Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
January 2019

Science: Physics

Unit 2

Higher Tier

[GPH22]

GPH22

THURSDAY 24 JANUARY, MORNING

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

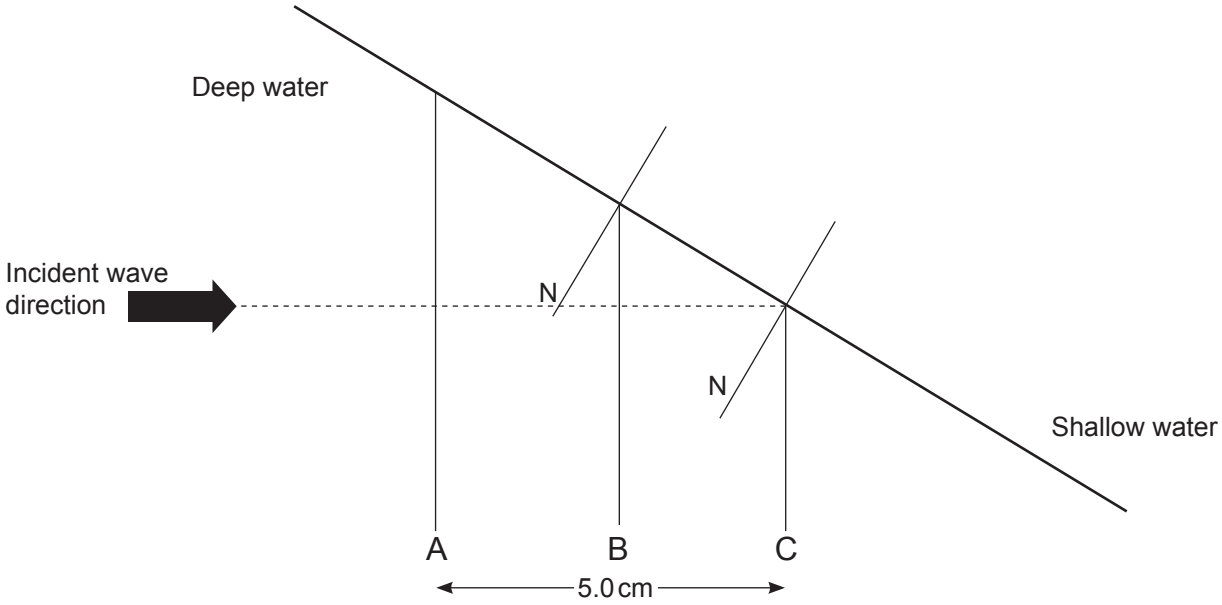
Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all six** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 115.
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 Questions **2(a)** and **5(a)**.

12007

1 **(a)** The diagram below shows three water wavefronts A, B and C moving from deep water to shallow water.
Wavefront A has just reached the boundary between the deep water and the shallow water. Parts of wavefronts B and C have already crossed into the shallow water.
The direction of these incident wavefronts is marked and the normals to the boundary are marked N.



(i) State what happens, if anything, to the following properties of the waves as they travel into the shallow water.

Speed _____

Wavelength _____

Frequency _____ [3]

(ii) Carefully complete the diagram above to show wavefronts B and C as they travel through the shallow water.

[2]

The water waves are made by a long bar vibrating in the water.

(iii) The long bar makes 24 vibrations in 6 seconds.
Calculate the frequency of the water waves produced.
Include the appropriate unit in your answer.

Frequency = _____ [2]

(iv) Using information from the diagram and your answer to part **(iii)** calculate the speed of the water waves in the deep water.
You are advised to show clearly how you get your answer, starting with the equation you plan to use.

Speed in deep water = _____ cm/s [3]

[Turn over

(b) (i) Ultrasound is a longitudinal wave.
Explain what is meant by a longitudinal wave.

_____

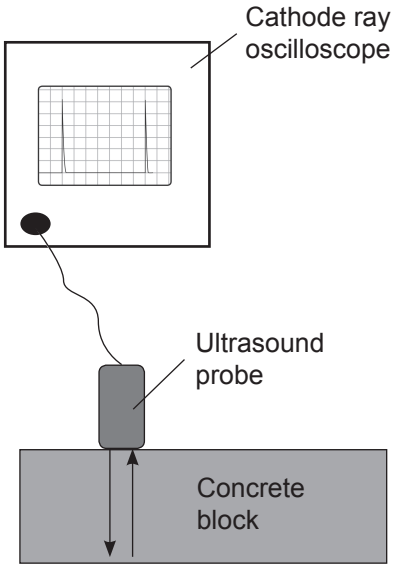
_____ [2]

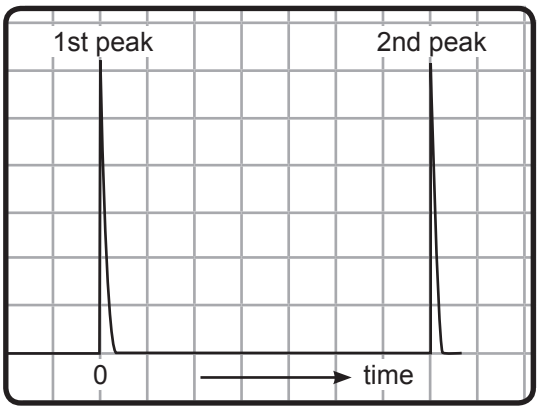
(ii) In what **two** ways is ultrasound different from audible sound?

