AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.6.1 WAVES IN AIR, FLUIDS AND SOLIDS (PACK 3)

SCORE	PERCENTAGE
/155	%

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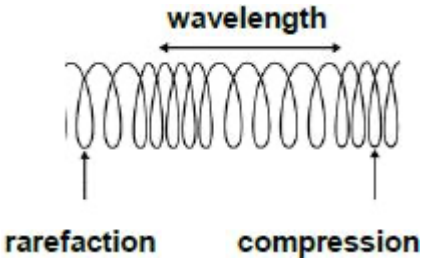
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Q1.

(a)



3

(b) longitudinal

1

(c) **Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and logically sequenced.

3–4

Level 1: The method would not necessarily lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- measure the distance between the student with the bricks and the wall
- trundle wheel or tape measure
- measure the time taken from banging the bricks to the echo
- double the measured distance to give the distance travelled or half the time
- use:

$$\text{speed} = \frac{\text{distance travelled}}{\text{time}}$$

- repeat timings
- remove anomalies
- calculate a mean

[8]

Q2.

(a) in a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer

allow direction of travel for energy transfer

1

in a transverse wave, the oscillations / vibrations are perpendicular to the direction of energy transfer

allow direction of travel for energy transfer

*if no other mark scored allow **1** mark for (oscillations / vibrations of) longitudinal waves*

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*are parallel **and** (oscillations / vibrations of) transverse waves are perpendicular*

*if no other mark scored allow **1** mark for transverse waves have peaks and troughs **and** longitudinal waves have compressions and rarefactions*

1

(b) $3.0 \times 10^8 = 4.8 \times 10^9 \times \lambda$

allow $\lambda = \frac{3.0 \times 10^8}{4.8 \times 10^9}$

this mark may be awarded if the standard form values are incorrectly converted

1

$\lambda = 0.0625$ (m)

1

$\lambda = 0.063$ (m)
or
$\lambda = 6.3 \times 10^{-2}$ (m)

allow an answer to 2 sig figs that is consistent with their calculated value of λ and has required rounding

1

*an answer of 0.063 (m) scores **3** marks*

(c) any **three** from:

- (the car aerial) absorbs radio waves or energy
- electrons are made to vibrate (in the aerial)
- creating an alternating current (in the aerial circuit)
- the (signal) frequency is the same (as the radio wave)

3

[8]

Q3.

(a) sound waves are longitudinal

1

in longitudinal waves, the oscillations / vibrations are parallel to the direction of energy transfer

allow direction that the wave is travelling for direction of energy transfer

1

water waves are transverse

1

in transverse waves, the oscillations / vibrations are at 90 degrees to the direction of energy transfer

ignore references to wave speed, wavelength or frequency

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an answer stating that sound waves travel in all directions but water waves don't is insufficient.

1

(b) $0.0083 = \frac{1}{\text{frequency}}$

1

$\text{frequency} = \frac{1}{0.0083}$

1

frequency = 120 (Hz)

*an answer of 120(.481...) scores **3** marks*

*an answer of 0.12 scores **2** marks*

1

(c)

Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5-6
Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	3-4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical thinking.	1-2
No relevant content	0
Indicative content **equipment** • a stopclock / stopwatch should be used to time the waves • a metre rule should be used to measure distance **determining the frequency of the waves** • the frequency could be determined by finding the time for several waves to pass a point • the frequency could be determined by finding the how many waves pass a point in a fixed time • frequency is the average time for one wave to pass a point • frequency = $\frac{\text{no.of waves}}{\text{total time for waves to pass}}$	

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determining the speed of the waves • the speed can be determined by measuring the distance travelled by a wave and the time taken to travel that distance • the distance used to determine speed should be as long as possible • speed = distance/time **determining the wavelength of the wave** • the wavelength can be calculated using the speed and frequency of the wave • wavespeed = frequency × wavelength • $\text{wavelength} = \frac{\text{wavespeed}}{\text{frequency}}$ • $\text{wavelength} = \frac{\left(\frac{\text{distance}}{\text{time}}\right)}{\left(\frac{\text{no. of waves}}{\text{second}}\right)}$	

6

[13]

Q4.

