UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4818907602

PHYSICS **5054/21**

Paper 2 Theory **May/June 2011**

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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, 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.

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.

DC (NF/DJ) 31813/4
© UCLES 2011

Section A

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

1 Fig. 1.1 shows the speed-time graph for a car.

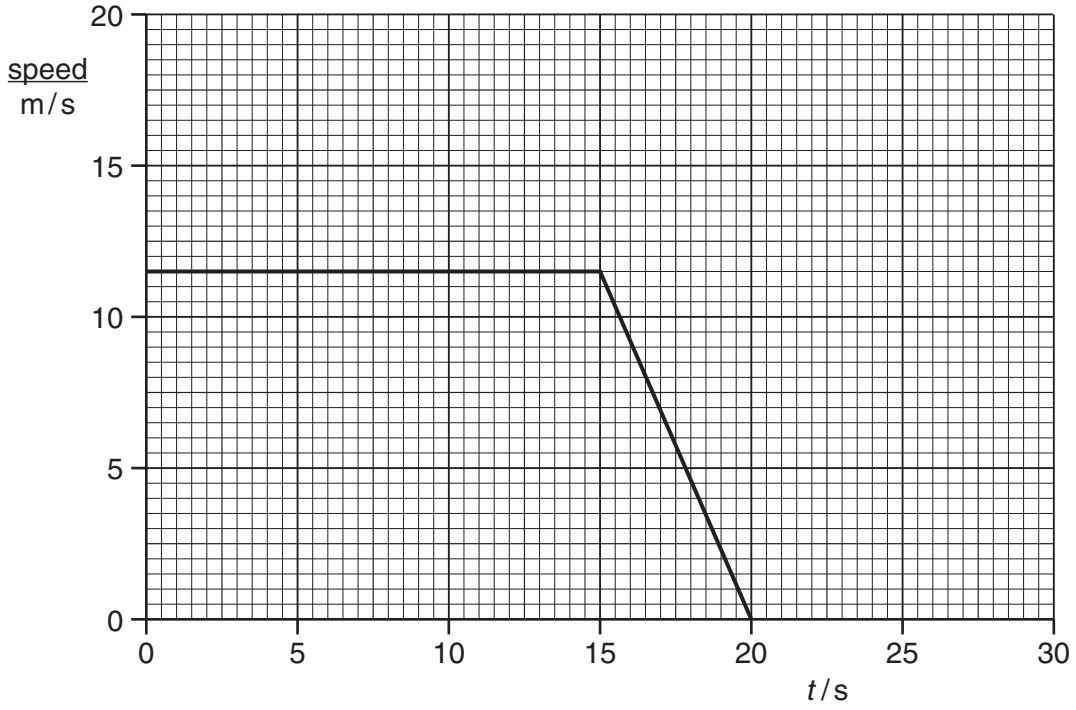


Fig. 1.1

At time $t = 15$ s, the brakes are applied and the car comes to rest with uniform deceleration.

(a) (i) State the speed of the car just before the brakes are applied.

speed = ... [1]

(ii) Explain what is meant by *uniform deceleration*.

.....

.....

..... [2]

(b) A lorry travels at a constant speed of 18 m/s for 15 s. At time $t = 15$ s, the brakes are applied and the lorry slows down with the same deceleration as the car.

(i) On Fig. 1.1, draw the speed-time graph for the lorry. [2]

(ii) Explain how your graph shows that, while braking, the lorry travels further than the car.

.....

..... [1]

© UCLES 2011

2 Fig. 2.1 shows a sky-diver falling vertically downwards at terminal velocity.

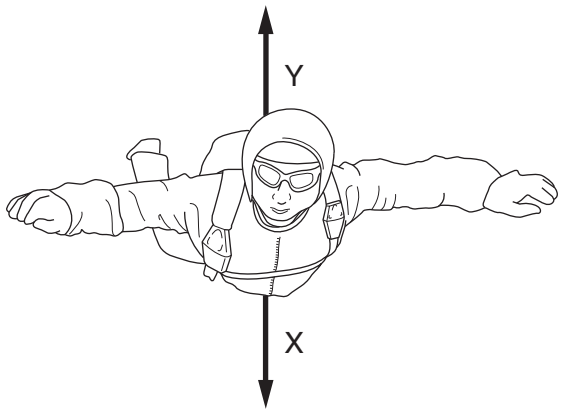


Fig. 2.1

Arrows X and Y show the two main forces acting on the sky-diver.

