Cambridge
O Level

Cambridge Assessment International Education
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5910008144

PHYSICS **5054/22**

Paper 2 Theory **May/June 2019**

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer any **two** questions.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **19** printed pages and **1** blank page.

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Section A

Answer **all** the questions in this section. Answer in the spaces provided.

1 A student records the mass and volume of two irregular objects, one made of iron and the other of copper. The student uses the equipment shown in Fig. 1.1.

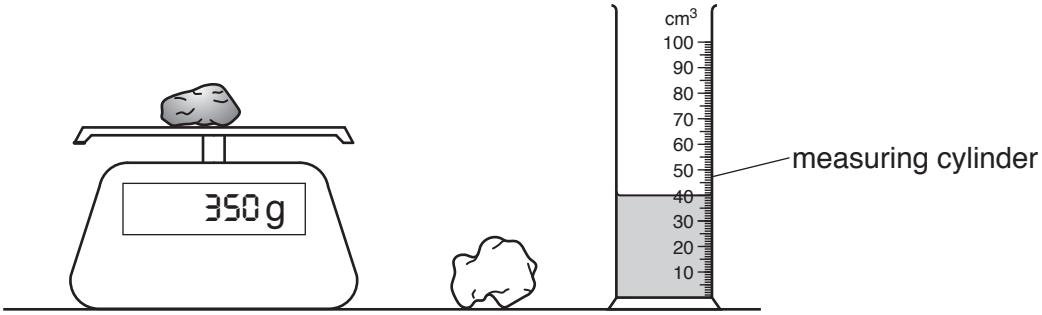


Fig. 1.1

Table 1.1 shows the results obtained.

Table 1.1

	mass / g	volume / cm^3
iron	400	51
copper	350	39

(a) Describe how to determine the volume of an irregular object with the measuring cylinder.

.....

.....

.....

.....

..... [2]

(b) Calculate the density of iron.

density = ... [2]

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(c) A third object, which is also made of copper, has the same volume as the iron object.

Calculate the mass of this copper object.

mass = ... [2]

(d) State and explain what happens to the density of the iron object when it is heated.

.....

.....

..... [1]

[Total: 7]

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[Turn over

2 Fig. 2.1 shows a container of gas connected to a manometer. The tube in the manometer has a constant cross-sectional area.