(a) **B**

1

(b) **A**

1

(c) $\frac{2.5\ (\text{waves})}{0.5\ (\text{s})}$

1

5(.0)(Hz)

1

(d) longitudinal

1

(e) timing (from seeing the blocks bang together and hearing the sound)
or
risk of cancelling the timer
ignore human error unqualified
*allow reaction time (of student **B**)*

1

(f) student to stand further away (so there is a greater time lag to measure)
allow other correct methods, eg using echoes

1

(g) both are transverse waves

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1

both can travel through a vacuum

1

[9]

Q5.

(a) wave speed = frequency × wavelength

allow $v = f\lambda$

1

(b)

Level 2: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3-4
Level 1: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	1-2
No relevant content	0
Indicative content • adjust the bar so that it just touches the surface of the water • adjust motor to produce low frequency wave • adjust the lamp until the pattern is seen clearly on the card underneath • place a metre rule at right angles to the waves • measure the length of a number of waves (minimum 3 waves) • divide the length by the number of waves to give wavelength • count the number of waves passing a point in a given time • divide the number of waves counted by the time to give the frequency	

4

(c) light is reflected off the coin (and travels through the water)

allow correct ray on diagram

1

as the light leaves the water its speed increases

allow correct ray on diagram

1

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(this causes) the light to refract in the direction of the eye

1

(d) in longitudinal waves oscillations are parallel to the direction of energy transfer

1

in transverse waves the oscillations are perpendicular to the direction of energy transfer

1

[10]

Q6.

(a) any **four** from:

- light waves are transverse whereas sound waves are longitudinal
- light waves travel faster than sound waves
- light waves have a higher frequency than sound waves
- light waves have a shorter wavelength than sound waves
- light waves have oscillations perpendicular (to the direction of energy transfer) whereas sound waves are parallel (to the direction of energy transfer)

4

(b) the baby can be seen in the dark

1

(c) wave speed = frequency × wavelength

accept $v = f\lambda$

1

(d) $3 \times 10^8 = f \times 0.125$

1

$f = 3 \times 10^8 / 0.125$

1

$f = 2.4 \times 10^9$ (Hz)

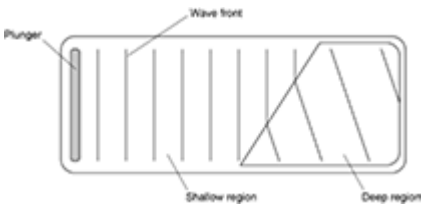
*allow 2.4×10^9 with no working for **3** marks*

1

[9]

Q7.

(a)



lines should be further apart with the bottom of the wave fronts further to the right than the top

1

(b) they will speed up

1

so wave (fronts) move further apart

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1

(c) longitudinal waves:

- the oscillations are parallel to the direction of energy transfer

1

- show areas of compression and rarefaction

1

transverse waves:

- the oscillations / movement are perpendicular to the direction of energy transfer.

1

(d) place a floating object / plastic duck on the surface of the water

1

it will stay in the same place **or** only bob up and down if the water doesn't move

1

(e) 0.42 = 1 / f

1

f = 2.38

1

v = 2.38 × 0.34

1

= 0.809

*allow 0.809 with no working shown for **4** marks*

1

*incorrect sig. figs max **3** marks*

m / s

correct unit

1

[13]

Q28.

(a) one of the areas where particles are spread out labelled R

1

(b) parallel

1

(c) 340 (m / s)

*allow **1** mark for correct substitution*
i.e. speed = 400 × 0.85 provided that no subsequent steps are shown

2

[4]

Q29.

(a) 2(dB)

1

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(b) 5500(Hz)

1

(c) 340(m / s)

allow 1 mark for correct substitution (20 x 17) provided no subsequent step

2

(d) echo(es)

1

[5]

Q30.

