General Certificate of Secondary Education
2022

Physics

Unit 2

Higher Tier

[GPY22]   *GPY22*
THURSDAY 23 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** 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 **2(a)**.

12980.06**R**

BLANK PAGE

DO NOT WRITE ON THIS PAGE

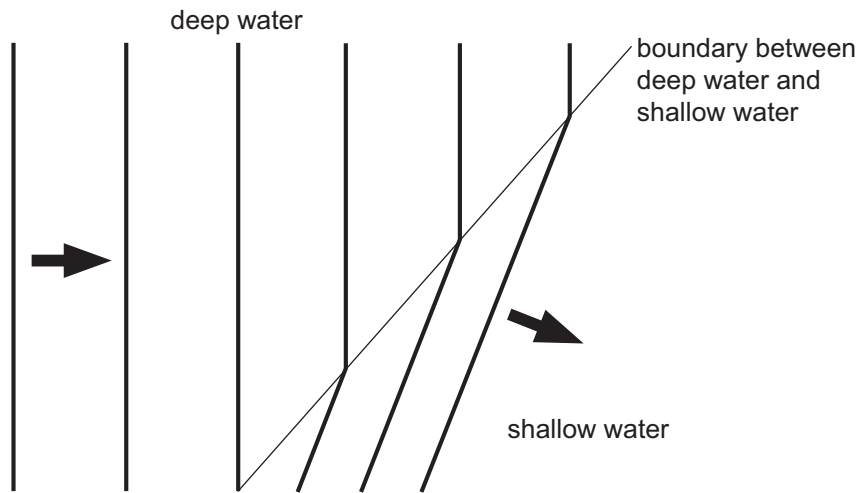**1 (a)** The diagram below shows water waves moving from deep water into shallow water. The boundary between the deep water and the shallow water is shown. Tick (✓) the appropriate boxes in the table below to show what happens to the wavelength, frequency and speed of the water waves as they pass from deep water to shallow water.
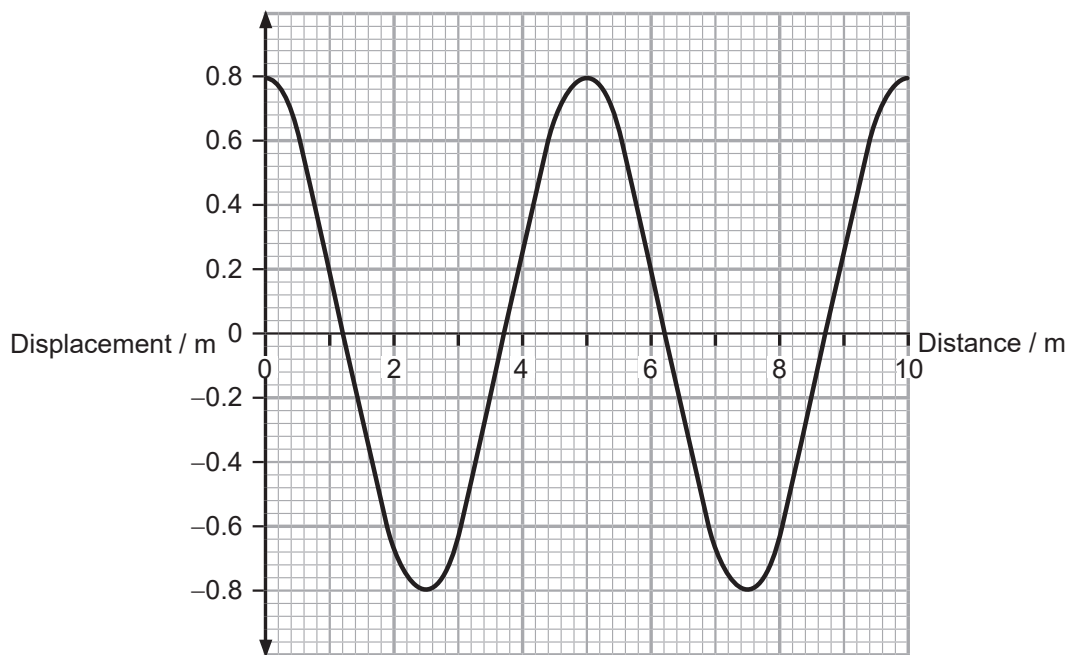

Source: Chief Examiner

	Decreases	Remains the same	Increases
Wavelength			
Frequency			
Speed			

[3]

