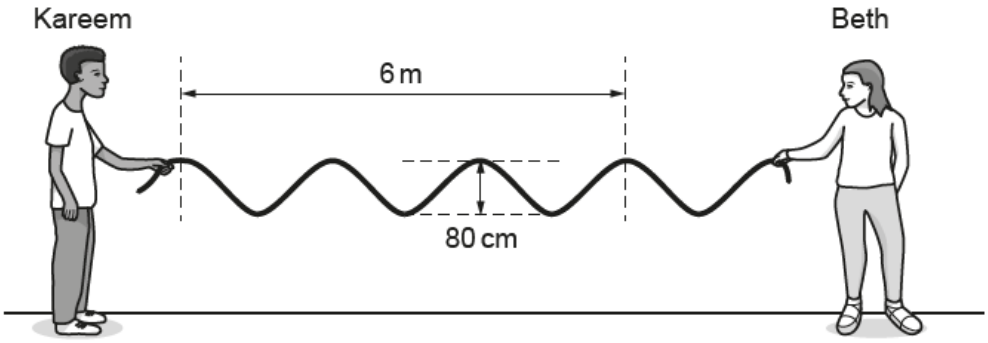
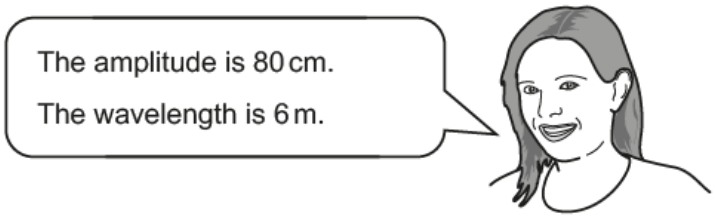
Radiation and waves – 2021/20 GCSE 21st Physics B

1. Nov 2021/Paper_J259/01/No.3

Beth and Kareem make waves on a rope.



(a)



Beth's description of the wave is **incorrect**.

State the correct amplitude and wavelength.

The amplitude is ..... cm.

The wavelength is ..... m. **[2]**

(b) Kareem moves his hand up and down to make 2 waves every second.

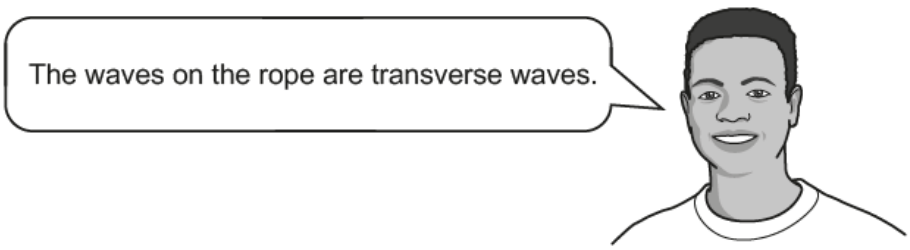
What is the frequency of the wave?

Put a (ring) around the correct answer.

0.5 Hz **0.5 s** **2.0 Hz** **2.0 s**

[1]

(c) Kareem describes the waves another way.



(i) Describe how the waves on the rope are an example of transverse waves.

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..... **[2]**

(ii) How are sound waves in air different to the waves on the rope?

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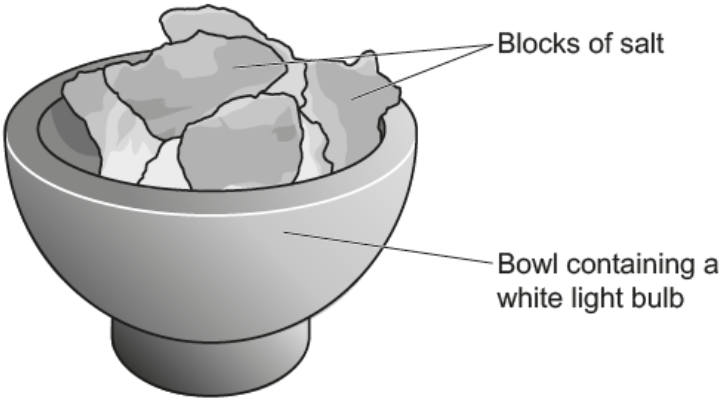
..... **[1]**

2. Nov 2021/Paper_J259/01/No.4

Jamal sees a 'salt lamp' in a shop, as shown in the diagram.



The salt lamp contains a white light bulb covered with blocks of salt.

(a) Which **two** statements about visible light waves are correct?

Tick (✓) **two** boxes.

Visible light waves are transverse. ☐

Visible light waves are electromagnetic waves. ☐

Visible light waves have a longer wavelength than radio waves. ☐

Visible light waves travel faster than microwaves through space. ☐

Visible light waves travel slower than sound waves. ☐

[2]

(b) When the lamp is switched on, visible light passes through the salt as it leaves the lamp. The salt lamp appears yellow.

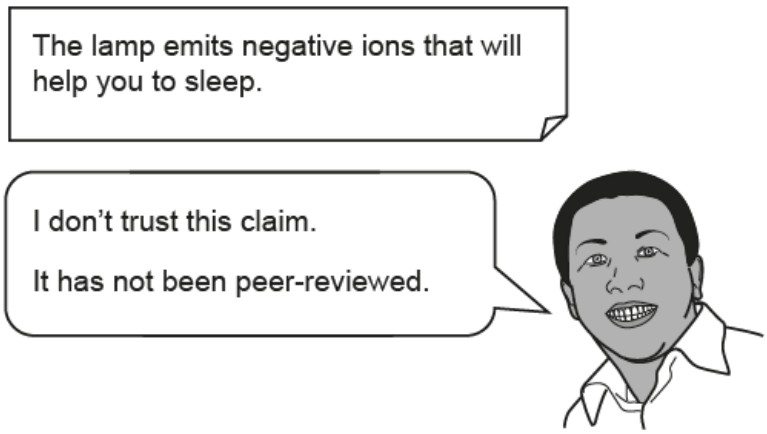
Complete the sentence to explain why the salt lamp appears yellow.

The salt lamp appears yellow because the salt ..... yellow light

and ..... all the other colours of white light.

[2]

(c) Jamal sees this claim on the packaging for the salt lamp.



Describe the **peer review** process.

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..... **[2]**

3. Nov 2021/Paper_J259/01/No.14

An atomic clock is a very accurate way of measuring time.

Many atomic clocks use electromagnetic radiation emitted from caesium atoms.

(a) Explain how an atom can emit electromagnetic radiation.

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.....

.....