(a) (i) State the name of force X and the name of force Y.

X .....

Y .....
[1]

(ii) Explain why force Y acts upwards.

.....

..... [1]

(b) When the sky-diver first started to fall, forces X and Y were unbalanced.

(i) Describe and explain the effect of the unbalanced forces on the motion of the sky-diver.

.....

.....

..... [2]

(ii) State what happened to the size of force X and the size of force Y as the sky-diver fell and reached terminal velocity.

.....

..... [2]

3 Fig. 3.1 shows part of a small hydroelectric system that generates electricity from moving water.

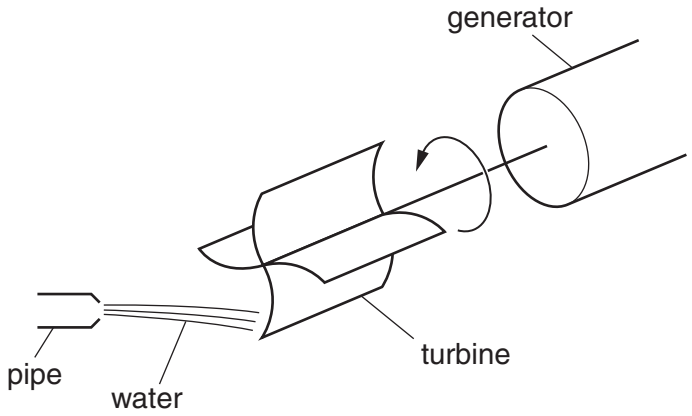


Fig. 3.1

(a) Every minute, water with kinetic energy 14 000 J emerges from the pipe. The water turns a turbine that is connected to the generator.
Half of the kinetic energy of the water is given to the generator.

(i) Calculate the power input to the generator.

power = ... [3]

(ii) Suggest a reason why only some of the kinetic energy of the water is given to the generator.

.....

..... [1]

(b) Hydroelectric systems use sources of renewable energy.

(i) State what is meant by *renewable energy*.

.....

..... [1]

(ii) State one source of **non**-renewable energy.

..... [1]

© UCLES 2011

4 Water at a temperature of 16 °C enters an ice-making machine and emerges as ice cubes at a temperature of –5 °C. The melting point of ice is 0 °C.

(a) Calculate the total energy removed from 1.0 kg of water as it cools from 16 °C, changes into ice, and then cools to –5 °C.

specific heat capacity of liquid water $= 4.2 \times 10^3$ J/(kg °C)
specific latent heat of fusion of water $= 3.4 \times 10^5$ J/kg
specific heat capacity of ice $= 2.1 \times 10^3$ J/(kg °C)

energy = ... [3]

(b) Using ideas about molecules,

(i) explain why energy is needed to change ice into water,

.....

.....

..... [1]

(ii) suggest why less energy is needed to change ice into water than to change the same mass of water into steam.

.....

.....

..... [1]

5 The fluorescent tube shown in Fig. 5.1 converts electrical energy into light more efficiently than a filament lamp.

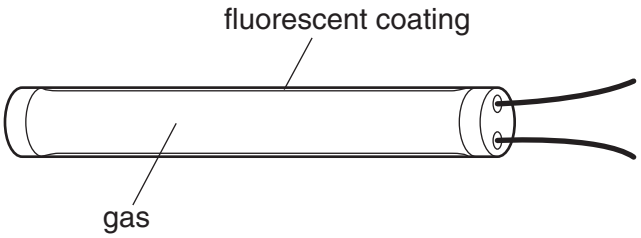


Fig. 5.1

In the gas inside the tube, both light and ultra-violet radiation are produced.

There is a fluorescent coating on the inside surface of the tube.

(a) Explain the purpose of the fluorescent coating.

.....

.....

..... [2]

(b) State the name of one region of the electromagnetic spectrum with wavelengths shorter than ultra-violet radiation.

