Waves part 2 AQA Triple Physics

Name: _____

Class: _____

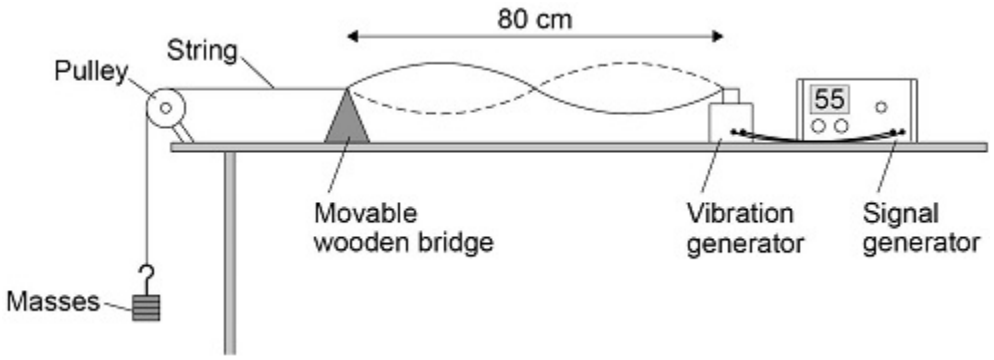
Date: _____

Time: **80 minutes**

Marks: **77 marks**

Comments:

1. The following figure shows the apparatus used to investigate the waves in a stretched string.



The frequency of the signal generator is adjusted so that the wave shown in the figure is seen.

At this frequency the string vibrates between the two positions shown in the figure.

(a) The wavelength of the wave shown in the figure above was measured as 80 cm

What piece of apparatus would have been suitable for measuring this wavelength?

_____

(1)

(b) Write down the equation which links frequency, wavelength and wave speed.

_____

(1)

(c) The string in the figure above vibrates at 55 Hz

Calculate the wave speed of the wave shown in the figure.

Use data given in the figure.

_____

_____

_____

Wave speed = _____ m/s

(3)

(d) The frequency of the signal generator is increased.

This makes the wavelength of the wave change.

The wave speed stays the same.

Describe how the apparatus could be adjusted to show one complete wave without reducing the frequency.

(2)

(e) A student wants to investigate how the speed of a wave on a stretched string depends on the tension in the string.

The student uses the apparatus in the figure above.

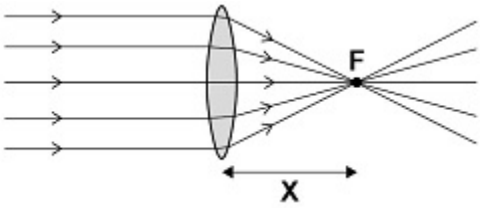
Describe a method the student could use for this investigation.

(4)

(Total 11 marks)

2. (a) **Figure 1** shows parallel rays of light being refracted by a convex lens.

Figure 1



What is distance '**X**' called?

_____

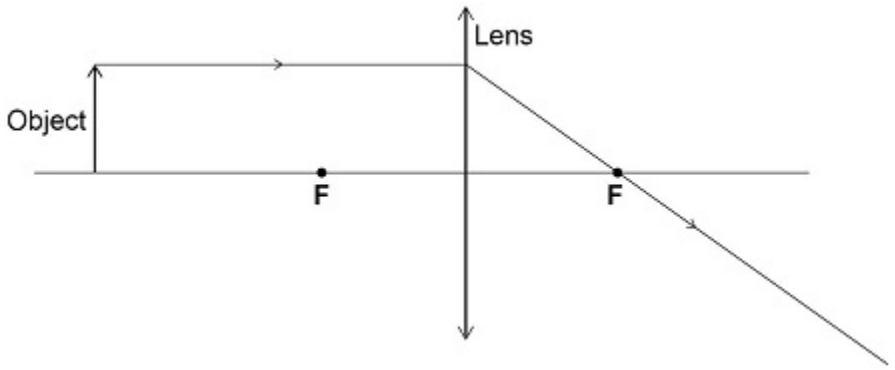
(1)

(b) Lenses can be used to form the image of an object.

Complete the ray diagram in **Figure 2** to show how a **convex** lens forms the image of the object.

Use an arrow to represent the image.

