**Centre Number**

**Candidate Number**

**General Certificate of Secondary Education**
**2023**

# Physics

Unit 2

Higher Tier

**[GPY22]**

*GPY22*

**FRIDAY 16 JUNE, MORNING**

**TIME**

1 hour 30 minutes.

**INSTRUCTIONS TO CANDIDATES**

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
**You must answer the questions in the spaces provided.**
**Do not write outside the boxed area on each page or on blank pages.**
Complete in black ink only. **Do not write with a gel pen.**
Answer **all five** questions.

**INFORMATION FOR CANDIDATES**

The total mark for this paper is 100.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in question **4(a)**.

13459

*28GPY2201*

**1** **(a)** A transverse wave created on a string is represented by the two graphs shown below.
Use the graphs to answer the following questions.
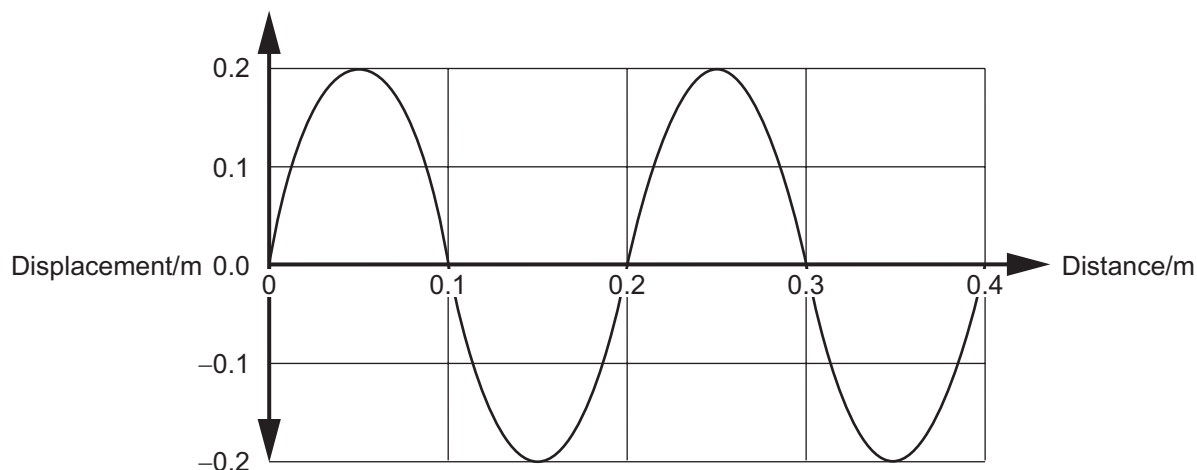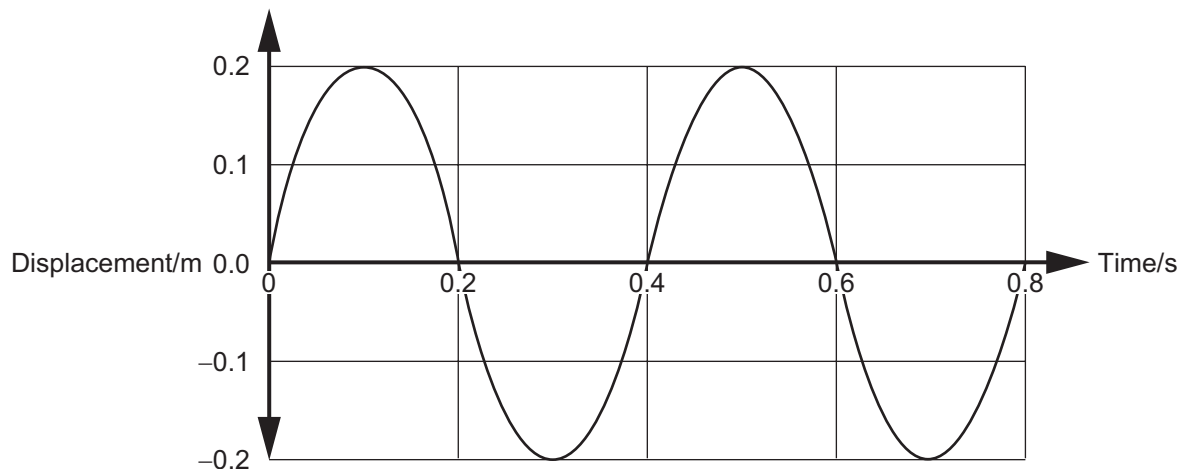


