

Wave Behaviour

Q1.a(2018)

Distance between 2 points on a wave which are in phase or identical / distance between the peaks / distance between the troughs (is 6 m) ✓

1

2.1

ALLOW descriptions of peaks and troughs e.g. the distance between the highest parts of the wave / from maximum amplitude to maximum amplitude

ALLOW one (complete) cycle of a wave (is 6 m) / the first wave starts at 0 m and ends at 6 m

ALLOW descriptions together with annotations on the graph e.g. distance between points X and Y with the X and Y correctly positioned on the graph

DO NOT ALLOW descriptions about the height or amplitude of the wave e.g. from 3 to -3 it is 6 m

Q1.b(2018)

FIRST CHECK THE ANSWER ON ANSWER LINE

If answer = 3 (m/s) award 3 marks

$(v =) f \times \lambda$ **OR** speed = frequency $\times$ wavelength ✓

$(v =) 0.5 \times 6$ ✓

$(v =) 3 \text{ (m/s)}$ ✓

Q2.(2018)

Either any two from:

Count number of waves passing a point ✓

Measure time (for these waves) with a **stopwatch** ✓

(Use frequency =) number of waves $\div$ time or divide number of waves by time ✓

Repeat and take average values ✓

Or any two from:

Measure length of n waves with ruler ✓

Divide by n to get wavelength ✓

Measure time (for these waves) with a **stopwatch** ✓

Use speed = distance $\div$ time ✓

Use frequency = speed $\div$ wavelength ✓

Repeat and take average values ✓

2

2 $\times$ 2.2

ALLOW count or measure the number of waves in a certain time ✓✓

DO NOT ALLOW frequency is measured using a stopwatch

ALLOW measure the length of **one** wave with a ruler

IGNORE measure how long the waves are

ALLOW measure the length of waves in a certain amount of time with a stopwatch

ALLOW $v = d/t$

ALLOW use speed from part (b)

ALLOW $f = v/\lambda$

Q3.a(2019)

selects the correct apparatus

use of appropriate named light source / protractor / slit ✓

correct procedure

change or measure the angle(s) of incidence / use of normal line / measure the angle(s) of refraction / trace the rays to show the angles ✓

2

2 × 3.3a

ALLOW answers from a labelled diagram

IGNORE just use light / use the sun / ruler

IGNORE just trace the rays / just measure the angles

Q3.b(2019)

using a ray box

bulb gets hot / bulb can burn or start a fire / AW ✓
do not leave on for long periods of time / switch off when not in use / allow to cool (between readings) / keep paper away from bulb / don't touch the bulb / AW ✓

OR

using a glass block

block may smash / block may fall on feet/toes / AW ✓
do not carry out experiment near end of bench / use a Perspex block / wear appropriate footwear / AW ✓

OR

using a (very) bright light or laser

light (very) bright / can damage eyes / may cause (temporary) blindness / AW ✓
do not look at filament directly / do not use high voltages / AW ✓

OR

working in low light conditions

may trip over / knock into people/ can't see easily ✓
place bags / coats / stools and other equipment out of the way / AW ✓

2

2 × 3.3b

Marks answers anywhere in answer space

IGNORE don't touch the apparatus

ALLOW ECF from (a) e.g. mirror may break

IGNORE be careful / wear gloves

IGNORE wear protective glasses/goggles/dark glasses

ALLOW use low light intensity

Q3.c(2019)

All points plotted correctly to within $\pm \frac{1}{2}$ square ✓

2

2 × 2.2

points plotted

angle i	angle r
50	28
60	32
70	35

Acceptable curve of best fit through 0,0 and taking into account all points on graph ✓

ALLOW including or not including the plot at 40,30

DO NOT ALLOW a totally straight line

Q3.d(2019)

<p>any two from: As the angle of incidence increases the angle of refraction increases ✓</p> <p>angle of incidence is (always) greater than the angle of refraction ✓</p> <p>For smaller angles/to start with angle of incidence directly proportional to angle of refraction / linear / straight line</p> <p>OR For larger angles/then change becomes non-linear / change in angle of refraction is less / non-linear for angles bigger than around 30° / AW ✓</p>	2	2 × 3.2b	<p>ALLOW there is a positive correlation / proportional</p> <p>ALLOW correct statement for candidates drawn line of best fit</p> <p>ALLOW directly proportional to start with</p> <p>ALLOW idea of being non-linear e.g. curve becomes less steep / curve levels out</p>
<p>Q3.e(2019) 23(°) or 24(°) ✓</p>	1	3.1b	<p>ALLOW 22-25(°) inclusive</p> <p>ALLOW ECF from candidates line of best fit if not in this range</p> <p>IGNORE units</p>
<p>Q3.f(2019) blue light ray refracts/bends more than red light / ORA ✓</p> <p>blue light travels more slowly than red light in the glass / blue light has a higher refractive index than red light / ORA ✓</p>	2	2 × 2.1	<p>ALLOW answers on a labelled diagram</p> <p>ALLOW comparative answers in terms of wavelength or frequency e.g. red has the longest wavelength / blue light has the highest frequency</p>