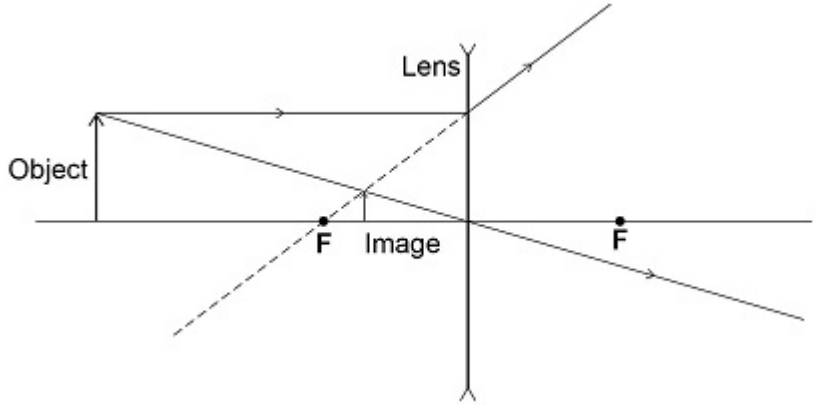
Figure 2



(2)

Figure 3 shows how a concave lens forms the image of an object.

Figure 3



(c) Give **one** similarity and **one** difference between the image formed by the convex lens and the image formed by the concave lens.

Similarity _____

_____

Difference _____

_____

(2)

(d) A person uses a lens to read the letters on the back of a coin.

The image height of the letters on the coin is 9.0 mm

The magnification produced by the lens is 6.0

Calculate the height of the letters on the coin.

Use the Physics Equations sheet.

_____

_____

_____

_____

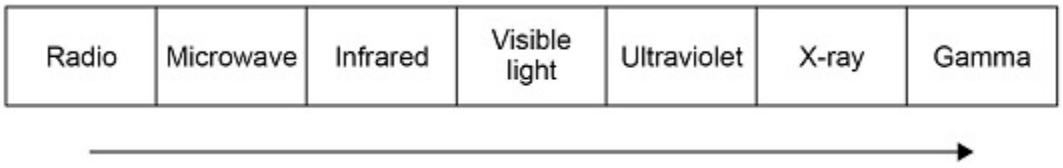
Height = _____ mm

(3)

(Total 8 marks)

3. (a) **Figure 1** shows the electromagnetic spectrum.

Figure 1



Which statement is correct for the direction of the arrow in **Figure 1**?

Tick (✓) **one** box.

The wavelength decreases and the wave speed in air increases. ☐

The frequency increases and the wavelength increases. ☐

The frequency increases and the wave speed in air stays the same. ☐

The wavelength increases and the wave speed in air increases. ☐

(1)

(b) Explain how the properties of X-rays make them suitable for the medical imaging of bones.

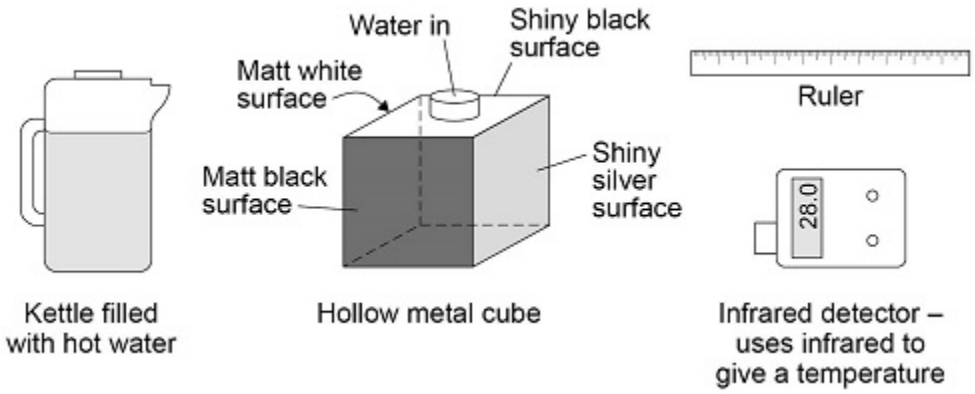
(2)

A student investigated the infrared radiation emitted from the sides of a hollow metal cube.

The sides of the cube are different colours or textures.

Figure 2 shows the equipment used.

Figure 2



Boiling water was poured into the cube. The amount of infrared radiation emitted from each vertical surface was then measured.

(c) Boiling water is a hazard in this investigation.

Suggest how the risk of harm could be reduced in this investigation.

(1)

(d) What is the control variable in this investigation?

(1)

The following table shows the results.