[Turn over

(b) The **displacement–distance** graph of a water wave is shown below.
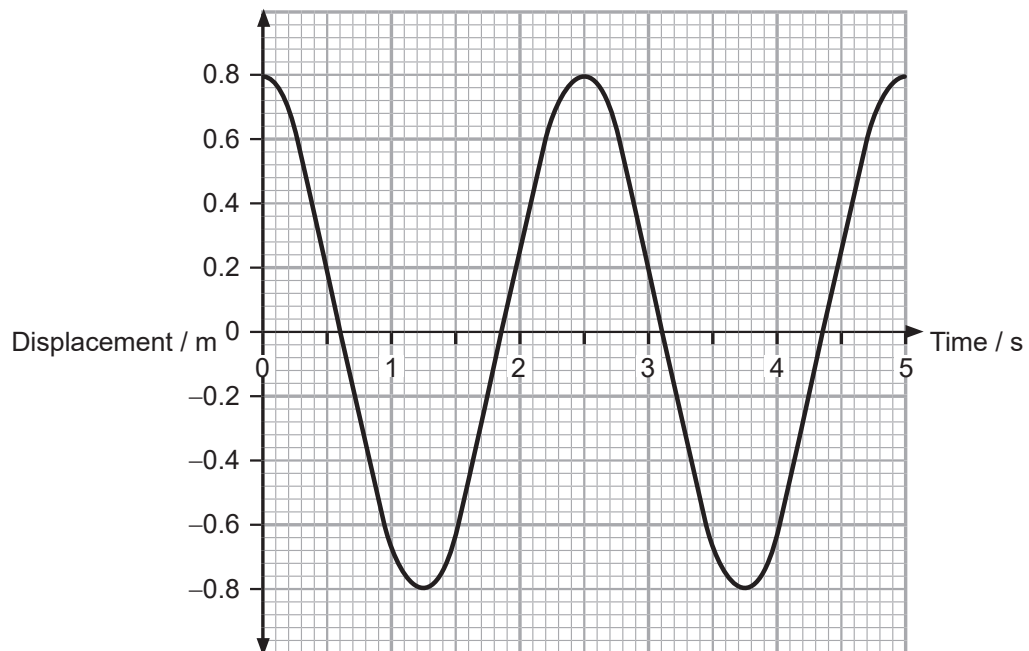

Source: Chief Examiner

(i) State the amplitude and wavelength of this wave.

Amplitude = _____ m   Wavelength = _____ m [2]

The **displacement–time** graph for this water wave is shown below.

Source: Chief Examiner

12980.06**R**

(ii) Using the information given in the displacement–time graph calculate the frequency of the wave.
Include the unit with your answer.
Show clearly how you get your answer.

Frequency = _____ [3]

Unit = _____ [1]

(iii) Using your answers to parts **(i)** and **(ii)**, calculate the speed of these waves.
Show clearly how you get your answer, starting with the equation you plan to use.
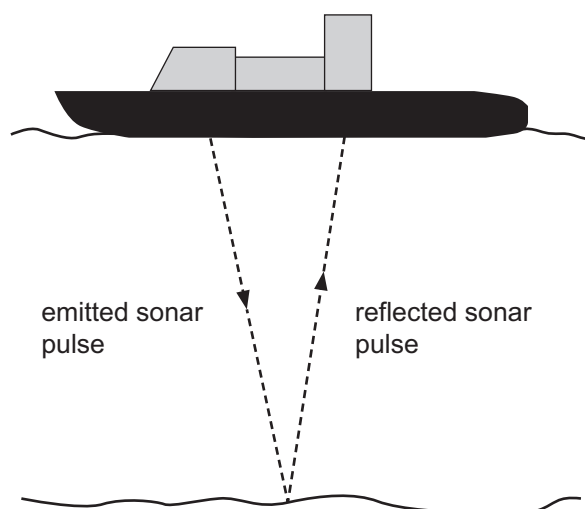
Speed = _____ m/s [3]

[Turn over

(c) The depth of the sea can be measured using sonar as shown in the diagram below. The ship sent out a sonar pulse which was reflected from the sea floor. The sea floor was found to be 3840 m below the surface.
The speed of sonar waves in sea-water is 1500 m/s.

emitted sonar
pulse

reflected sonar
pulse

Source: Chief Examiner

(i) Calculate the time that passed between the emission of the sonar pulse and detection of the echo by the ship on the surface.
Show clearly how you get your answer, starting with the equation you plan to use.

Time = _____ s [4]

12980.06**R**

(ii) Sonar is widely used to detect stationary objects under water such as shipwrecks and moving objects such as submarines.
Radar is always used to detect aircraft in flight.
What is the main reason why sonar cannot be used to detect aircraft in flight?

_____

_____

_____ [1]

(d) (i) Four electromagnetic waves are listed below.

microwaves   X-rays   ultraviolet light   radio waves

Typical wavelengths for these waves are shown below.
Beside each wavelength write the appropriate electromagnetic wave.

Wavelength/m	Electromagnetic wave
1×10^{-9} m	
1×10^{-7} m	
3×10^{-2} m	
300 m	

[4]

(ii) Name a property unique to electromagnetic waves.

_____ [1]

[Turn over

2 **(a)** White light is composed of a mixture of colours. This can be demonstrated in the laboratory.
Describe how this may be done.

In your answer you should respond to the following points:

- what equipment is required;
- name the process that causes the colours to appear;
- what the spread of colours is called;
- list the colours as they appear, starting with the longest wavelength;
- why the colours appear in the order they do.