..... [1]

(c) The ultra-violet radiation inside the tube has a wavelength of 3.6×10^{-7} m. Calculate the frequency of the ultra-violet radiation.
(speed of light = 3.0×10^{8} m/s)

frequency = ... [2]

© UCLES 2011

6 Fig. 6.1 shows a bat.

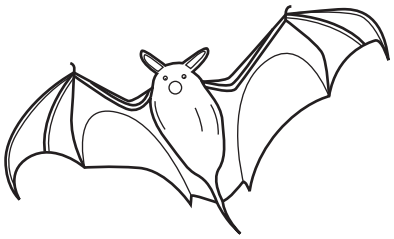


Fig. 6.1

Bats emit short bursts of ultrasound. The echoes of the ultrasound help the bat find insects and prevent the bat flying into objects.

(a) State what is meant by an *echo*.

.....

..... [1]

(b) Fig. 6.2 shows the variation with time of air pressure caused by a burst of ultrasound.

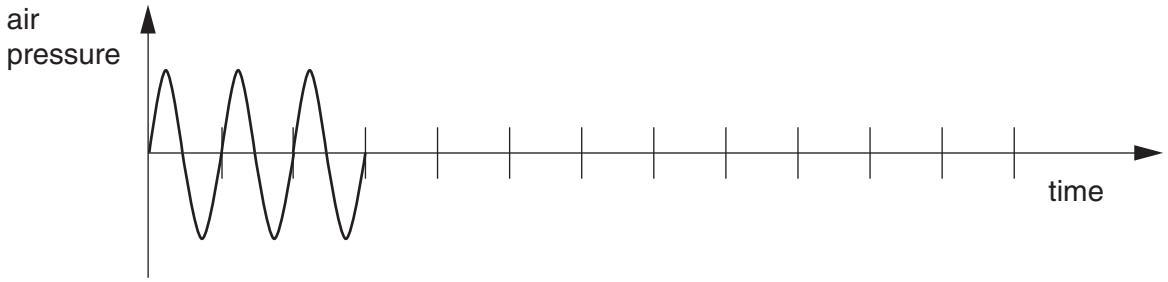


Fig. 6.2

On Fig. 6.2, draw a possible echo formed by this burst of ultrasound. [2]

(c) State

(i) the approximate range of frequencies of sound audible to humans,

..... [1]

(ii) how the frequency of ultrasound differs from frequencies in this audible range.

.....

..... [1]

7 Fig. 7.1 shows the structure of a circuit-breaker that uses an electromagnet. The circuit-breaker operates when the current is 10 A.

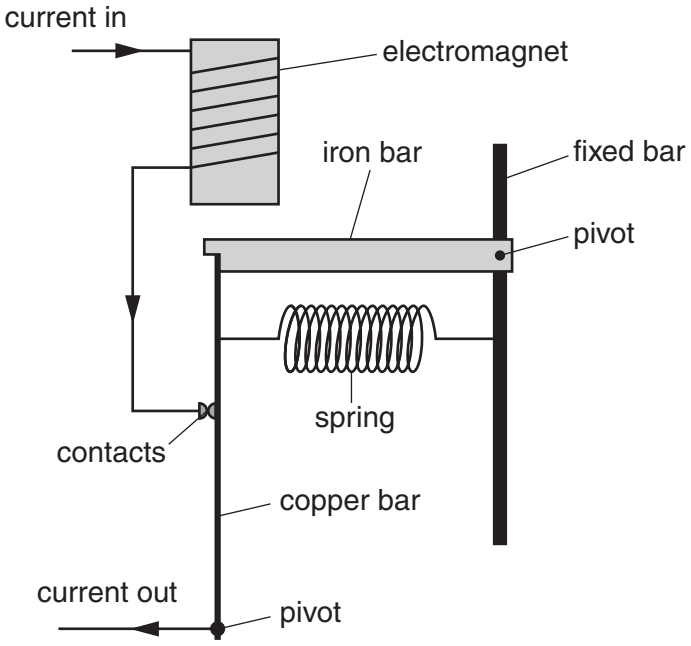


Fig. 7.1

(a) On Fig. 7.1, mark with an arrow the force on the iron bar caused by the electromagnet. [1]

(b) Suggest one reason why the iron bar does not move when the current is less than 10 A.

.....