**(i)** What is the wavelength of the wave shown? _____ m  [1]

**(ii)** Calculate the frequency of the wave.
Include the unit for frequency with your answer.
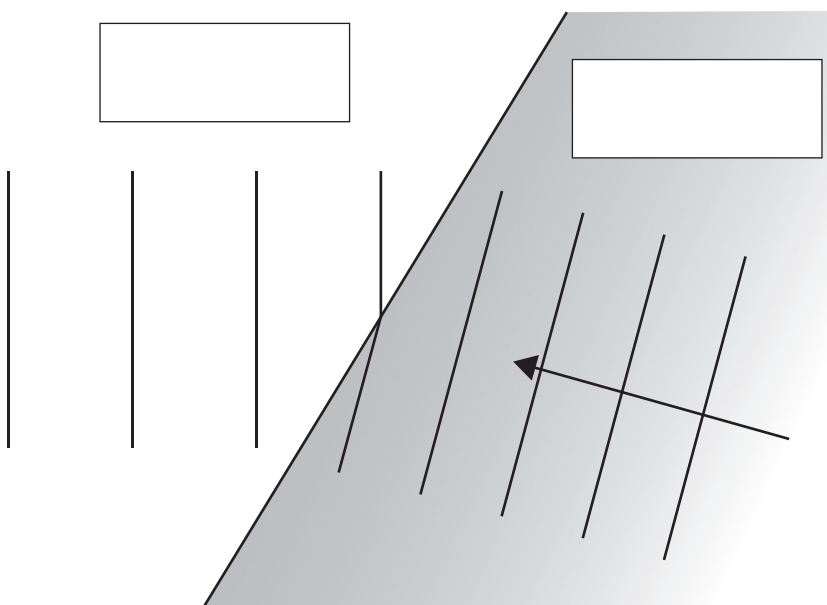**Show clearly how you get your answer.**

Frequency = _____

Unit = _____  [3]

13459

**(iii)** Using your values from **(i)** and **(ii)**, calculate the velocity of the wave.
**Show clearly how you get your answer, starting with the equation you plan to use.**

Velocity = _____ m/s  [3]

**(b)** The diagram shows a water wave travelling in deep water and in shallow water.



**(i)** Label the deep water and the shallow water. Write the names in the boxes.

[1]
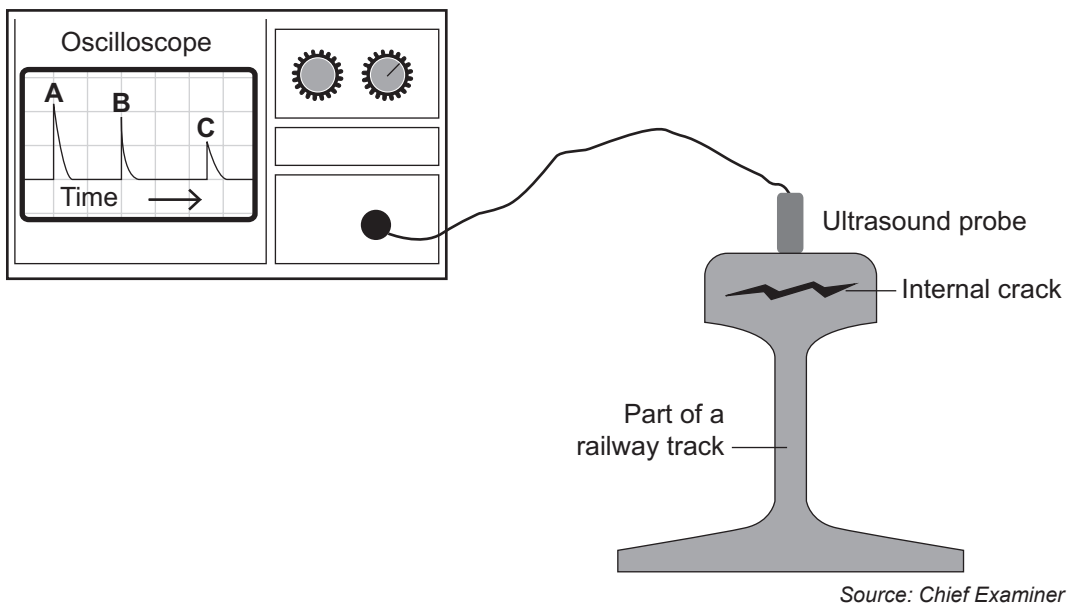
**(ii)** Explain how you arrived at your answer.

_____

_____  [1]

**[Turn over**

**(c) (i)** What is ultrasound?

_____

_____ [1]


Ultrasound can be used to detect a crack in large pieces of metal such as part of a railway track as shown below. The ultrasound is reflected from the various parts of the rail.
These reflections show up on the oscilloscope as pulses **A**, **B** and **C**.
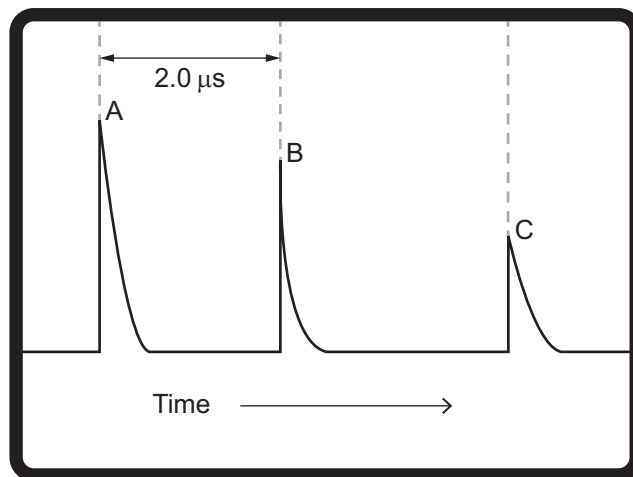