(a) Group 1

ignore figures

reason only scores if group correct

Reason: Loudest sound needed for person to notice it.

allow louder sound

allow exposed to loud noise for longest / longer

1

(b) any **three** from:

ignore Group 1 has the worst hearing

ignore figures unqualified

- the *longer* the exposure (to loud sounds) the greater the hearing loss
- no exposure / *Group 3* has the best hearing

  allow better
- hearing worsens (significantly) for frequencies above 1000Hz (or converse).

  ignore hearing is worse at high frequencies
- the first 10 years exposure has more of an effect than the next 10 years

  allow 10 years exposure to loud noise has no effect on hearing at 500 Hz

3

[4]

Q31.

0.000294 or 2.94×10^{-4} (m)

*a correct answer given to an incorrect number of significant figures gains **2** marks*

*eg 2.939×10^{-4} (m) **or** 2.93×10^{-4} (m)*

***or** 0.0002939 (m) **or** 0.000293 (m)*

***or** 2.9×10^{-4} (m) **or** 0.00029 (m)*

***or** 3×10^{-4} (m) **or** 0.0003 (m)*

*allow **1** mark for correct substitution*

$1540 = 5\ 2400\ 000 \times \lambda$

***or** $1540 = 5.24 \times 10^{6} \times \lambda$*

provided no subsequent step

***or** allow **1** mark for correct substitution and rearrangement*

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$$\lambda = \frac{1540}{5\,240\,000}$$

or

$$\lambda = \frac{1540}{5.24 \times 10^6}$$

provided no subsequent step

an answer of 2.94 gains one mark only

an answer given to an incorrect number of s.f. and including a rounding error gains one mark only

eg 2.938 × 10^{-4} (m)

3

[3]

Q32.

(a) 2.5(cm)

*10 / 4 for **1** mark*

2

(b) (i) 3 (m/s)

*allow 0.5 × 6 for **1** mark*

2

(ii) any **one** from:

- cheaper
- (easier) to make adjustments
- easier to handle
- external conditions can be controlled
- for safety
- fit for purpose

allow to see if it works / floats / has faults

1

[5]

Q33.

(a) X = wavelength

1

Y = frequency

1

wavelength in metres / m and frequency in hertz / Hz

*both units correct for **1** mark (independent of first two marking points)*

correct units must match correctly named quantities

allow Hertz

allow multiples of the units eg kHz, km (or in words)

1

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(b) (i) galaxy A is stationary (relative to Earth / us)

1

galaxy B is moving towards (Earth / us)

allow 1 mark for identifying galaxies B and C are moving in opposite directions

1

galaxy C is moving away from (Earth / us)

*allow **1** mark if say <u>all</u> moving away / towards **or** stationary*

1

(ii) galaxy C is fast<u>er</u> (than galaxy B)

allow converse statement

*do **not** accept galaxy C <u>expanding</u> faster*

1

(iii) sample is too small

accept three is too few

allow not enough evidence

ignore inaccurate, invalid, anomalous

1

compared to the size of the population

accept there are a very <u>large</u> number of galaxies in the Universe

*allow A, B and C are moving differently (from each other) for **1** mark*

1

[9]

Q34.

(a) (i) B

1

(ii) longitudinal

1

(b) (i) the sound wave travels to the building and back

allow (because) it is an echo

1

(ii) 0.30 / 0.3

*allow **1** mark for*

$$\frac{0.30 + 0.27 + 0.33}{3}$$

or

$$\frac{0.9}{3}$$

2

(iii) 100 (m)

allow ecf from (b)(ii) with a tolerance of ± 10 (m)

1

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(iv) use a sound sensor and a datalogger to measure the time

1

(v) (amplitude of echo is) smaller

ignore quieter

allow lower

1

[8]

Q35.