..... [1]

(c) When the current is greater than 10 A, the circuit-breaker stops the current. Explain what happens in the circuit-breaker when this occurs.

.....

.....

.....

..... [3]

(d) State and explain how the electromagnet can be altered so that the circuit-breaker stops the current at less than 10 A.

.....

.....

..... [2]

© UCLES 2011

8 **(a)** A wire carrying a current in a magnetic field experiences a force due to the current. On Fig. 8.1, insert the words **current**, **field** and **force** in the boxes to show the relative directions of the current, the magnetic field and the force.

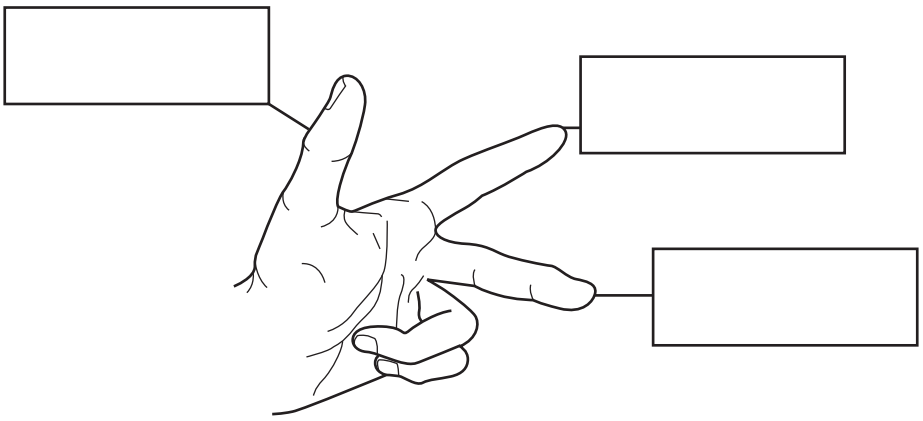


Fig. 8.1

[1]

(b) Fig. 8.2 shows a current-carrying coil ABCD in a magnetic field.

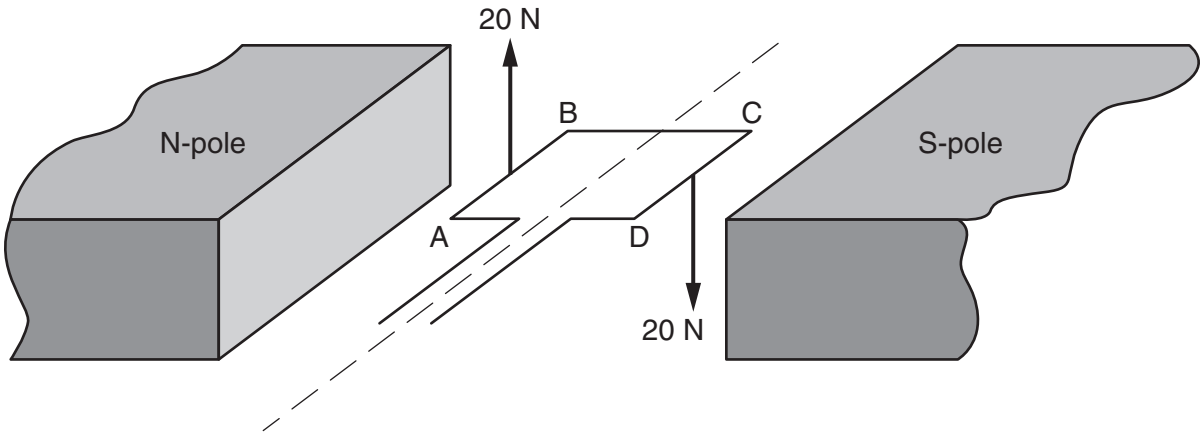


Fig. 8.2

Each side of the coil is 4.0 cm in length. The force on AB is 20 N and the force on CD is 20 N.

(i) Calculate the total moment caused by these forces.

moment = ... [2]

(ii) The moment is increased by using a stronger magnetic field.

State two other ways to increase the moment.

1. .....

2. .....