..... **[2]**

(b) The frequency of electromagnetic radiation emitted from caesium atoms is 9.19×10^9 Hz.

Calculate the wavelength of this radiation.

Speed of light = 3.0×10^8 m/s.

Wavelength = ... m **[3]**

(c) Satellite navigation systems rely on atomic clocks for their accuracy.

Suggest **one** way that society has benefited from the invention of accurate satellite navigation systems.

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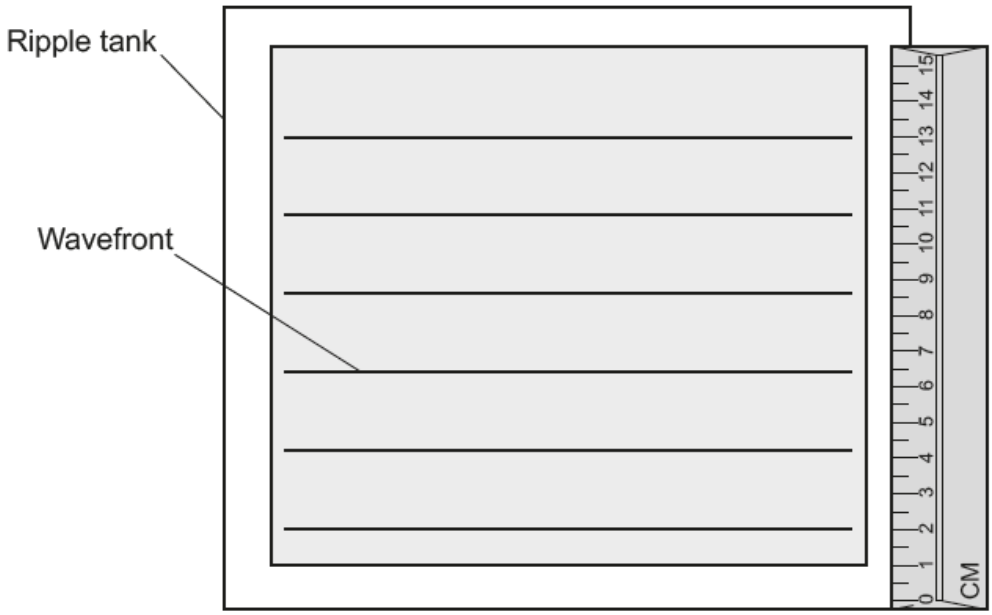
..... **[1]**

4. Nov 2021/Paper_J259/02/No.8

Sarah investigates how the speed of a water wave changes with the depth of water.

She uses a ripple tank to produce a wave on the surface of the water.

Sarah observes the wavefronts shown in the diagram. The diagram is **not** to scale.



(a) (i) Describe how Sarah can accurately measure the wavelength of the wave.

Include an accurate measurement of the wavelength in your answer.

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..... **[3]**

(ii) Describe how Sarah can calculate the speed of the wave.

Include in your answer any equipment and equations that she would need to use.

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..... **[3]**

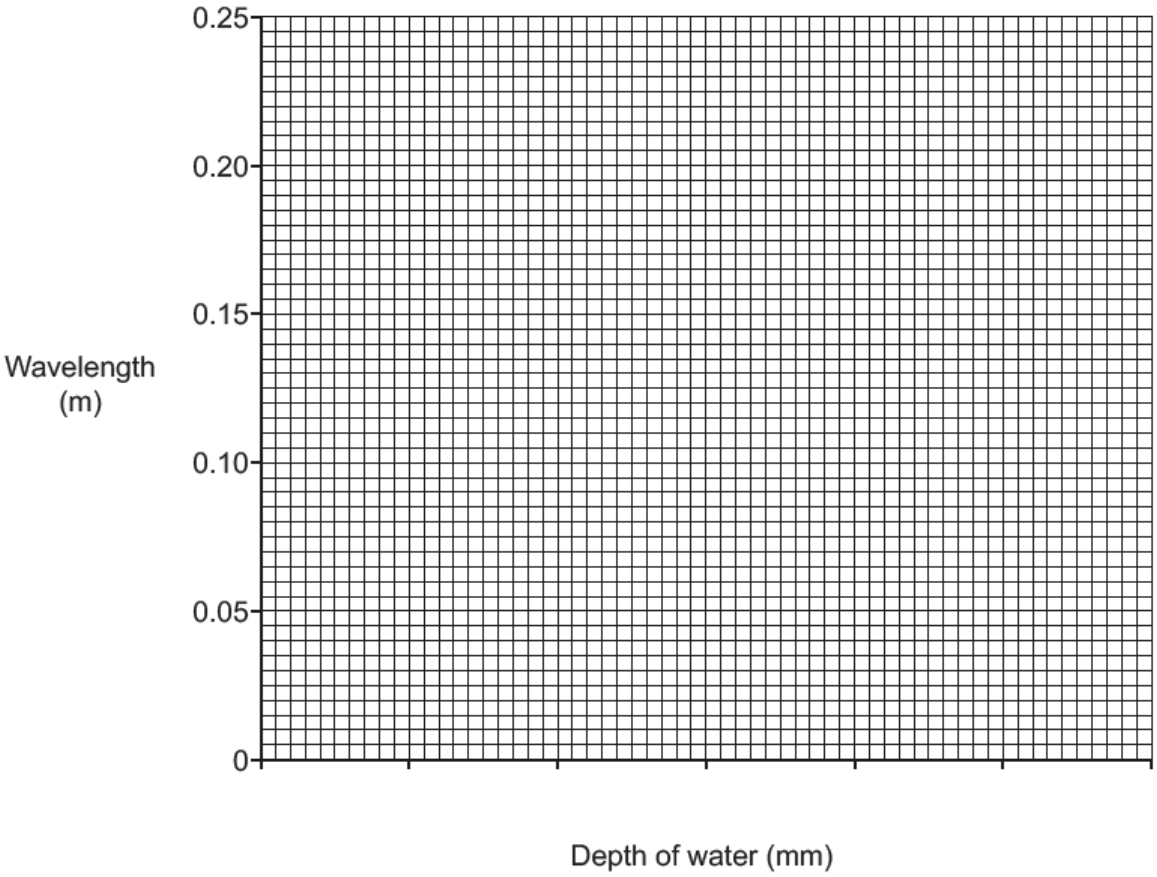
(b) Sarah measures the wavelength with different depths of water.

She records her results in the table.

