

Waves 2

Name: _____

Class: _____

Date: _____

Time: **74 minutes**

Marks: **67 marks**

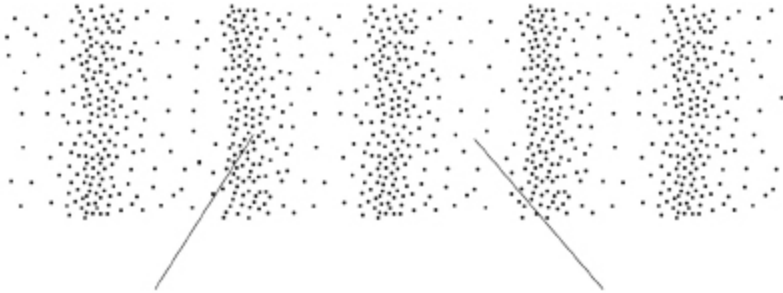
Comments:

1.

Sound waves are longitudinal waves.

(a) **Figure 1** shows a sound wave.

Figure 1



Complete the labels on **Figure 1**.

Choose answers from the box.

| | | |
|--------------------|-------------------|--------------------|
| compression | extension | rarefaction |
| reflection | resistance | |

(2)

(b) Which of the following is true for longitudinal waves?

Tick (✓) **one** box.

- Longitudinal waves transfer charge.
- Longitudinal waves transfer energy.
- Longitudinal waves transfer matter.

(1)

Figure 2 shows a device a farmer uses to scare away birds.

Figure 2



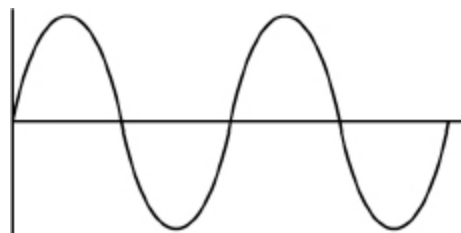
The device emits a very loud sound.

The farmer measures the sound emitted by the device at different distances from the device.

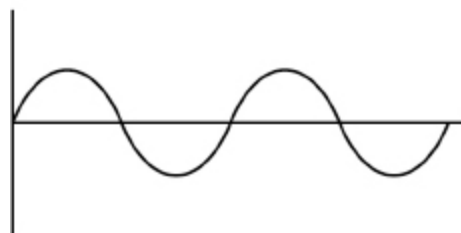
(c) **Figure 3** shows a visual display of the sound waves at different distances from the device.

Both waves are drawn to the same scale.

Figure 3



At a distance of 80 m



At a distance of 200 m

Which property of the wave changes between 80 m and 200 m?

Tick (✓) **one** box.

Amplitude

Frequency

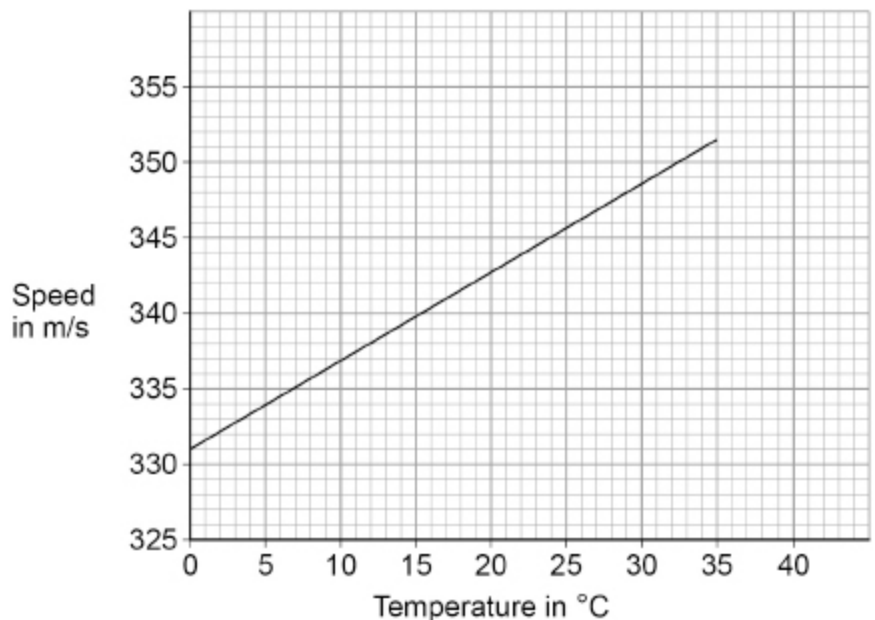
Period

Wavelength

(1)

Figure 4 shows how the speed of the sound emitted by the device is affected by the temperature of the air.