_____

_____ [2]

Ultrasound is used to measure the thickness of a concrete block as shown below.





(iii) Describe how the ultrasound produces the second peak shown on the screen.

_____

_____

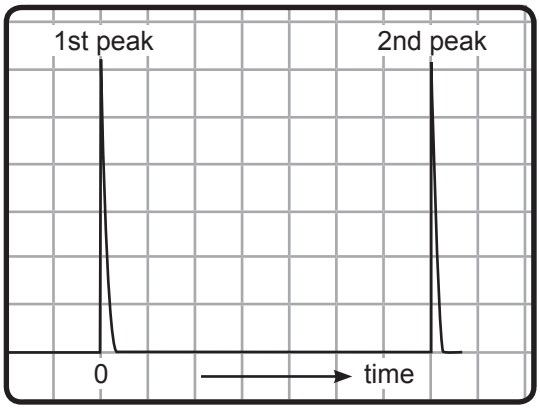
_____ [1]

(iv) The speed of ultrasound in concrete is 3000 m/s.
Each division on the screen represents a time of 0.000 05 s.
Using these data, calculate the thickness of the concrete block.
Show clearly how you get your answer, starting with the equation you plan to use.

Thickness = _____ m [4]

(v) Ultrasound can also be used to detect cracks in blocks of concrete.
On the grid below show the display that would be seen on the screen if such a crack were detected.

[1]



[Turn over

2 **(a)** Write an account of the dispersion of white light in glass.
In your answer, you should:

- state what dispersion is;
- explain what causes dispersion;
- draw a labelled diagram of the apparatus needed to show dispersion;
- describe how the apparatus is used to show dispersion;
- describe what would be observed if the apparatus was set up correctly.

You will be assessed on your written communication skills including the use of specialist science terms.

What dispersion is _____

_____

What causes dispersion _____

_____

Labelled diagram

How the apparatus is used: _____

_____

_____

Observations: _____

_____

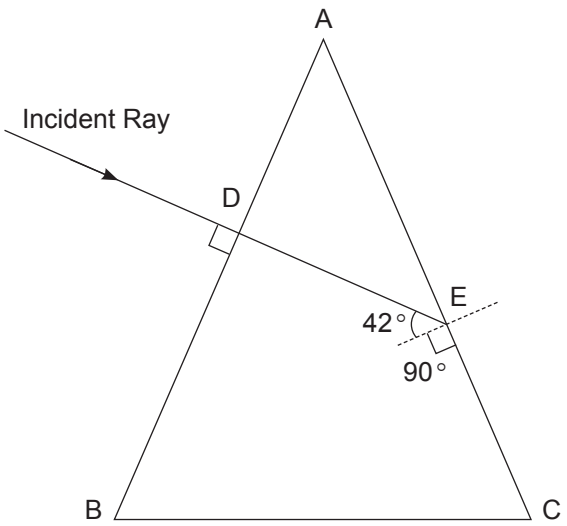
_____ [6]

(b) (i) Explain carefully what is meant by the statement that the critical angle for glass is 42°.

_____

_____ [1]

(ii) The diagram shows a ray of red light passing through a glass prism.
The angle the ray makes with the normal is shown.
Complete the diagram to show what happens to the ray at the point E.



[1]

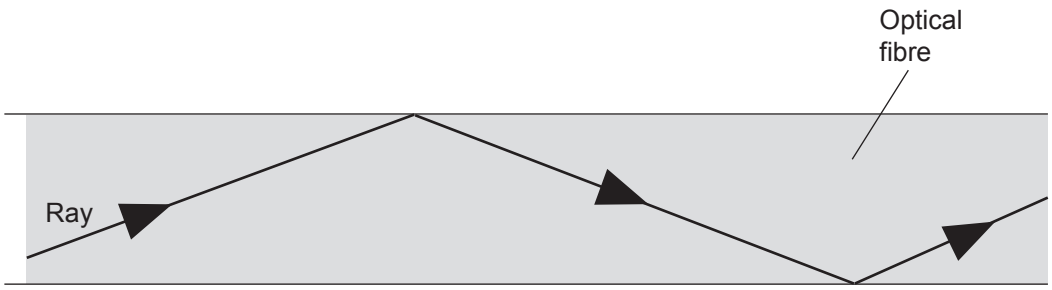
(iii) Explain why the ray of red light follows the path it takes at D.

_____

_____ [1]

[Turn over

(c) Optical fibres play an important role in communications.



(i) Name the process by which the ray follows the path shown.