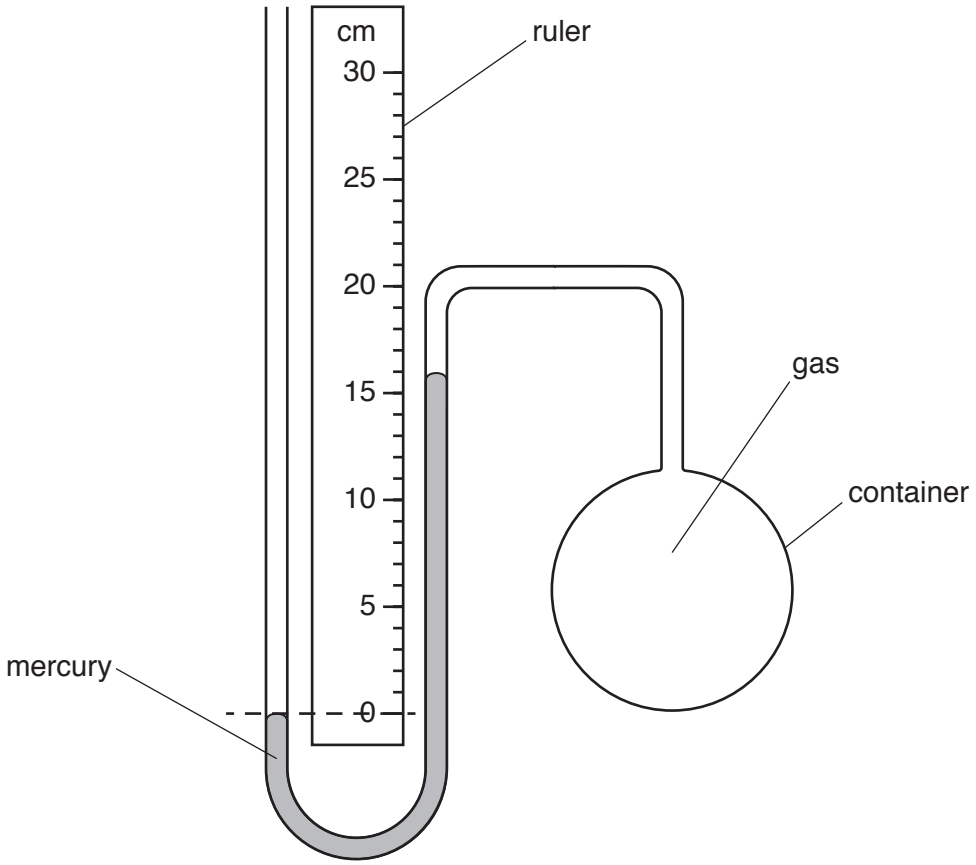


Fig. 2.1

The gas in the container exerts a pressure.

(a) Define the term *pressure*.

.....

..... [1]

(b) The density of mercury is 1.4×10^4 kg/m^3. The gravitational field strength g is 10 N/kg.

The pressure of the atmosphere is 1.0×10^5 Pa.

Calculate the pressure of the gas in the container.

pressure = ... [3]

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(c) In Fig. 2.1, the mercury level on the left-hand side of the manometer is lower than on the right-hand side.

The gas inside the container is heated. This causes the mercury levels on both sides to become the same.

(i) Determine the mercury level, as shown on the ruler, when this happens.

..... [1]

(ii) Explain, in terms of the gas molecules, what causes the level of mercury to become the same.

.....

.....

.....

.....

.....

..... [3]

[Total: 8]

3 Fig. 3.1 shows three rays of light travelling in water from a light source S.

One ray of light is totally internally reflected at the boundary between water and air.

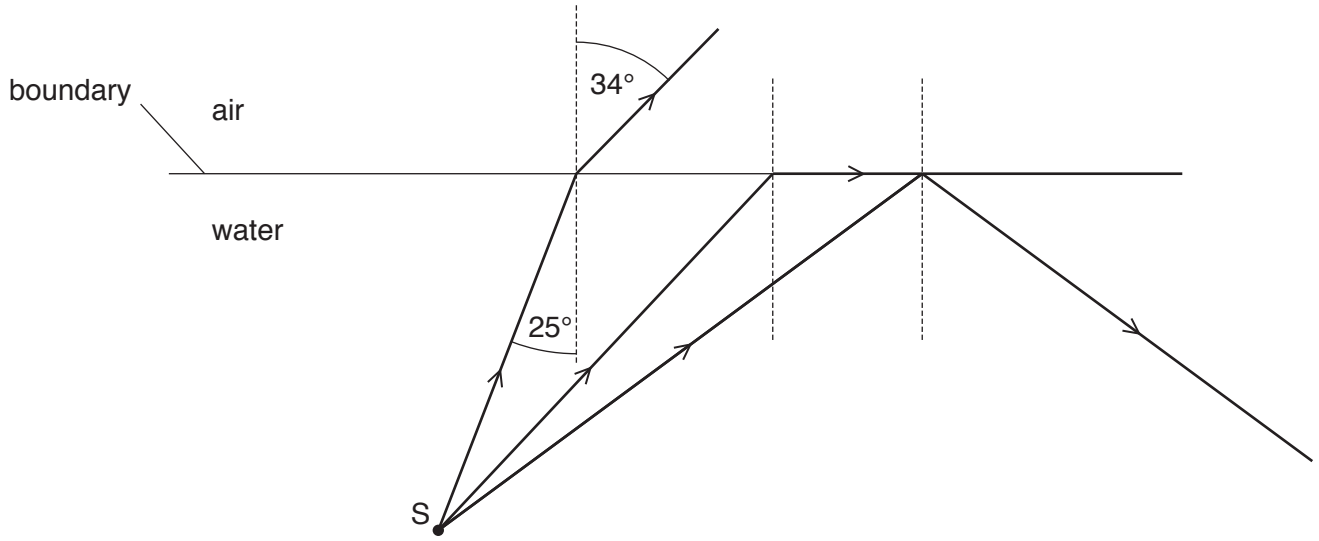


Fig. 3.1 (not to scale)

(a) On Fig. 3.1, mark the critical angle and label it *c*. [1]

(b) State why only one of the three rays is totally internally reflected.

.....

..... [1]

(c) Calculate:

(i) the refractive index for water

refractive index = ... [2]

(ii) the critical angle for the boundary between water and air.

critical angle = ... [2]

[Total: 6]

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4 A star emits electromagnetic radiation over a range of wavelengths.

