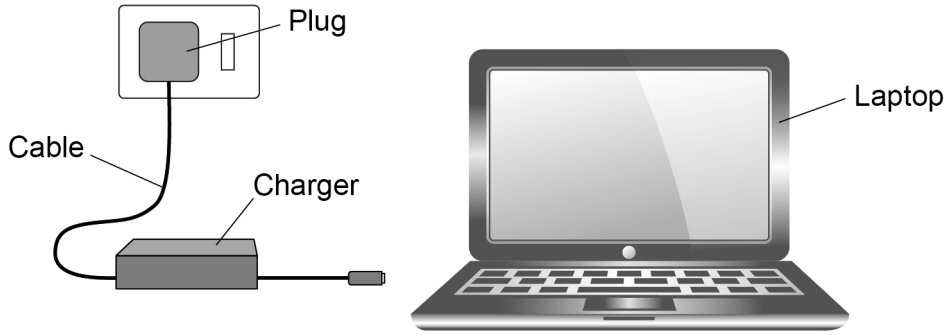
6.6.1.2 Properties of waves

Question 13

June 2025 | 8464/P/1H | Original Q5

0 5 **Figure 5** shows a laptop computer, and a charger plugged into the mains supply.

Figure 5



0 5 . 1 Give the potential difference and frequency of the UK mains electricity supply.

[2 marks]

Potential difference _____ V

Frequency _____ Hz

0 5 . 2 The cable that connects the charger to the plug contains **two** wires that have coloured insulation.

The cable does **not** contain an earth wire.

Name each wire in the cable.

Give the colour of the insulation covering each wire.

[2 marks]

Name of wire _____ Colour of insulation _____

Name of wire _____ Colour of insulation _____

6.6.1.2 Properties of waves

Question 13 · continued

0 5 . 3 The input to the charger is an alternating potential difference.

The output from the charger is a direct potential difference.

Describe the difference between an alternating potential difference and a direct potential difference.

[2 marks]

Question 5 continues on the next page

6.6.1.2 Properties of waves

Question 13 · continued

A student is using the laptop computer.

The student notices that the battery has no stored energy.

The student quickly plugs the charger into the laptop and continues to use the laptop.

0 5 . 4 The laptop charger provides a constant power to the laptop.

The laptop takes longer to charge when the student uses the laptop than when the laptop is not used.

Explain why.

[2 marks]

6.6.1.2 Properties of waves

Question 13 · continued

0 5 . 5 The potential difference across the laptop circuit is 15 V.

The average current in the laptop circuit when it is being used is 4.8 A.

The laptop charger provides a constant power of 97 W.

The maximum energy that the battery can store is 225 kJ.

Calculate the time taken to fully charge the battery from zero when the laptop is used continuously.

Use the Physics Equations Sheet.

Give your answer in hours.

[6 marks]

Time = _____ hours

14

6.6.1.2 Properties of waves

Question 14

0 3 A pair of sunglasses has lenses that absorb all ultraviolet and some visible light.

0 3 . 1 Ultraviolet and visible light are both transverse waves.

What is meant by 'transverse waves'?

[2 marks]

0 3 . 2 Ultraviolet can cause sunburn and eye damage.

Give **one** other risk to health from exposure to ultraviolet.

[1 mark]

0 3 . 3 Complete the sentence.

[1 mark]

Compared with the wavelength of visible light, the wavelength of ultraviolet is _____.

Question 3 continues on the next page

6.6.1.2 Properties of waves

Question 14 · continued

0 3 . 4 A wave of visible light has a frequency of 6.25×10^{14} Hz.

speed of light = 3.00×10^{8} m/s

Calculate the wavelength of this light.

Use the Physics Equations Sheet.

Give your answer in nanometres (nm).

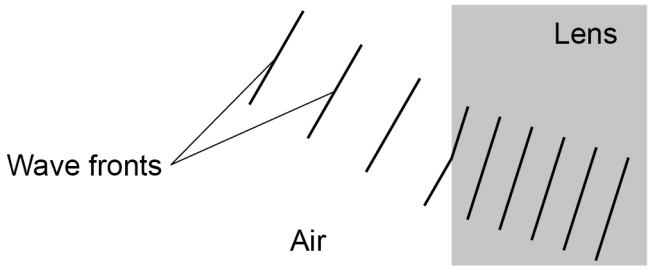
[4 marks]

Wavelength = _____ nm

0 3 . 5 A ray of visible light incident on the lens in a pair of sunglasses is refracted.

Figure 3 shows a wave front diagram for visible light incident on the lens.

Figure 3



For each wave front, one end of the wave front enters the lens before the other end.

Explain why the light refracts as it enters the lens.

[2 marks]

Question 3 continues on the next page

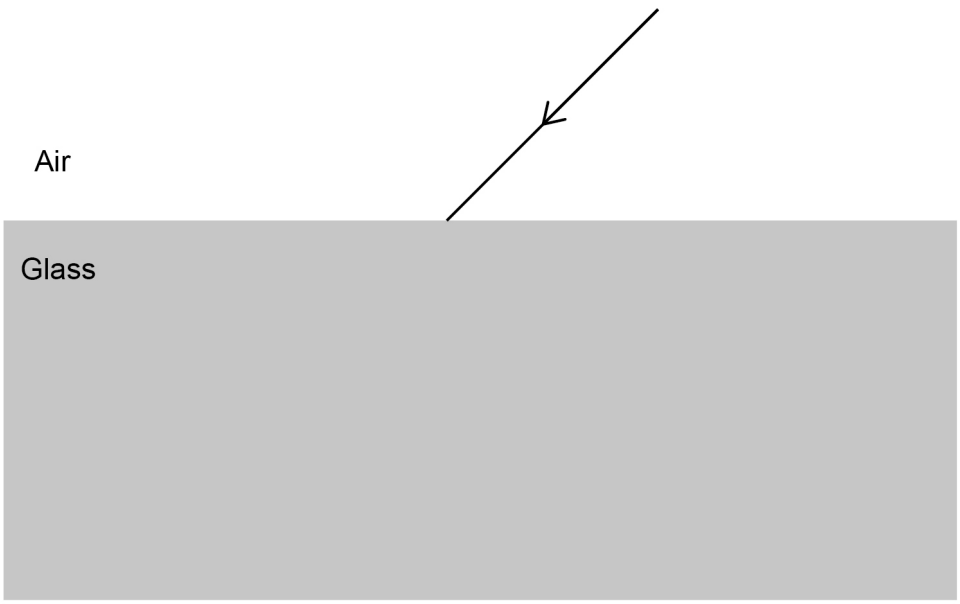
6.6.1.2 Properties of waves

Question 14 · continued

0 3 . 6 **Figure 4** shows a ray of visible light incident on glass.

The angle of incidence is 45°.

Figure 4



The angle of refraction of the ray in the glass is 28°.

Complete the ray diagram in **Figure 4** to show the path of the ray in the glass.

You should:

- draw the normal line
- draw the refracted ray in the glass.

You do **not** need to draw the ray leaving the glass.

[2 marks]

12