Figure 4



(d) The farmer tests the device on a day when the temperature of the air is 15 °C.

What is the speed of the sound emitted by the device when the temperature of the air is 15 °C?

Speed = _____ m/s

(1)

(e) The farmer stands a safe distance from the device.

It takes a time of 0.20 s for the sound to travel from the device to the farmer.

Calculate the distance between the device and the farmer.

Use your answer to part (d) and the equation:

$$\text{distance} = \text{speed} \times \text{time}$$

Distance = _____ m

(2)

- (f) Explain how the time taken for the sound to reach the farmer is affected by the temperature of the air.

Use **Figure 4**.

(2)
(Total 9 marks)

2.

The Sun emits a continuous spectrum of electromagnetic waves.

Figure 1 names some of the groups of waves in the electromagnetic spectrum.

Figure 1

| | | | | | | |
|---|---|----------|---------------|-------------|---|------------|
| A | B | Infrared | Visible light | Ultraviolet | C | Gamma rays |
|---|---|----------|---------------|-------------|---|------------|

- (a) Name groups **A**, **B** and **C** in **Figure 1**.

A _____

B _____

C _____

(2)

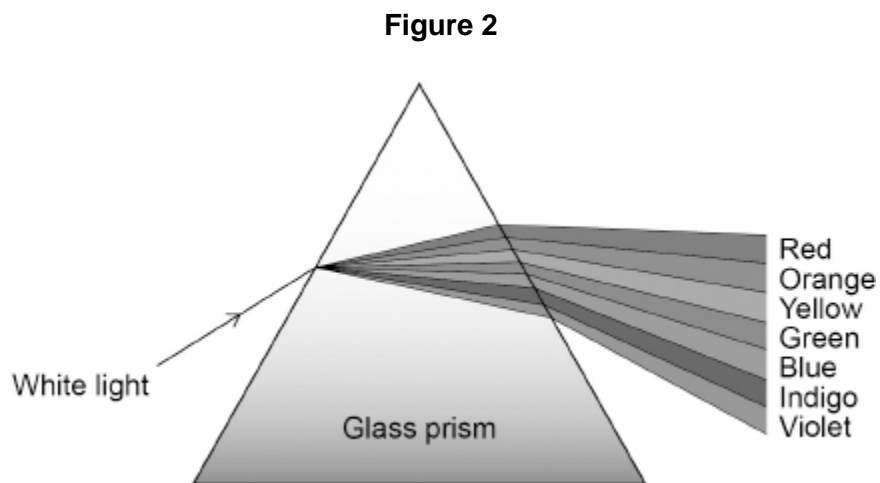
- (b) Give **one** similarity and **one** difference between the properties of ultraviolet waves and gamma rays.

Similarity _____

Difference _____

(2)

Figure 2 shows white light split into a spectrum of different colours by a glass prism.



(c) Light changes direction when it enters the glass prism.

What name is given to this process?

(1)

Use the Physics Equations Sheet to answer parts (d) and (e).

(d) Write down the equation that links frequency (f), wavelength (λ) and wave speed (v).

(1)

(e) The wave in the middle of the spectrum has a wavelength of 5.0×10^{-7} m.

wave speed of light = 3.0×10^8 m/s

Calculate the frequency of the wave.

Frequency = _____ Hz

(3)

(Total 9 marks)

3.

A teacher used a ripple tank to demonstrate water waves.

The teacher used a lamp to project a shadow of the water waves onto a screen below the ripple tank.

(a) The figure below represents the shadow of the water waves seen on the screen.