_____

_____ [1]

(ii) Name a medical use of optical fibres.

_____ [1]

(d) This part of the question is about electromagnetic waves.
Electromagnetic waves consist of vibrating electric and magnetic fields.

(i) State two properties which are **unique** to all electromagnetic waves.

1. _____

2. _____ [2]

(ii) Complete the table below which shows some of the uses and dangers of three different electromagnetic waves.

Name of the wave	Use	Danger
	Detect bank note forgeries	
	Used in burglar alarm systems to detect intruders	Can cause burns
Gamma waves		Can cause cancer

[4]

(iii) Some of the names of members of the electromagnetic spectrum are shown below. The waves are listed in order of increasing wavelength.

Increasing wavelength →

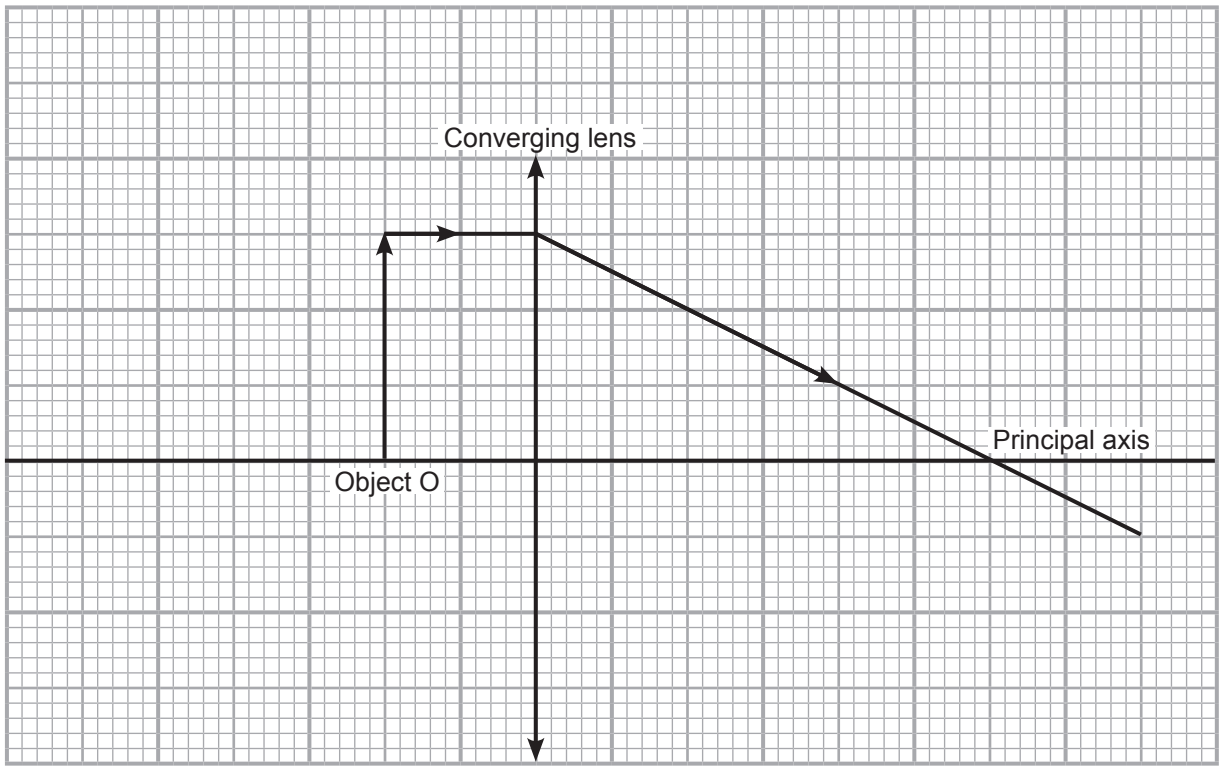
	X-rays		Visible light		Microwaves	**A**

Name the electromagnetic wave that should be in the box marked **A**.

_____ [1]

[Turn over

3 **(a)** The **full scale** ray diagram below for a converging (convex) lens is incomplete.



(i) Complete the ray diagram to show the formation of the image.
The image must be clearly labelled with the letter I.

[3]

(ii) Mark clearly on the diagram, with an **F**, the location of the principal focus of the lens.

[1]

(iii) What is the focal length, in mm, of the lens?

Focal length = _____ mm [1]

(iv) Which **two** of the following words best describe the image?
Circle your answer.

Real **Inverted** **Erect** **Virtual** [2]

(v) The magnification of the image may be calculated using the formula:

$$\text{Magnification} = \frac{\text{Height of image}}{\text{Height of object}}$$

By taking measurements from your completed ray diagram, calculate the magnification of the image.