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

Equipment _____

_____

_____

_____

Name the process _____

Spread of colours _____

List of colours in order _____

_____

Why the colours appear in the order they do _____

_____

_____

_____

_____ [6]

BLANK PAGE

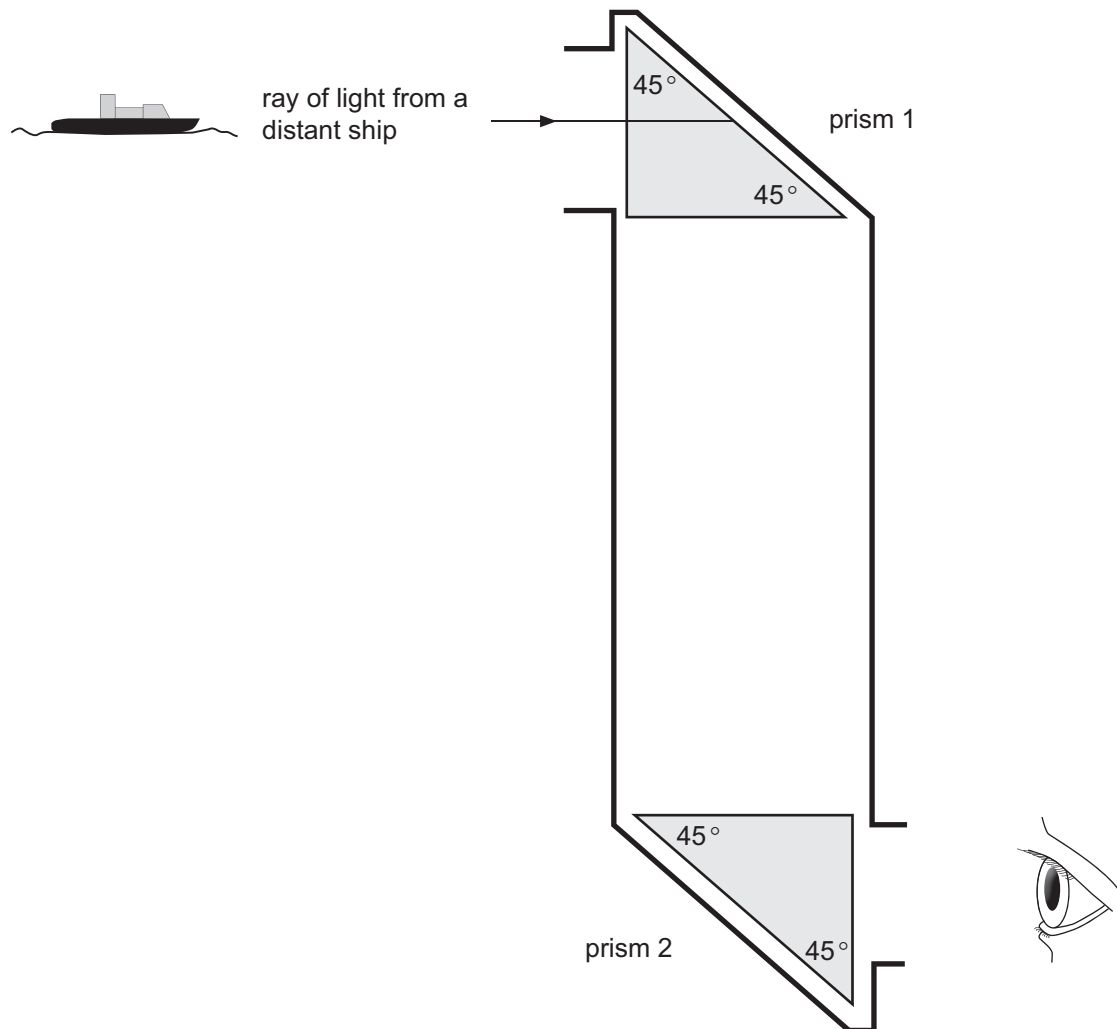**DO NOT WRITE ON THIS PAGE**

(Questions continue overleaf)

12980.06**R**

32GPY2209

(b) Optical instruments known as periscopes are used in submarines.
They allow the crew to look above the water.
High quality periscopes use glass prisms as shown in the diagram below.
The critical angle for the glass used to make the prism is 42°.

Source: Chief Examiner

32GPY2210

(i) Explain why the ray of light entering prism 1 is not refracted.

_____

_____ [1]

(ii) Continue the path of the light ray through prisms 1 and 2 to show how it reaches the eye of the user. [2]

(iii) What is the name of the effect that makes the light follow the path you have drawn?
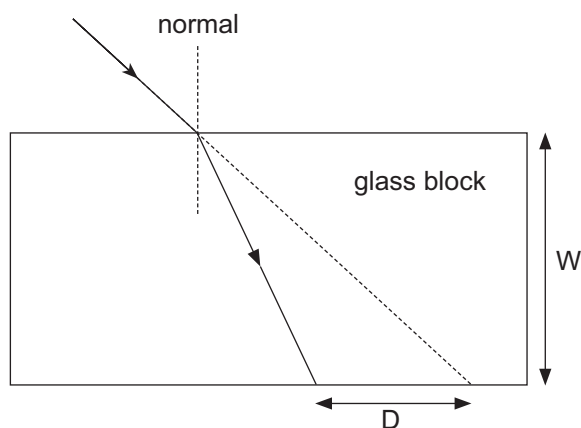
_____ [1]

(c) When a ray of light passes from air into glass it is refracted.
The ray of light is displaced from its original path.
The diagram below shows this.
The distance between the point where the refracted ray emerges from the glass block and the original path is the displacement D.

Source: Chief Examiner

(i) On the diagram mark with an **i** the angle of incidence when the light enters the glass and with an **r** the angle of refraction in the glass. [1]

An experiment was carried out to investigate if the displacement, D, depended on the width, W, of the glass block.

**(ii)** What must be kept the same during this investigation?

_____ [1]

The table below shows the results for glass blocks of different widths.