1.0 mm on the figure above represents 5.0 mm on the screen.

Determine an **accurate** value for the wavelength of the waves on the screen.

Give your answer in mm.

Show how you work out your answer.

Wavelength = _____ mm

(3)

The teacher adjusted the frequency of the waves produced in the ripple tank.

The teacher measured the wavelength five times.

The table below shows the results.

| Measurement | 1 | 2 | 3 | 4 | 5 | Mean |
|---------------------------|----|----|----|---|----|------|
| Wavelength in millimetres | 96 | 99 | 97 | X | 97 | 97 |

(b) Calculate value X in the table above.

X = _____ mm

(2)

(c) The teacher states that the results are very precise.

Which of the following supports the statement made by the teacher?

Tick (✓) **one** box.

The mean value is very close to the true value.

The spread of values about the mean is very small.

The values are all given to the nearest millimetre.

The wavelength measurement was taken five times.

(1)

(d) Describe the difference between longitudinal waves and transverse waves.

(2)

(Total 8 marks)

4.

There are different types of electromagnetic waves.

(a) What do all electromagnetic waves transfer?

Tick (✓) **one** box.

| | |
|--------|--------------------------|
| Charge | <input type="checkbox"/> |
| Energy | <input type="checkbox"/> |
| Matter | <input type="checkbox"/> |
| Sound | <input type="checkbox"/> |

(1)

(b) Complete the sentence.

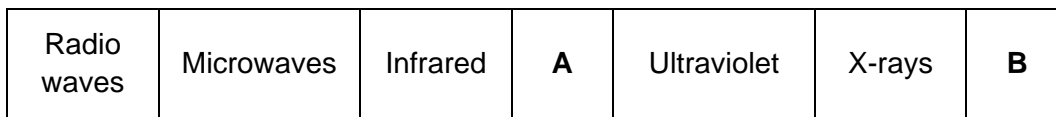
Choose answers from the box.

| | | | |
|---------------|------------------|--------------|-------------------|
| charge | frequency | speed | wavelength |
|---------------|------------------|--------------|-------------------|

Different types of electromagnetic waves have a different _____
and a different _____.

(2)

(c) The diagram below shows the electromagnetic spectrum.



Give the names of parts **A** and **B** of the electromagnetic spectrum.

A _____

B _____

(2)

(d) Different types of electromagnetic waves have different uses.

Draw **one** line from each type of electromagnetic wave to its use.

| Type of electromagnetic wave | Use |
|--|---|
| <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Microwaves</div> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Electrical heaters</div> |
| <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Ultraviolet</div> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Energy efficient lamps</div> |
| <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">X-rays</div> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Imaging bones</div> |
| | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Satellite communications</div> |

(3)

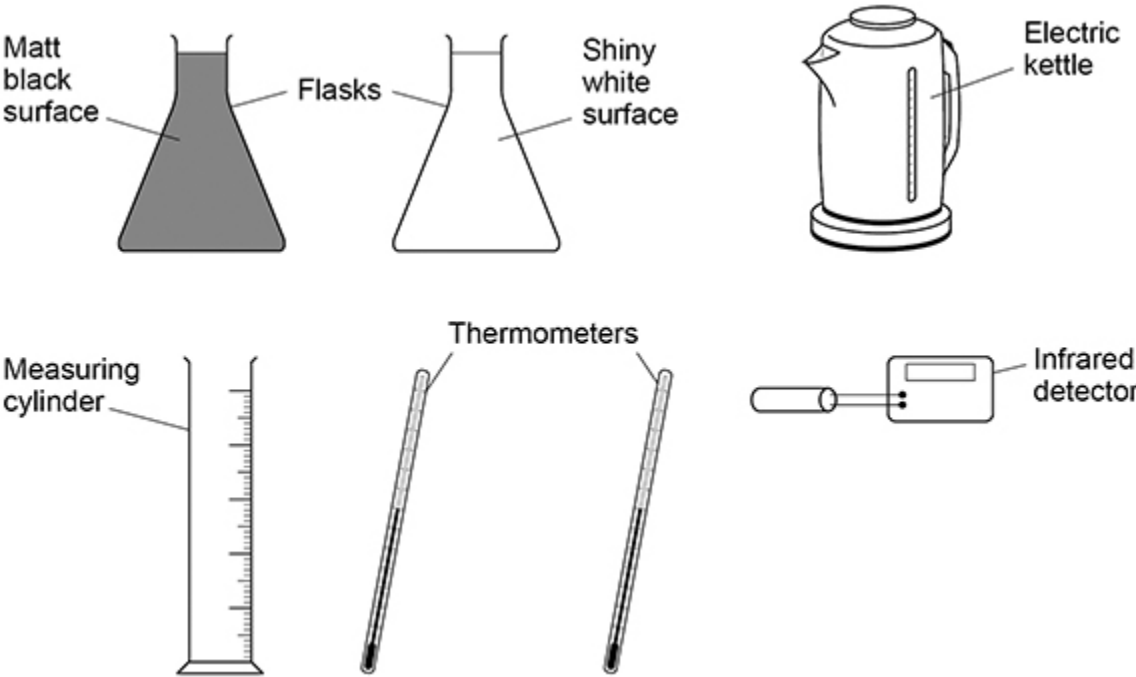
(Total 8 marks)