(a) any **two** from:

- (longitudinal) oscillations are parallel to the direction of energy transfer
- (transverse) oscillations are perpendicular / 90° to the direction of energy transfer

allow vibrations for oscillations

allow correct description of particle movement for oscillation

allow direction of wave for direction of energy transfer

- (longitudinal waves) show areas of compression and rarefaction

marks can be gained from correctly labelled diagrams

ignore references to need for a medium to travel through

2

(a) (i) reaction time

allow a description of reaction time

allow measuring the time

1

(as) time measured is very small

allow (as) sound travels quickly

1

(ii) 0.28(3)

*an answer of 283(.3) gains **2** marks*

*allow correct substitution and unit conversion for **2** marks*
*340 =1200 λ **or** 340 / 1200 = λ provided no subsequent step shown*

*allow correct substitution for **1** mark 340 =1.2 λ **or** 340 / 1.2 = λ provided no subsequent step shown*

3

[7]

Q36.

(a) (light waves) are transverse

1

(sound waves) are longitudinal

1

(b) (i) B

1

(ii) D

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1

[4]

Q37.

(a) 2 cm

1

(b) 5 (hertz)

ignore incorrect units

1

(c) $v = f \times \lambda$

10 (cm/s)

*allow correct substitution for **1** mark (20 × 0.5) **or** (2 × 5)*

2

(d) (i) point at 6 cm on x-axis should be circled

1

(ii) line of best fit drawn through points ignoring anomalous point at 6 cm

line should be a curve through every point (including 0) except anomalous point

tolerance ±1 square at each cross

ignore line after 16 cm

*do **not** accept straight lines joining crosses*

1

(iii) 3.5 (cm/s)

tolerance ± half a square from students line

allow ecf from (d)(ii)

if no extrapolation accept 3.5

1

[7]

Q38.

$v = f \times \lambda$

1.5×10^{10} (hertz)
or
15 000 000 000

*allow **1** mark for correct substitution and transformation ($3 \times 10^8 / 0.02$)*
*allow **1** mark for 1.5×10^8*
***or** 150 000 000*

2

[2]

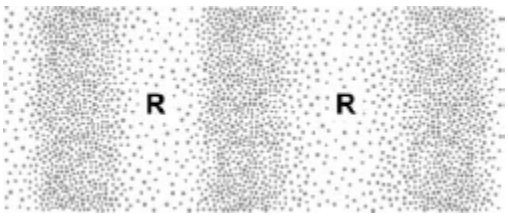
Q39.

(a) same / parallel to

1

(b) (i) letter R where the particles are furthest apart

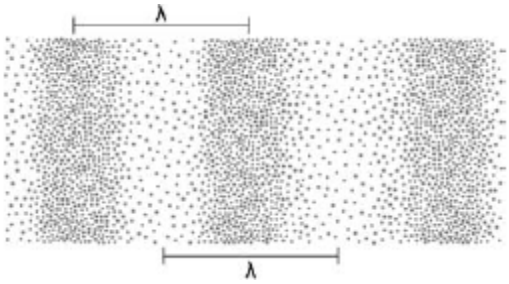
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1

(ii) student correctly indicates one wavelength

wavelength may be from one rarefaction to the next or from one compression to the next



1

[3]

Q40.

(a) (i) radio (waves)

1

(ii) gamma (rays)

accept γ

do ***not*** *accept* α

1

(iii) X-rays

or

gamma (rays)

accept γ

do ***not*** *accept* α

1

(b) (i) 2

1

(ii) 4(cm)

1

(iii) 3(cm)

ignore + or – in front of 3(cm)

1

(iv) transverse

1

[7]

Q41.

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(a) any **two** similarities and any **two** differences

read whole answer to ensure that there are no contradictory statements which negates that mark

ignore reference to senses in similarities and differences

similarities

- (both can be) reflected
- (both can be) refracted

  allow both travel through any correctly named solid / gas / liquid
- (both can be) diffracted
- (both) interfere
- (both) transfer energy

  ignore both are types of energy / waves / oscillations
- (both exhibit) Doppler effect

  *do **not** accept statements like both are transverse as a similarity*

differences

- light can travel through a vacuum
  or
  sound cannot travel through a vacuum

  allow sound requires a medium / particles to travel through
- (different) speed / velocity
- one is longitudinal and one is transverse

  accept light is faster than sound

  *do **not** accept sound is transverse and light is longitudinal*

  allow correct description:

  (longitudinal) the oscillations / vibrations are parallel to / same direction as (the direction of energy transfer)

  and

  (transverse) the oscillations / vibrations are 90° to / perpendicular to (the direction of energy transfer)
- sound is a mechanical wave / caused by vibrations and light is an electromagnetic wave

  accept sound waves have a longer wavelength / lower frequency

  *if no other marks gained allow **1** mark for any correct difference(s) where the waves are not specified*

  eg one is transverse

  eg have different wavelengths / frequencies

4

(b) (i) *working must be shown for **3** marks*

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4800 x 0.25

1

1200(m/s)

1

(liquid) C

ignore water / named liquid

1

(ii) (yes / no)

ignore yes / no, marks are for the explanation

speed increases as density increases

allow positive correlation

allow the more dense the liquid the less time (for sound to travel through)

ignore they both increase

ignore there was no pattern

1

but, mercury should have a (much) greater speed given the higher density

allow mercury does not fit the pattern / is an anomaly

1

[9]

Q42.

(a) (i) oscillation

1

direction

1

correct order only

(ii) sound

1

(b) 1.6

*allow **1** mark for correct substitution into correct equation ie 2 × 0.8*

2

m/s

1

(c) as the wavelength increases so does the wave speed

1

extra information, eg wave speed increases faster between 0-40 m than between 100-140 m

1

or

not in proportion

[8]

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Q1.

(a) 88% of students gained at least one mark with only 19% scoring all three. Most students were able to correctly label wavelength however many confused rarefaction and compression with amplitude and frequency.

(b) Only 55% of students correctly identified a sound wave as being longitudinal; many of those that did not score selected transverse.

(c) Level two required students to produce a plan that would lead to a valid outcome. Key steps are needed for this including measuring time, distance and how to calculate speed from these measurements.

Only 9% of students were able to achieve level 2 with many just writing a clear account of how to measure the correct time for sound to travel to and from the wall. Many of those that did mention distance failed to give any account of what would be done with the measured values.

Nearly 27% did not gain any marks, with a significant number stating that the bricks should be thrown at the wall despite the stem of the question indicating that they would be banged together.

Q2.

(a) Nearly 13% gave accurate answers to score both marks. A further 20% were able to score a compensation mark by vague references to parallel and perpendicular, but it was clear that many students do not realise the importance of what is oscillating and the direction of energy transfer. There were many vague incorrect descriptions of ‘up and down’ and ‘side to side’.

(b) 25% gained full marks, and a further 18% gained two marks, usually not giving the answer to two significant figures. There were a large number of responses using an incorrect rearrangement of the equation and generally the use of standard form was not the cause of the errors.

(c) This was very poorly done, with just over 1% gaining full marks. There were many vague responses and a significant number of candidates wrote about transverse and longitudinal waves. There was also considerable reference to radio waves being reflected off the ionosphere.

A significant minority of students did not attempt this question which might suggest that they were unfamiliar with the material.

Q28.

(a) The letter R was often written so that it overlapped areas of rarefaction and compression, so did not gain credit. Those who knew the answer wrote the letter R very clearly in a correct position.

(b) Very few students gained the mark for this question. Many thought that vibrations travel.

(c) Most students who attempted this question gained full marks for calculating the speed of sound.

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Q29.

(a) Most students interpreted the graph correctly and identified the minimum sound level needed to detect sound at 2000 Hz as 2 dB.

(b) Many students did not fully understand what the graph was showing, and found it more difficult to take a reading from the x-axis than taking one from the y-axis, as they had done in part (a).

(c) The question was well answered and most students gained full marks. A few gained 1 mark for showing 20×17, but then worked this out to give an incorrect answer. Students should be informed that the first mark in a calculation is for the substitution, and so should be encouraged to show their working. A few multiplied 20 by 20, rather than by 17. Others carried out a division instead of a multiplication.

(d) Only about a quarter of the students knew that reflected sound waves are called echoes.

Q30.

