Waves part 6 AQA Triple Physics

Name: _____

Class: _____

Date: _____

Time: **76 minutes**

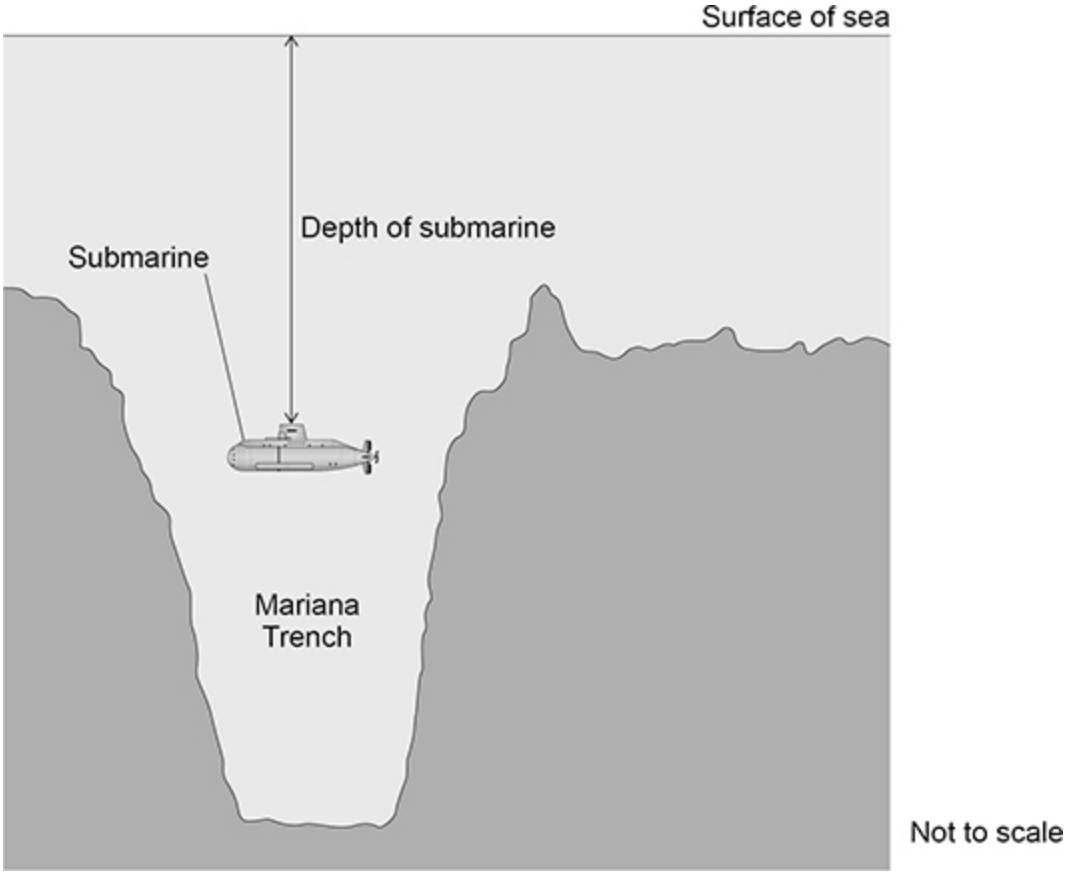
Marks: **73 marks**

Comments:

1. The Mariana Trench is the deepest part of the Pacific Ocean.

Figure 1 shows a submarine going to the bottom of the Mariana Trench.

Figure 1



(a) The depth of the submarine increases.

Explain what happens to the pressure on the submarine.

_____

_____

_____

_____

(2)

(b) The submarine moved from the surface of the water to the bottom of the Mariana Trench.

The change in pressure was 110 000 kPa.

mean density of sea water = 1026 kg/m^3

gravitational field strength = 9.8 N/kg

Calculate the depth of the Mariana Trench.

Use the Physics Equations Sheet.

Depth = _____ m

(4)

Earthquakes often occur at the Mariana Trench.

P-waves and S-waves are produced by earthquakes.

(c) Which statement describes P-waves and S-waves?

Tick (✓) **one** box.

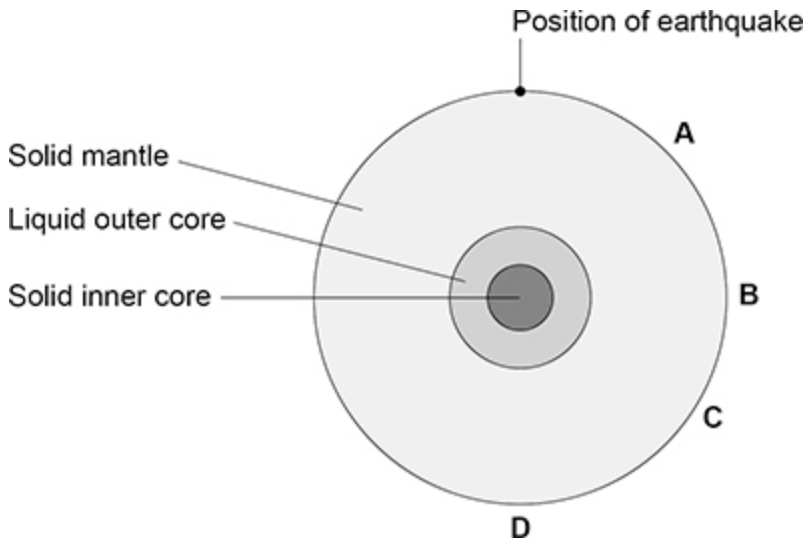
- Both P-waves and S-waves are longitudinal. ☐
- Both P-waves and S-waves are transverse. ☐
- P-waves are longitudinal and S-waves are transverse. ☐
- P-waves are transverse and S-waves are longitudinal. ☐