5.

A student investigated how the colour of a surface affects the power of the infrared radiation emitted by the surface.

Figure 1 shows the equipment used.

Figure 1



The infrared detector measures the power of the infrared radiation emitted by the flasks.

(a) The student poured hot water into each flask.

What should the student do to reduce the risk of burning herself with the hot water?

(1)

(c) Describe the pattern shown by the data in the table above.

(2)

(d) What is the most likely value for the power of the infrared radiation emitted after 480 seconds?

Use the table above.

Tick (✓) **one** box.

4.0 W

4.2 W

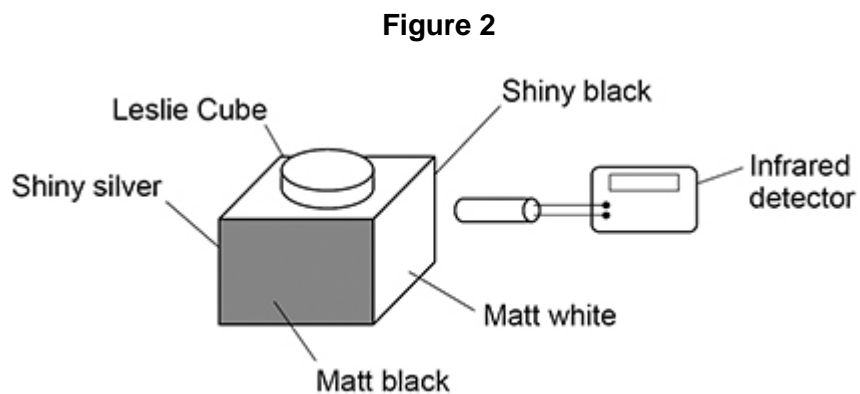
4.4 W

4.6 W

(1)

A Leslie Cube is used to demonstrate that different surfaces emit different amounts of infrared radiation.

Figure 2 shows an infrared detector and a Leslie Cube filled with hot water.



(e) Give **one** advantage of using a Leslie Cube rather than the equipment in **Figure 1** above.

(1)

- (f) The teacher improved the demonstration by using four infrared detectors connected to a data logger and computer. Each detector was pointed at a different surface of the Leslie Cube.

The distance between the surface and the detector was the same in each case.

Give **two** reasons why this improved the demonstration.