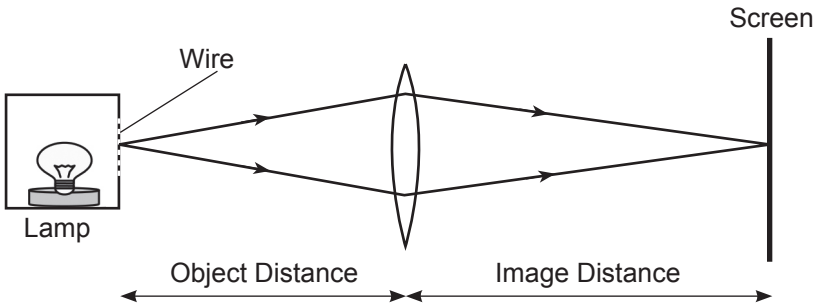
Magnification = _____ [2]

(vi) What name is given to a converging (convex) lens when used to produce an image of the type shown opposite?

_____ [1]

[Turn over

(b) To investigate the properties of the image formed by a converging (convex) lens a student set up the apparatus shown below.
The student placed a wire mesh object, illuminated by the lamp, at various distances from the lens.
For each object distance the screen was moved until the best image was seen on the screen.



(i) How would the student know when the best image position is located?

_____ [1]

(ii) Are the images in this investigation real or virtual?

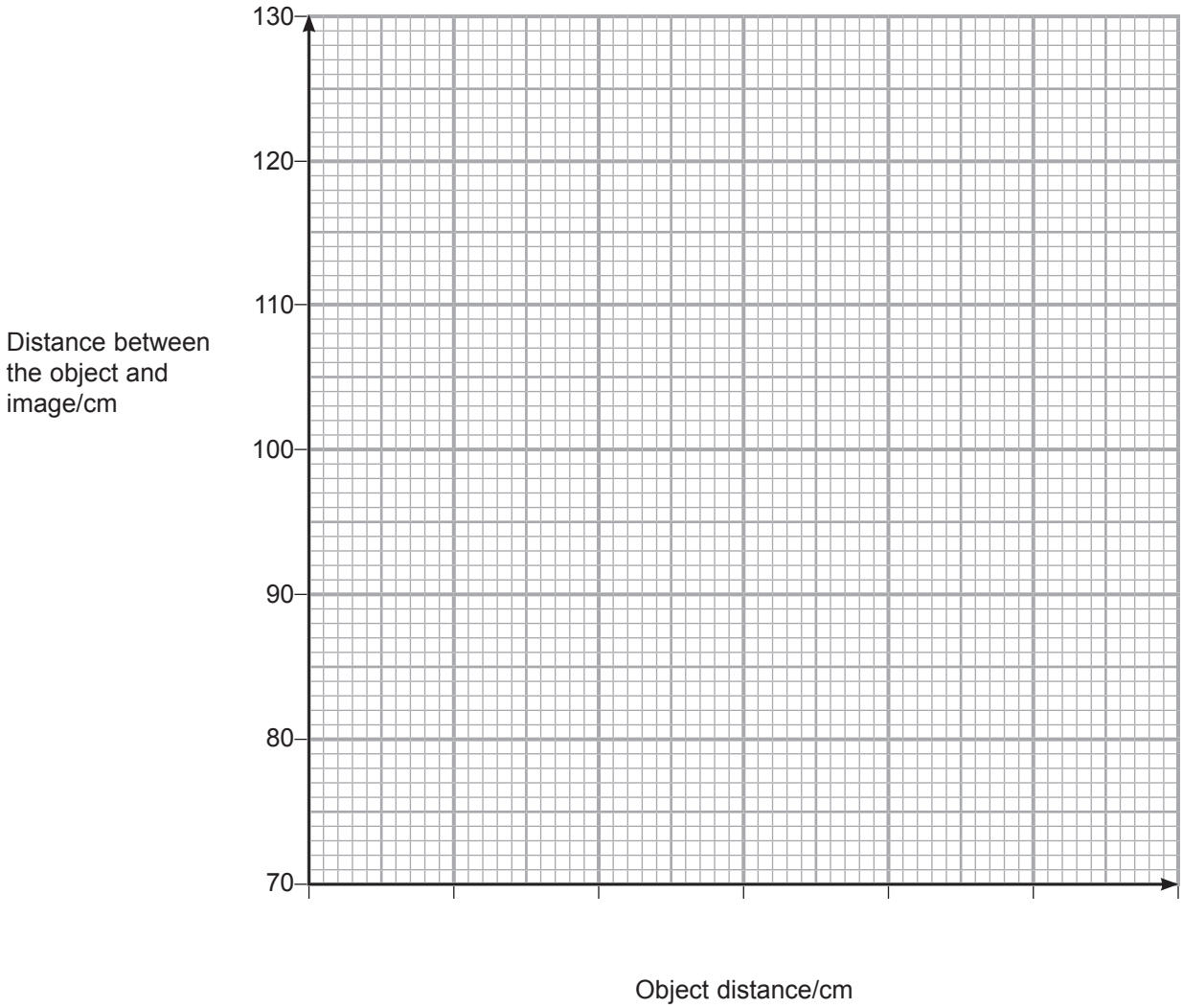
Type of image _____

Explanation _____ [2]

(iii) The student made a note of the object distance and also the distance between the object and the image
(i.e. the object distance + the image distance).
The results are shown in the table below.