Type of surface	Temperature in °C
Matt black	68.0
Matt white	65.6
Shiny black	66.3
Shiny silver	28.0

(e) The four temperature values in the table cannot be used to show that the infrared detector gives precise readings.

Give the reason why.

_____

_____

_____

(1)

(f) The student looked at the data in the table above and concluded:

'A black surface always emits more infrared radiation than a white surface.'

Explain how using an infrared detector with a resolution of 1 °C would have affected the student's conclusion.

_____

_____

_____

_____

_____

(2)

Albedo is a measure of the amount of solar radiation reflected by an object compared to the total solar radiation incident on the object.

A perfect reflector has an Albedo value of 1.0
A perfect absorber has an Albedo value of 0.0

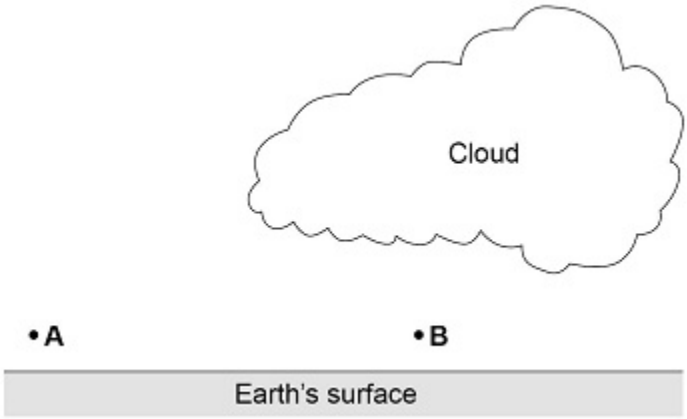
(g) What is the Albedo value of a perfect black body?

_____

(1)

(h) **Figure 3** shows two points, **A** and **B**, just above the Earth's surface.

Figure 3



The average Albedo value of the Earth's surface is 0.3
The Albedo value of thick cloud varies between 0.6 and 0.9

At night the air at point **A** cools faster than the air at point **B**.

Explain why.

_____

_____

_____

_____

_____

_____

(3)

(Total 12 marks)

4. (a) The table below gives the frequencies in the hearing ranges of five different animals.

Animal	**Frequencies of hearing range**
Cat	55 Hz to 77 kHz
Chicken	125 Hz to 2 kHz
Dog	20 Hz to 30 kHz
Gerbil	56 Hz to 60 kHz
Horse	55 Hz to 33 kHz

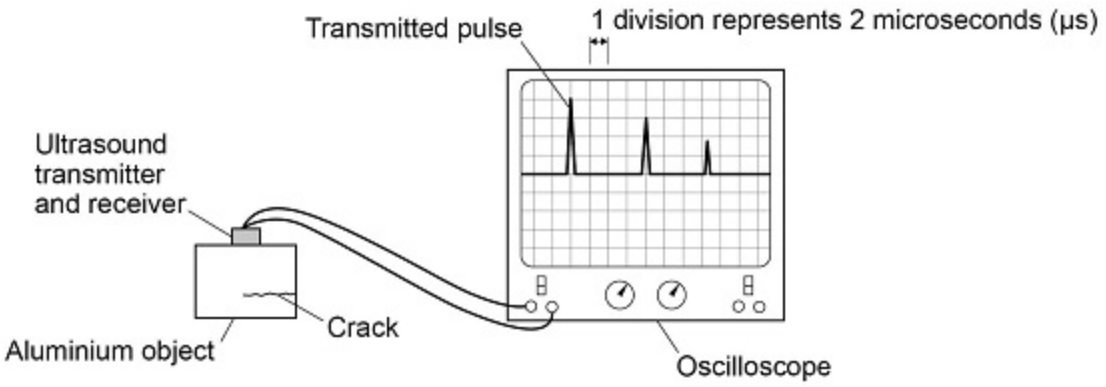
Which **one** of the animals from the table would not be able to hear ultrasound?

_____

(1)

Figure 1 shows ultrasound being used to detect a hidden crack in a solid aluminium object. The transmitted and reflected pulses of ultrasound are shown on the screen.

Figure 1



(b) Which of the following is the same as 2 microseconds?

Tick (✓) **one** box.

2×10^{3} s ☐

2×10^{-3} s ☐

2×10^{-6} s ☐

2×10^{-9} s ☐

(1)

(c) Ultrasound travels at 6300 m/s in aluminium.

Determine the depth of the crack below the top surface of the aluminium.

Use information from **Figure 1**.

