UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICS **5054/22**

Paper 2 Theory **October/November 2013**

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 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.

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 **15** printed pages and **1** blank page.

Section A

For Examiner's Use

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

1 A set of traffic lights hangs from the end of a metal cable. A horizontal chain pulls the traffic lights to the right so that they are above the middle of the road. Fig. 1.1 shows the metal cable inclined to the vertical.

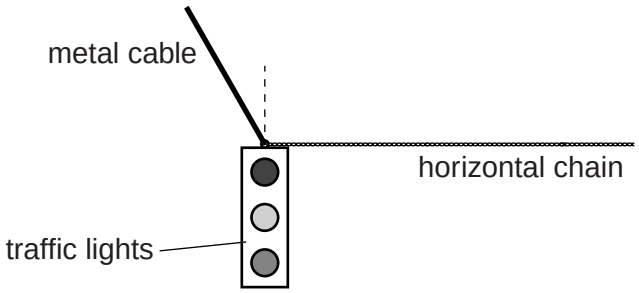

Fig. 1.1

The weight of the traffic lights is 240 N.

(a) Two of the forces on the traffic lights are the tension in the horizontal chain and the weight of the traffic lights.

On Fig. 1.1, mark

(i) an arrow that represents the tension in the horizontal chain, [1]

(ii) an arrow that represents the weight of the traffic lights. [1]

(b) The tension in the horizontal chain is 140 N. Use a scale diagram to determine the size of the resultant of the weight and the tension in the chain. State the scale used for the diagram.

scale = ...

resultant force = ...

[3]

2 Fig. 2.1 shows a boy moving a water container in a wheelbarrow.

For Examiner's Use

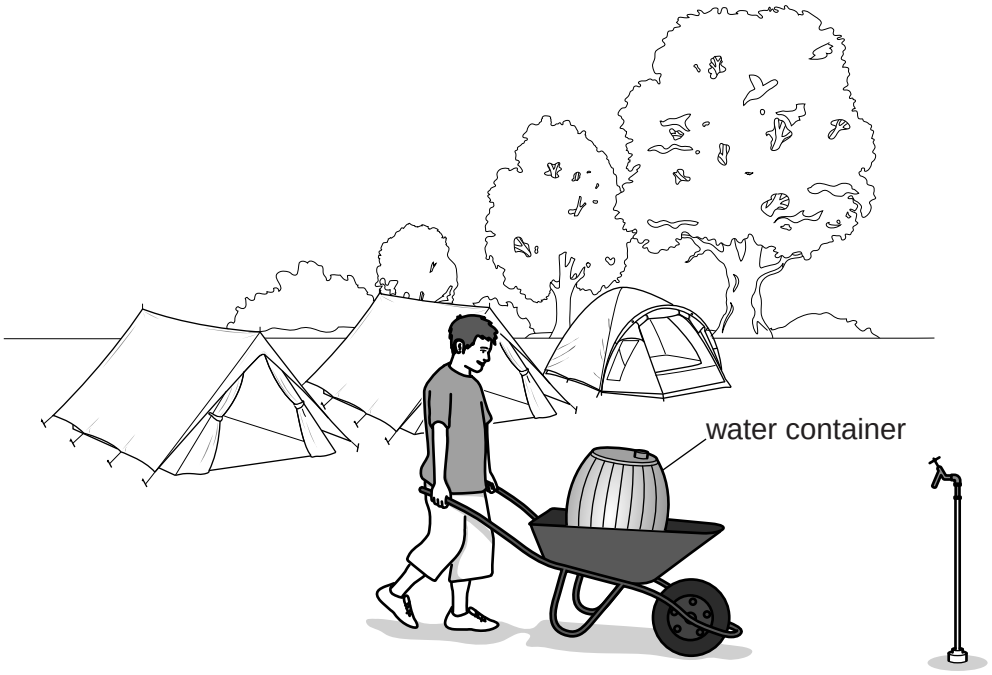

Fig. 2.1

The container has a volume of 0.15 m^3 and is filled with water of density 1000 kg/m^3.

(a) Calculate the mass of water in the container when it is full.

mass = ...[2]

(b) It is harder to stop the wheelbarrow when the container is full than when it is empty.

Explain this.

.....

.....

.....[2]

3 A farmer uses a hydraulic system to operate machinery that is pulled behind a tractor.

For Examiner's Use

Two cylinders and the flexible pipe that joins them contain oil. Two pistons keep the oil in the cylinders. The arrangement is shown in Fig. 3.1.