Width W of the glass block/cm	0	2	4	6	8	10
Displacement D/cm	0	1.0	1.9	2.8	3.7	4.7

(iii) On the grid opposite, plot a graph of the displacement D (y-axis) against the width of the glass block W (x-axis).
Clearly indicate the points using ⊙ or X.
Draw a line of best fit through the points. [4]
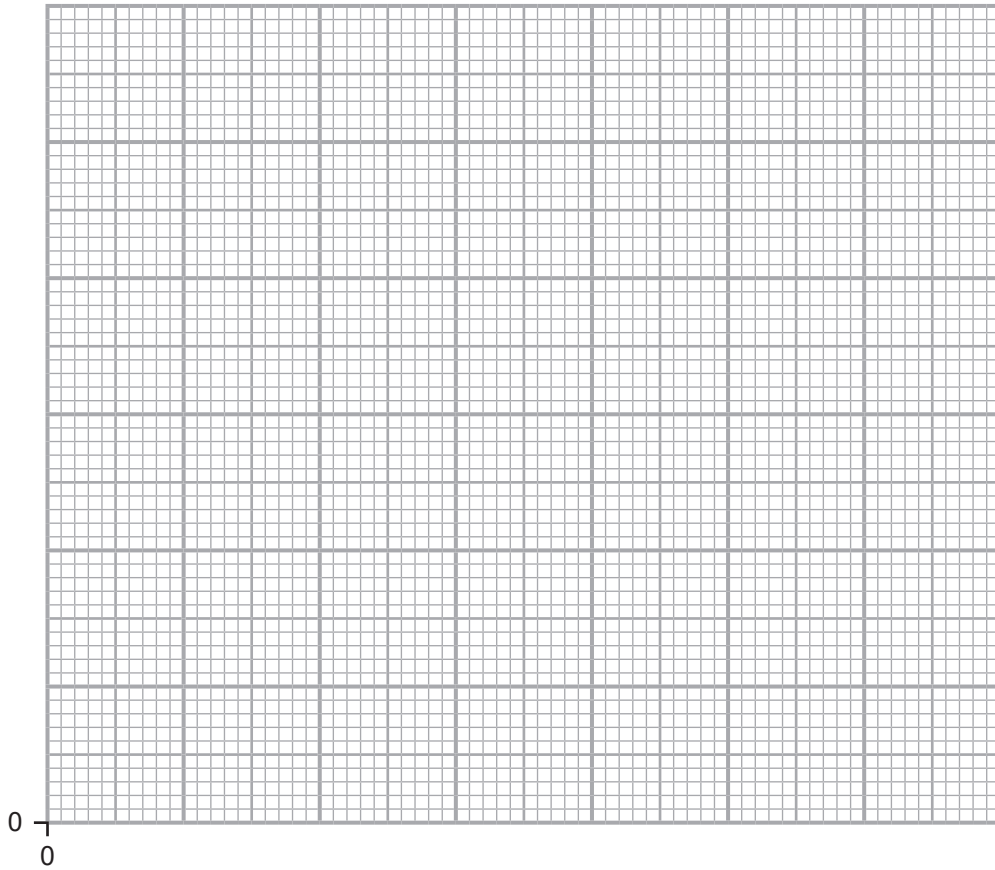
The displacement D and the width of the glass block W are related by the equation
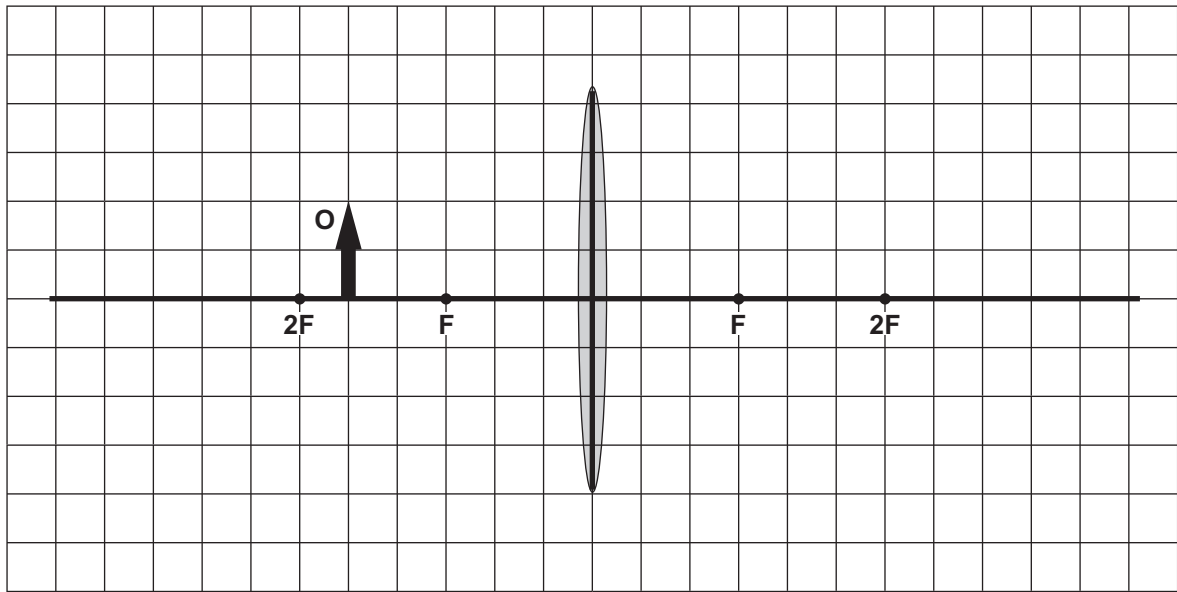
$$\frac{D}{W} = k$$

(iv) Using your **best fit** line find the value of k.

k = _____ [3]

[Turn over

(d) A converging lens can be used as a projector lens.