1 _____

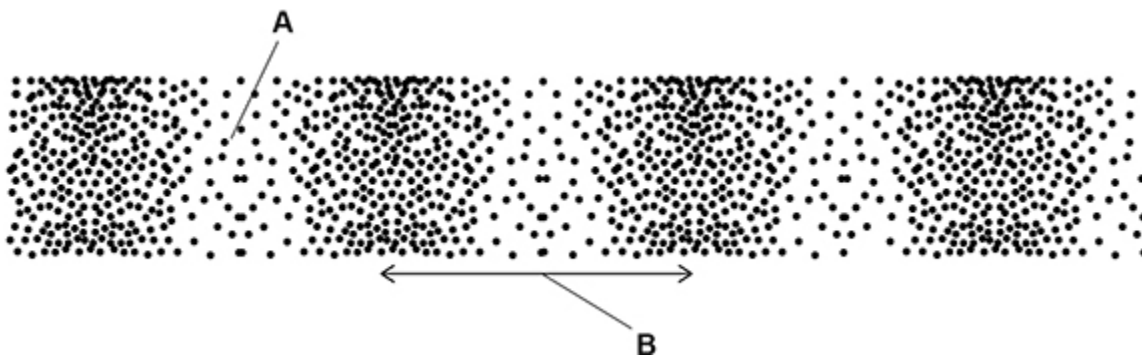
2 _____

(2)

(Total 11 marks)

6. **Figure 1** shows a longitudinal wave.

Figure 1



- (a) What do the labels **A** and **B** on **Figure 1** represent?

Choose answers from the box.

| | | | | |
|-----------|-----------|-------------|------------|------------|
| amplitude | frequency | rarefaction | reflection | wavelength |
|-----------|-----------|-------------|------------|------------|

A _____

B _____

(2)

(b) The wave shown in **Figure 1** has a frequency of 4.0 kHz

Calculate the period of the wave.

Use the Physics Equations Sheet.

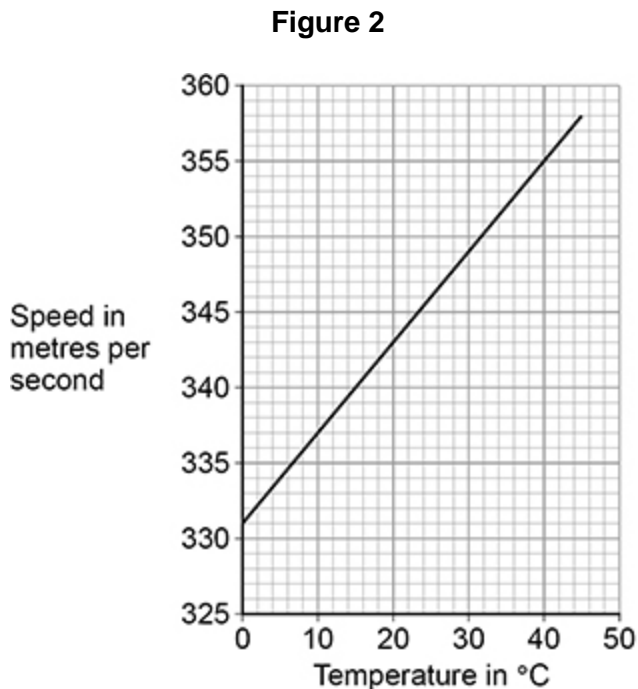
Give the unit.

Period = _____ Unit _____

(4)

Sound waves are longitudinal.

Figure 2 shows how the speed of sound varies with the temperature of the air.



Use the Physics Equations Sheet to answer parts (c) and (d).

(c) Write down the equation that links frequency (f), wavelength (λ) and wave speed (v).

(1)

(d) A sound wave with a frequency of 300 Hz travels through the air.

The air has a temperature of 28.0 °C

Determine the wavelength of the sound wave.

Use **Figure 2**.

Wavelength = _____ m

(4)

(Total 11 marks)

7.

A student made water waves in a ripple tank.

- (a) Describe how the frequency and wavelength of the water waves in the ripple tank can be measured accurately.

(4)

The student recorded values for the frequency and the wavelength of waves in the ripple tank.

Table 1 and **Table 2** show the results.

Table 1

| Reading | 1 | 2 | 3 |
|--------------------|-----|-----|-----|
| Frequency in hertz | 9.8 | 9.4 | 9.3 |

Table 2

| Reading | 1 | 2 | 3 |
|------------------|-----|-----|-----|
| Wavelength in cm | 1.7 | 2.2 | 2.1 |

(b) Determine the mean wave speed.