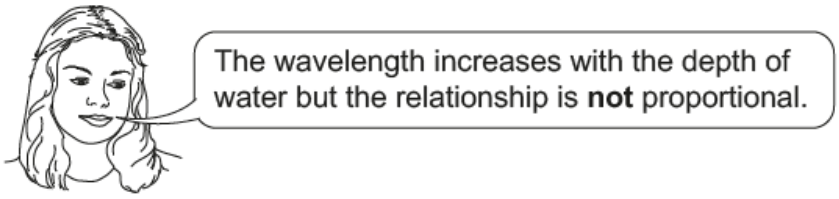
Depth of water (mm)	Wavelength (m)
20	0.12
40	0.17
60	0.20
80	0.22
100	0.23

(i) Plot a graph of the results from the table.

Use an appropriate scale **and** draw a line of best fit. **[3]**



(ii) Sarah concludes



Is Sarah correct?

Yes ☐

No ☐

Use data from the table to explain your answer.

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..... **[2]**

5. Nov 2020/Paper_J259/01/No.3

Jane uses a ripple tank to measure the speed of water waves.

(a) The ripples on the surface of the water in the ripple tank are an example of transverse waves.

Describe the difference between transverse and longitudinal waves.

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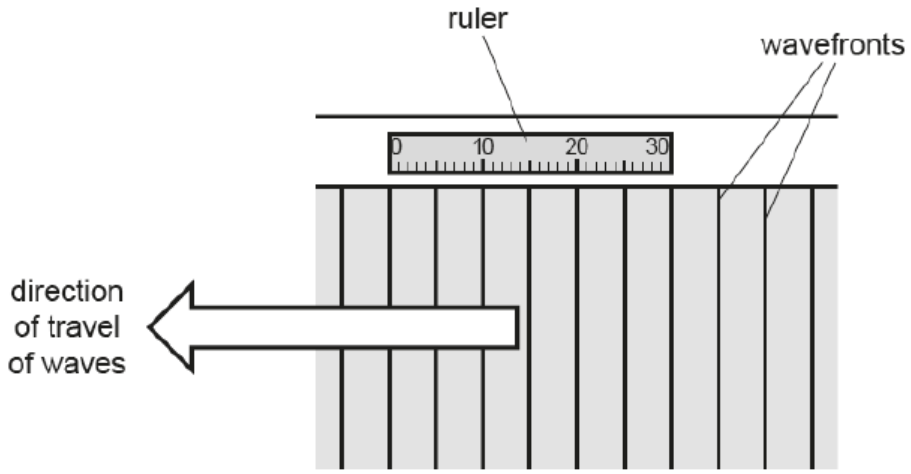
..... **[2]**

(b) The diagram shows a view of part of the ripple tank from above. Waves are travelling from right to left.

A ruler has been placed next to the ripple tank.



(i) The ruler next to the ripple tank is 0.30 m long.

The ruler is the same length as **6** of the waves.

Calculate the wavelength of the waves.

Wavelength = ... m **[2]**

(ii) Suggest how Jane could use a stopwatch to measure the frequency of the waves in the ripple tank.

.....

..... **[1]**

(c) Ben measures the wavelength of the waves to be 0.08 m.

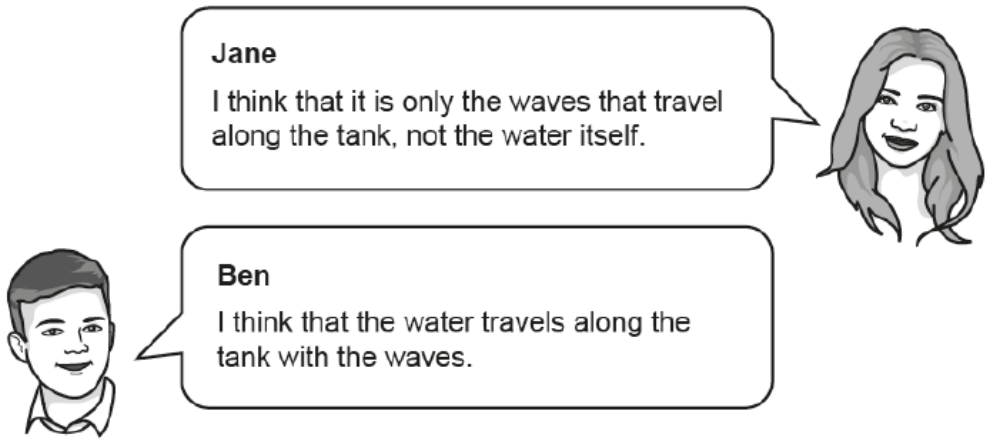
The frequency of the waves is 3.0 Hz.

Calculate the speed of the waves that Ben measures.

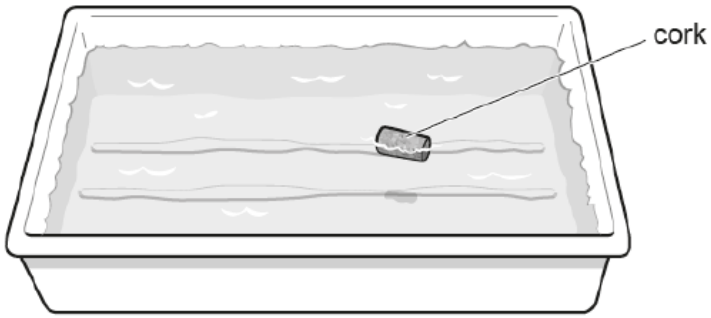
Use the equation: wave speed = frequency × wavelength

Speed = ... m/s **[2]**

(d) Jane and Ben talk about the experiment.



Jane places a small cork on the water to show Ben that she is correct.



Describe the motion of the cork.

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..... **[2]**

6. Nov 2020/Paper_J259/01/No.9

Amaya and Li measure the speed of sound in air:

- Amaya stands 30 m away from Li;
- Amaya claps her hands;
- Li starts a timer when he sees the clap;
- Li stops the timer when he hears the sound.

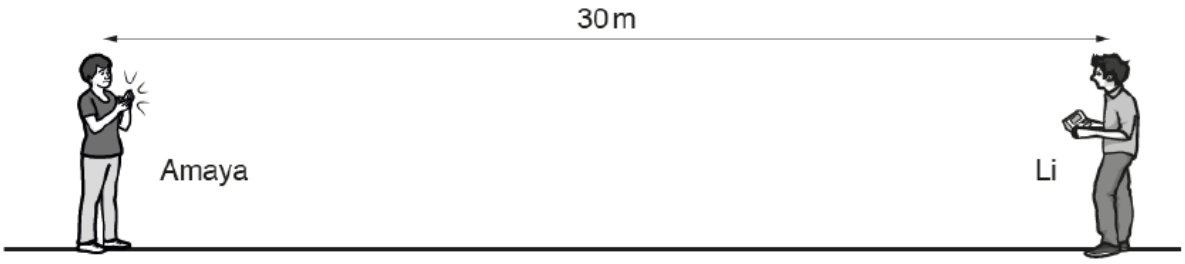

Table 9.1 shows their results.