(1)

(d) **Figure 2** shows the layers inside the Earth.

An earthquake occurs at the position shown.

Figure 2



Which letter shows the position where **only** P-waves will be detected?

Give a reason for your answer.

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Reason _____

_____

(2)

(e) An S-wave has a frequency of 3.6 Hz.

The S-wave has a speed of 4.5 km/s.

Calculate the wavelength of this S-wave.

Use the Physics Equations Sheet.

Wavelength = _____ m

(3)

(f) A seismometer is a device that detects earthquakes.

P-waves travel at a known speed between an earthquake and a seismometer.

S-waves travel at a slower speed than P-waves.

A P-wave and an S-wave from the earthquake arrive at the seismometer at different times.

Describe the relationship between the distance from the earthquake to the seismometer and the time between the P-wave and the S-wave arriving.

(2)

(Total 14 marks)

2. Radio waves and gamma rays both transfer energy.

(a) Give **three** other similarities between radio waves and gamma rays.

1 _____

_____

2 _____

_____

3 _____

_____

(3)

Both radio waves and gamma rays are used in medicine.

(b) Give **one** medical use of gamma rays.

_____

_____

(1)

(c) Explain why exposure to gamma rays can be harmful but exposure to radio waves is **not** harmful.

_____

_____

_____

_____

(2)

(d) Some medical scanners produce radio waves at a specific frequency.

Explain how radio waves are produced at a specific frequency.

_____

_____

_____

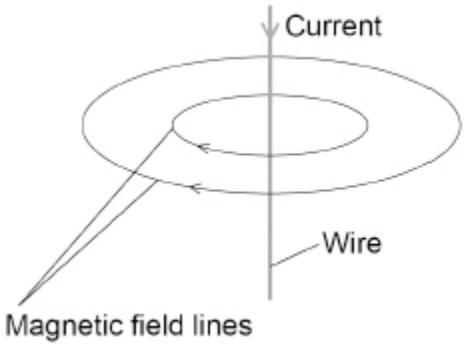
_____

(2)

(Total 8 marks)

3. **Figure 1** shows the magnetic field pattern produced when there is a current in a wire.

Figure 1



(a) What do the arrows on the magnetic field lines represent?

_____

_____

(1)

(b) How could the strength of the magnetic field be increased?

Tick (✓) **one** box.

Change the direction of the current in the wire ☐

Increase the current in the wire ☐

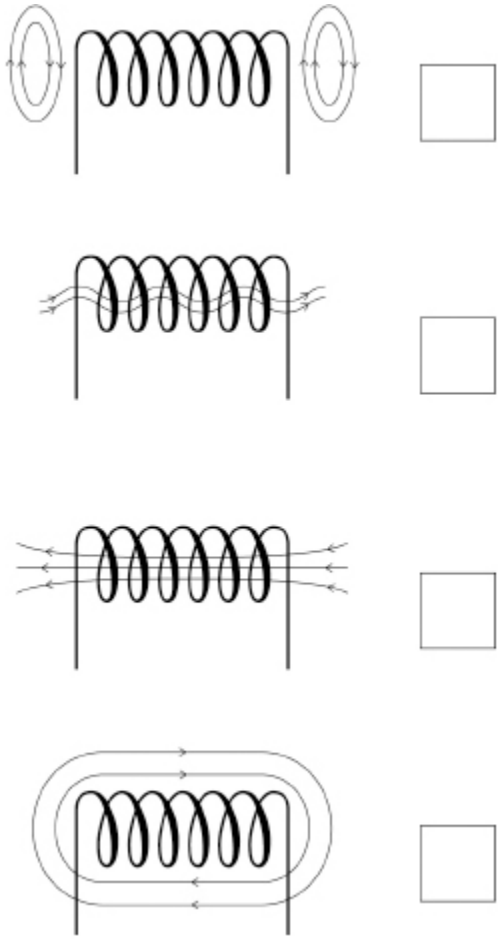
Increase the temperature of the wire ☐

(1)

(c) The wire is coiled to make a solenoid.

Which diagram in **Figure 2** shows the magnetic field pattern produced when there is a current in the solenoid?