Mean wave speed = _____ m/s

(4)

(c) What is the advantage of taking repeat readings and then calculating a mean?

(1)

(d) The speed of the wave is affected by the depth of the water in the ripple tank.

The deeper the water the faster the wave.

Explain how the depth of the water affects the wavelength of the wave if the frequency is constant.

(2)

(Total 11 marks)

Mark schemes

1.

(a) compression

this order only

1

rarefaction

1

(b) longitudinal waves transfer energy

1

(c) amplitude

1

(d) 340 (m/s)

allow answers in the range 339 to 340 (m/s)

1

(e) $s = 340 \times 0.20$

1

$s = 68 \text{ m}$

allow ecf from part (d)

1

(f) the higher the temperature the greater the speed

do not accept the greater the speed the higher the temperature

1

(so) time taken is less

1

[9]

2.

(a) **A** radio waves

B microwaves

C X-rays

allow 1 mark if 2 correct

2

(b) **Similarity**

any **one** from:

- same speed (in a vacuum)
- both transfer energy
- both transverse

allow both can travel through a vacuum

allow both are ionising

allow both can harm living tissue

allow both can be used for medical treatment / imaging

1

Difference

any **one** from:

- gamma has a higher frequency
allow gamma has more energy
- gamma has a shorter wavelength
- gamma is more ionising
- gamma is more penetrating

1

(c) refraction

1

(d) wave speed = frequency × wavelength

or

$$v = f \lambda$$

1

(e) $3.0 \times 10^8 = f \times 5.0 \times 10^{-7}$

1

$$f = \frac{3.0 \times 10^8}{5.0 \times 10^{-7}}$$

allow a correct rearrangement using incorrect powers of 10

1

$$f = 6 \times 10^{14} \text{ (Hz)}$$

allow a correct calculation of f using incorrect powers of 10

allow 6.0×10^{14} (Hz)

1

[9]

3.

(a) distance across all 8 wavelengths = 113 (mm)

allow a range from 108 (mm) to 118 (mm)

1

their distance × 5.0

1

wavelength = 70 (mm)

allow a range from 68 mm to 72 mm

1

(b) $97 \times 5 = (96 + 99 + 97 + \mathbf{X} + 97)$

allow $\mathbf{X} = (97 \times 5) - (96 + 99 + 97 + 97)$

1

$$\mathbf{X} = 96$$

1

- (c) the spread of values about the mean is very small 1
- (d) the oscillations / vibrations in longitudinal waves are parallel to the direction of energy transfer

allow direction of wave travel for direction of energy transfer

1

(whereas) the oscillations / vibrations in transverse waves are perpendicular to the direction of energy transfer

1

*if no other mark awarded allow 1 mark for oscillations / vibrations in longitudinal waves are parallel **and** oscillations / vibrations in transverse waves are perpendicular*

[8]

4.

(a) energy 1

(b) frequency 1

wavelength 1

either order

(c) **A** = visible light

allow visible

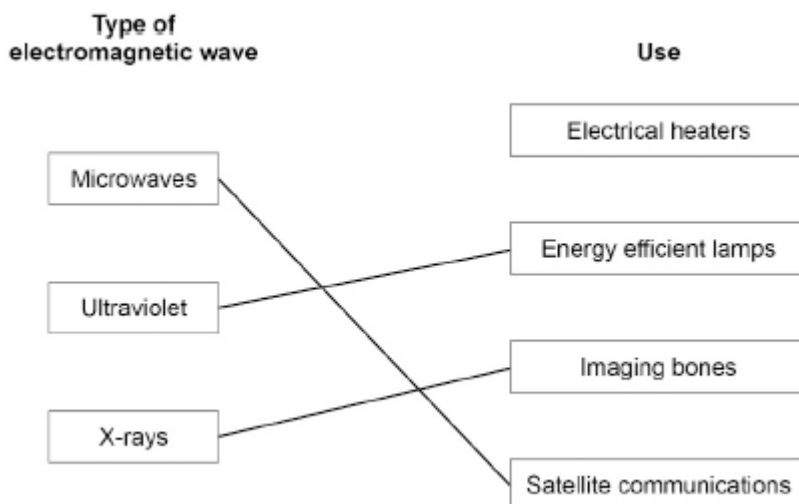
allow light

1

B = gamma (rays / waves / radiation)