Source: Chief Examiner

**(ii)** State the cause of the reflections **A**, **B** and **C**.

_____

_____

_____ [1]

**(iii)** The speed of ultrasound in steel is 5900 m/s.
Using the information shown in the diagram below, calculate the distance between the top of the railway track and the crack.
**Show clearly how you get your answer, starting with the equation you plan to use.**



*Source: Chief Examiner*

$1\,\mu s = 1 \text{ microsecond} = 1.0 \times 10^{-6}\,s$

Distance = _____ m  [4]

**(d)** Complete the diagram below by writing the various regions of the electromagnetic spectrum in the appropriate boxes. Place them in order of increasing wavelength.

| | | | Visible | | | |
|---|---|---|---|---|---|---|

Increasing wavelength ➡

[3]

**(e)** Electromagnetic waves travel at the speed of light.
Name **two** properties that make electromagnetic waves different from sound waves.

1. _____

_____

2. _____

_____ [2]

**BLANK PAGE**
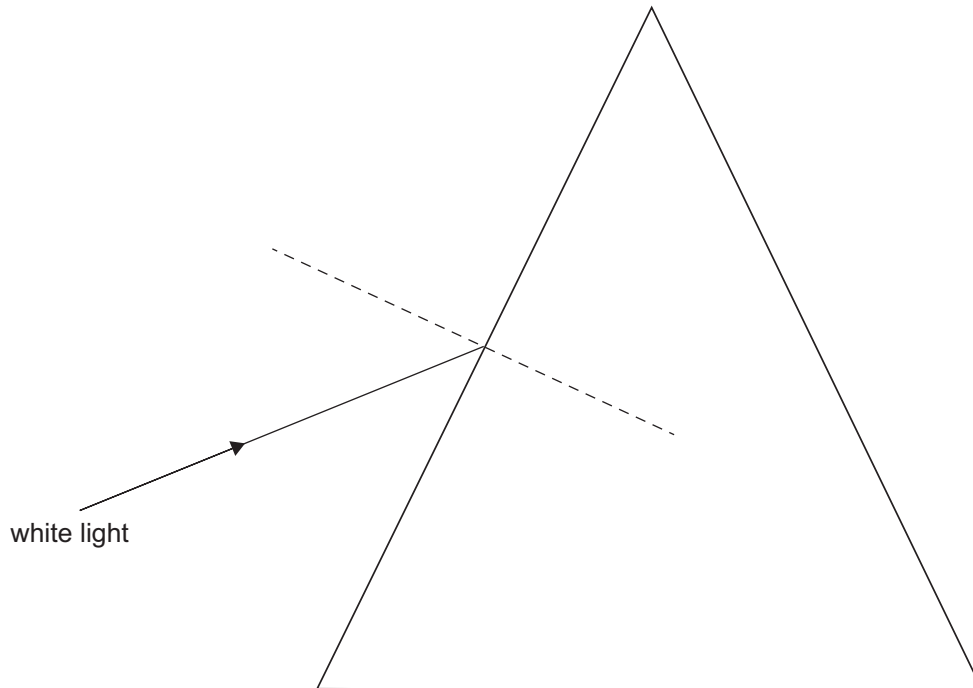
**DO NOT WRITE ON THIS PAGE**

**(Questions continue overleaf)**

**2** **(a)** When white light passes through a glass prism it is split into its component colours. This is known as dispersion.

**(i)** Complete the diagram below to show the paths taken by the red light and violet light through and out of the prism. Label each colour. [4]