Fig. 4.1 shows the brightness of the radiation from the star at different wavelengths.

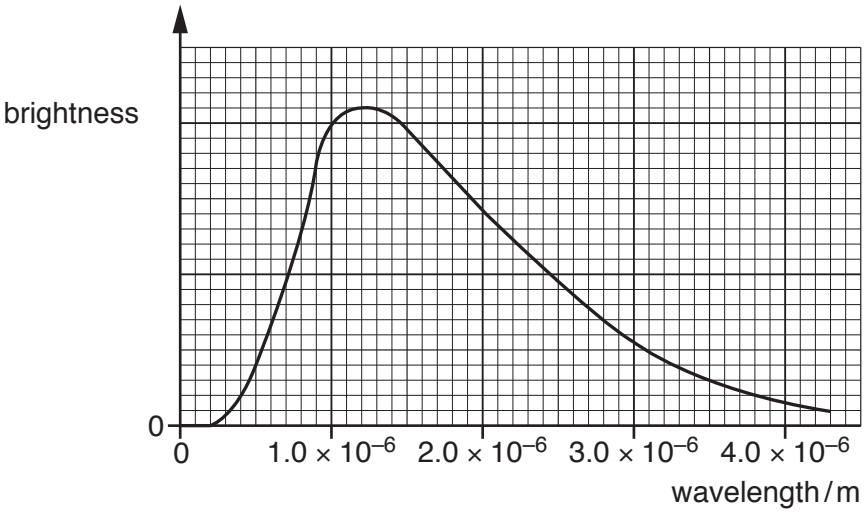


Fig. 4.1

Radiation from the star is brightest at one wavelength.

(a) Determine the wavelength where the radiation is brightest.

wavelength = ... [1]

(b) Visible light has a wavelength between 4.0×10^{-7} m and 7.0×10^{-7} m.

The radiation in **(a)** lies just outside the visible part of the electromagnetic spectrum.

State the name of the region of the spectrum that contains the radiation in **(a)**.

..... [1]

(c) Determine the frequency of the radiation in **(a)**.

The speed of light is 3.0×10^{8} m / s.

frequency = ... [3]

[Total: 5]

5 **(a)** Fig. 5.1 shows part of a machine used to investigate electrostatic charging.

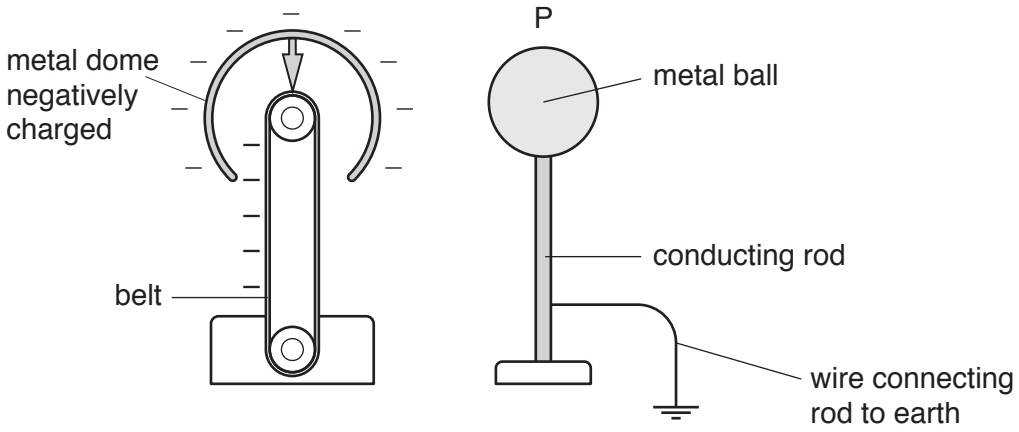


Fig. 5.1

Before the machine is switched on the metal dome and the ball are uncharged.

When the machine is switched on, the metal dome becomes negatively charged.

Explain how charging the dome causes the metal ball P to become positively charged.

.....

.....

.....

..... [2]

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(b) A photocopier works using electrostatic charging. It contains a drum whose surface conducts charge where it is exposed to light.

Fig. 5.2 shows a piece of paper, the drum and the heater of a photocopier.