(a) Less than half the students gained this mark. Many students correctly identified Group 1 as having the worst hearing; however, there was no mark for this; the mark was awarded for a correct reason. The reason had to include a comparative statement; “They could only hear loud noises” was therefore not creditworthy. Most gained the mark by saying they had the highest minimum sound level detectable. A few chose Group 3, because they had not understood what the graph was showing.

(b) Many students struggled to understand the graph, so found it hard to make a sensible conclusion. The most common correct responses were that Group 3 had the best hearing, and the longer you are exposed to loud noises the worse your hearing is. Both of these ideas had to be expressed comparatively. Many students thought the graph was showing the age of people, so gave conclusions such as the older you are the worse your hearing. Some thought that the group with the longest exposure to loud sounds could hear the best because they were used to it. A lot of students did not give conclusions; instead they gave descriptions of the frequencies heard by the different groups.

Q31.

Very few students gained full marks, and only just over a third scored 1 mark or more. Students should be told that the first mark in a calculation is for the substitution, not for the rearrangement. Many students scored no marks because they did not show their working. Many students were not able to give an answer to 3 significant figures, but gained 2 marks for 2.939×10^{-4} m or an equivalent alternative. Those students who just showed a correct substitution into the equation were awarded 1 mark, even if they went on to make an error in their calculation. The most common error was to divide 5240 000 by 1540, which gave an answer of 3402.6 m.

Q32.

(a) Many students gave the correct answer of 2.5 cm. Others made errors in counting the number of waves; 3 or 5 waves were often recorded instead of 4. Others tried to use the wave equation from the Physics Equation Sheet. If the question says use the diagram, it means that there is information in the diagram to be used.

(b) (i) The majority of students answered the question correctly. It was pleasing to see so many students showing their working as this would gain credit even

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if the final answer was incorrect. Students who answered incorrectly had attempted to rearrange the equation and calculated 6 divided by 0.5 instead of 0.5 times 6. Students should be reminded that rearranging equations will only be required on the Higher Tier paper, not the Foundation Tier. Students should be aware that only the last equation on the Physics Equation Sheet applies to SCA2 papers.

(ii) Most responses said to see if the boat floats, or to see if it works, both of which gained credit.

Q33.

(a) Most students did not know what quantities X and Y were, but those who did often scored the third mark for naming the correct units.

(b) (i) Many responses referred to the speed that the galaxies were travelling at, rather than their directions relative to Earth. Others gave their relative distances from Earth. Many gained 1 mark for realising that galaxies B and C were moving in opposite directions. A few gave detailed explanations for their conclusions in terms of red and blue shift.

(ii) The question asked for a comparison between the speed of galaxy B and the speed of galaxy C, relative to the observer. Many responses did not refer to one being faster or slower than the other, but to relative distances from the observer, or amount of red or blue shift.

(iii) Only a few students realised that there wasn't enough evidence, or that 3 galaxies were too few to base conclusions about all galaxies on. Even fewer mentioned that there are a very large number of galaxies in the Universe.

Q34.

(a) (i) Just under half of the students could identify the wavelength of the sound wave. All representations of waves should be taught.

(ii) Just over half of the students knew that a sound wave is longitudinal. Many thought it is transverse.

(b) (i) About a third of students correctly realised that the sound wave must travel to the building and back. Most incorrect answers focussed on the <u>two</u> metal bars or the <u>two</u> students as reasons to divide by two.

(ii) Most students correctly calculated the mean time.

(iii) Most students gave the correct reading from the graph. Mistakes arose when students thought they needed to do a calculation to answer the question. If they made a mistake in part **(b)(ii)** they could still gain this mark if they had correctly read the graph using their own figure for the time.

(iv) Three quarters of the students chose the correct improvement of using a sound sensor and data logger to measure the time.

(v) A lot of students misinterpreted the question thinking it was asking them for a reason why the amplitude changed, rather than the simpler question of how it changed. Many said that the echo would be quieter, but this was given in the question so was not creditworthy.

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Q35.

(a) Very few students scored on this question and struggled to give the differences between longitudinal and transverse waves. A common phrase seen was that a longitudinal wave is travelling parallel to the direction of the wave, but a reference to the direction of the vibrations or oscillations was needed.