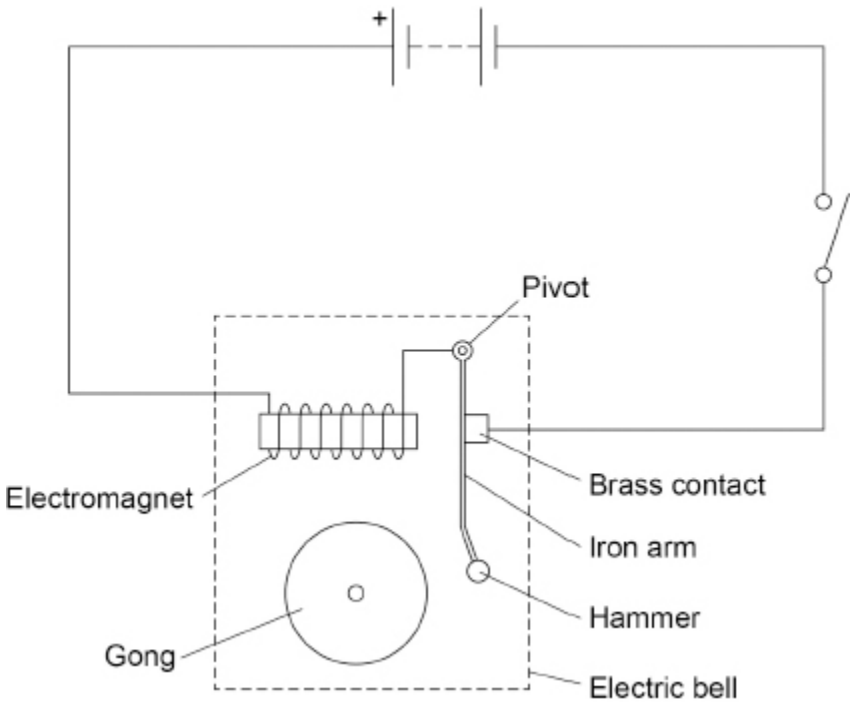
Figure 2



(1)

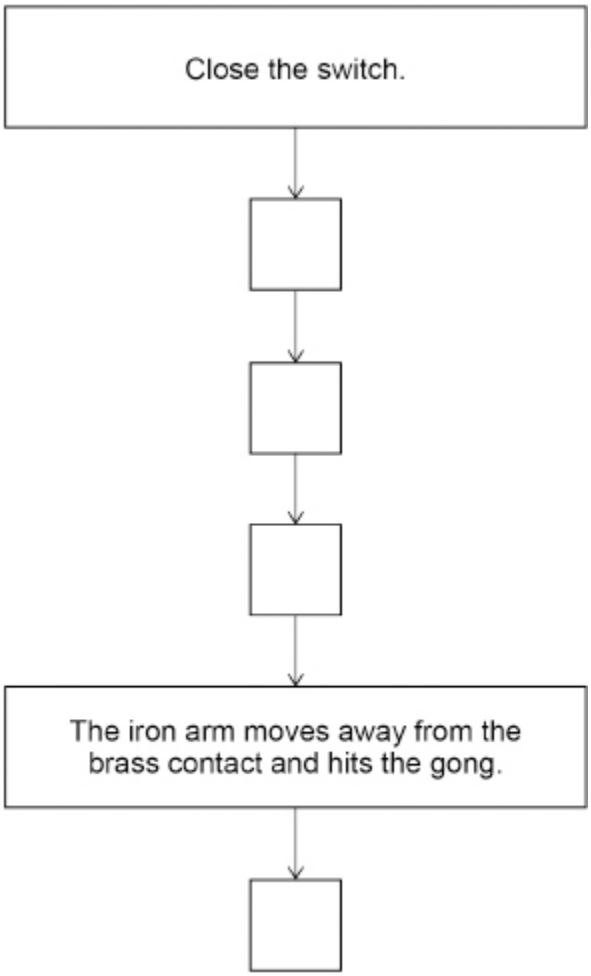
Figure 3 shows the parts of an electric bell.

Figure 3



(d) **Figure 4** shows an incomplete sequence of how the bell works.

Figure 4



Write **one** letter in each box to show the correct sequence.

Use each letter once.

A A magnetic field is created around the electromagnet.

B A resultant force acts on the iron arm causing it to move towards the electromagnet.

C The iron arm returns to its original position.

D There is a current in the circuit.

(2)

(e) Which of the following would increase the resultant force on the iron arm?

Tick (✓) **one** box.

Decrease the distance between the electromagnet and the iron arm ☐

Decrease the number of cells in the circuit ☐

Decrease the number of turns on the electromagnet ☐

(1)

(f) The iron arm of the bell vibrates with a frequency of 6.25 Hz.

Calculate the period of the iron arm.