Give your answer to two significant figures.

_____

_____

_____

_____

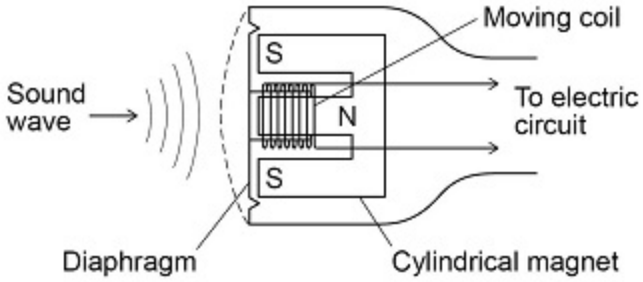
_____

Depth = _____ m

(4)

Figure 2 shows the parts of a moving-coil microphone.

Figure 2



(d) What is the function of a microphone?

_____

_____

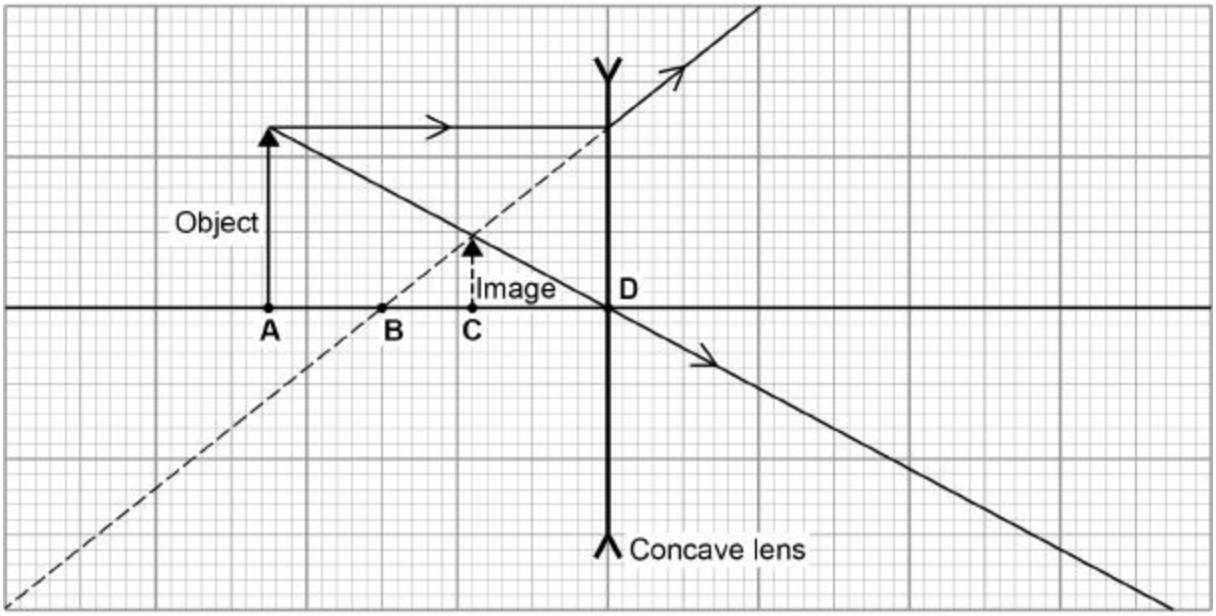
(1)

(e) Explain how a moving-coil microphone works.

(4)

(Total 11 marks)

5. The graph shows how a concave lens forms an image of an object.



(a) Which point on the graph above marks the position of the principal focus of the lens?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) Which **two** words describe the image?

Tick **two** boxes.

Enlarged ☐

Inverted ☐

Real ☐

Upright ☐

Virtual ☐

(2)

(c) Calculate the magnification produced by the lens.

Use the equation:

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

_____

_____

_____

_____

Magnification = _____

(4)

(d) Complete the sentence.