Q4.(2020)

D

Q5.(2020)

<p>Any one from: Light is faster (than sound) / ORA ✓</p> <p>Light is transverse / sound is longitudinal ✓</p> <p>Light does not need a medium (to travel through) / sound needs a medium ✓</p> <p>Light is an EM wave / sound is a mechanical wave ✓</p> <p>Light has vibrations at 90° to the direction of propagation / sound has vibrations parallel to it ✓</p>	1	1.1	<p>ALLOW light has a shorter wavelength (than sound) / ORA</p> <p>IGNORE sound waves are not visible</p>
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Q6.a(2020)

Force up > force down / resultant force up on cork ✓	1	2.1	ALLOW force of water on the cork is greater than force of Earth on cork
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Q6.b(2020)

The cork vibrates up and down and the wave moves across the tray / AW✓

Q7.a(2020)

FIRST CHECK THE ANSWER ON ANSWER LINE

If answer = 0.02 (s) award 1 mark

$$(4 \times 0.005 =) 0.02 \text{ (s)} \checkmark$$

Q7.b(2020)

FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 50 (Hz) award 3 marks	3		
Use of $f = 1/T$ OR understanding of frequency as number of waves per second $\checkmark$		1.2	
$1 / 0.02 \checkmark$		2.1	
$= 50 \text{ (Hz)} \checkmark$		2.1	ALLOW ECF from (c)(i)

Q7.c(2020)

FIRST CHECK THE ANSWER ON ANSWER LINE

If answer = 348 (m/s) award 3 marks

Recall wave speed = frequency $\times$ wavelength / ($v =$) $f \times \lambda$

$\checkmark$

$$1200 \times 0.29 \checkmark$$

$$= 348 \text{ (m/s)} \checkmark$$

Q7.d(2020)

Any one from:	1	3.3b	
Use lower frequencies so distance is longer or easier to measure $\checkmark$			
Repeat experiment and average readings / repeat with a distance to two wavelengths $\checkmark$			ALLOW remove zero error from signal generator/oscilloscope
Calibrate sound from speaker $\checkmark$			
Calibrate signal generator $\checkmark$			
Use equipment with higher resolution $\checkmark$			

Q7.e(2020)

Any three from:

Measure distance to wall ✓

Make a clap / noise / shout / use a speaker ✓

Time how long it takes to hear the echo ✓

Divide time by 2 / multiply distance by 2 ✓

Use $s = d/t$ to calculate speed ✓

Q8.(2021)

A

Q9.(2021)

A

Q10.a(2021)

Gravitational (store decreases/empties) ✓

Kinetic (store increases/fills) **OR** thermal (store increases/fills) ✓

Q10.b(2021)

FIRST CHECK THE ANSWER ON ANSWER LINE

If answer = 0.25 (Hz) award 2 marks

(Idea that) frequency = number of waves per second ✓

(5 drops in 20s = 5/20 per second =) 0.25 (Hz) ✓

Q10.c(2021)

(Idea that) the water does **not** move to the side of the bowl
/ water is left in the bowl / AW ✓

1

1.1

ALLOW water (only) moves up and down / a small
object/piece of cork (only) moves up and down

Q10.d(2021)

FIRST CHECK THE ANSWER ON ANSWER LINE

If answer = 4×10^{-8} ($^{\circ}\text{C}$) award 3 marks

(temperature rise =) $E \div (m \times c)$ ✓

(temperature rise =) $5.04 \times 10^{-4} \div (3 \times 4200)$ ✓

(temperature rise =) 4×10^{-8} ($^{\circ}\text{C}$) ✓

Q11.(2022)

C ✓

Q12.a(2022)

Place (sheet of) plastic in tray or in ripple tank or in water
/ decrease depth of water ✓

2

2 × 2.2

ALLOW under the water

DO NOT ALLOW idea that the plastic floats

(Water) waves change speed / travel slower / ORA ✓

IGNORE light refracts / light reflects / water reflects

IGNORE waves travel faster in shallow water

IGNORE the water waves go through the (sheet of) plastic

Q12.b(2022)

For one mark:

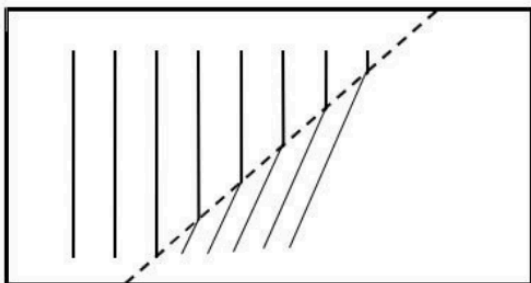
Wave pattern shown bending ✓

OR

Wave pattern lines are closer together ✓

For two marks:

Wave pattern shown bending in correct direction
(towards the normal) **AND** wavefronts are continuous
with incident wavefronts **AND** wave pattern lines are
closer together ✓✓