Use the equation:

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

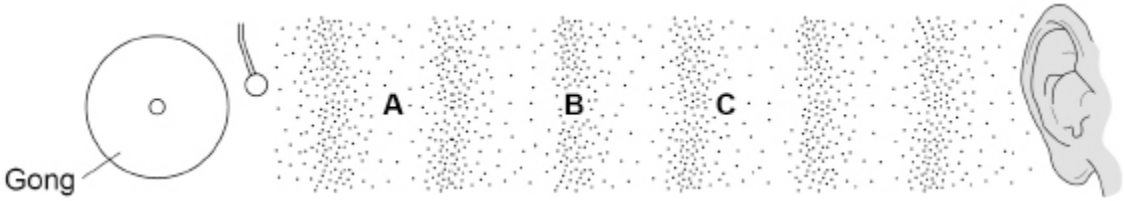
Period = _____ s

(2)

(g) The sound waves produced by the bell are longitudinal waves.

Figure 5 shows the position of the air particles at one point in time as the sound waves travel through the air.

Figure 5



Which letter represents an area of compression?

Tick (✓) **one** box.

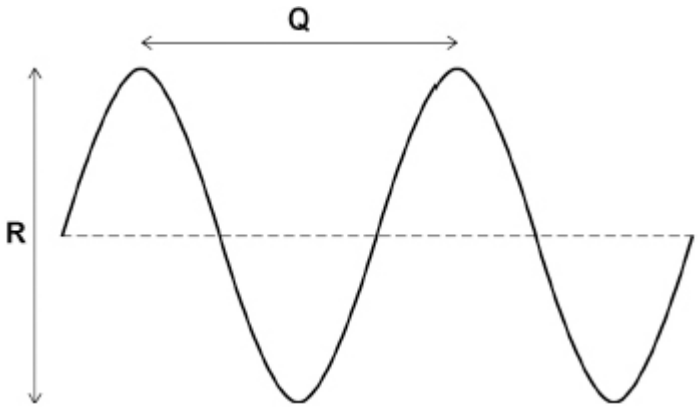
A ☐ **B** ☐ **C** ☐

(1)

(Total 9 marks)

4. Electromagnetic waves are transverse.

The figure below represents a transverse wave.



(a) Which of the following gives the wavelength of the transverse wave?

Tick (✓) **one** box.

$\text{wavelength} = \frac{Q}{2}$ ☐

wavelength = Q ☐

wavelength = 2 Q ☐

(1)

(b) Which of the following gives the amplitude of the transverse wave?

Tick (✓) **one** box.

$\text{amplitude} = \frac{R}{2}$ ☐

amplitude = R ☐

amplitude = 2 R ☐

(1)

(c) Microwaves are electromagnetic waves used for mobile phone communications.

Which other type of electromagnetic wave is also used for communications?

Tick (✓) **one** box.

Radio waves ☐

Ultraviolet ☐

X-rays ☐

(1)

(d) Microwaves from a mobile phone take 0.000 009 s to reach a mobile phone mast.

speed of microwaves = 300 000 000 m/s

Calculate the distance between the mobile phone and the mobile phone mast.

Use the equation:

distance = speed × time

_____

_____

_____

Distance = _____ m

(2)

(e) Mobile phone communications is only one of the uses for microwaves.

Give **one** other use of microwaves.

_____

_____

(1)

(Total 6 marks)

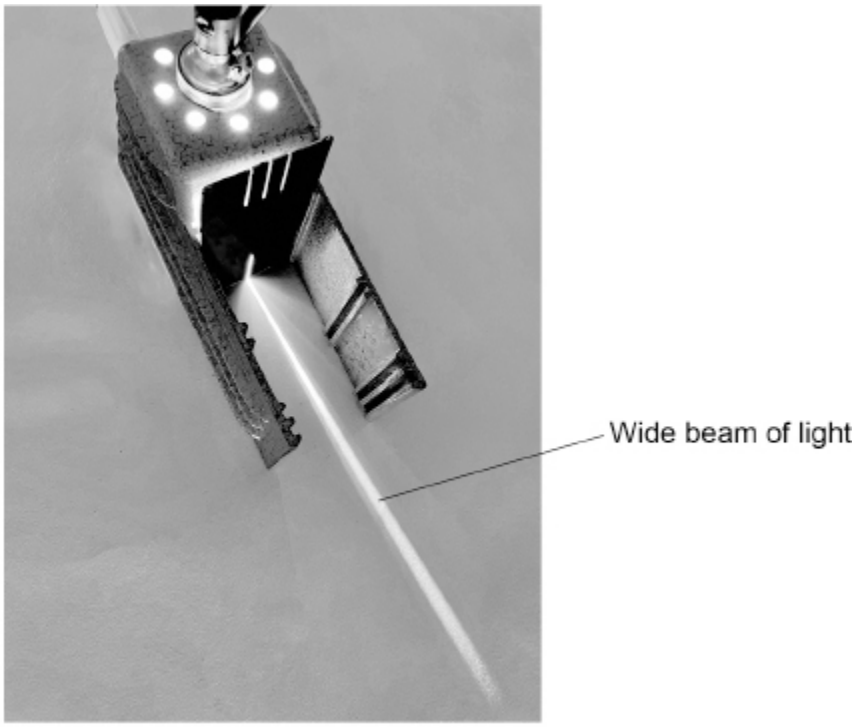
5. A student investigated the refraction of light through a glass block.