Choose an answer from the box.

decrease	**increase**	**not change**

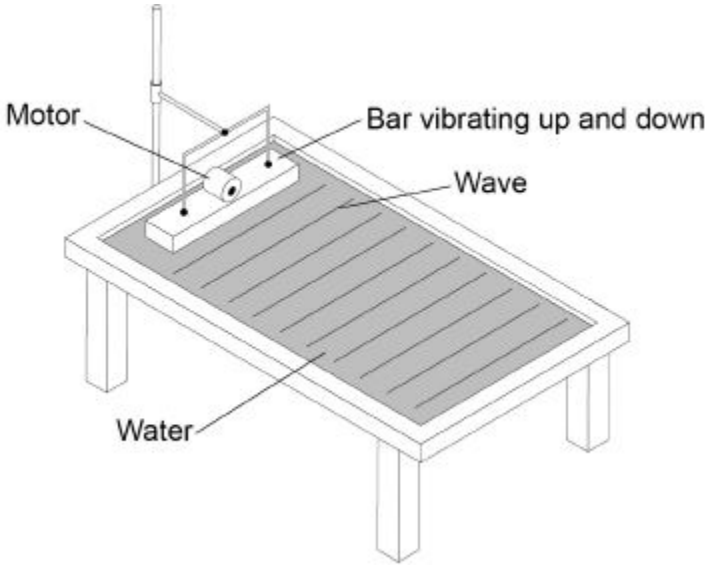
As the object is moved further away from the lens, the size of

the image will _____ .

(1)

(Total 8 marks)

6. The diagram below shows a ripple tank that a student used to investigate water waves.



(a) The student adjusted the speed of the motor so that the bar hit the water more times each second.

What happened to the frequency of the waves produced?

Tick **one** box.

Decreased ☐

Did not change ☐

Increased ☐

(1)

(b) Describe how the frequency of the water waves in the ripple tank can be measured.

_____

_____

_____

_____

(2)

(c) The student measured the frequency of the water waves as 5 hertz.

Calculate the period of the water waves.

Use the equation:

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

Choose the unit.

metres	**metres / second**	**seconds**

Period = _____ Unit = _____

(3)

(Total 6 marks)

7. P-waves and S-waves are two types of seismic wave caused by earthquakes.

(a) Which **one** of the statements about P-waves and S-waves is correct?

Tick **one** box.

P-waves and S-waves are transverse. ☐

P-waves and S-waves are longitudinal. ☐

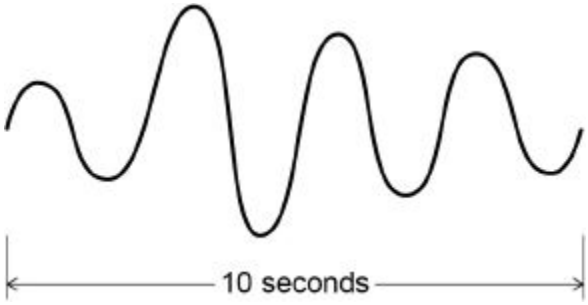
P-waves are transverse and S-waves are longitudinal. ☐

P-waves are longitudinal and S-waves are transverse. ☐

(1)

Seismometers on the Earth's surface record the vibrations caused by seismic waves.

The diagram below shows the vibration recorded by a seismometer for one P-wave.



(b) Calculate the frequency of the P-wave shown in the diagram above.

Frequency = _____ Hz

(1)

(c) Write down the equation which links frequency, wavelength and wave speed.

(1)

(d) The P-wave shown in the diagram above is travelling at 7200 m/s.

Calculate the wavelength of the P-wave.

Wavelength = _____ m

(3)

(e) Explain why the study of seismic waves provides evidence for the structure of the Earth's core.

_____

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

8. P-waves and S-waves are two types of seismic wave caused by earthquakes.

(a) Which **one** of the statements about P-waves and S-waves is correct?

Tick **one** box.

P-waves and S-waves are transverse. ☐

P-waves and S-waves are longitudinal. ☐

P-waves are transverse and S-waves are longitudinal. ☐

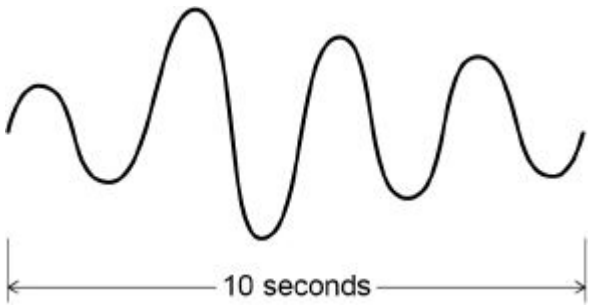
P-waves are longitudinal and S-waves are transverse. ☐

(1)

Seismometers on the Earth's surface record the vibrations caused by seismic waves.

Figure 1 shows the vibration recorded by a seismometer for one P-wave.

Figure 1



(b) Calculate the frequency of the P-wave shown in **Figure 1**.