[2]

Section B

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

9 Fig. 9.1 shows a rotating magnet in an alternating current generator that is used to power a lamp.

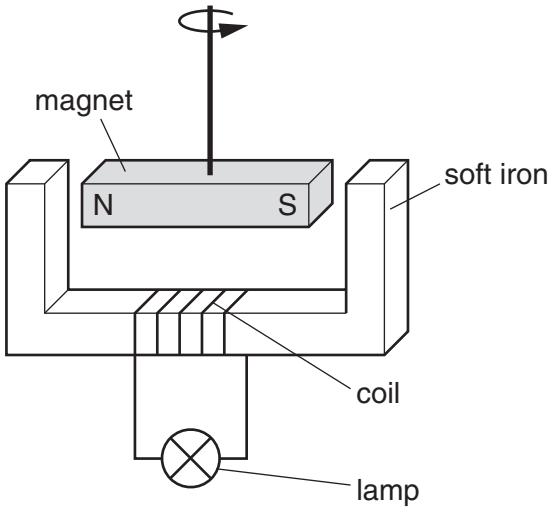


Fig. 9.1

(a) (i) State how an *alternating* current differs from a *direct* current.

.....

.....

..... [1]

(ii) Explain, in detail, how **alternating** current is produced by the apparatus shown in Fig. 9.1.

.....

.....

.....

.....

.....

..... [4]

(iii) State two ways in which the current in the lamp may be increased.

1. .....

2. .....

[2]

© UCLES 2011

(b) The generators at a power station produce a voltage of 25 000 V. This voltage is stepped up to 400 000 V by a transformer for long-distance transmission on overhead power lines. The voltage is later stepped down to 240 V.

(i) State and explain why the voltage is stepped up for long-distance transmission.

.....

.....

..... [2]

(ii) Calculate the ratio of the number of turns in the primary coil of the step-up transformer to the number of turns in its secondary coil.

ratio = ... [1]

(iii) State one advantage and one disadvantage of using thicker wire in the overhead power lines.

advantage: .....

.....

disadvantage: .....

.....
[2]

(iv) An electric drill of power 1000 W is used in a country where the mains voltage is 240 V.
State and explain the most appropriate fuse to use with this drill.
You should select a fuse from the following values: 1 A, 3 A, 4 A, 13 A.

.....

.....

.....

..... [3]

10 (a) A 1500 Ω resistor is used on an electronic circuit board in a television.

Fig. 10.1 shows the bands on a resistor.

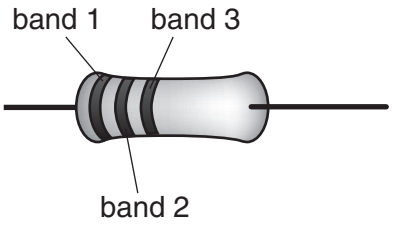


Fig. 10.1

digit or multiplier	colour
0	black
1	brown
2	red
3	orange
4	yellow
5	green
6	blue
7	violet
8	grey
9	white

Fig. 10.2

The table of Fig. 10.2 shows the colour code for the bands.

(i) State the colours of the bands on a 1500 Ω resistor.

band 1 .....

band 2 .....

band 3 .....

[2]

(ii) Determine the maximum value of resistance that can be shown with this three-band colour code.

resistance = ... [1]

(iii) The 1500 Ω resistor on the electronic circuit board has a correct power rating of 0.25 W.

State a disadvantage of using a different 1500 Ω resistor with a power rating that is

1. much less than 0.25 W,

.....

..... [1]

2. much greater than 0.25 W.

.....

..... [1]

© UCLES 2011

(b) Fig. 10.3 shows part of a circuit that includes a variable resistor R and a battery of e.m.f. 9.0 V.

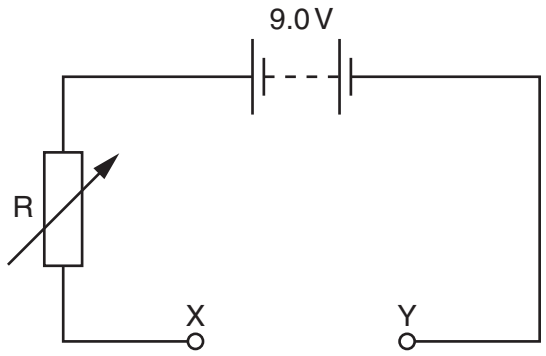


Fig. 10.3

(i) State one similarity and one difference between electromotive force (e.m.f.) and potential difference (p.d.).

similarity: .....