Figure 1 shows the ray box used.

The student aimed the beam of light from the ray box towards a glass block.

The student measured the angle of incidence at the point where the light entered the glass block.

Figure 1



(a) Why is using a wide beam of light less likely to give accurate results than using a narrow beam?

Tick (✓) **one** box.

It will be harder to judge where the centre of the beam is. ☐

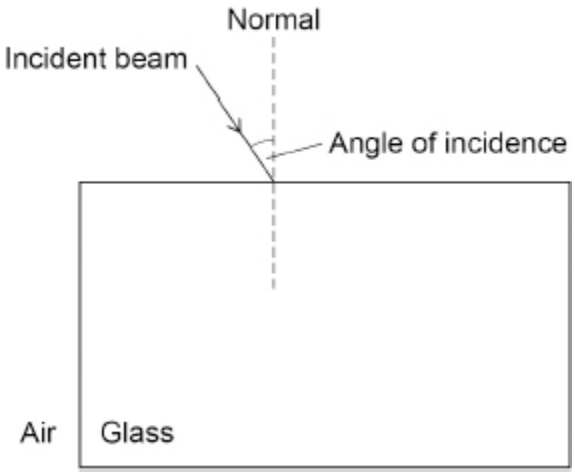
It will cause a smaller uncertainty in the measurements. ☐

The angle of refraction will be larger than it should be. ☐

(1)

(b) **Figure 2** shows the beam of light incident on the glass block.

Figure 2

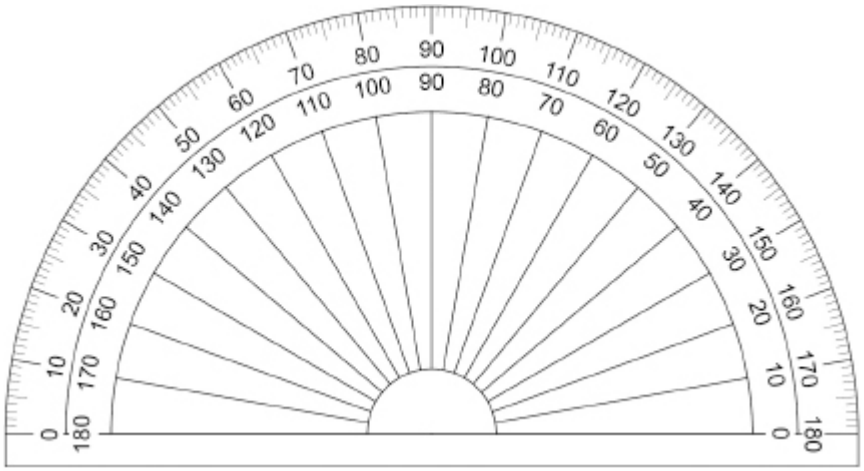


Complete **Figure 2** to show the path taken by the beam of light through the glass block and back into the air.

(3)

Figure 3 shows the protractor used by the student.

Figure 3



(c) What is the resolution of the protractor?

Tick (✓) **one** box.

1 degree ☐

10 degrees ☐

180 degrees ☐

(1)

(d) For one angle of incidence the student measured the angle of refraction three times.

The three measurements were:

35° 31° 33°

Calculate the mean angle of refraction.

_____

_____

Mean angle of refraction = _____ °

(1)

The student placed a red filter in front of the white beam of light.

Only red light passes through the filter.

(e) Complete the sentence.

When white light is incident on the red filter, all colours except for red are

_____ by the filter.

(1)

Use the Physics Equations Sheet to answer parts (f) and (g).

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

_____

(1)

(g) Light has a wave speed of 3.0×10^8 m/s in air.

The frequency of the red light is 4.0×10^{14} Hz.

Calculate the wavelength of the red light in air.

Wavelength = _____ m

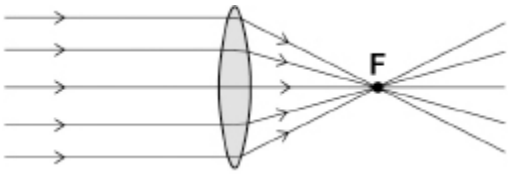
(3)

(Total 11 marks)

6. Lenses can be used to form an image of an object.

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

Figure 1



What is the position marked '**F** called?

Tick (✓) **one** box.