white light

**(ii)** Explain fully why different colours are refracted by different amounts when they enter the glass prism.
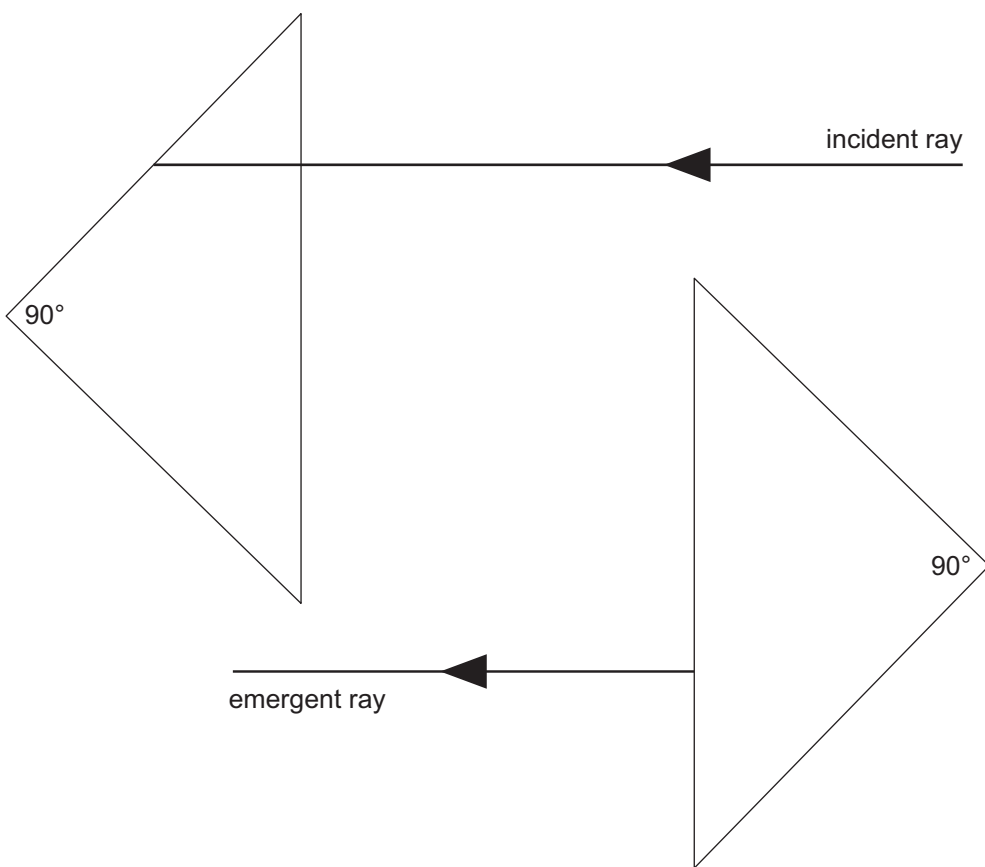
_____

_____ [2]

13459

*28GPY2208*

**(b) (i)** What **two** conditions are needed before total internal reflection happens?

1. _____

_____

2. _____

_____ [2]

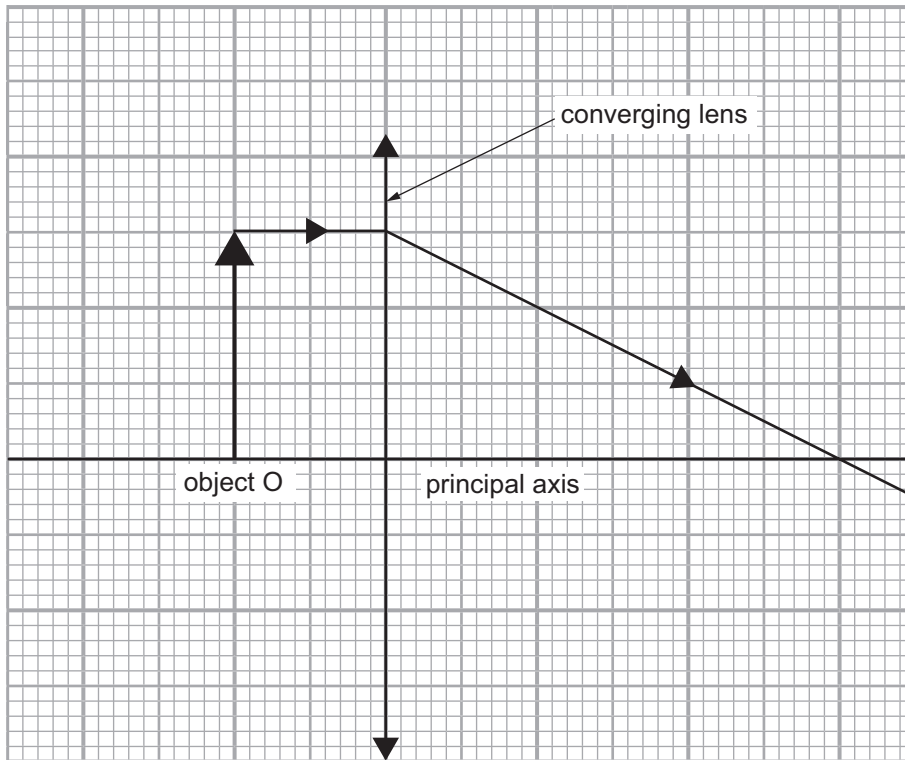**(ii)** On the diagram below, draw **carefully** the path of the incident ray of light through the two right angled glass prisms until it emerges.

incident ray

90°

90°

emergent ray

[2]

**(c)** The ray diagram for a converging lens shown below is incomplete.



**(i)** On the diagram mark with a letter **F** the focal point (principal focus) of the lens. [1]

**(ii)** Draw another ray and use it and the ray shown to locate the image.
Place an arrow on this ray.
Draw the image and label it **I**. [4]