Attempt	Time (s)	Calculated speed (m/s)
1	0.32	94
2	0.44	68
3	0.37	81
4	0.49	61
5	0.40	

Table 9.1

(a) Calculate the speed of sound for Attempt **5**.

Use the equation: speed = distance ÷ time

Speed = ... m/s **[2]**

(b) The expected value for the speed of sound in air is about 300 m/s.

(i) State why the data in **Table 9.1** is inaccurate.

.....

..... **[1]**

(ii) State why the data in **Table 9.1** is imprecise.

.....

..... **[1]**

(c) **(i)** Describe **one** improvement to the method.

.....

..... **[1]**

(ii) State how your improvement in **(c)(i)** will produce better data.

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..... **[1]**

7. Nov 2020/Paper_J259/01/No.13

Ultraviolet radiation can be used to disinfect water.

Fig. 13.1 shows an ultraviolet disinfection unit.

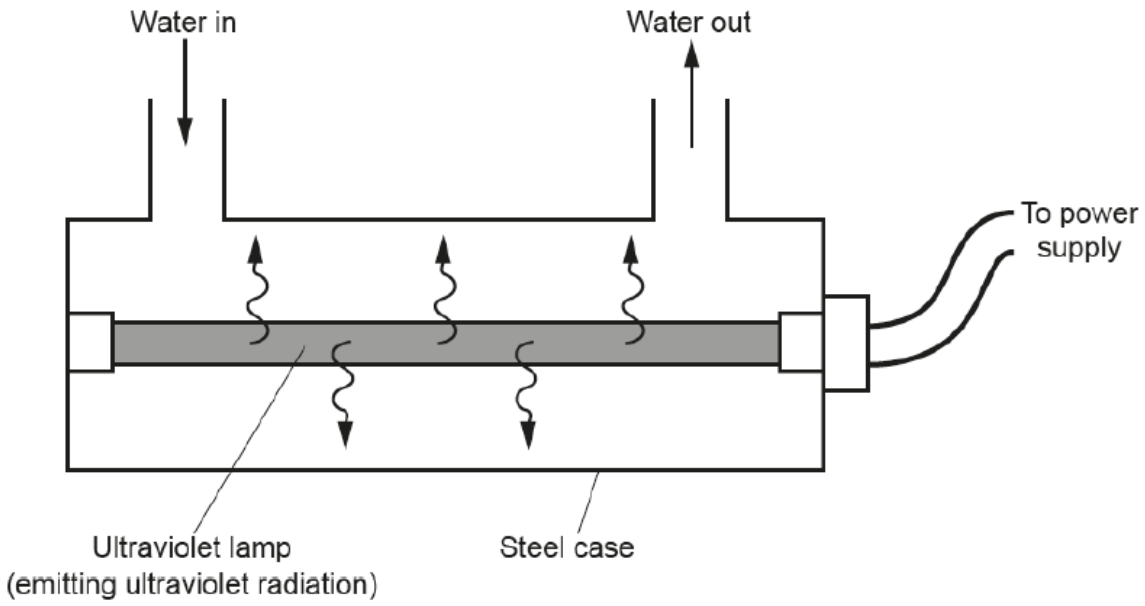

Fig. 13.1

(a) Ultraviolet radiation is emitted by the atoms in the ultraviolet lamp.

Describe how changes in atoms can generate ultraviolet radiation.

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..... **[2]**

(b) Ultraviolet disinfection works because ultraviolet radiation harms micro-organisms in the water.

(i) Explain why ultraviolet radiation is also harmful to living organisms, including humans.

.....

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..... **[2]**

(ii) Suggest how the design of the disinfection unit in **Fig. 13.1** prevents it from harming humans.

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..... **[1]**

(c) Alpha radiation is also harmful to living organisms.

Give **two** reasons why alpha radiation would not be suitable for disinfecting water.

1 .....

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2 .....

.....

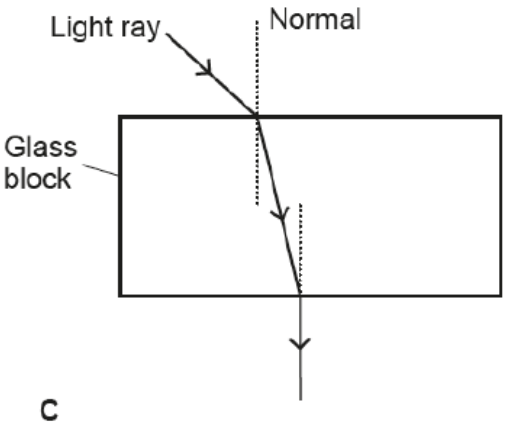
[2]

8. Nov 2020/Paper_J259/02/No.1

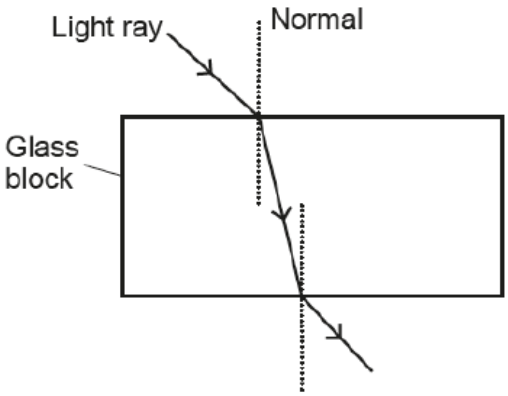
Nina does an experiment to show the refraction of a ray of white light through a glass block.

(a) Which diagram, **A**, **B**, **C** or **D**, shows the correct path of the ray of white light through the glass block?