The ray diagram below shows the position of an object O in front of this lens.

Source: Chief Examiner

Draw two rays from the top of the object O to show how its image is formed.
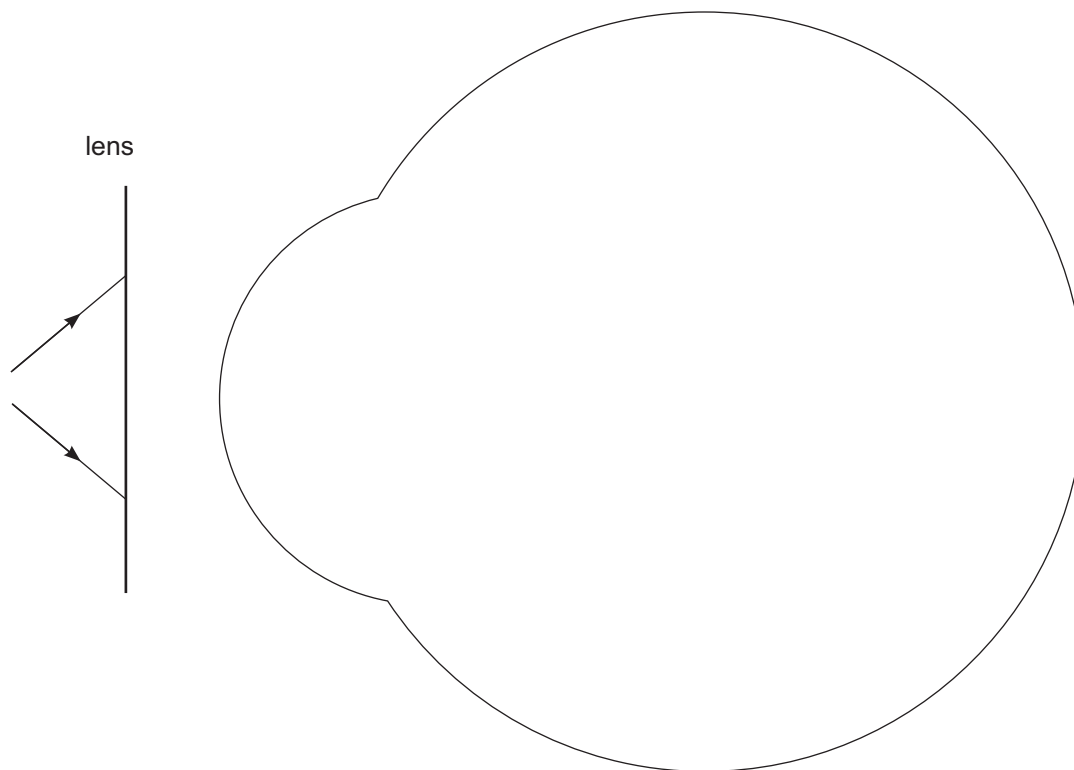Clearly label the image with the letter **I**. [4]

(e) A person with long sight can have it corrected using a suitable spectacle lens.

(i) Name the type of lens to be used.

Type of lens is = _____ [1]

(ii) Complete the diagram below by continuing the two rays to show clearly their path after passing through the correcting lens and after entering the eye. [3]

lens

Source: Chief Examiner

[Turn over

12980.06**R**

3 **(a)** **(i)** Write down the equation that is used to calculate electrical power using current and voltage.

_____ [1]

(ii) To investigate how the electrical power and the length of a metal wire are related, the circuit shown below was built.
Complete the circuit below to show how an ammeter and voltmeter should be connected to this circuit.


wire
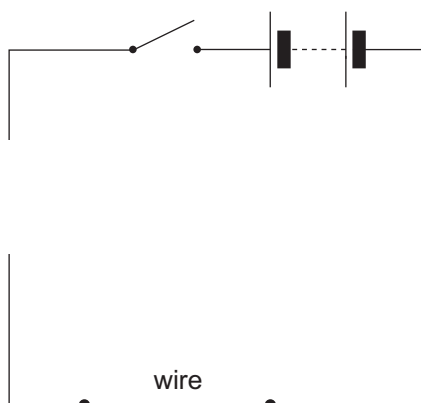
Source: Chief Examiner

[1]

(iii) Some of the results of this investigation are shown in the table below.
Several measurements have been omitted.
Calculate the value of the missing measurements and insert your answer in each appropriate blank space.
Use the space below for your calculations.

Length of wire/m	10	20	30
Voltage/V	6.0		4.8
Current/A	1.2	0.4	
Power/W		3.6	2.4

[3]