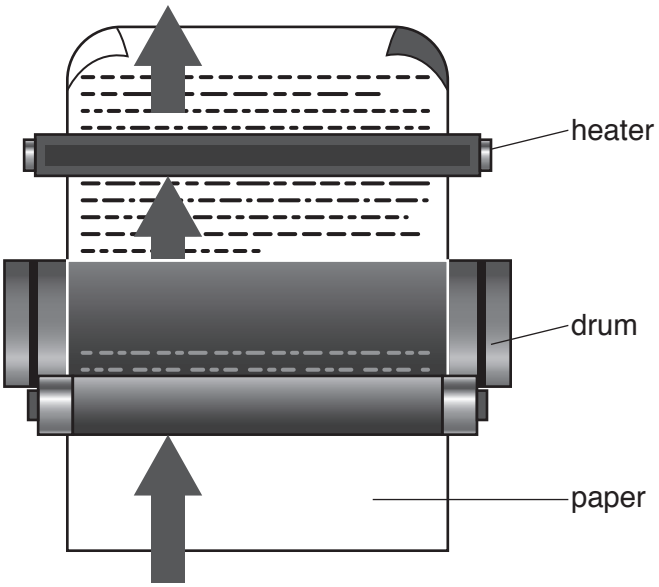


Fig. 5.2

The photocopier produces a copy of an original page on a piece of paper.

The sentences below describe the process of making the copy but the sentences are in the wrong order.

A The drum is given a positive charge.

B The positively charged parts of the drum attract a black powder.

C Where light hits the drum, the positive charge leaks away.

D An image of the original page is projected onto the drum.

E The drum rolls against a piece of paper, transferring powder to the paper.

F The paper is heated which makes the black powder stick to it.

Arrange the sentences in the correct order. The first and last sentences are already in the correct boxes.

A	→		→		→		→		→	**F**

[2]

[Total: 4]

6 Two lamps, P and Q, are connected to a battery of electromotive force (e.m.f.) 6.0 V and an ammeter, as shown in Fig. 6.1.

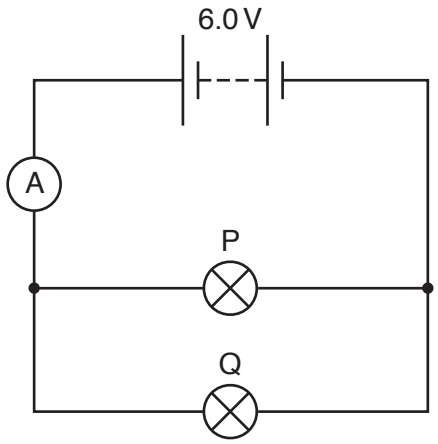


Fig. 6.1

Lamp P has a resistance of 15 Ω. The ammeter reading is 0.65 A.

(a) Calculate the current in lamp P.

current = ... [2]

(b) Calculate the resistance of lamp Q.

resistance = ... [2]

(c) The two lamps are now connected in series to the ammeter and the same battery.

(i) In the space below draw the circuit diagram.

[1]

(ii) Explain why the ammeter reading is less than 0.65 A when the lamps are connected in series.

.....

..... [1]

[Total: 6]

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7 Fig. 7.1 shows a copper wire placed on two copper rods in the magnetic field between the poles of a magnet.