**(iii)** List **two** of the properties of this image.

_____

_____

_____ [2]

**(d)** To measure the focal length of a converging lens, a student placed the lens in front of a screen and used it to obtain the image of a distant tree on the screen.
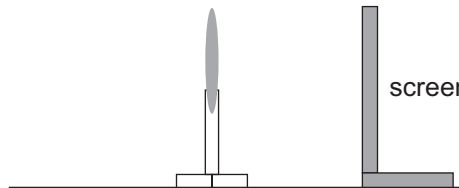
distant tree                     converging lens

screen

**(i)** How will the student know when the lens is in the correct position to allow the focal length to be measured?

_____

_____ [1]

**(ii)** What distance should be measured to obtain the focal length?

_____

_____ [1]

**(iii)** What should the student do to obtain a reliable value for the focal length?
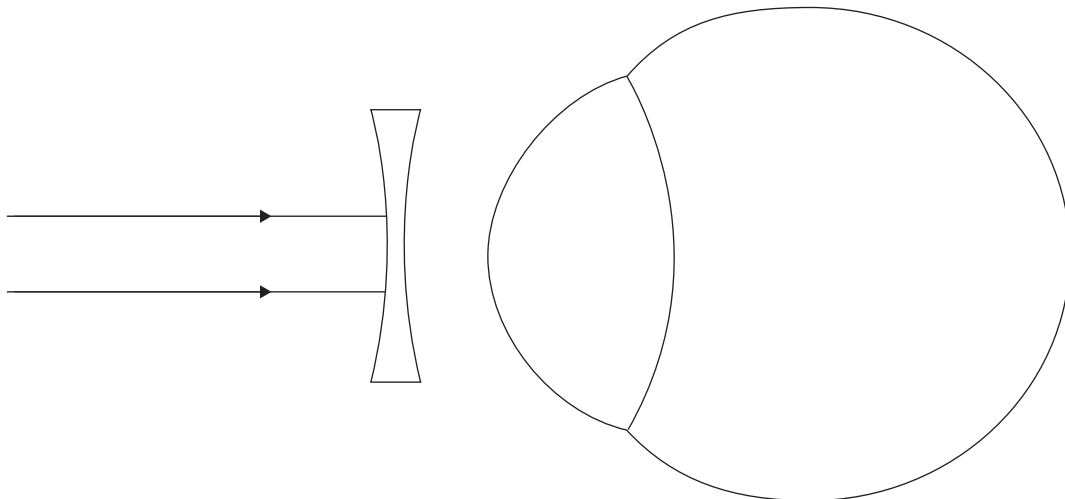
_____

_____ [2]

**[Turn over**

**(e)** A person who is short-sighted is unable to see distant objects sharply.

**(i)** This problem is corrected by using a lens as shown in the diagram below.

Name the type of lens used. _____ [1]

**(ii)** Complete the diagram below to show how two parallel rays of light from a distant object pass through the diverging lens, the person's eye and reach the retina.

[3]

**BLANK PAGE**
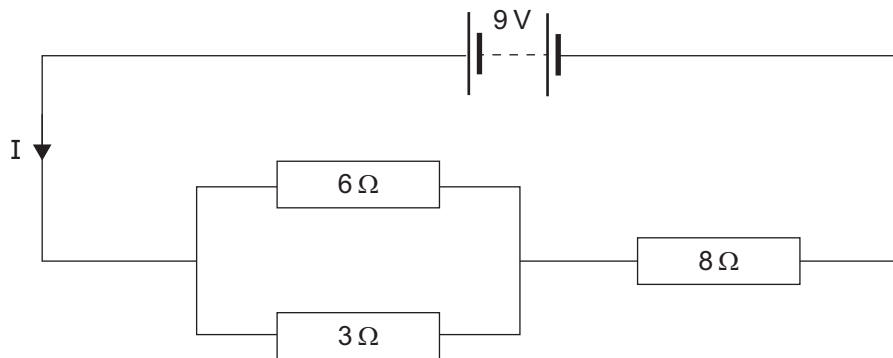
**DO NOT WRITE ON THIS PAGE**

**(Questions continue overleaf)**

**3** **(a) (i)** Calculate the total resistance of the circuit shown below.
   **Show clearly how you get your answer.**



Resistance = _____ Ω [3]

**(ii)** Calculate the current marked **I**.
   **Show clearly how you get your answer, starting with the equation you plan to use.**

Current = _____ A [3]

**(iii)** Calculate the voltage across the 8 Ω resistor.
   **Show clearly how you get your answer.**

Voltage = _____ V [2]

**(iv)** Calculate the current through 6 Ω resistor.
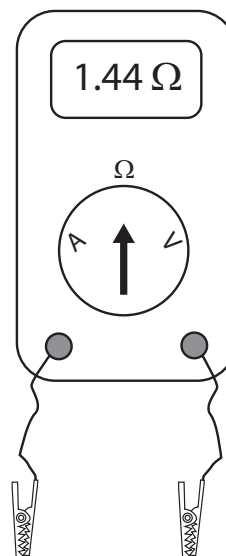   **Show clearly how you get your answer.**

Current = _____ A [2]

**(b)** To investigate how the resistance of a metal wire depends on its area of cross-section, a meter was used to measure the resistance of 10 cm lengths of wire of different cross-sectional areas.