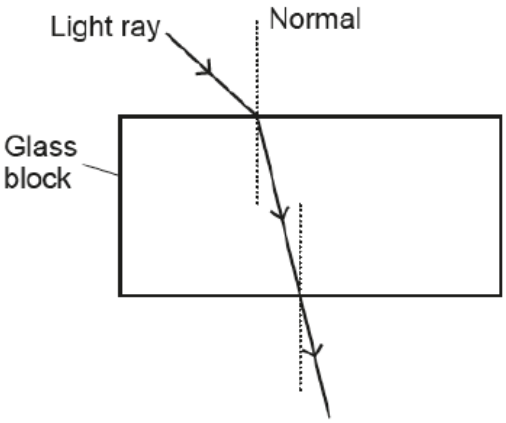
A



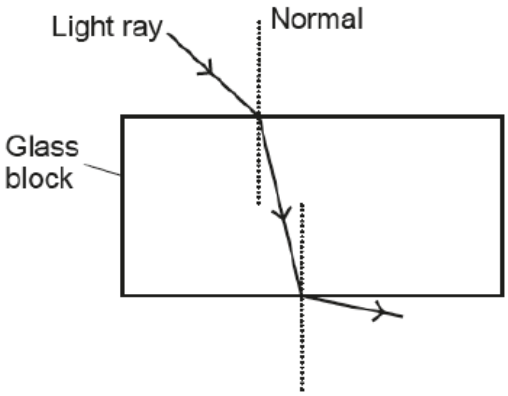
B



C



D



Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

(b) Nina then shines the ray of white light through a triangular prism, and observes that the white light spreads out into a band of colours, as shown in **Fig. 1.1**.

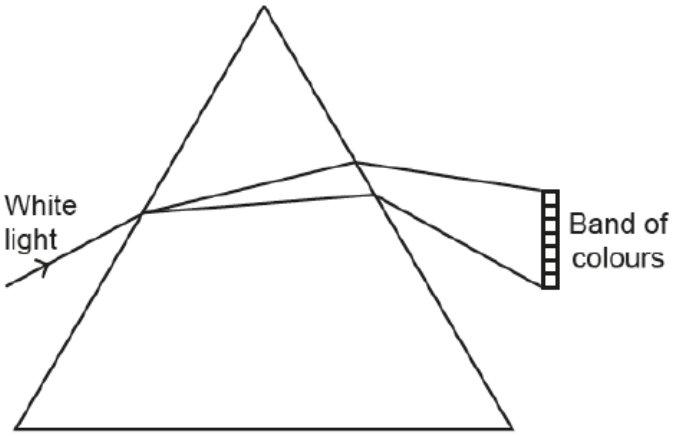


Fig. 1.1

What is the correct scientific name for the **band** of colours?

Put a (ring) around the correct answer.

Dispersion **Rainbow** **Reflection** **Spectrum** **[1]**

(c) When white light passes through the prism, the different colours of white light refract by different amounts, which forms the band of colours shown in **Fig. 1**.1.

(i) Which colour of white light refracts the most?

Tick (✓) **one** box.

Red ☐

Green ☐

Violet ☐

Yellow ☐

[1]

(ii) Which colour of white light refracts the least?

Tick (✓) **one** box.

Red ☐

Green ☐

Violet ☐

Yellow ☐

[1]

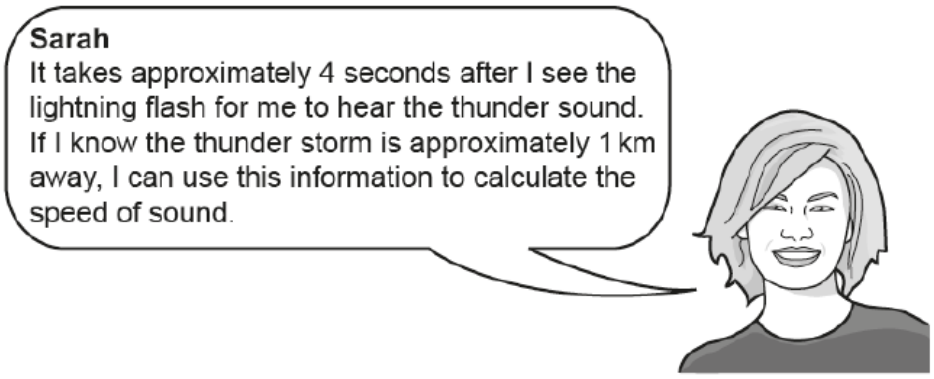
(iii) Why do the different colours of white light refract by different amounts in **Fig. 1.1**?

.....

..... **[1]**

9. Nov 2020/Paper_J259/02/No.7

Sarah is investigating how to measure the speed of sound, and knows that sound is produced when there is a lightning flash during a thunder storm.



Explain why Sarah's method is inaccurate, and suggest one other method Sarah can use to accurately measure the speed of sound.

The speed of sound in air is approximately 340 m/s.

Use the equation: speed = distance ÷ time

You may include a diagram to support your answer.

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..... **[6]**

10. Nov 2021/Paper_J259/03/No.3

An atomic clock is a very accurate way of measuring time.

Many atomic clocks use electromagnetic radiation emitted from caesium atoms.

(a) Explain how an atom can emit electromagnetic radiation.

.....

.....

.....

..... **[2]**

(b) The frequency of electromagnetic radiation emitted from caesium atoms is 9.19×10^9 Hz.

Calculate the wavelength of this radiation.

Speed of light = 3.0×10^8 m/s.

Wavelength = ... m **[3]**

(c) Satellite navigation systems rely on atomic clocks for their accuracy.

Suggest **one** way that society has benefited from the invention of accurate satellite navigation systems.

.....

..... **[1]**

11. Nov 2021/Paper_J259/03/No.4

The Voyager 1 spacecraft was launched into space in 1977 to study the outer Solar System.

(a) Radio waves transfer information from Voyager 1 back to the Earth.

What else is transferred by the radio waves?

..... **[1]**

(b) **(i)** The radio waves emitted by Voyager 1 have a wavelength of approximately 14 cm. The distance between the Earth and Voyager 1 is approximately 2×10^{10} km.

Estimate the total number of complete wavelengths in the space between the Earth and Voyager 1.

Number of wavelengths = ... **[3]**

(ii) Define the **wavelength** of a radio wave.

You can draw a diagram to support your answer.

.....

..... **[2]**

(c) Voyager 1 is moving away from the Earth at a high speed. This causes the wavelength of the radio waves to change as they travel towards the Earth.

Explain how the wavelength of the radio waves has changed when they are received on the Earth.

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..... **[2]**

12. Nov 2021/Paper_J259/03/No.8

Ali investigates different types of lenses.

Fig. 8.1 shows how rays of light are refracted by a **concave** lens.

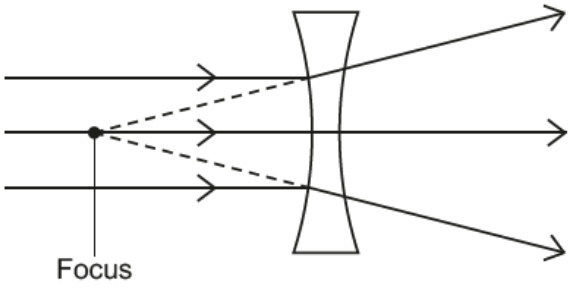


Fig. 8.1

Fig. 8.2 shows rays of light directed at a convex lens.