Frequency = _____ Hz

(1)

(c) Write down the equation which links frequency, wavelength and wave speed.

(1)

(d) The P-wave shown in **Figure 1** is travelling at 7200 m/s.

Calculate the wavelength of the P-wave.

Wavelength = _____ m

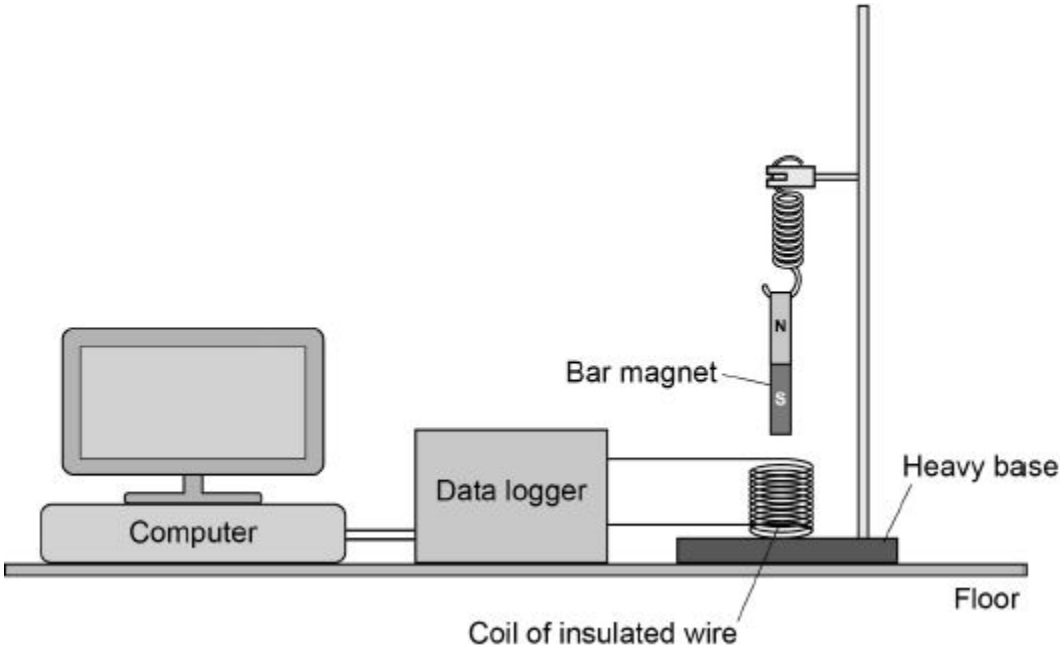
(3)

(e) Explain why the study of seismic waves provides evidence for the structure of the Earth's core.

(2)

Figure 2 shows a simple seismometer made by a student.

Figure 2



To test that the seismometer works, the student pushes the bar magnet into the coil and then releases the bar magnet.

(f) Why does the movement of the bar magnet induce a potential difference across the coil?

_____

_____

(1)

(g) Why is the induced potential difference across the coil alternating?

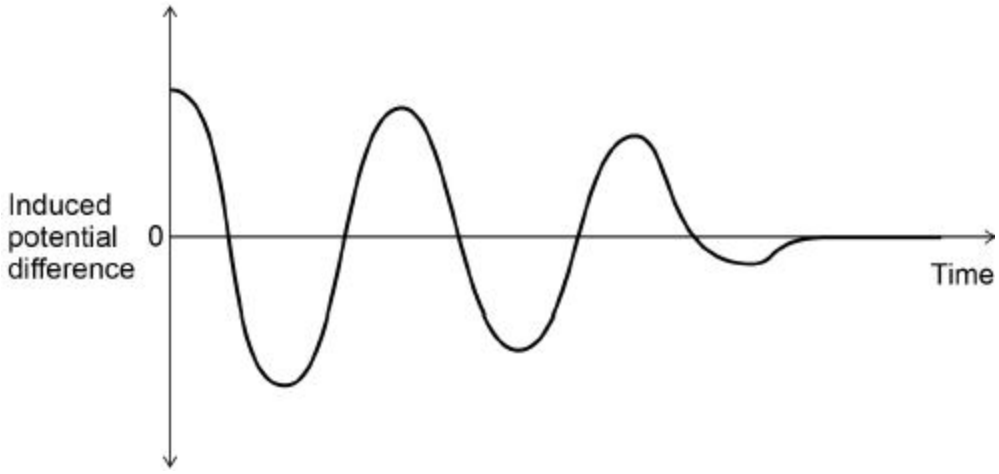
_____

_____

(1)

(h) **Figure 3** shows how the potential difference induced across the coil varies after the bar magnet has been released.