.....

difference: .....

.....

[3]

(ii) A light-emitting diode (LED) is connected between points X and Y, so that it emits light.

On Fig. 10.3, draw the symbol for the LED connected between points X and Y. [2]

(iii) The resistance of R is increased. State what happens to the p.d. across the LED and to the current in the LED.

p.d.: .....

current: .....

[1]

(iv) The LED is marked "maximum current 25 mA when the p.d. is 1.7 V".

Calculate the minimum value of the resistance of R.

resistance = ... [4]

© UCLES 2011

[Turn over

11 An atom of one isotope of sodium contains 11 protons, 13 neutrons and 11 electrons.

(a) **(i)** State the nucleon number (mass number) of this isotope.

..... [1]

(ii) Explain why the number of protons is equal to the number of electrons in a neutral atom.

.....

..... [1]

(b) A nucleus of this isotope undergoes radioactive decay by the emission of a beta-particle.

(i) State the energy change that occurs during radioactive decay.

.....

..... [2]

(ii) Complete the nuclear equation that represents this decay by filling in the appropriate numbers in the blank spaces. Na is the chemical symbol for sodium.

$$\overset{\cdots\cdots}{\underset{11}{\cdots\cdots}}\mathrm{Na} \rightarrow \overset{\cdots\cdots}{\underset{\cdots\cdots}{\cdots\cdots}}\beta + \overset{\cdots\cdots}{\underset{\cdots\cdots}{\cdots\cdots}}\mathrm{Mg} \qquad [4]$$

(c) At the start of an experiment, the count rate due to a sample of this isotope of sodium is found to be 1200 counts per minute. This is shown on Fig. 11.1 by a point plotted at time $t = 0$.

The half-life of this isotope is 15 hours.

(i) On Fig. 11.1, draw a smooth line to show how the count rate is expected to change between $t = 0$ and $t = 30$ hours. [3]

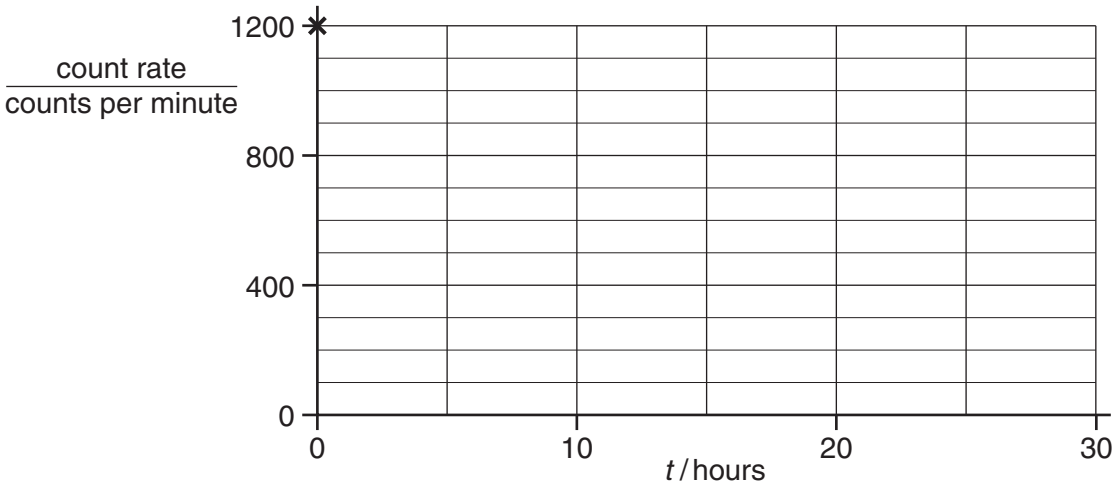


Fig. 11.1

(ii) Explain why readings taken in an actual experiment may not follow a smooth line.

.....

..... [1]

(iii) Determine the count rate due to this isotope 30 hours before the start of the experiment.

count rate = ... [1]

(iv) In the space below, draw a labelled diagram of the apparatus used to measure the count rate of the radioactive isotope.

[2]

© UCLES 2011

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© UCLES 2011