1

(d)



additional line from a box on the left negates the mark for that box

3

[8]

- 5.** (a) any **one** from:
- stand up
 - use a funnel
 - pour water slowly
 - pour at arms-length
 - wear heat-proof gloves
- gloves on its own is insufficient*
allow do not touch hot objects (with bare hands)

1

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

3–4

Level 1: The method 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

- use the kettle to heat the water
- use measuring cylinder to measure volume of water
- same volume of water in each flask
- use the thermometer to measure temperature of the water
- ensure temperature is the same in each flask
- infrared detector the same distance from each flask
- use the infrared detector to measure the power of infrared radiation from each flask and compare results

- (c) as time increases the power decreases

1

the change (in power) each 60s decreases as the time increases

allow rate of decrease of power decreases

1

- (d) 4.4 W

1

- (e) any **one** from:

- all surfaces will be at the same temperature
- temperature of the water does not need to be measured
- more surfaces can be tested

allow different surfaces can be tested at the same time

- the procedure only needs to be done once
- volume of water does not need to be measured

1

- (f) measurements can be taken at the same time
allow no need to move the detectors / cube

1

results will be more accurate

1

[11]

6.

- (a) **A** = rarefaction

1

B = wavelength

1

- (b) $f = 4000 \text{ Hz}$

1

$$T = \frac{1}{4000}$$

allow a correct substitution using an incorrectly / not converted value of f

1

$$T = 0.00025$$

allow a correct calculation using an incorrectly / not converted value of f

1

seconds **or** s

1

- (c) wave speed = frequency \times wavelength

or

$$v = f \lambda$$

1

(d) $v = 348$

allow a value in the range 347 to 348

subsequent marks may only be awarded if value for v is in the range 343 to 349

1

$$348 = 300 \times \lambda$$

allow correct substitution using an incorrect value of v read from graph

1

$$\lambda = \frac{348}{300}$$

allow a correct rearrangement using an incorrect value of v read from graph

1

1.16 (m)

allow 1.2 (m)

allow a correct calculation using an incorrect value of v read from graph

allow a maximum of 2 marks for use of $v = 330$ m/s

1

[11]

7.

(a) **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

Wavelength

- place a metre rule at the side of the screen perpendicular to the wave fronts
- use the metre rule to measure the length of the screen
- take a photograph of the shadow on the screen
- count the number of complete waves on the screen
- determine the wavelength by dividing the length of the by the number of complete waves

or

- place a metre rule at the side of the screen perpendicular to the wave fronts
- take a photograph of the shadow on the screen
- use the metre rule to measure the distance between two wave front

Frequency

- count the number of waves that pass a given point
- time how long it takes for the waves to pass that point using a stop clock
- frequency is number of waves divided by time taken

or

- put a stop clock on the screen
- use a digital video camera to record the waves passing a point
- replay in slow motion and count the number of waves passing a point in 1 second

There must be a description of both frequency and wavelength measurement to access level 2

(b) mean $f = 9.5 \text{ Hz}$ 1

mean $\lambda = 0.020 \text{ m}$ 1

$v = 9.5 \times 0.020$
allow a correct substitution of an incorrect value of mean frequency and/or wavelength 1

$v = 0.19 \text{ (m/s)}$
allow a correct calculation using an incorrect value of mean frequency and/or wavelength 1

or

$v = 9.8 \times 0.017$

and

$v = 9.4 \times 0.022$

and

$v = 9.3 \times 0.021 \text{ (2)}$

$v = \frac{(1.67 + 2.07 + 1.95)}{3} \text{ (1)}$

$v = 0.19 \text{ (m/s) (1)}$
allow a maximum of 2 marks if a single pair of values is used

(c) reduces the effect of random errors
allow anomalous readings can be discarded before calculating a mean 1

(d) deeper water means longer wavelength 1

because

v increases and f is constant
allow for a fixed frequency period is constant 1

[11]