The results are shown in the table.

| Area of cross-section/mm$^2$ | Resistance/$\Omega$ |
|---|---|
| 1.0 | 1.60 |
| 2.0 | 0.85 |
| 3.0 | 0.55 |
| 4.0 | 0.40 |
| 5.0 | 1.35 |

1.44 $\Omega$

$\Omega$

**(i)** One measurement is clearly anomalous.
Circle the anomalous measurement. [1]

**(ii)** Why is it important to use wires of the same length during this investigation?

_____

_____ [1]

**(iii)** The relationship between resistance R and the area of cross-section A is shown below. In this equation **k** is a constant.

$$R = \frac{k}{A}$$

Explain how the results support this relationship.

_____
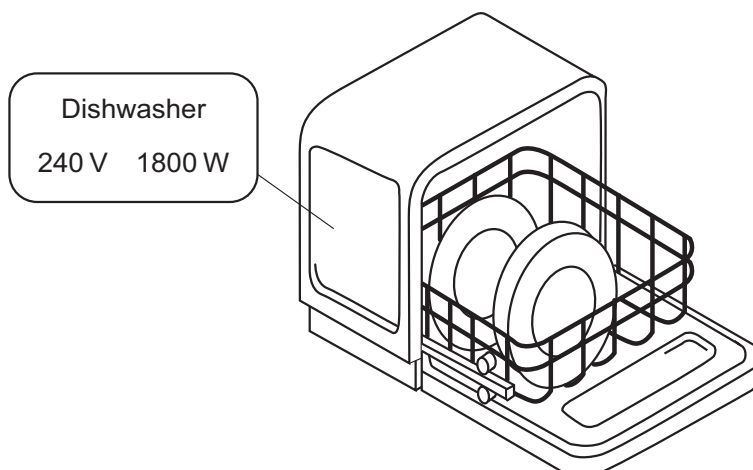
_____ [1]

**[Turn over**

13459

**(iv)** Using values from the table, find the value of the constant **k**.
Include the unit for k with your answer.
**Show clearly how you get your answer.**

**k** = _____

Units of k = _____ [4]

**(c)** A household dishwasher has the following information on a label attached to it.

Dishwasher

240 V    1800 W

**(i)** Choose a suitable fuse rating for the plug attached to it.
The range of fuses available is, 2A, 3A, 5A and 13A.
**Show clearly how you get your answer, starting with the equation you plan to use.**

Suitable fuse rating = _____ A  [4]

**(ii)** A unit of electricity costs 19p.
Calculate the cost of using the dishwasher for 120 minutes.
**Show clearly how you get your answer, starting with the equation you plan to use.**

Cost = _____ p  [3]

**[Turn over**

13459

*28GPY2217*

**4 (a)** Two coils of wire are wrapped around a soft iron core.
One coil is connected to a cell and a switch.
The other coil is connected to a centre-zero ammeter.

**soft iron core**

**coil 1**          **coil 2**

0

centre-zero ammeter
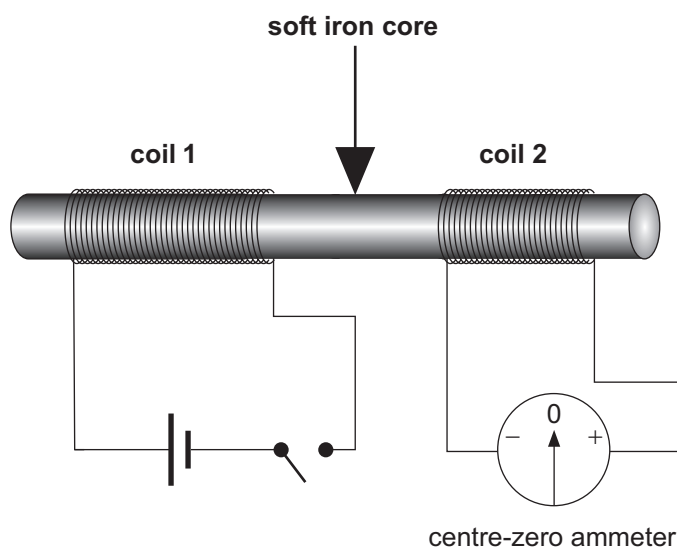
*Source: Principal Examiner*

Describe how this apparatus is used to investigate electromagnetic induction.

In your description you should state:

- what is meant by electromagnetic induction, in the context of this experiment

- the purpose of the soft iron core

- what is observed on the centre-zero ammeter when the switch is closed and left closed

- what is observed on the centre-zero ammeter when the switch is reopened

- what device used in the transmission of electricity is based on the apparatus shown above.

**In this question, you will be assessed on your written communication skills including the use of specialist scientific terms.**

**Write your answers in the appropriate space on the page opposite.**

What is electromagnetic induction?

_____

_____

_____

Purpose of the soft iron core

_____

_____

_____

What is observed when the switch is closed and left closed?