Object distance/cm	Distance between object and image/cm
25	125
30	90
35	82
40	80
45	81
50	88

Plot a graph of the Distance between object and image and the Object distance on the grid below.
Choose a suitable scale for the horizontal axis and draw the best fit curve through the points.



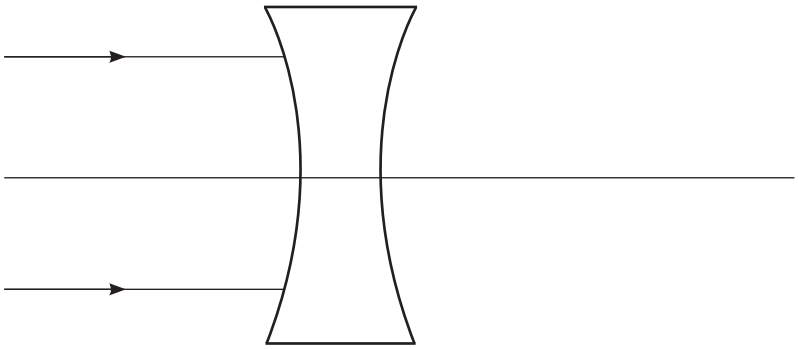
[4]

[Turn over

(iv) When the object and image are at their closest distance apart, the object distance is equal to twice the focal length of the lens.
Using your graph estimate the focal length of the lens used.
You should show clearly how you get your answer.

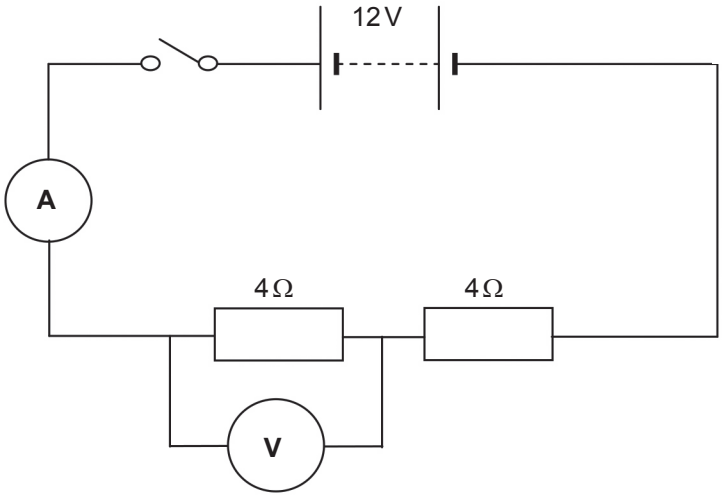
Focal length = _____ cm [2]

(c) On the diagram below complete the paths of the two light rays to show what happens after they emerge from the concave lens.



[1]

4 **(a)** A circuit was set up using a 12 V battery as shown below.



(i) Calculate the ammeter reading when the switch is closed.
Show clearly your calculation, starting with the equation you plan to use.

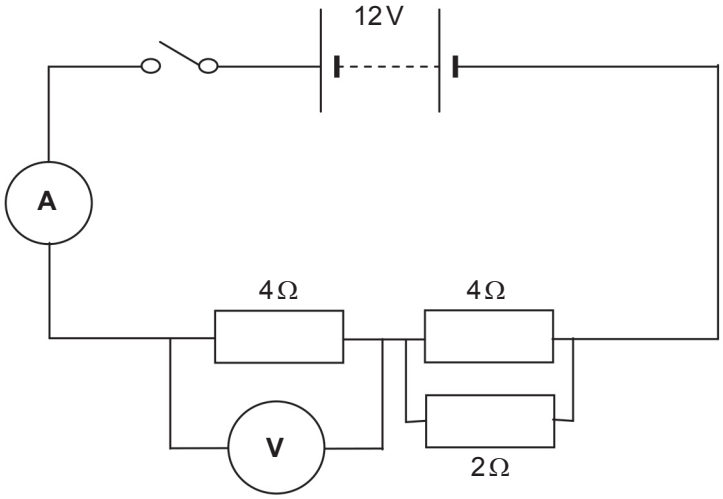
Ammeter reading = _____ A [4]

(ii) When the switch is closed, what will the voltmeter read?
Show clearly your calculation, starting with the equation you plan to use to get your answer.

Voltmeter reading = _____ V [2]

[Turn over

(b) The circuit is then altered by connecting a 2 Ω resistor as shown below.