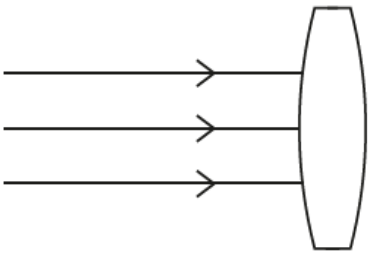


Fig. 8.2

(a) Complete **Fig. 8.2** to show how rays of light are refracted by a **convex** lens.

Clearly label the **focus** of the lens. **[2]**

(b) Ali looks at three more lenses, as shown in **Fig. 8.3**.

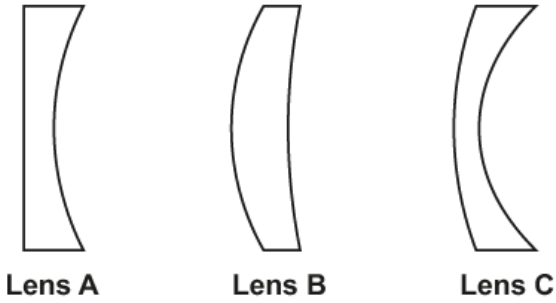
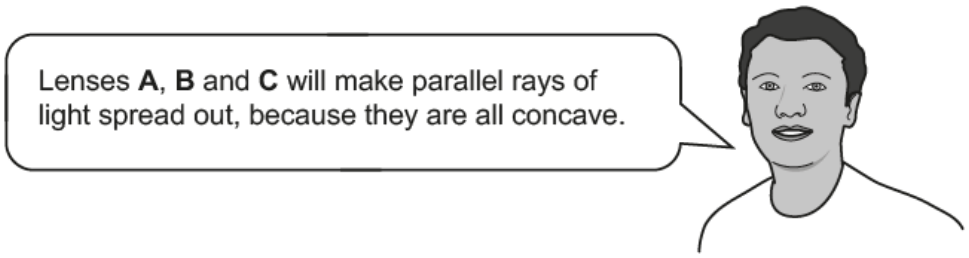


Fig. 8.3



Explain why Ali is wrong.

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..... **[2]**

(c) Ali wants to make a lens to focus sound waves.
He uses a large convex glass lens that is designed to focus light.

Sound travels faster in glass than in air.

Suggest what will happen to sound waves when they arrive at the lens.

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..... **[2]**

13. Nov 2020/Paper_J259/03/No.3

Ultraviolet radiation can be used to disinfect water.

Fig. 3.1 shows an ultraviolet disinfection unit.

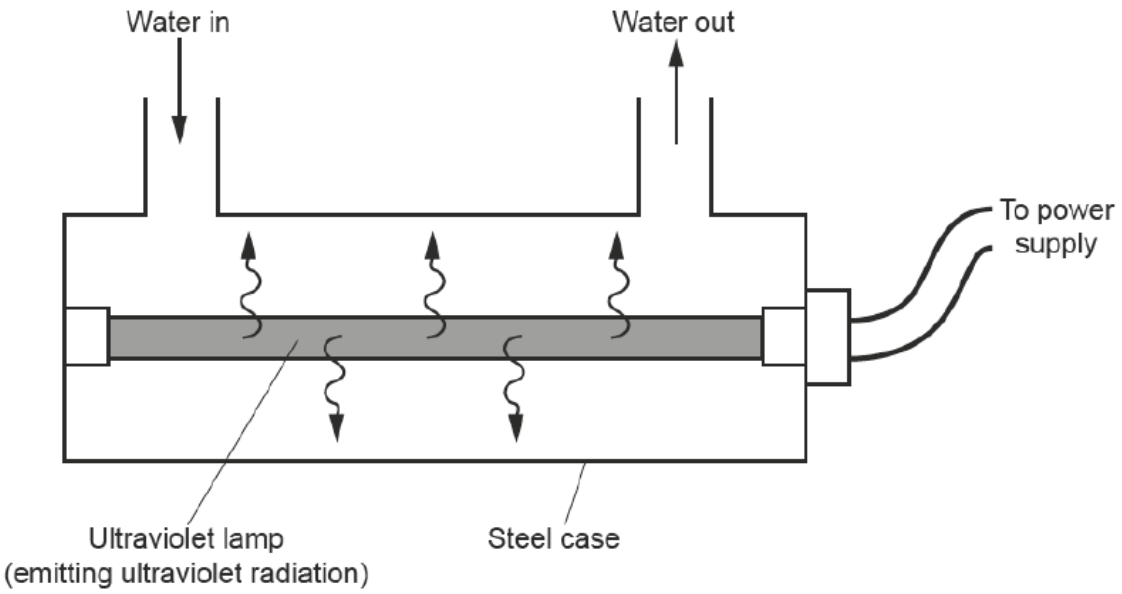

Fig. 3.1

(a) Ultraviolet radiation is emitted by the atoms in the ultraviolet lamp.

Describe how changes in atoms can generate ultraviolet radiation.

.....

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..... **[2]**

(b) Ultraviolet disinfection works because ultraviolet radiation harms micro-organisms in the water.

(i) Explain why ultraviolet radiation is also harmful to living organisms, including humans.

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..... **[2]**

(ii) Suggest how the design of the disinfection unit in **Fig. 3.1** prevents it from harming humans.

.....

..... **[1]**

(c) Alpha radiation is also harmful to living organisms.

Give **two** reasons why alpha radiation would not be suitable for disinfecting water.

1 .....

.....

2 .....

.....

[2]

14. Nov 2020/Paper_J259/03/No.5

Sarah and Jack experiment with two hand-held radios.

(a) The radio waves have a frequency of 446 MHz and speed of 3.0×10^8 m/s.

(i) Explain why Sarah and Jack cannot see the radio waves.

.....

.....

..... **[2]**

(ii) Calculate the wavelength of the radio waves.

Use the equation: wavelength = wave speed ÷ frequency

Give your answer to **2** significant figures.

Wavelength = ... m **[4]**

(b) Describe how electrical circuits in the radios can produce radio waves.

.....