Figure 3



Which statement describes the movement of the magnet when the induced potential difference is zero?

Tick **one** box.

Accelerating upwards. ☐

Constant speed upwards. ☐

Decelerating downwards. ☐

Stationary. ☐

(1)

(i) The seismometer cannot detect small vibrations.

Suggest **two** changes to the design of the seismometer that would make it more sensitive to small vibrations.

1. _____

_____

2. _____

_____

(2)

(Total 13 marks)

1.

(a) metre rule

allow metre ruler

allow tape measure

do not accept ruler

do not accept metre stick

1

(b) (wave) speed = frequency × wavelength

allow $v = f\lambda$

1

(c)

*an answer of 44 (m/s) scores **3** marks*

80 cm = 0.8 m

1

v = 55 × 0.8

this mark may be awarded if wavelength is incorrectly or not converted

1

v = 44 (m/s)

allow correct calculation using an incorrectly or not converted wavelength

*an answer of 4400 (m/s) scores **2** marks*

1

(d) move the (wooden) bridge

1

to the right

dependent on 1st mp being scored

1

OR

change the mass/weight (on the string) scores **1** mark

add more masses/weights (to the string) scores both marks

(e) **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 lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

add or take away masses from the string (ignore any stated values)

adjust frequency using the signal generator and/or move the wooden bridge

observe a steady / stationary pattern measure the wavelength

calculate wave speed from frequency and wavelength

a Level 1 answer should include a way of changing tension a complete Level 2 answer would include either changing frequency and/or moving the bridge

[11]

2. (a) focal length

this answer only

1

(b) one correct line drawn from the top of the object, passing through the lens and crossing or meeting given line

ignore any arrow drawn on the line

if two lines are drawn, both must be correct

1

inverted image drawn at the correct position and length

arrowhead required

1

(c) similarity

(both are) diminished

1

difference

concave is <u>virtual</u> and convex is <u>real</u>

or

concave is upright and convex is inverted

allow smaller for diminished

a comparison must be made

ignore reference to positions of images

1

(d)

*an answer of 1.5 (mm) scores **3** marks*

$$6.0 = \frac{9.0}{\text{object height}}$$

1

$$\text{object height} = \frac{9.0}{6.0}$$

1

object height = 1.5 (mm)

*provided working can be seen, an attempt to convert 9.0 mm to cm or m with all other steps correct scores **2** marks*

1

[8]

3. (a) The frequency increases and the wave speed in air stays the same

1

(b) pass through soft tissue

allow penetrate for pass through

allow skin/muscle/etc… for soft tissue

pass through tissue is insufficient

1

(but) absorbed by bone

allow do not pass through bone

*do **not** accept reflected by bone*

1

(c) accept a sensible practical suggestion eg

- complete the investigation standing up
- use (slightly) cooler water
- do not touch the hot cube

*do **not** accept use cold water*

pour water in carefully is insufficient

ignore wear safety goggles or gloves

1

(d) distance between each side (of the cube) and the (infrared) detector

allow distance between cube and detector

1

(e) measurements (for each surface) have not been repeated (to show that they cluster closely)

*do **not** accept any answer for measurement should be repeated for any reason other than to show they cluster eg to show accuracy / average / anomalies would be wrong*

1

(f) (the student) could not conclude that black surfaces always emit more (infrared) than a white surface

a (matt) white surface (appears to) emit(s) the same amount (of infrared) as a (shiny) black surface

the conclusion is wrong is insufficient

1

(as) the reading for the matt white and shiny black would both be 66 (°C)

allow (as) the reading for the matt white and shiny black would be the same

1

(g) 0.0

allow 0

allow zero

1

(h) at night, more radiation is emitted from the Earth than absorbed from space

1

cloud reflects radiation (towards the Earth)

allow solar radiation for radiation

1

at A, (there is no cloud cover so) a larger proportion of radiation will be emitted into space

1

[12]

4. (a) chicken

allow a correct answer indicated in Table 3 provided the answer space in blank

1

(b) 2×10^{-6}

1

(c)

*an answer 0.025 (m) scores **4** marks*

time = 8μs = 8×10^{-6} (s)
or
4 × their answer to part (b)

subsequent marks may be scored if the number of squares is miscounted or t = 2μs is used