_____

_____

_____

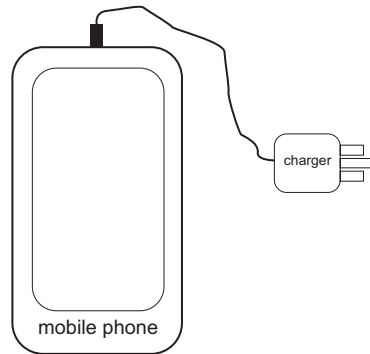What is observed when the switch is re-opened?

_____

_____

_____

Device used in electricity transmission

_____ [6]

**(b)** The diagram below shows a mobile phone connected to its charger.
The charger converts the mains voltage of 230 V a.c. to 5 V a.c.



**(i)** The charger consists of two coils.
The primary coil has 2300 turns of copper wire.
Calculate the number of turns on the secondary coil.
**Show clearly how you get your answer, starting with the equation you plan to use.**

Number of turns = _____ [3]

Another component in the charger converts 5.0 V a.c. to 5.0 V d.c. which is used to charge the battery of the mobile phone.

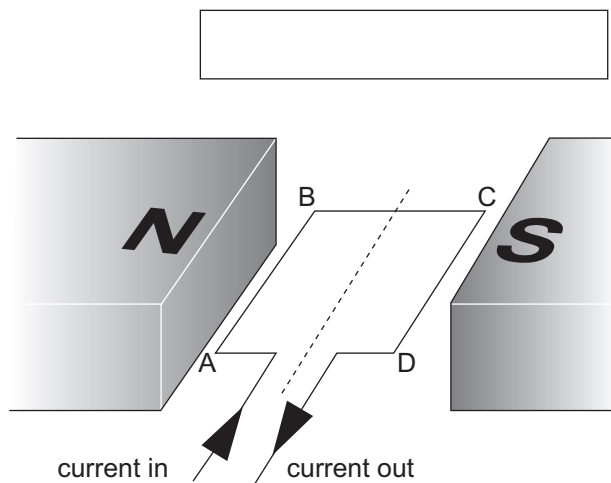**(ii)** Describe how a.c. is different from d.c.

a.c. _____

_____

d.c. _____

_____ [2]

13459

**(c)** A coil of wire labelled A B C D is placed between the poles of a magnet as shown below.

current in    current out

*Source: Principal Examiner*

**(i)** Mark in the box the direction of the magnetic field between the two poles. [1]

**(ii)** An electric current is passed through the coil of wire in the direction shown.
**Circle in the table** the directions of the force on the sides AB and CD of the coil.

| Side A B | No force | Vertically upwards | Vertically downwards | Horizontally to the right | Horizontally to the left |
|---|---|---|---|---|---|
| Side C D | No force | Vertically upwards | Vertically downwards | Horizontally to the right | Horizontally to the left |

[2]

**(iii)** What effect do these forces have on the coil of wire?

_____ [1]

**[Turn over**

**5** **(a)** **(i)** What is meant by a light year?

_____

_____

_____ [2]

At one point in its orbit, Earth is at a distance of 4320 million kilometres from Neptune. A radio signal transmitted from a probe at Neptune is directed towards the Earth.

**(ii)** If radio waves travel in space at a speed of $3 \times 10^8$ m/s, how long after transmission will the signal be detected on Earth?
Give your answer in hours.
**Show clearly how you get your answer, starting with the equation you plan to use.**

Time = _____ hours  [5]

13459

**(b) (i)** What is a galaxy?

_____

_____ [1]

**(ii)** What observation allows astronomers to state that space is expanding?

_____

_____

_____ [1]

**[Turn over**

**(c)** An astronomer called Edwin Hubble discovered that the speed of many galaxies was directly proportional to their distance from Earth.
This is known as Hubble's Law.

The data below gives information about five galaxies.

| Galaxy | Distance/ Billions of light years | Speed/Megametres/second (Mm/s) |
|---|---|---|
| Ursa Major | 1.0 | 15 |
| Corona Borealis | 1.4 | 21 |
| Bootes | 2.6 | 39 |
| Unnamed galaxy | 3.0 | 45 |
| Hydra | 4.0 | 60 |

**(i)** Use the data to plot on the grid opposite a graph of speed (y-axis) against distance (x-axis).
Use ⦿ or ✗ to clearly show your plotted points.
Draw the best fit straight line through your points. [3]