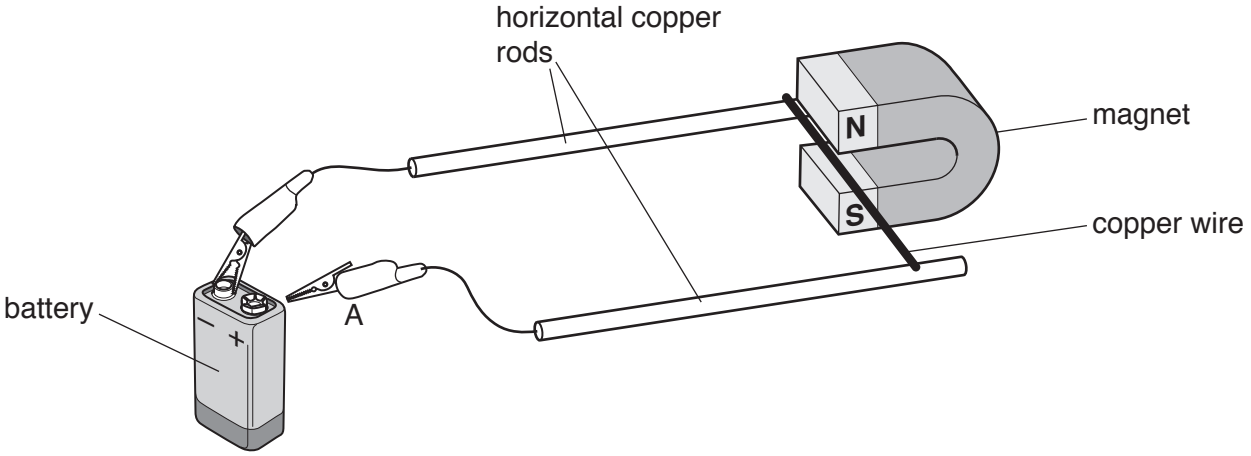


Fig. 7.1

The crocodile clip A touches the positive terminal of the battery. This causes the copper wire to move.

(a) On Fig. 7.1, mark with an arrow the direction of the current in the copper wire. [1]

(b) Explain why the copper wire moves along the copper rods.

.....

.....

.....

..... [2]

(c) Name **two** different devices that use this effect.

1. .....

2. .....

[2]

[Total: 5]

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8 Fig. 8.1 shows a device that is used to show the force on an electron in an electric field.

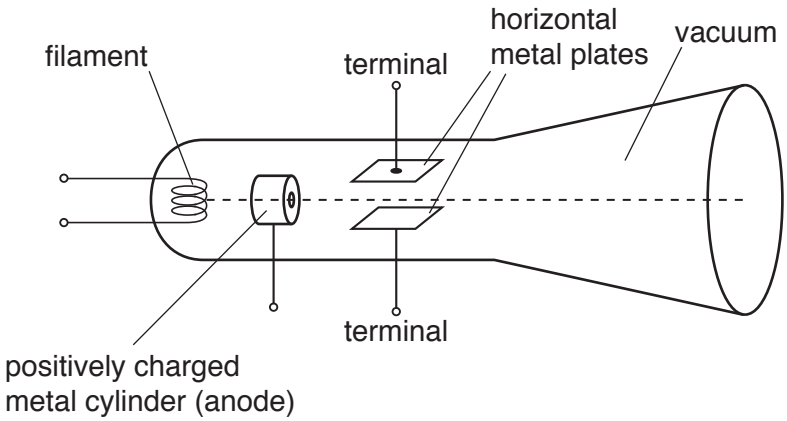


Fig. 8.1

(a) Explain how a continuous flow of electrons from the filament is produced in this apparatus.

.....

.....

.....

.....

..... [2]

(b) When an electron is in an electric field there is a force on the electron.

The direction of this force is in the opposite direction to the electric field.

Describe how the metal plates in Fig. 8.1 can be used to show this.

.....

.....

.....

.....

..... [2]

[Total: 4]

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Section B

Answer **two** questions from this section. Answer in the spaces provided.

9 Fig. 9.1 shows a map of the route taken by a car as it travels from town A to town B.

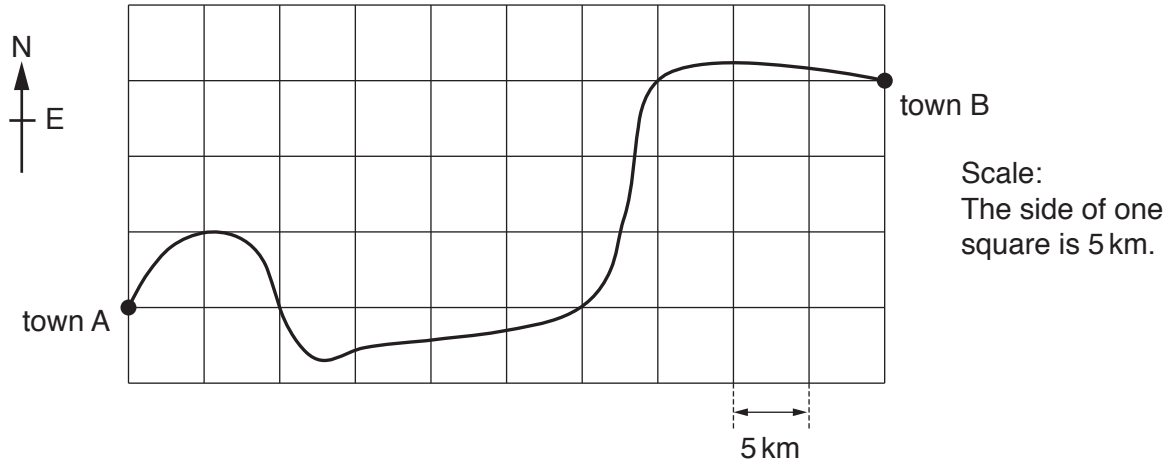


Fig. 9.1

The journey involves a distance and a displacement.