1

distance = ½ × 6300 × 8×10^{-6}

allow 8×10^{3} or 8×10^{-3} or 8×10^{-9} for 8×10^{-6}

1

distance = 0.0252 (m)

allow a correctly calculated answer using 8×10^{3} or 8×10^{-3} or 8×10^{-9}

1

distance = 0.025 (m)

allow a calculated value correctly rounded to 2 sig figs
*an answer 0.050 (m) scores **3** marks*
*an answer 0.05 or 0.0504 (m) scores **2** marks*

1

(d) to convert (the pressure variations in) sound (waves) into variations in current / p.d

allow electrical signal for variations in current / p.d.
*do **not** accept amplifies sound*

1

(e) sound (waves) cause the diaphragm to vibrate

diaphragm moves is insufficient

1

the diaphragm causes the coil / wire to vibrate

*do **not** accept moves the coil / wire up and down*
*if m.p.1 and m.p.2 do not score, allow sound (waves) cause the coil / wire to vibrate for **1** mark*

1

the coil / wire moves through the magnetic field
or
the coil / wire cuts magnetic field lines

1

a potential difference is <u>induced</u> (across the ends of the coil / wire)

allow <u>induced</u> current for <u>induced</u> p.d.

1

[11]

5. (a) B

1

(b) upright

1

virtual

1

(c) image height = 9.5(mm)

allow any value between 9 and 10 inclusive

allow 5 (squares)

1

object height = 24(mm)

allow 12 (squares)

1

$$\text{magnification} = \frac{9.5}{24}$$

or

$$\frac{\text{their image height}}{\text{their object height}}$$

1

magnification = 0.4

allow an answer that rounds to 0.4 provided both object height and image height are correct

or

$$\frac{\text{their image height}}{\text{their object height}}$$

ignore any units

correctly calculated

1

*an answer of 0.4 scores **4** marks*

(d) decrease

1

[8]

6. (a) increased

1

(b) (count) how many waves pass a point

1

in one second

this is dependent on the first mark point being awarded

1

or

(count) number of waves that pass a point in a given time

allow a specific time for a given time

or
(count) number of waves that are produced in a given time (1)

and divide by that time in seconds

this is dependent on the first mark point being awarded

allow an answer in terms of measuring the frequency of the vibrating bar

(c) $\text{period} = \frac{1}{5}$

1

period = 0.2

1

seconds / s

1

[6]

7. (a) Regrettably, this part of the question assessed content that we had stipulated would only be assessed on the Higher tier. All students were awarded full marks for this part of the question.

1

(b) 0.4

1

(c) wave speed = frequency × wavelength

allow $v = f\lambda$

1

(d) 7200 = 0.4 × wavelength

1

$$\text{wavelength} = \frac{7200}{0.4}$$

1

wavelength = 18 000 (m)

allow up to full marks for ecf using their answer to part ***(b)***

a method shown as
7200 × 2.5 = 18 000
scores ***0*** *marks*

1

an answer 18 000 scores ***3*** *marks*

(e) Regrettably, this part of the question assessed content that we had stipulated would only be assessed on the Higher tier. All students were awarded full marks for this part of the question.

2

[8]

8. (a) P-waves are longitudinal and
S-waves are transverse

1

(b) 0.4

1

(c) wave speed = frequency × wavelength

allow $v = f\lambda$

1

(d) 7200 = 0.4 × wavelength

1

$$\text{wavelength} = \frac{7200}{0.4}$$

1

wavelength = 18 000 (m)

allow up to full marks for ecf using their answer to part ***(b)***

a method shown as
7200 × 2.5 = 18 000
scores ***0*** *marks*

1

an answer 18 000 scores ***3*** *marks*

(e) because S-waves cannot travel through a liquid

1

and S-waves do not travel through the (outer) core

*allow some (seismic) waves cannot travel through a liquid and do not go through the core for **1** mark*

1

(f) magnetic field around the coil changes
or
the magnetic field (lines) cut by the coil

allow the generator effect

1

(g) because the magnet changes direction

1

(h) stationary

1

(i) any **two** from:

- stronger magnetic field

  allow stronger magnet
  allow heavier magnet
  bigger magnet is insufficient

- more turns on the coil

  bigger coil is insufficient
  *do **not** accept more coils of wire*

- turns pushed closer together

- spring with a lower spring constant

  allow less stiff spring
  allow weaker spring

  *do **not** accept add an iron core*

2

[13]