32GPY2216

(iv) If the measurements were used to plot a graph, which one of the graphs shown below would be obtained?
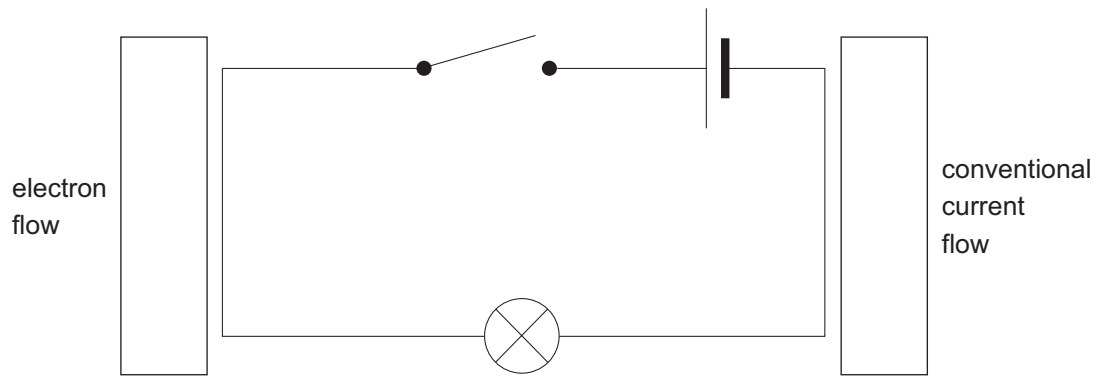Explain your answer.
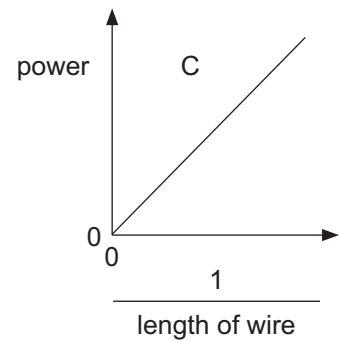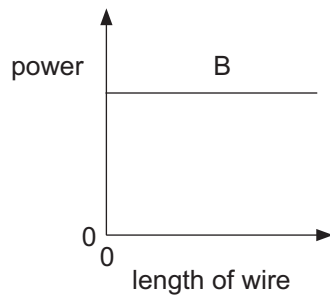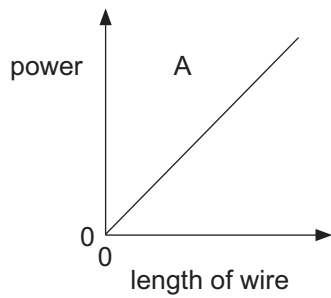
Source: Chief Examiner

Graph _____

Explanation _____

_____ [2]

(b) When the switch in the circuit below is closed, the lamp is lit.
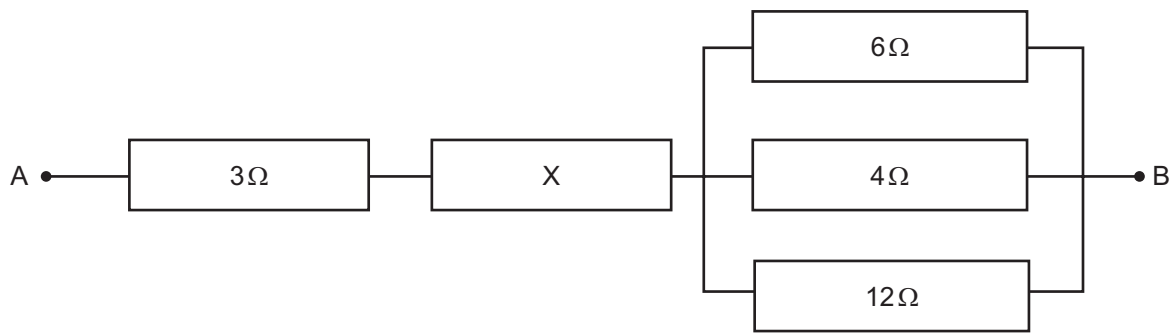Draw an arrow in each box to show the direction of conventional current flow and electron flow.

electron flow

conventional current flow

Source: Chief Examiner

[2]

[Turn over

(c) Five resistors are connected in the arrangement shown below.

Source: Chief Examiner

(i) Calculate the total resistance of the three resistors connected in parallel.

Resistance of three resistors connected in parallel = _____ Ω [3]

(ii) The total resistance between the points A and B is 16 Ω.
Calculate the value of the resistor marked X.
Show clearly how you get your answer.

Resistor X = _____ Ω [2]

12980.06**R**

BLANK PAGE

DO NOT WRITE ON THIS PAGE

(Questions continue overleaf)

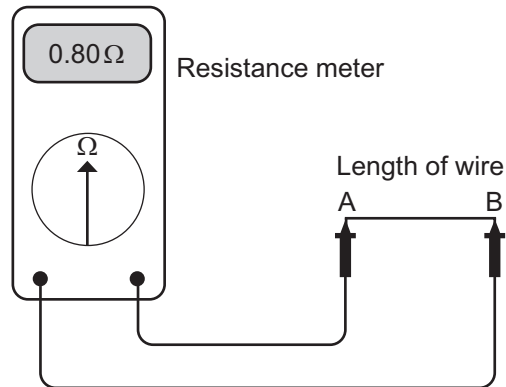*32GPY2219*

(d) To investigate how the resistance of a metal wire depends on its area of cross-section, a resistance meter was used to measure the resistance as shown in the diagram below.

Source: Chief Examiner

(i) The temperature of the wire was kept constant during the investigation. Name two other factors that must be kept constant during the investigation.

1. _____

2. _____ [2]

The table below shows the area of cross-section and the resistance of the wire with that area of cross-section.

Area of cross-section/mm^2	Resistance/Ω
0.10	2.50
0.30	0.80
0.40	0.70
1.20	0.20

The resistance of the wire is given by the equation below.

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

R = the resistance of the wire in Ω
L = length of the wire is **500 mm**
A = area of cross-section in mm^2
K = a constant

(ii) Using data from the table, find the value of K when the area
of cross-section equals $0.10\,mm^2$.
Remember the length of the wire is 500 mm.
Show clearly how you get your answer.