Focal length ☐

Focus point ☐

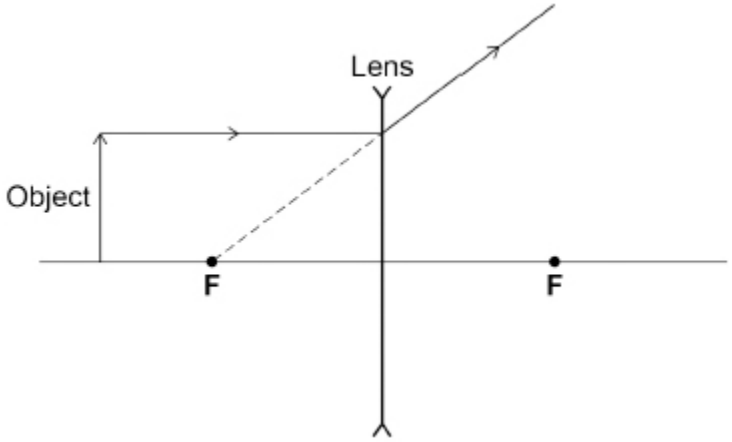
Principal focus ☐

(1)

(b) Complete the ray diagram in **Figure 2** to show how a **concave** lens forms the image of the object.

Use an arrow to represent the image.

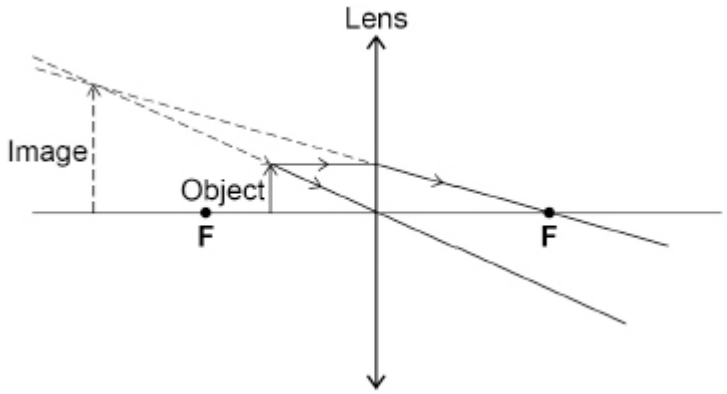
Figure 2



(2)

(c) **Figure 3** shows how a **convex** lens can be used to form a magnified image of an object.

Figure 3



Give **two** ways that the image formed by the convex lens in **Figure 3** is similar to the image formed by the concave lens.

1 _____

2 _____

(2)

(d) A convex lens is used as a magnifying glass to identify a symbol on the back of a silver spoon.

The symbol has an actual height of 1.6 mm.

The magnification produced by the lens is 3.5

Calculate the image height of the symbol when viewed through the magnifying glass.

Use the Physics Equations Sheet.

_____

_____

_____

_____

_____

Image height = _____ mm

(3)

(Total 8 marks)

7. Infrared waves are transverse waves.

(a) Complete the sentence.

In a transverse wave, the direction of oscillation is _____

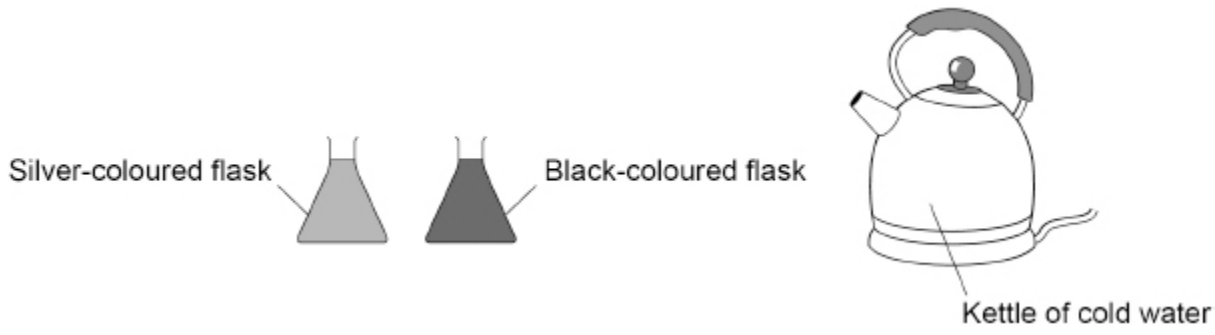
to the direction of energy transfer by the wave.

(1)

A student investigated how the colour of a surface affects the rate at which the surface emits infrared radiation.

Figure 1 shows some of the equipment used.

Figure 1



(b) The student wrote the following hypothesis:

‘The black-coloured flask will emit more infrared radiation than the silver-coloured flask during 10 minutes of cooling.’

Describe a method to test this hypothesis.

(6)

(c) When will the flasks emit infrared radiation at the greatest rate?

Give a reason for your answer.

Tick (✓) **one** box.

During the 1st minute ☐

During the 5th minute ☐

During the 9th minute ☐

Reason _____

(2)

Another student investigated the absorption of infrared radiation by different surface colours.

The student filled four hollow metal cubes with cold water.

Each cube was the same size but had a different surface colour.

The cubes were then placed the same distance from an infrared heater.

After 10 minutes, the student measured the temperature increase of the water inside each cube.

(d) What was the dependent variable in this investigation?

_____

_____

(1)

(e) The table below shows the results.

Surface colour of the cube	**Temperature increase after 10 minutes in °C**
Matt white	3.0
Shiny white	2.0
Matt black	6.5
Shiny black	4.0

Give **two** conclusions that can be made from the results in the table above.

