GCSE
PHYSICS
AQA - COMBINED SCIENCE
MARK SCHEME

P6
WAVES
TEST 3
Mark schemes

(a) 

\[ \text{wavelength} \]

\[ \text{rarefaction} \quad \text{compression} \]

1 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.

**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]

2 1

(a) R 1

(b) they have the same wave speed as visible light 1

they have a lower frequency than gamma rays 1
(c) any two from:
• ageing of the skin
  allow sunburn
  burn unqualified is insufficient
• skin cancer
  cancer is insufficient
  allow mutation of genes in skin cells
• eye damage
  allow blindness

(d) any two from:
• gamma (rays)
• X-rays
• ultraviolet

(a) light
ionising

(b) x-rays have a longer wavelength and a lower frequency

(c) \[
\frac{0.039 + 0.035 + 0.040}{3}
\]
\[
= 0.038 \text{ (millisieverts)}
\]

an answer of 0.038 scores 2 marks

(d) the dose decreases if you stand further from the machine

(e) \[
\frac{0.180}{0.012}
\]
\[
= 15 \text{ days}
\]

an answer of 15 days scores 2 marks

(f) the benefit (of a correct diagnosis) outweighs the risk
  allow the (increased) risk of cancer is very small for an x-ray
  allow for medical imaging, eg to see broken bones
\[
20 \times \frac{40}{100} \quad \text{allow } 20 \times 40\%
\]

\[= 8 \text{ (millisieverts)}\]

an answer of 8 (millisieverts) scores 2 marks

(a) decreases

\textit{correct order only}

increases

(b) (i) intensity (of transmitted light) depends on thickness

or
to enable a valid comparison

or

it is a control variable

accept absorption depends on thickness

it would affect the results is insufficient

fair test is insufficient

(ii) transmits the least light

or

absorbs the most light

accept very little light is transmitted

\textbf{do not} accept transmits none of the light

\textbf{do not} accept absorbs all of the light

any reference to heat negates this mark
(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
(b) (i) \textit{working must be shown for 3 marks}

\[4800 \times 0.25\]

1

\[1200 \text{(m/s)}\]

1

\text{(liquid) C}

\textit{ignore water / named liquid}

1

(ii) \textit{(yes / no)}

\textit{ignore yes / no, marks are for the explanation}

speed increases as density increases

\textit{allow positive correlation}

\textit{allow the more dense the liquid the less time (for sound to travel through)}

\textit{ignore they both increase}

\textit{ignore there was no pattern}

1

but, mercury should have a \textit{(much) greater speed given the higher density}

\textit{allow mercury does not fit the pattern / is an anomaly}

1

\[\text{(a) at least two wave fronts drawn to the right of the glass block, parallel to the other wave fronts and with equal spacing compared with the wave fronts to the left of the glass block}\]

\[\text{Diagram of wave fronts and glass block}\]
(b) ray of light refracts towards the normal where it is incident on the glass block

ray of light does not refract when it exits the glass block

a normal is drawn on where the ray is incident on the glass block

the angle of refraction is labelled

\[ \text{lines should be drawn with a ruler} \]

(c) light travels more slowly (in the glass block than in the air)

so it changes direction

\[ \text{allow so it bends towards the normal} \]

(d) the angle of incidence

the type of glass used

\[ \text{allow the glass block} \]

(e) the resolution of a normal protractor is too big

so it could not measure the difference between results

\[ \text{allow so it could not read angles to 2 decimal places} \]

(f) a longer wavelength gives a greater angle of refraction

(g) absorbed / reflected
(a) any three from:
- same surface area of bag (exposed to sun)
  
  allow same sized bag
- same volume / mass of water
  
  allow same amount of water
- use same starting temperature of water
  
  allow measure temperature at the start
- place all bags out at the same time
- place all bags out in same area / conditions
- same thickness of material / bag
- same type of material (for each bag)
- use IR lamp in a lab

(b) 0.1 (°C)

(c) any one from:
- more cloudy
- less sunny
  
  ignore less Sun
- less sunlight
- cooler day

(d) 24.3 (°C)

(e) black

(it has the) greatest (temperature) rise

  allow it is the best absorber of IR (radiation)
  ignore best emitter of IR (radiation)

reason only scores if black is given

[8]
(a) In a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer.

\[ \text{allow direction of travel for energy transfer} \]

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

\[ \text{allow direction of travel for energy transfer} \]

If no other mark scored allow 1 mark for (oscillations / vibrations of) longitudinal waves 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.

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

\[ \text{allow } \lambda = \frac{3.0 \times 10^8}{4.8 \times 10^9} \]

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

\[ \lambda = 0.0625 \text{ (m)} \]

\[ \lambda = 0.063 \text{ (m)} \]

Or

\[ \lambda = 6.3 \times 10^{-2} \text{ (m)} \]

\[ \text{allow an answer to 2 sig figs that is consistent with their calculated value of } \lambda \text{ and has required rounding} \]

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 marks

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(a) Wave speed = frequency \times \text{wavelength}

\[ \text{allow } v = f \lambda \]

1 mark
| 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

(c) light is reflected off the coin (and travels through the water) *allow correct ray on diagram*

as the light leaves the water its speed increases *allow correct ray on diagram*

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

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

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