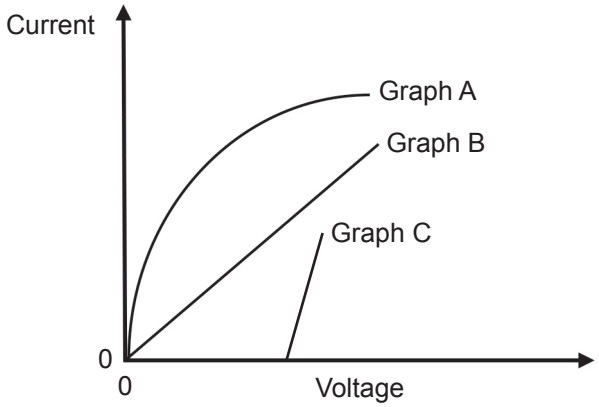
(i) Calculate the total resistance of this altered circuit.
Show clearly your calculation, starting with the equation you plan to use.

Total resistance = _____ Ω [4]

(ii) Calculate the new reading on the voltmeter.
Show clearly your calculation, starting with the equation you plan to use.

New voltmeter reading = _____ V [3]

(c) The diagram below shows three current–voltage graphs.



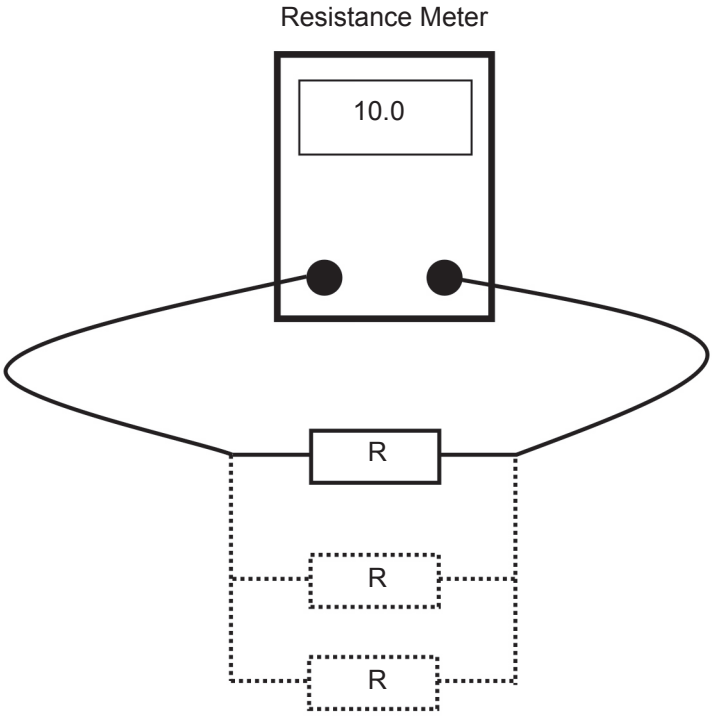
Complete the table below to identify the component that would produce each current–voltage graph.

Graph	Component
A	
B	
C	

[3]

[Turn over

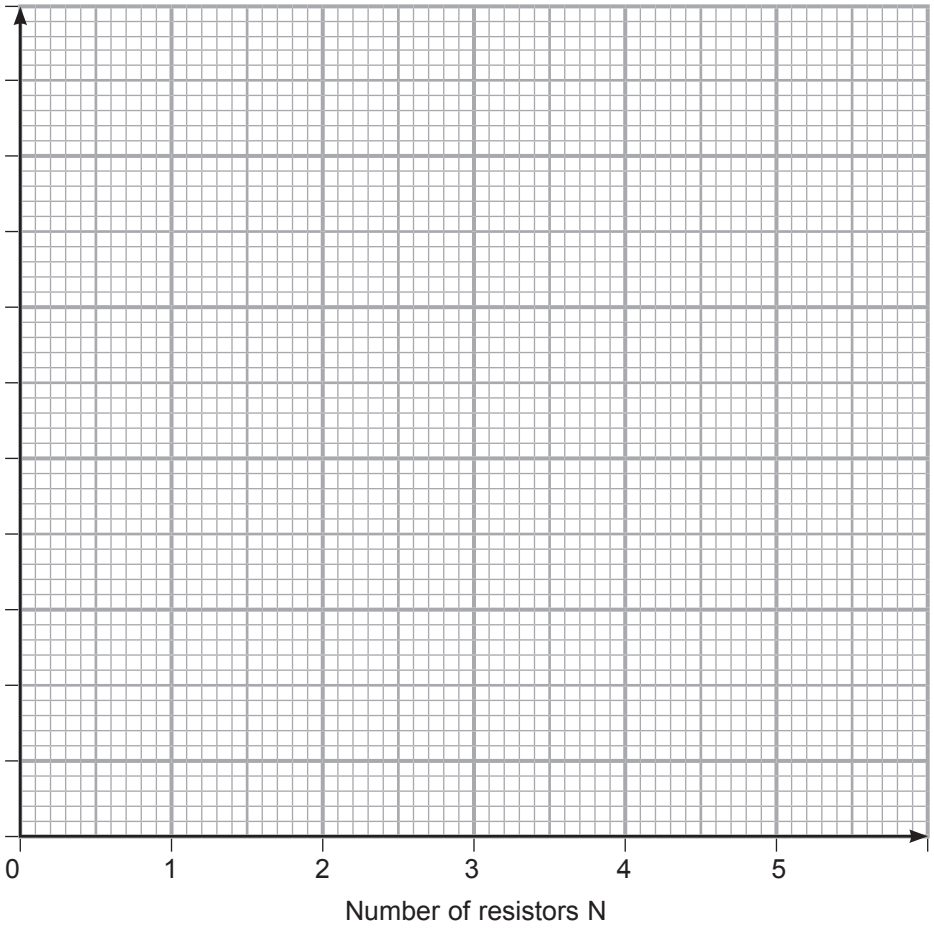
(d) A student investigated how the total combined resistance (R_T) of a circuit changed as the number of equal resistors connected in parallel was varied using the circuit shown below. The resistance was measured directly using a resistance meter.