K = _____ [3]

(iii) Find the units of K.

_____ [2]

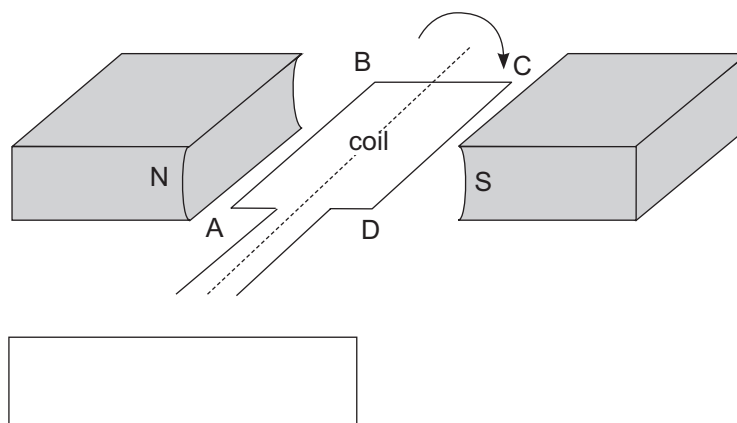**4** **(a)** The diagram below shows the construction of a simple electric motor.
A coil of wire is placed between the poles of a magnet.

(i) Show, using an arrow, the direction of the magnetic field.
Place the arrow in the box provided. [1]

Source: Chief Examiner

(ii) Section AB of the wire experiences a force which causes it to move
upwards. Show, using an arrow, the direction of the current in the
section AB. [1]

**(iii)** Name the rule that is used to determine the direction of the current.

_____ [1]

(b) (i) Describe, fully, how alternating current (a.c.) is different from direct current (d.c.).

Alternating current _____

_____

Direct current _____

_____ [2]

(ii) The diagrams below show two graphs of current changing with time.
State if the current shown is a.c. or d.c., or neither.
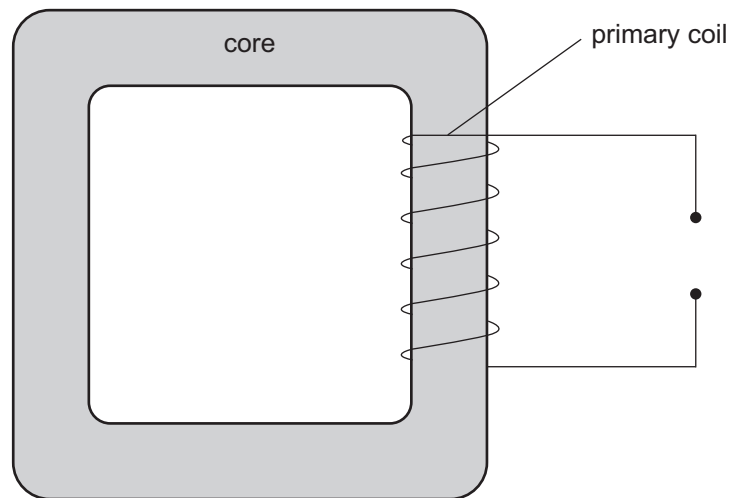Write your answer in the box beside each graph.

Source: Chief Examiner

[1]
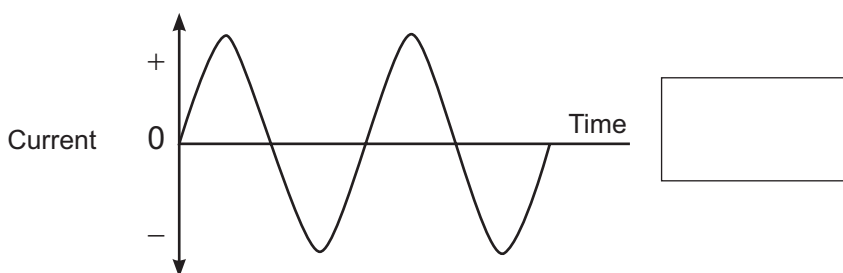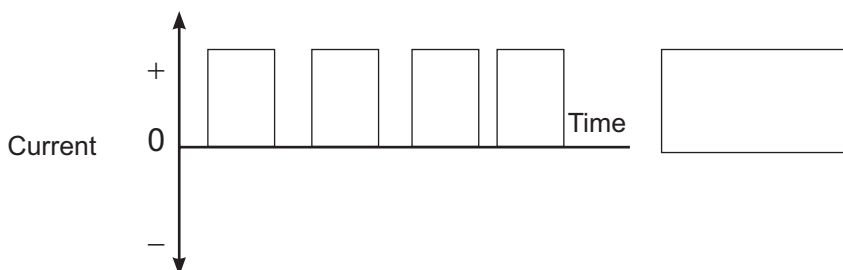
12980.06**R**

(c) The diagram below shows the structure of a transformer.
The diagram is incomplete.

core

primary coil

Source: Chief Examiner

(i) Complete the diagram to show the secondary coils in a
step-up transformer. [1]

(ii) How will the output voltage compare with the input voltage in a
step-up transformer?