1 _____

_____

2 _____

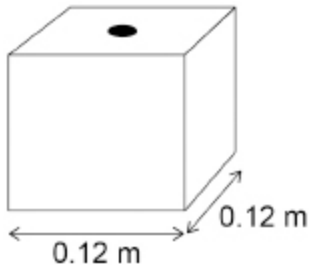
_____

(2)

Figure 2 shows one of the cubes. The cube is filled with water.

The weight of the water exerts a pressure on the bottom of the cube.

Figure 2



Use the Physics Equations Sheet to answer parts (f) and (g).

(f) Which equation correctly links area, force and pressure?

Tick (✓) **one** box.

pressure = force × area^2 ☐

pressure = force × area ☐

$\text{pressure} = \frac{\text{force}}{\text{area}}$ ☐

$\text{pressure} = \frac{\text{area}}{\text{force}}$ ☐

(1)

(g) The water pressure at the bottom of the cube is 1500 Pa.

Calculate the force of the water on the bottom of the cube.

Force = _____ N

(4)

(Total 17 marks)

1.

(a) the height of the (column of) water above the submarine increases

allow volume / mass for height

1

which increases the force / weight (of the water) acting on the submarine so pressure increases

allow p = ρgh and ρ and g remain constant so pressure increases

1

(b) p = 110 000 000 Pa

1

110 000 000 = 1026 × 9.8 × Δh

allow a correct substitution of an incorrectly / not converted value for p

1

$$\Delta h = \frac{110\,000\,000}{1026 \times 9.8}$$

allow a correct re-arrangement using an incorrectly / not converted value for p

1

Δh = 10 940 (m)

allow a correct calculation from using an incorrectly / not converted value for p

allow 11 000 (m) if correct working shown

1

(c) P-waves are longitudinal and S-waves are transverse

1

(d) D

1

only P-waves can travel through liquids

allow only P-waves can travel through the outer core

allow S waves cannot travel through liquids

allow S waves cannot travel through the outer core

MP2 dependent on MP1

1

(e) $4500 = 3.6 \times \lambda$

allow a correct substitution of an incorrectly / not converted value for v

1

$$\lambda = \frac{4500}{3.6}$$

allow a correct re-arrangement using an incorrectly / not converted value for v

1

$\lambda = 1250$ (m)

allow 1300 (m)

only allow an answer consistent with a correctly converted value for v

1

(f) the distance is (directly) proportional to the time between the two waves arriving (at the seismometer)

allow they are (directly) proportional

*allow a greater distance means a greater time for **1** mark*

*allow there is a positive correlation for **1** mark*

2

[14]

2. (a) any **three** from:

- they travel at the same speed (in a vacuum / air)

  allow they travel at the speed of light
- they can travel through a vacuum

  allow they do not need a medium (to travel)
- they are transverse (waves)
- they are electromagnetic (waves)

  ignore they can be reflected / refracted / absorbed / transmitted / diffracted.

3

(b) any **one** from:

- (medical) imaging

  allow correctly named method eg PET scan, tracer, gamma camera

  do not accept ultrasound, CT scan, X-rays, MRI scan
- (medical) treatments

  allow correctly named treatment eg radiotherapy, brachytherapy, gamma knife

  do not accept chemotherapy

  allow sterilising medical equipment

1

(c) gamma rays are (weakly) ionising but radio waves are <u>not</u> (ionising)

1

(so gamma rays) can cause mutations in genes / DNA
or
(so gamma rays) can increase the risk of cancers

allow can cause cancer

allow damages / kills cells

1

(d) (radio waves are produced by) oscillations in electrical circuits (of the scanner)

allow (radio waves are produced by) alternating current

allow (radio waves are produced by) oscillating electrons (in an aerial)

1

the radio waves have the same frequency as the oscillations

MP2 dependent on MP1

1

[8]

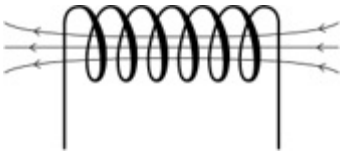
3. (a) direction (of the magnetic field)

1

(b) increase the current in the wire

1

(c)



1

(d) **D A B C**

*allow **1** mark for D B A C*

2

(e) decrease the distance between the electromagnet and the iron arm

1

(f) $\text{period} = \frac{1}{6.25}$

1

period = 0.16 (s)

1

(g) **B**

1

[9]

4. (a) wavelength = Q

1

(b) $\text{amplitude} = \frac{R}{2}$

1

(c) radio waves

1

(d) s = 300 000 000 × 0.000009

1

s = 2700 (m)

1

(e) satellite communications
or
cooking /heating food
allow WiFi

1

[6]