Hubble's Law can be written as

$$v = H_0\, d$$

where **v** is the speed of the galaxy, **d** is its distance from Earth and $H_0$ is the Hubble constant.
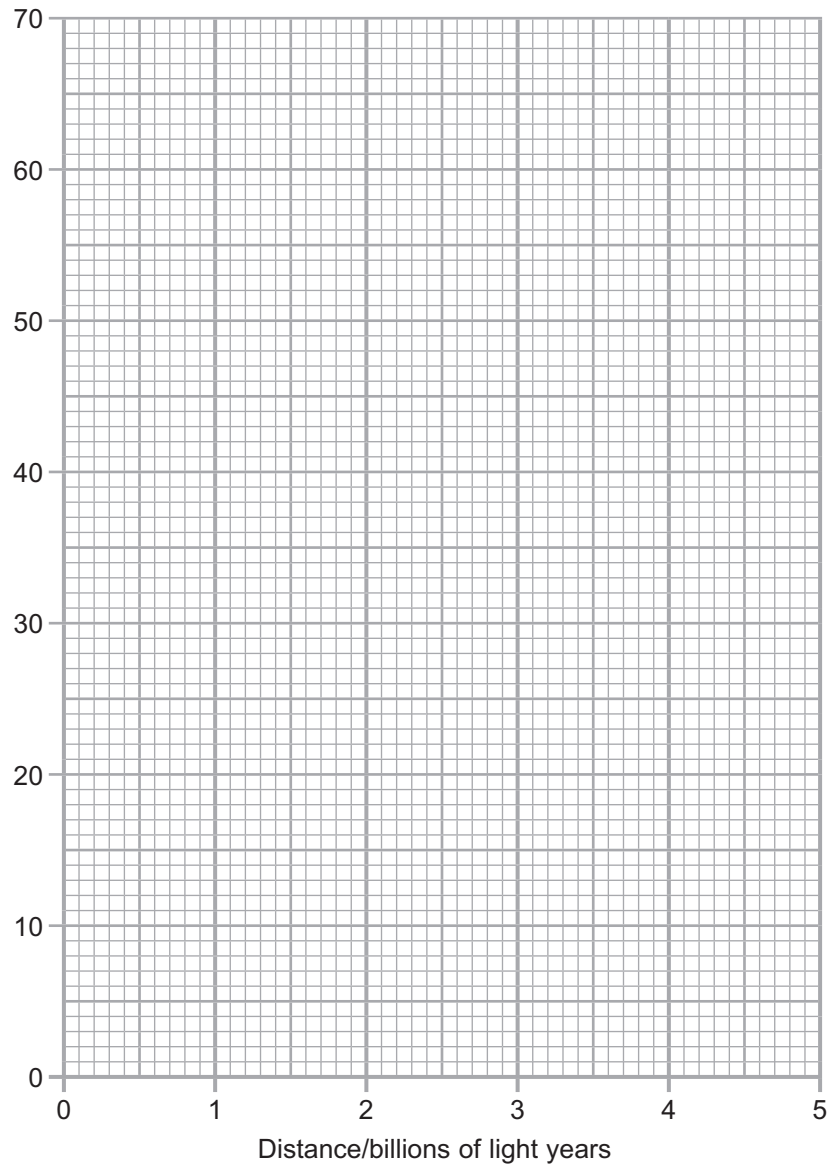
**(ii)** Use your graph to determine the Hubble constant.
**Show clearly how you get your answer.**

$H_0$ = _____ [2]

13459

Speed/Mm/s

Distance/billions of light years
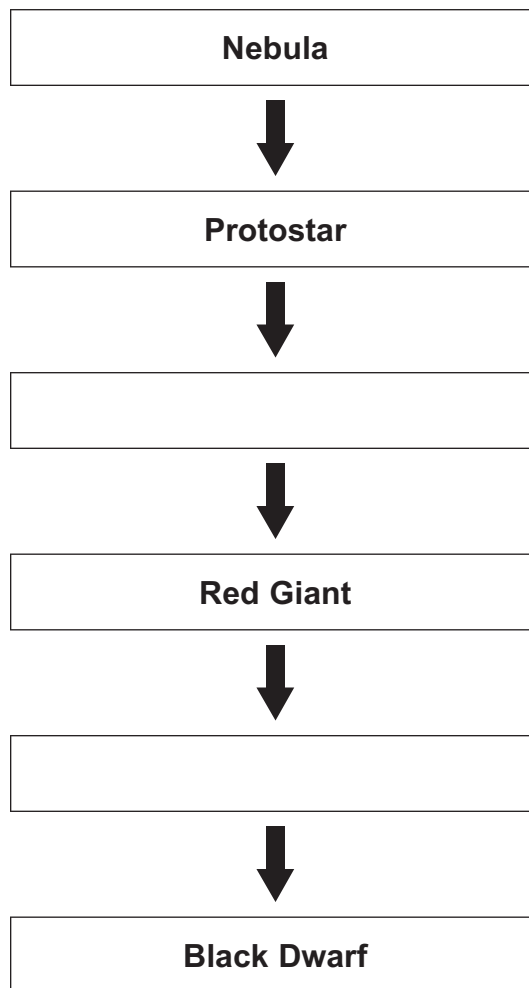
13459

**(d)** The life cycle of a star the same mass as our Sun is shown below.
However two stages are missing from the diagram.
Write the names of the missing stages in the empty boxes.

| Nebula |
|:---:|

⬇

| Protostar |
|:---:|

⬇

|  |
|:---:|

⬇

| Red Giant |
|:---:|

⬇

|  |
|:---:|

⬇

| Black Dwarf |
|:---:|

[2]

_____

## THIS IS THE END OF THE QUESTION PAPER

_____

**BLANK PAGE**

**DO NOT WRITE ON THIS PAGE**

**DO NOT WRITE ON THIS PAGE**