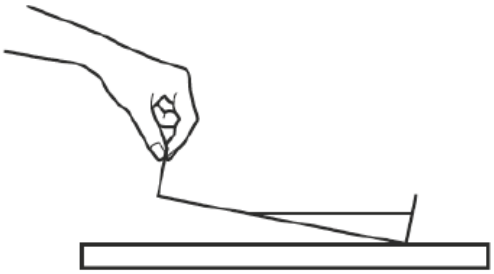
..... **[1]**

15. Nov 2020/Paper_J259/03/No.8

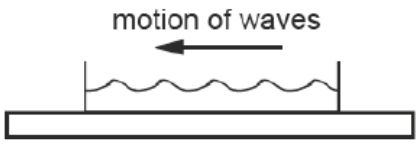
Amaya is investigating waves using a tray of water.

She makes waves by dropping one end of the tray so that waves travel up and down the length of the tray.

The diagram shows her method.



Amaya lifts one end of the tray.



Amaya drops the tray. Waves travel along the surface of the water.

It takes less than 1 second for the waves to travel the length of the tray.

(a) (i) Describe how to accurately determine the **speed** of the waves.

You should include in your answer how accurate measurements can be obtained from the apparatus used.

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..... **[3]**

(ii) Amaya finds that she gets a different result every time she repeats the measurements.

She thinks this is because her method makes slightly different waves every time.

Suggest how Amaya can make her method more **repeatable**.

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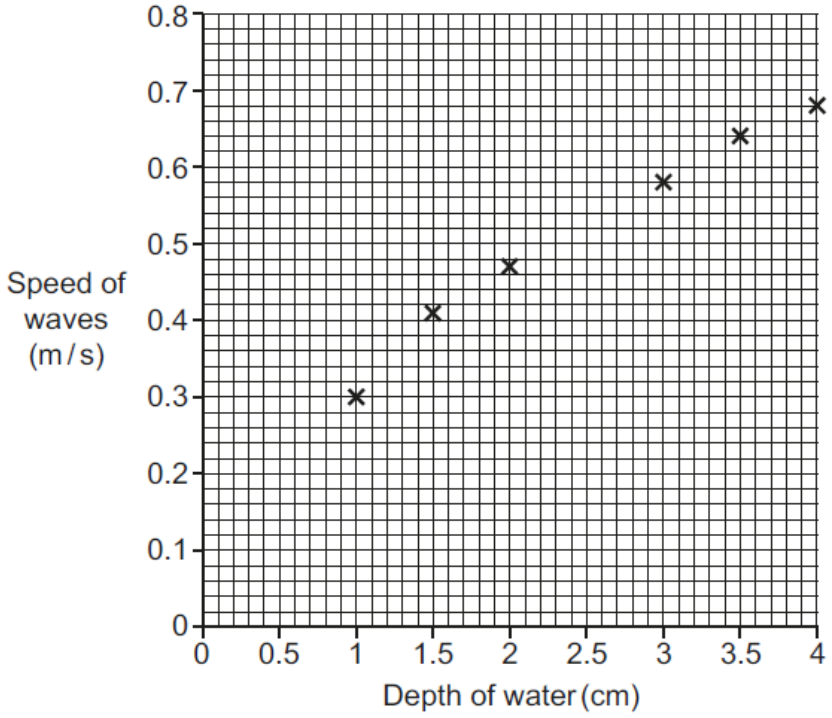
..... **[1]**

(b) Amaya investigates how the speed of the waves depends on the depth of the water.

The table and graph show her results.

Depth of water (cm)	Speed of waves (m/s)
1.0	0.30
1.5	0.41
2.0	0.47
2.5	0.53
3.0	0.58
3.5	0.64
4.0	0.68



(i) Plot the missing point on the graph. **[1]**

(ii) Describe **two** key features of the pattern shown by the data.

.....

.....

..... **[2]**

(iii) Estimate the speed of waves in a depth of water of 0.5 cm.

Show your working on the graph.

Speed = ...m/s **[2]**

16. Nov 2020/Paper_J259/03/No.10

Sundip is a scientist in the UK, and studies the waves produced by Earthquakes to understand more about the inside of the Earth.

The table shows some properties of the two main types of wave produced by earthquakes.

Name of wave	Type of wave	Travels through solids	Travels through liquids
P-wave	Longitudinal	Yes	Yes
S-wave	Transverse	Yes	No

(a) Compare the vibration of particles in P-waves and S-waves.

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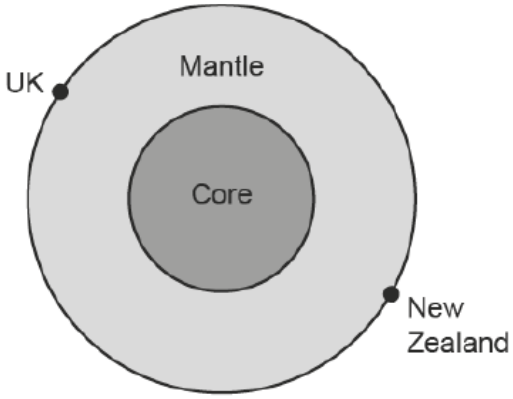
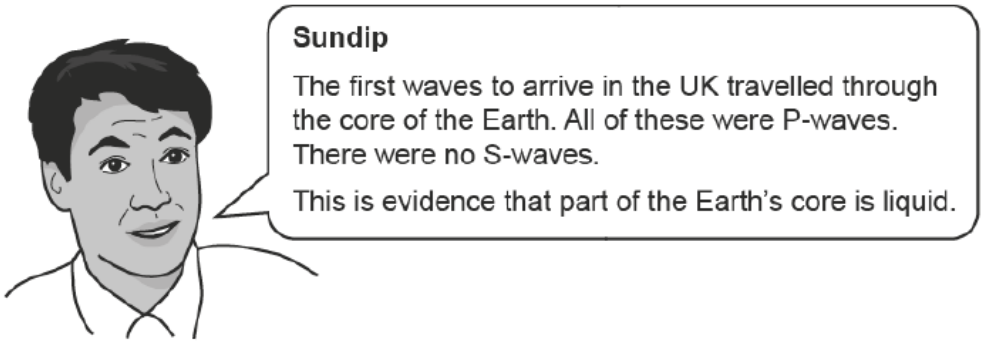
..... **[2]**

(b) There is an earthquake in New Zealand, almost on the opposite side of the Earth to the UK.



Sundip studies waves produced by this earthquake.



(i) Explain why Sundip is correct.

Use the information in the table to support your answer.

.....

.....

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..... **[2]**

(ii) Sundip detected some S-waves in the UK later, but these did **not** travel through the centre of the Earth.

Suggest how these S-waves reached Sundip's detector in the UK.