(a) (i) Using the scale on Fig. 9.1, determine the displacement in travelling from A to B.

size of displacement = ...

direction of displacement = ...
[3]

(ii) State how *distance* differs from *displacement*.

.....

.....

..... [1]

(iii) In some parts of the journey, the car is travelling at a constant speed but is also accelerating.

Explain how this is possible.

.....

.....

..... [2]

(b) At town B the car makes an emergency stop.

The total stopping distance of the car is the thinking distance added to the braking distance.

(i) Describe what is meant by the *thinking distance*.

.....

..... [1]

(ii) The brakes on the car work badly. This increases the braking distance.

State **two** other factors that increase the braking distance.

1. .....

.....

2. .....

.....
[2]

(c) The mass of the car and driver is 1200 kg. Just before the brakes are applied, the speed of the car is 30 m / s.

(i) Calculate the kinetic energy of the car and driver just before the brakes are applied.

kinetic energy = ... [3]

(ii) The braking force that stops the car is 1800 N.

Calculate the deceleration of the car.

deceleration = ... [2]

(iii) Explain why the temperature of the brakes increases during braking.

.....

..... [1]

[Total: 15]

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10 Fig. 10.1 is a diagram of a soldering iron. Solder is a mixture of metals used to make a permanent contact between electrical wires.

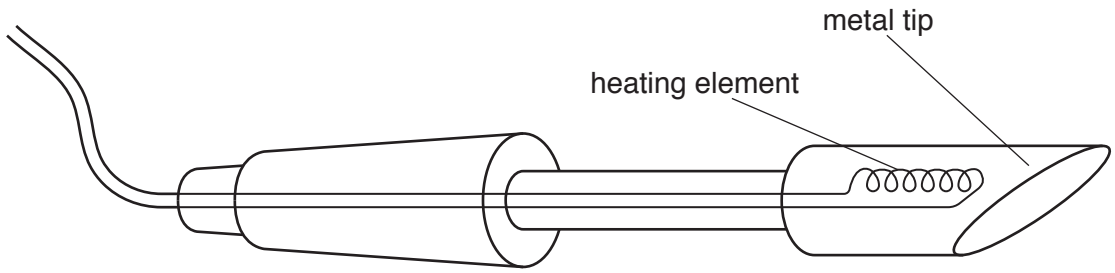


Fig. 10.1

The heating element raises the temperature of the metal tip. When solder is placed against the tip, the solder melts over the wires to be joined. When the solder cools, it solidifies and the permanent connection is made.

The working temperature of the metal tip is 380 °C.

(a) The boxes in Fig. 10.2 show two materials and some different melting points.

material	melting point
	1000 °C
metal of the metal tip	
	380 °C
	200 °C
	20 °C
solder	
	0 °C

Fig. 10.2

On Fig. 10.2, draw a line from the metal of the metal tip and a line from the solder to a suitable melting point for each. [2]

(b) The heating element is rated at 24 V, 3.3 A.

The heating element is switched on.

The temperature of the metal tip rises from 20 °C to 320 °C in the first 10 s.

(i) Calculate the electrical energy supplied to the heating element in the first 10 s.

energy = ... [2]

(ii) The metal tip is made of copper and has a mass of 2.3 g. The specific heat capacity of copper is 0.39 J / (g °C).

Calculate the thermal energy (heat) gained by the metal tip in the first 10 s.

thermal energy = ... [3]

(c) **(i)** Describe, in terms of free electrons, the process by which heat transfers through the metal tip.

.....

.....

.....

..... [2]

(ii) Heat is lost from the metal tip by convection in the air.

Explain how convection occurs in the air.

.....

.....

.....

..... [2]

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(d) The temperature of the metal tip is measured with a thermocouple.

(i) In the space below, draw a labelled diagram of a thermocouple. Mark with a letter H the part of the thermocouple that is placed on the metal tip.