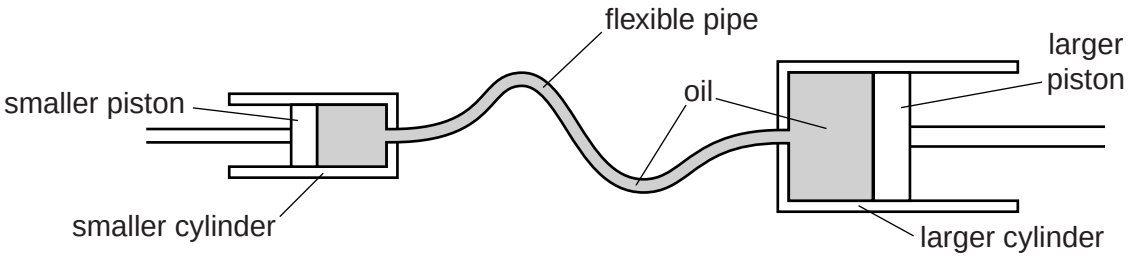

Fig. 3.1

The cross-sectional area of the smaller cylinder is 0.048 m^2.
The cross-sectional area of the larger cylinder is 0.14 m^2.

The smaller piston exerts a force of 12 000 N on the oil.

(a) Calculate

(i) the pressure in the oil,

pressure = ...[2]

(ii) the force exerted by the oil on the larger piston.

force = ...[1]

(b) Suggest why the resultant force on the larger piston is less than the value obtained in **(a)(ii)**.

.....

.....[1]

(c) The smaller piston moves a distance of 0.065 m into the cylinder.

Calculate the work done on the oil by the smaller piston.

work done = ...[2]

(d) Suggest one advantage of using oil rather than air in the system.

.....[1]

4 A large test-tube contains wax above its melting point. It is placed in a cool room.

For Examiner's Use

Fig. 4.1 shows how the temperature *T* of the wax changes in a time of 30 minutes.

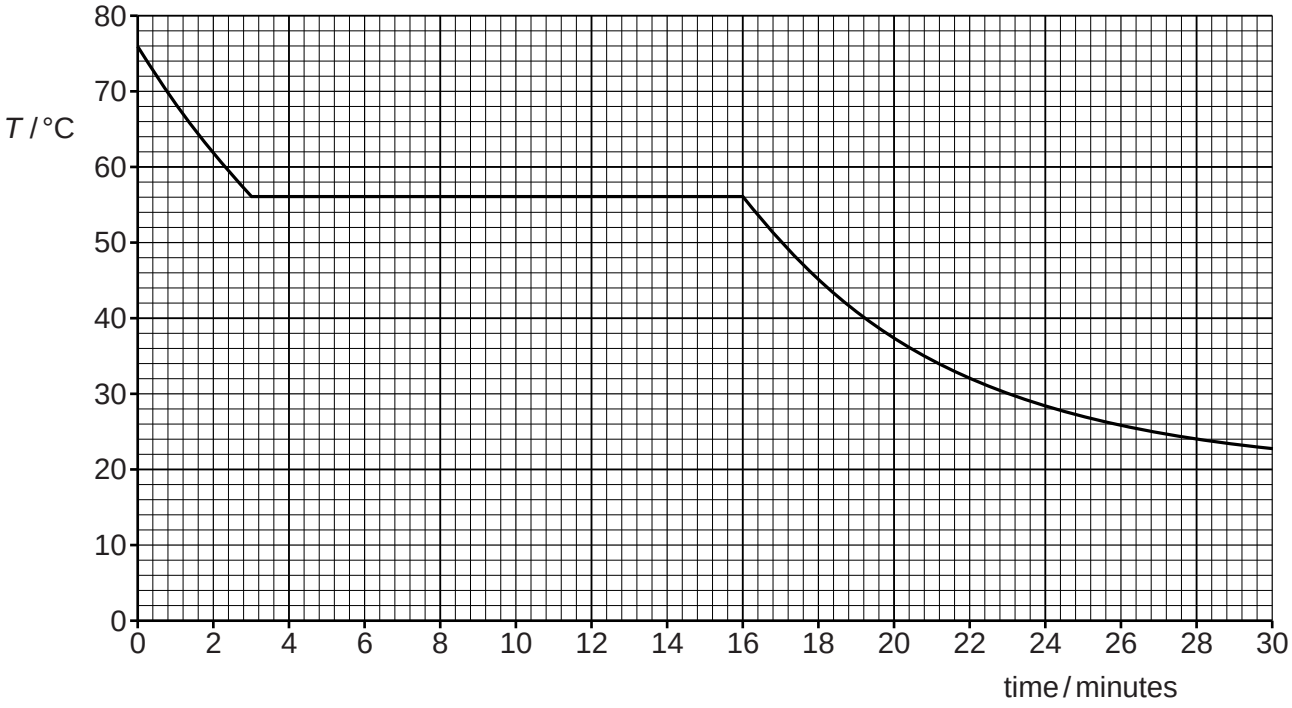

Fig. 4.1

(a) Determine the melting point of the wax.