5. (a) it is harder to judge where the centre of the beam is

1

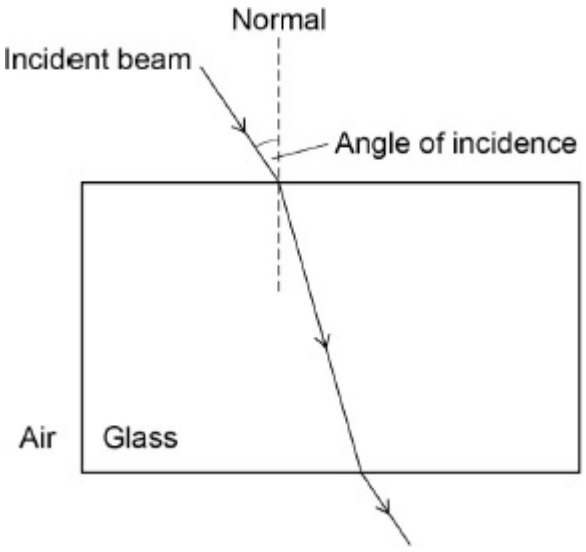
(b) ray shown refracted to the right of the normal as it enters the glass block

1

refraction towards the normal

1

emergent ray parallel to incident ray
*do **not** accept a continuation of the incident ray through the glass block*
ignore arrows



1

(c) 1 degree

1

(d) 33 (°)

1

(e) absorbed

1

(f) wave speed = frequency × wavelength

allow correct re-arrangement

or

$v = f \lambda$

1

(g) $3.0 \times 10^8 = 4.0 \times 10^{14} \times \lambda$

1

$$\lambda = \frac{3.0 \times 10^8}{4.0 \times 10^{14}}$$

1

$\lambda = 7.5 \times 10^{-7}$ (m)

allow 0.000 000 75 (m)

1

[11]

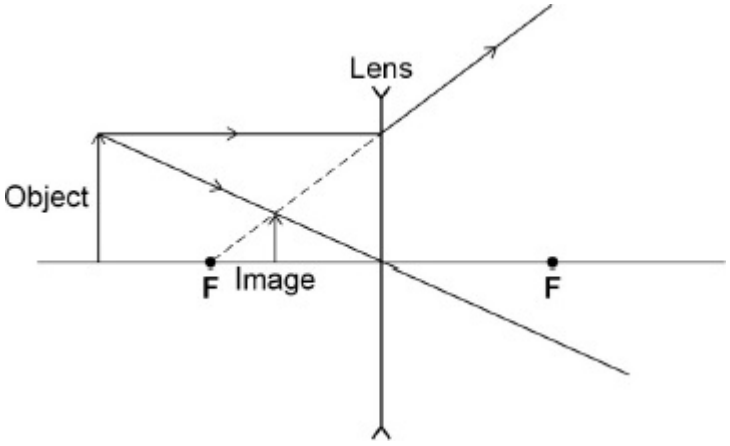
6. (a) principal focus

1

(b) ray through the centre of the lens

1

image in correct position and with correct orientation



1

(c) upright

allow right way up

1

virtual

ignore not real

1

ignore it is on the same side of the lens

(d) $3.5 = \frac{\text{image height}}{1.6}$

1

image height = 3.5 × 1.6

1

image height = 5.6 (mm)

1

[8]

7. (a) perpendicular

1

(b) **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

5-6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully 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

Method:

- heat the water / kettle
- add an equal volume of (hot) water to each flask
- insert a thermometer into each flask
- record the initial temperature from both flasks
  OR
- place an IR detector near each flask
- the distance between the IR detector and the flask should be the same each time
- record initial reading from IR detectors

- (and) start a stop clock
- record the temperatures / readings after 10 minutes from both flasks
- calculate the change in temperatures / readings during the 10 minutes

- compare the results to test the hypothesis

to access level 3 the method must allow the correct consideration of a temperature decrease for both flasks or the correct comparison of IR detected from both flasks

(c) during the 1st minute

1

there is the greatest temperature difference (between the hot water and the surroundings)

allow highest temperature or hottest

1

MP 2 dependent on scoring MP1

(d) the temperature (increase / change after 10 minutes)

allow the final temperature

do not allow temperature decrease

1

(e) black surfaces absorb more (infrared than white surfaces)

allow black surfaces have a greater temperature increase (than white surfaces)

1

matt surfaces absorb more (infrared) than shiny surfaces of the same colour

allow matt surfaces have a greater temperature increase than shiny surfaces of the same colour

if no other marks scored, allow 1 mark for matt black surface is the best absorber and shiny white surface is the worst absorber

if no other marks scored, allow 1 mark for matt black has the greatest temperature increase and shiny white has the smallest temperature increase

1

(f) $\text{pressure} = \frac{\text{force}}{\text{area}}$

1

(g) area of base = 0.0144 (m^2)

do not allow this or subsequent marks unless base area is used

1

$$1500 = \frac{F}{0.0144}$$

this mark may be awarded if base area is incorrectly calculated

1

$F = 1500 \times 0.0144$

this mark may be awarded if base area is incorrectly calculated

1

$F = 21.6$ (N)

this mark may be awarded if base area is incorrectly calculated

allow 22 (N)

1

[17]