[2]

(ii) State **two** reasons why a thermocouple thermometer is suitable for measuring how the temperature of the metal tip varies during the first 10 s.

1. .....

.....

2. .....

.....

[2]

[Total: 15]

11 **(a)** Stars are formed inside a cloud of gas and dust in space.

When a star forms, the cloud first becomes smaller as it collapses.

(i) State what causes the gas cloud to collapse.

..... [1]

(ii) Eventually nuclear fusion occurs in the star.

State **two** conditions required for nuclear fusion to occur in the star.

1. .....

2. .....
[2]

(b) When a large star explodes, nuclei of heavy elements are formed.

One such nucleus is uranium-235 ($^{235}_{92}U$).

(i) State the name and the number of each type of particle found in one nucleus of $^{235}_{92}U$.

name of particle ..... number found in nucleus .....

name of particle ..... number found in nucleus .....
[2]

(ii) State one feature that is the same for the nuclei of all isotopes of uranium.

.....

..... [1]

(iii) A nucleus of $^{235}_{92}U$ in a nuclear reactor can undergo nuclear fission.

Describe the process of nuclear fission in a nuclear reactor.

.....

.....

..... [2]

(iv) State one difference between nuclear fusion and nuclear fission.

.....

..... [1]

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(v) The nucleus of $^{235}_{92}U$ is not stable.

It decays by the emission of an alpha-particle (α) into a nucleus of thorium (Th).

Complete the nuclear equation that represents this decay.

$$^{235}_{92}U \rightarrow {}^{\ldots\ldots}_{\ldots\ldots}Th + {}^{\ldots\ldots}_{2}\alpha$$

[2]

(c) Geiger and Marsden carried out an experiment to investigate the scattering of alpha-particles. Fig. 11.1 shows a diagram of the apparatus that they used.

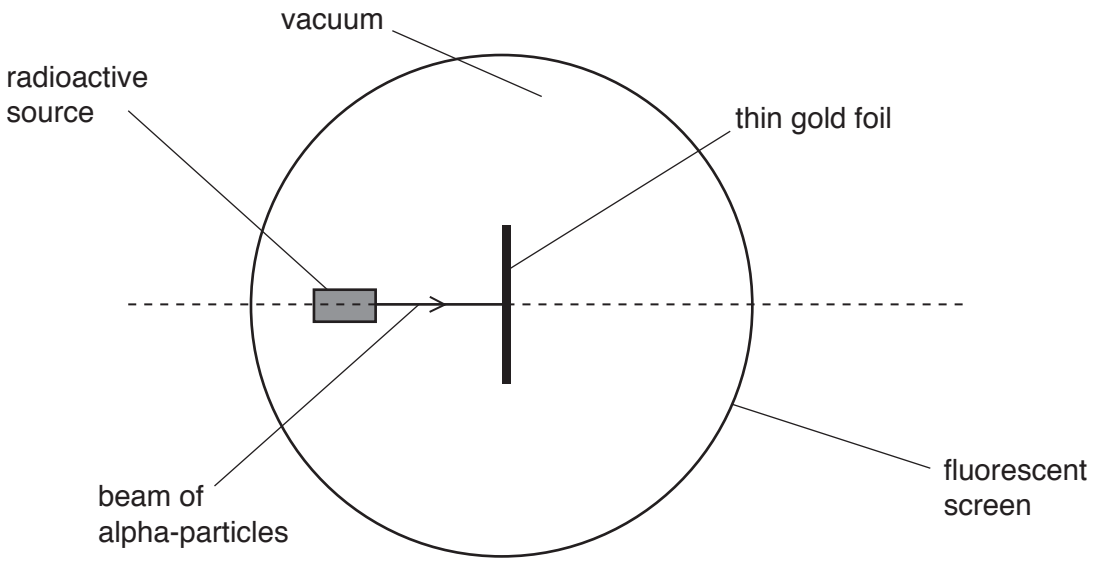


Fig. 11.1

When an alpha-particle strikes the fluorescent screen a flash of light is emitted.

(i) On Fig. 11.1, mark with a letter P where most flashes occur on the screen. [1]

(ii) Describe what is seen on the other parts of the screen.

.....

..... [1]

(iii) State two conclusions about atoms of gold that resulted from this experiment.

.....

.....

.....

..... [2]

[Total: 15]

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