(b) (i) Very few students gained a mark for this question. Those who did usually said that measuring the time, or stopping the stop clock would be inaccurate, but very few realised this was because the time measured would be small or that sound travels quickly.

(ii) Many students gained 2 marks for an answer of 283.3; their only error was that they had not converted kilohertz to hertz. A common mistake was to substitute into the equation incorrectly and divide the frequency by the speed for which no marks could be gained. Answers of 28.3 or 2.83 did not gain any marks unless there was a supporting calculation. Students should be reminded to show their working in all calculations.

Q36.

(a) Most students scored a mark for this question. For incorrect answers, longitudinal and transverse were often given the wrong way round.

(b) (i)+(ii) These questions were well answered with a few students putting answers B and D the wrong way round.

Q37.

(a) A very well answered question. The most common incorrect response was 3 cm.

(b) Less than half of students answered this question correctly. The most common incorrect response was 20 with others giving an incorrect answer of 0.2.

(c) Most students gained full credit for this question. A number of students were able to substitute correctly into the formula but were then unable to calculate 20 × 0.5. Some students selected the wrong equation.

(d) Generally, graph skills were poor.

(i) Most students correctly circled the anomaly.

(ii) The drawing of a line of best fit was done very badly with only a tenth of students gaining one mark. Many students did not appreciate that a line of best fit can be a curve or they did not include the (0, 0) point. Sometimes a ruler was used to join the points with straight lines, or a curve that had little relationship to the points was drawn.

(iii) Some students did not use the line they had drawn to take the graph reading. Others had a guess without drawing any line at all. Just over a third of students gained credit for this question.

Q38.

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It was apparent that most students are unfamiliar with working in standard form, a mathematical requirement for Higher Tier students on this new specification. Only one third of the students scored one mark, the majority of which for 1.5×10^8.

Q39.

(a) The majority of students were not familiar with the direction of oscillations of the air particles compared to the transfer of energy in a sound wave. Almost one third of the students did not attempt the question.

(b) (i) Over half of the students correctly identified an area of rarefaction, but many students 'hedged their bets' by placing the R very close to the boundary between the two areas, receiving no credit.

(ii) Students used a wide variety of methods to indicate wavelength, many drawing a waveform. Only a fifth of the students indicated wavelength correctly, the most common error being to include the whole of two darkly stippled areas and one lightly stippled area.

Q40.

(a) (i) Two-thirds of students identified radio waves as having a wavelength longer than microwaves.

(ii) Almost two-thirds of students identified gamma rays as having more energy than X-rays.

(iii) Despite the high number of correct responses for questions (a)(i) and (a)(ii), less than half the students could identify a part of the electromagnetic spectrum with a higher frequency than ultraviolet.

(b) (i) Just under two-thirds of students identified that two complete waves were shown on the diagram.

(ii) Only a quarter of students were able to work out the correct wavelength from the diagram.

(iii) Just over half the students gave the correct amplitude of the waves.

(iv) Only a quarter of students were able to identify the type of wave as transverse.

Q41.

(a) Very few students gained three or four marks. Most students struggled to give two similarities of light and sound waves. The most common difference given was that light travels faster than sound. A few said sound waves cannot travel through a vacuum. Many got transverse and longitudinal waves mixed up. Many students said light can be seen, but sound cannot, rather than focussing on the properties of the waves themselves.

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(b) (i) Many students identified the wavelength and frequency from the question, but had trouble substituting into the equation. Although almost half the students scored full marks, a number of students attempted to guess what the liquid was; a common answer was ‘water’, rather than choosing a letter from the bar chart.

(ii) Over half the students did not score any marks on this question. Many students gained one mark for either identifying the pattern (up to mercury) or by identifying the fact that mercury did not fit the pattern. The irregular intervals between values in the table confused many students and they were unfamiliar with the way that the hypothesis was stated: ‘There is a link between…’. Some students attempted to find a mathematical relationship between the two quantities rather than simply identifying the trend.

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