Q13.(2023)

Any two from:

Particles vibrating parallel to the direction of propagation/travel of the wave ✓

Longitudinal ✓

Compressions **and** rarefactions ✓

Compressions are high pressure areas/particles are close together ✓

Rarefactions are low pressure areas/particles are far apart ✓

Description of a wavelength ✓

Travel faster in solid/liquid than air ✓

2

2 × 1.1

ALLOW marking points on a labelled diagram
ALLOW 'slinky' type diagram
IGNORE drawing of a transverse wave (wavy line)

ALLOW air/particles move back and forth /
air/particles oscillate

ALLOW compressions and rarefactions parallel to
direction of wave for 2 marks

Q14.a(2023)

First check the answer on answer line
If answer = 336 (m / s) award 3 marks

(Wave speed =) frequency × wavelength ✓

(Wave speed =) $4 \times 0.175 \times 480$ **or** 0.7×480 ✓

(Wave speed =) 336 (m/s) ✓

3

1.2

2.1

ALLOW 0.175×480 for 1 mark

2.1

ALLOW 84 for 2 marks

Q14.b(2023)

First check the answer on answer line
If answer = 2.5 (%) award 3 marks

(Range =) 16 (m/s) ✓

(Mean =) 320 (m/s) ✓

(% uncertainty =) 2.5 (%) ✓

3

3 × 3.3b

ALLOW an error in the calculation for 2 marks
e.g., any of the following as the final answer:
 $0.5 / 0.025 / 25 / 1.09(375)$ or $1.1 / 0.78(125)$

Q14.c(2023)

Precision:

(Yes because) results are close together / range is small
Or
(No because) results are not close together / range is large ✓

Accuracy:
(No because) too far from the true value
Or
(Yes because) near to true value ✓

ALLOW use of data e.g.,
(Yes as) range is only 16 / (no as) range is 16 / too far from 343 / lower than 343 / no value near 343 / not around the 340 / closest answer is 13 / mean is only 23 away / (yes as) no outliers / (yes as) no anomalies

ALLOW use of data e.g.,
(mean) is only 23 from true value / close to 343 / within 10% of true value / student's answer is only 7 away

ALLOW use of the following data to explain answers to precision and accuracy:

Student	Speed of sound (m/s)
1	314
2	320
3	330
4	315
5	321

Range = 16 m/s
Mean = 320 m/s
Speed of sound = 343 m/s
Student's answer = 336 m/s

Q14.d(2023)

Holding the tuning fork as close as possible to the end of the tube ✓

1

3.3a

ALLOW any indication of the first box selected e.g., X or circling but ticking takes precedence

DO NOT ALLOW more than one box ticked

Q14.e(2023)

Using a ruler with a zero error ✓

1

3.3b

ALLOW any indication of the fourth box selected e.g., X or circling but ticking takes precedence

DO NOT ALLOW more than one box ticked

Q15.(2024)

Air particles vibrate/oscillate (parallel to direction of energy transfer) ✓

Compressions and rarefactions ✓

2

2 × 1.1

ALLOW answers in description or on a labelled diagram anywhere in the answer space

ALLOW they/it vibrate/oscillate
IGNORE waves vibrate/oscillate

Q16.(2024)

Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.

Level 3 (5–6 marks)

Detailed description of the relationship shown in the data which includes analysis

AND

Detailed explanation of what the student sees

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)

Detailed description of the relationship shown in the data

AND

Basic explanation of what the student sees

OR

Basic description of the relationship shown in the data

AND

Detailed explanation of what the student sees

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)

Basic description about wavelength, speed or refraction

AND

Basic description or explanation of what the student sees

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks

No response or no response worthy of credit.

6

2 × 2.2

2 × 3.1a

2 × 3.2b

AO2.2 – Apply knowledge and understanding of scientific enquiry, techniques and procedures to describe what the student sees.

- Ray refracts towards normal in glass
- Red refracts least / violet refracts most / correct colour labelled on diagram
- Different colours spread out/disperse
- Order of colours correctly identified / correct colours labelled on diagram

AO3.1a - Analyse information and ideas to describe relationship between wavelength and speed in glass.

- Each colour has a different wavelength
- Different colours/wavelengths are slowed by different amounts / different colours/wavelengths have different speeds in glass
- As wavelength decreases, speed in glass decreases / **ORA**
- Red light travels fastest (in glass)
- Violet light travels slowest (in glass)

AO3.2b - Analyse information and ideas to draw conclusions about how changes in speed explain what the student sees.

- Speed of light decreases in glass
- Change in speed causes refraction
- Violet light slows down more than red light (in the glass)
- Shorter wavelengths slow down more than longer wavelengths (in the glass)
- Each colour or wavelength refracts by a different amount

ALLOW answers in terms of optical density e.g. speed of light decreases as light moves to a more dense medium / light refracts as it moves to a more dense medium

IGNORE references to frequency throughout