The results recorded by the student are shown in the table below.

Number of resistors N	Total combined resistance R_T/Ω
1	10.0
2	5.0
3	3.3
4	2.5
5	2.0

(i) Using the grid below plot a graph of total combined resistance R_T against the number of resistors N connected in parallel.
Choose a suitable scale for the Total combined resistance axis and draw the best fit curve through the points.



[4]

(ii) What is the name of the mathematical relationship between R_T and N suggested by the graph and the data in the table opposite?

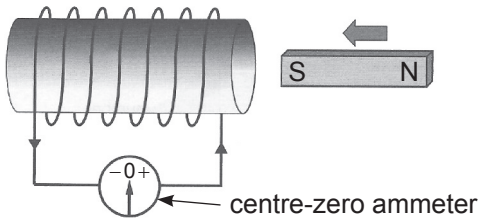
_____ [1]

(iii) Write down an equation that would link R_T and N.

_____ [1]

[Turn over

5 **(a)** Electromagnetic induction is investigated using a bar magnet, a coil of wire and a centre-zero ammeter, as shown below.



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

You are to describe, carefully, what is observed on the centre-zero ammeter when the magnet is moved in and out of the coil. Describe also how the apparatus can be used to produce an alternating current:

- The south pole of the magnet is **moved slowly towards** the coil.

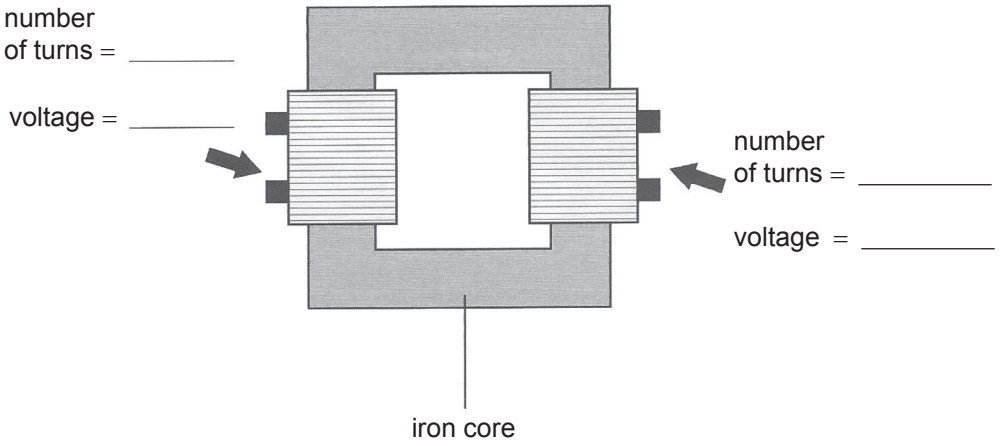
- The south pole is then **held stationary** for a few seconds close to the coil.

- The south pole of the magnet is **moved quickly away** from the coil.

- How you would use the bar magnet and the coil to produce an alternating (a.c.) current.

[6]

(b) A transformer has two coils, one with 200 turns, the other with 20 turns. The transformer is required to change 240 V to 24 V.



(i) Label the diagram with the number of turns on each coil and indicate clearly to which of the coils the 240 V and 24 V should be connected. [2]

(ii) Complete the table below by identifying the type of voltage.
Tick (✔) the correct box.

	a.c.	d.c.
240 V input voltage		
24 V output voltage		

[2]

(iii) Transformers are used in power stations in Northern Ireland to step up the voltage before it is connected to the overhead transmission cables.
Explain fully why this is done.