melting point = ...[1]

(b) The test-tube contains 110 g of wax that has a specific latent heat of fusion of 210 J / g.

Calculate the thermal energy transferred from the wax between 3 and 16 minutes.

energy = ...[2]

(c) **(i)** State what happens to the wax between 3 and 16 minutes.

.....[1]

(ii) Between 3 and 16 minutes, the temperature of the wax is above room temperature and energy is lost to the room.

Explain, in terms of molecules, why the temperature of the wax remains constant.

.....

.....

.....[2]

For Examiner's Use

5 A physics textbook states that sound is a longitudinal pressure wave with a frequency within the audible range.

(a) Explain what is meant by a *longitudinal wave*.

.....

.....

.....[2]

(b) **(i)** State the approximate range of audible frequencies.

highest frequency: .....

lowest frequency: .....
[2]

(ii) The speed of sound in air is 330 m / s. Using your answer in **(i)**, calculate the shortest wavelength in air of sound in the audible range.

wavelength = ...[2]

6 At an airport, fuel is pumped through a pipe from a tanker to an aeroplane, as shown in Fig. 6.1.

For Examiner's Use

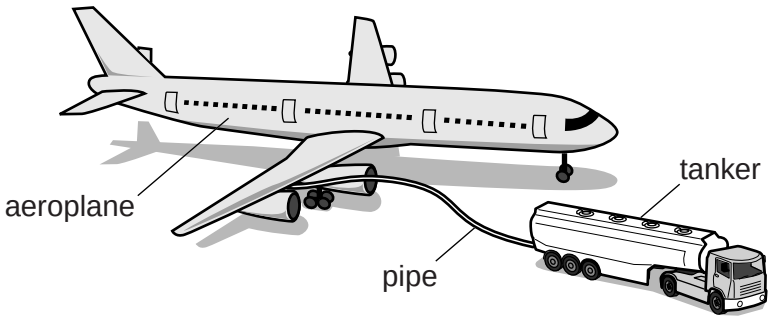

Fig. 6.1

As it rubs against the pipe, the fuel becomes negatively charged and this charges the aeroplane.

(a) Explain, in terms of the particles involved, how the fuel becomes negatively charged.

.....

.....

.....[2]

(b) Suggest and explain one problem that can arise when an aeroplane becomes charged.

.....

.....

.....[2]

(c) To prevent an aeroplane becoming charged, a metal cable connects the aeroplane to the ground.

Explain

(i) why the cable is made of metal,

.....

.....[1]

(ii) how the cable prevents the aeroplane becoming charged.

.....

.....[1]

[Turn over

For Examiner's Use

7 An electric saw is rated at 1200 W. When working on a job that lasts for four days, a workman uses the saw, on average, for 75 minutes each day. The cost of 1 kW h of electrical energy is 21 cents.

(a) Calculate the cost of using the saw for this job.

cost = ...[3]

(b) The metal case of the electric saw is earthed.

Explain how this protects the workman.

.....

.....

.....[2]

8 A smoke detector containing an alpha-particle source is fixed to the ceiling in a room. The alpha-particles ionise the air between two metal plates so that a battery produces a current between the plates.

For Examiner's Use

If smoke enters the detector, it reduces the current between the plates and an alarm sounds.

Fig. 8.1 shows the arrangement.

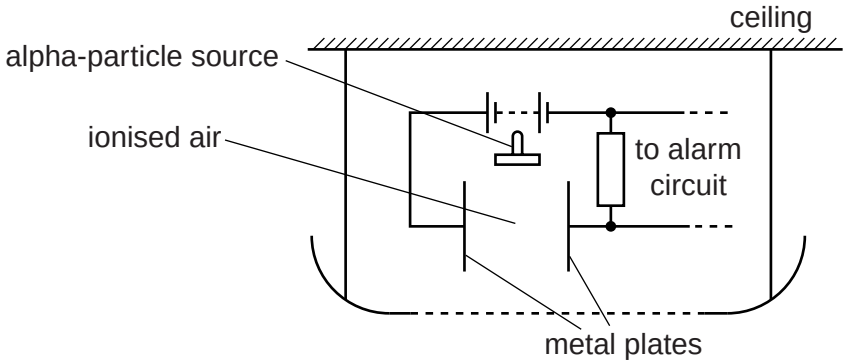

Fig. 8.1

(a) A technician removes the source from the smoke detector and measures the count rate of the source.