_____ [1]

32GPY2224

A power station in Northern Ireland generates electricity at 15.75 kV and uses a transformer to change this to 110 kV before it is connected to the transmission cables.
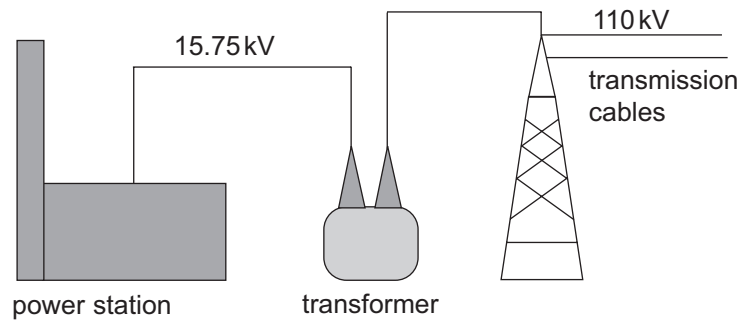
Source: Chief Examiner

(iii) Calculate the ratio of the number of turns on the secondary coil to the number of turns on the primary coil.
Show clearly how you get your answer, starting with the equation you plan to use.

Ratio = _____ [2]

(d) (i) The unit of energy used in calculating the cost to the consumer of using electricity is the kilowatt-hour (kWh).

An electric fire is marked **3 kW**.
Calculate the cost of using this electric fire for 6 hours.
The cost of a one kilowatt-hour is 17 pence.
Show clearly how you get your answer, starting with the equation you plan to use.

Cost = _____ pence [2]

(ii) Calculate, in joules, the quantity of electrical energy used when a **1 kW** electric fire is used for 1 hour.
Show clearly how you get your answer, starting with the equation you plan to use.

Electrical energy used = _____ J [4]

BLANK PAGE
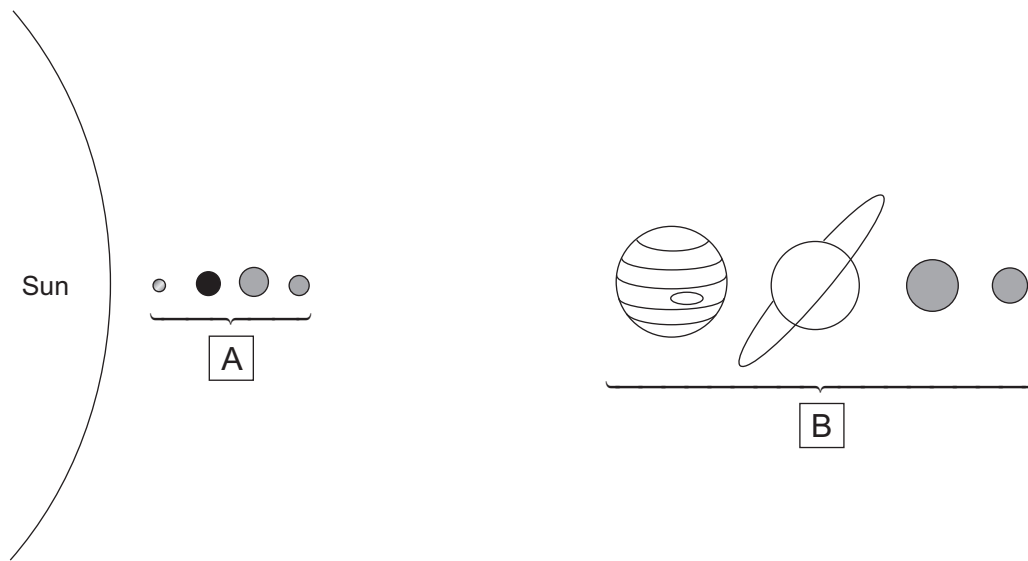
DO NOT WRITE ON THIS PAGE

(Questions continue overleaf)

5 **(a)** The diagram shown below shows the eight planets that make up our Solar System.

Source: Chief Examiner

The planets can be divided into two groups, A and B as shown above
What do all the planets in each group have in common?

Group A _____

Group B _____ [2]

(b) **(i)** Many stars remain stable for billions of years emitting energy at a constant rate.
State the two forces acting on the star that provide this stability.

1. _____

2. _____ [2]

(ii) Although hydrogen and helium are the two main elements found in stars, all elements are produced by stars.
What process in stars is responsible for this?

_____ [1]

(iii) The stages in the life cycle of a very massive star are shown below, but not in the correct order.

1. The star explodes with its outer layers of gas ejected into space.
2. The remaining core of the star collapses to become a neutron star.
3. The star emits light for billions of years as a main sequence star.
4. The star becomes visible from Earth due to its increased brightness.
5. The star expands to become a red supergiant.

Place them in the order in which they occur.
Write the order in the boxes provided.   [2]

First to occur ➡ ☐ ☐ ☐ ☐ ☐ ⬅ Last to occur

(c) It is believed the Universe began as a rapid expansion of space.
This is now known as the Big Bang.

(i) How long ago did this happen? _____ [1]

(ii) The table below shows two observations that support the Big Bang.
State the evidence that supports each observation.

Observation that supports the Big Bang	Evidence observed
Distant galaxies should move away	
The initial energy from the Big Bang should now be thinly spread across the whole Universe	

[2]

[Turn over

(d) The Earth is 25 000 light years from the centre of the galaxy.
Calculate this distance in **kilometres**.
1 year $= 3.15 \times 10^7$ s. Speed of light $= 3.0 \times 10^8$ m/s.

Distance = _____ km [4]

THIS IS THE END OF THE QUESTION PAPER

BLANK PAGE

DO NOT WRITE ON THIS PAGE

DO NOT WRITE ON THIS PAGE