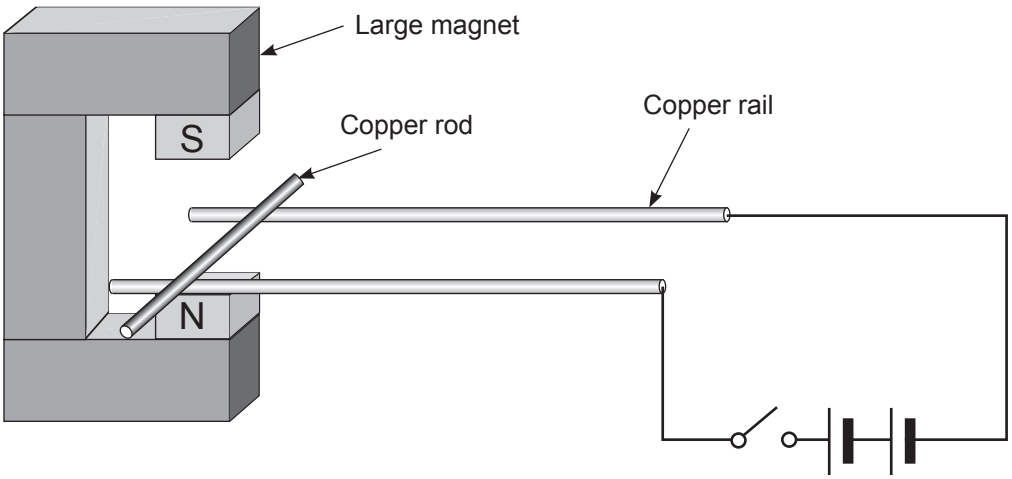
_____

_____

_____ [2]

[Turn over

(c) The diagram below shows apparatus sometimes used to demonstrate the force on a current carrying conductor when it is in a magnetic field.



(i) On the diagram mark, using **an arrow**, the direction of the current in the copper rod when the switch is closed. [1]

(ii) Determine the direction of the force on the copper rod when the switch is closed.
Mark this direction with **an arrow** labelled F. [2]

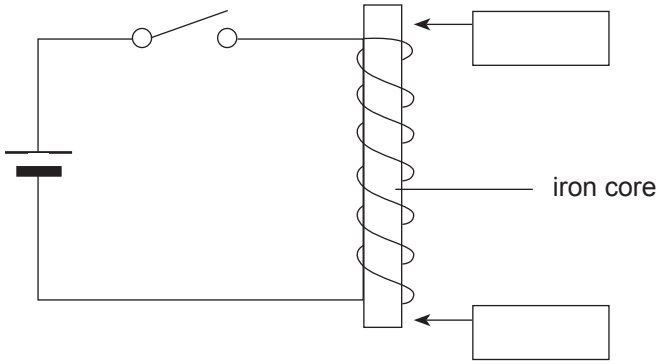
(iii) When the battery is replaced by a source of alternating current (a.c.) the force causes the copper rod to vibrate.
Explain, fully, why this happens.

_____

_____

_____ [2]

(d) When the switch is closed in the circuit below, an electromagnet is created.



(i) The strength of the magnetic field can be increased by using a larger current in the coil. State one other way that the magnetic field strength can be increased.

_____ [1]

(ii) On the diagram, in the boxes provided, mark the polarity of the magnetic field produced. [1]

(iii) The iron core is replaced by a wooden rod. What effect does this have on the magnetic field?

_____ [1]

[Turn over

6 **(a)** Radiation can be detected coming from the spaces between stars and galaxies. This faint radiation can be detected from all directions and is not associated with any star or galaxy.

(i) What name is given to the faint radiation referred to in the passage above?

_____ [1]

(ii) What theory is put forward by physicists to explain this faint signal?

_____ [1]

(iii) Galaxies are moving apart. What observation provides information for this conclusion?

_____ [1]

(b) Gravity plays an important role in shaping the Universe.
For each of the examples below describe the role gravity has played.

(i) Star formation _____

_____

(ii) The stability of a star _____

_____

(iii) Orbital motion of the Earth around the Sun _____

_____ [3]

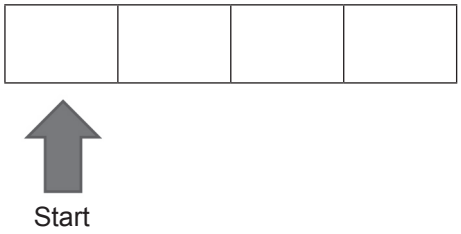
(c) The formation and evolution of the Universe involved a number of stages.
These are described in the numbered statements below.
Place them in the correct order in which they occurred.
Write your answers in the boxes provided.

1. electrons combine with neutrons and protons to form hydrogen **atoms**

2. rapid expansion and cooling of the Universe

3. neutrons and protons formed

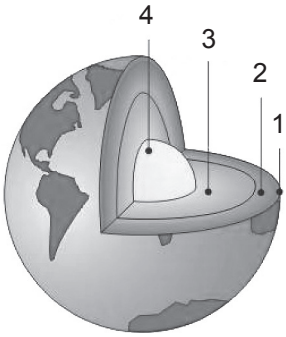
4. hydrogen **nuclei** form



[2]

[Turn over

(d) The Earth is made up of a number of layers as shown in the diagram below.



(i) Complete the table below.

	Name of layer	**Solid or liquid or both**
1		
2		
3		
4		

[4]

(ii) Tectonic activity is responsible for many earthquakes.
Explain what tectonic activity is and describe how it produces earthquakes.

[3]

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For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
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Total Marks	

Examiner Number