You may draw a diagram to support your answer.

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.....

..... **[2]**

17. Nov 2020/Paper_J259/03/No.12

Kareem is completing a project on stars.

He finds out this information about three stars.

Star	A	B	C
Temperature (°C)	6000	3000	12000
Relative diameter	1	900	40
Relative brightness	1	42000	28000
Colour	Yellow	Red	Blue

(a) The colour of a star depends on the wavelengths of light that it emits.

Explain why the three stars have different colours.

Use data from the table to support your answer.

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..... **[2]**

(b) (i) Star **B** is expected to explode in the next few thousand years.
When it explodes, it will emit huge amounts of visible light radiation.

Calculate, in **years**, the time it will take for the visible light radiation to reach the Earth.

The distance from Earth to star **B** is about 6×10^{18} m.

The speed of visible light in space is 3.0×10^{8} m/s.

1 year = 3.2×10^{7} s.

Time = ...years **[3]**

(ii) The explosion will also emit radiation from other regions of the electromagnetic spectrum.

Scientists predict that all this radiation will reach the Earth at the same time.

Explain why.

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..... **[1]**

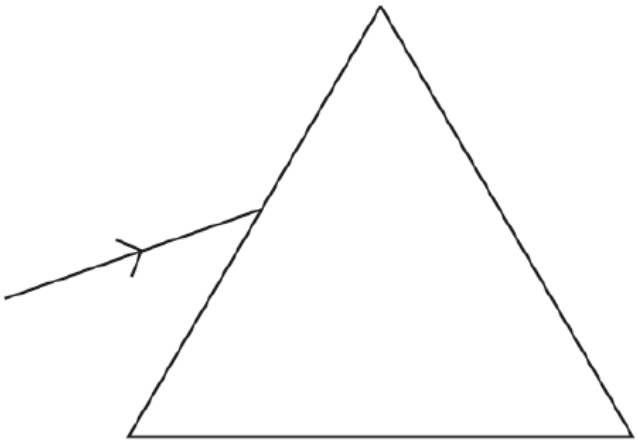
18. Nov 2020/Paper_J259/04/No.3

Nina wants to make a rainbow maker for her window.

A rainbow maker is a prism and when sunlight hits the prism it makes a rainbow around the room.

(a) Complete the ray diagram to show what happens when a ray of **white light** enters and leaves a prism.

You should include the normal lines on your diagram.



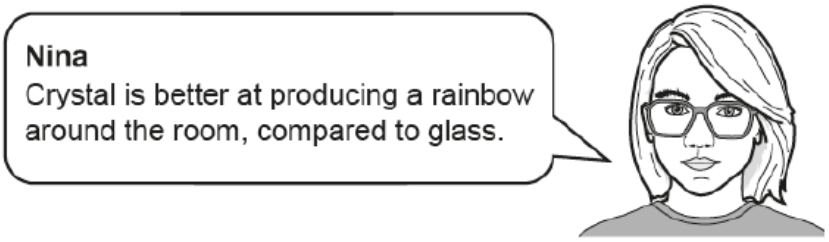
[2]

(b) Nina investigates whether to use a glass prism or a crystal prism for her rainbow maker.

Nina measures the refracted angles of red light and violet light as they emerge from each prism, and records them in the table shown.

Prism	Angle of refraction of red light emerging from the prism (°)	Angle of refraction of violet light emerging from the prism (°)
Glass	53.5	55.2
Crystal	65.2	69.8

Nina comes to the following conclusion.



Do you agree with Nina's conclusion?

Yes ☐

No ☐

Use data from the table to explain your answer.

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..... **[2]**

19. Nov 2020/Paper_J259/04/No.10(a)

Ben and Ali want to make a loudspeaker to connect to a mobile phone.

They build a loudspeaker from a plastic cup, permanent magnet and coil of wire as shown in **Fig. 10.1**.

An alternating current flows through the coil of wire when music is played on the mobile phone. This alternating current matches the pattern of the sound waves from the music.

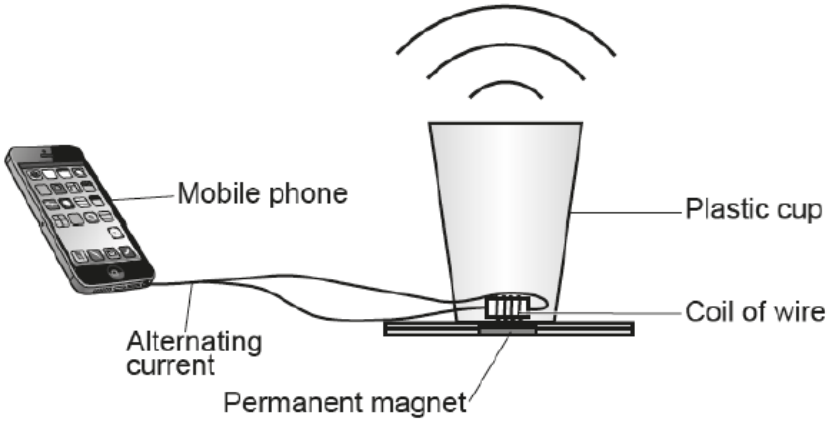
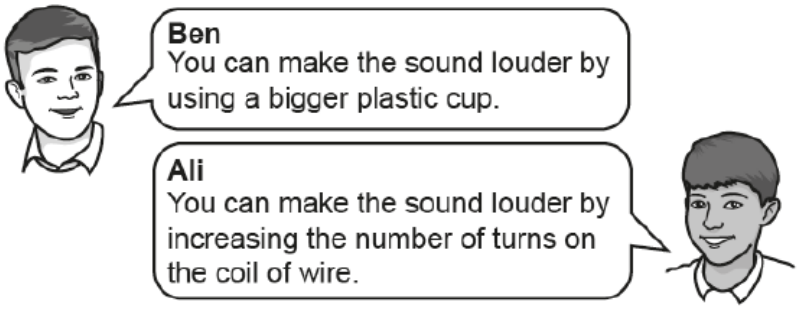


Fig. 10.1

(a) (i) When Ben connects the loudspeaker to his mobile phone and plays music, the sound produced is very quiet, even on the phone's maximum volume.



Who do you agree with?

Ben ☐

Ali ☐

Explain your answer.

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..... **[3]**

(ii) When Ben's mobile phone is connected to the loudspeaker it produces a sound which has a wavelength of 24 cm.

Calculate the frequency of the sound produced.

Give your answer to **2** significant figures.

The speed of sound in air is approximately 340 m/s.

Frequency = ... Hz **[5]**