(i) Suggest two precautions that the technician should take when working with the source.

1. .....

2. .....

[2]

(ii) The technician measures the count rate, in counts / s, five times. On each occasion, the arrangement of the equipment is the same.

The values obtained are: 81 77 80 83 and 79.

Suggest why the values are different.

.....

.....[1]

(b) Radioactive sources that emit beta-particles or gamma-rays are not used in smoke detectors. State and explain two reasons for this.

1. .....

.....

2. .....

.....

[3]

Section B

For Examiner's Use

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

9 **(a)** State what is meant by the *moment of a force*.

.....

.....[2]

(b) The anchor of a sailing ship has a mass of 350 kg. Six sailors raise the anchor from the sea-bed by turning a large axle. They push the handles attached to the axle and it rotates. The anchor is on the end of a chain that winds on to the rotating axle.

Fig. 9.1 shows the sailors lifting the anchor.

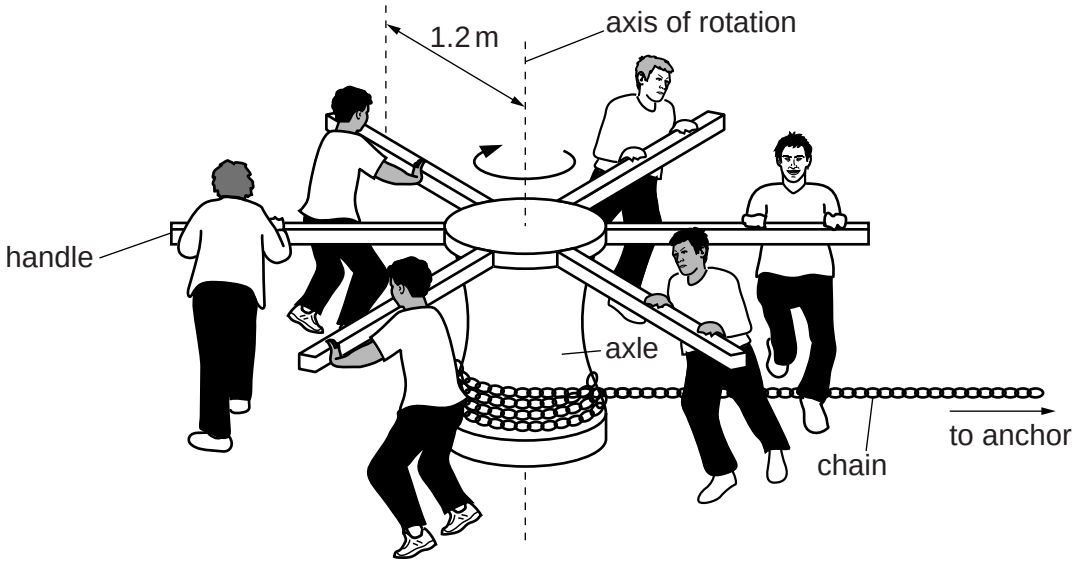

Fig. 9.1

Each of the sailors exerts a force of 750 N on his handle at a distance of 1.2 m from the axis of rotation. The axle rotates through one complete revolution and the anchor is lifted through a distance of 160 cm.

The gravitational field strength g is 10 N / kg.

(i) Calculate

1. the total moment exerted on the axle by the six sailors,

moment = ...[2]

2. the gravitational potential energy gained by the anchor as the axle rotates through one complete revolution.

For Examiner's Use

energy = ...[3]

(ii) The work done on the axle by the sailors is very much larger than the gravitational potential energy gained by the anchor.

State and explain how energy is wasted.

.....

.....

.....[2]

(iii) Explain why the power produced by the sailors is larger when the anchor is lifted at a faster rate.

.....

.....[2]

(c) Describe, with the aid of a labelled diagram, how to verify the principle of moments.

.....

.....

.....

.....

.....

.....[4]

10 Fig. 10.1 shows an electric train of mass 5.5×10^5 kg.

For Examiner's Use

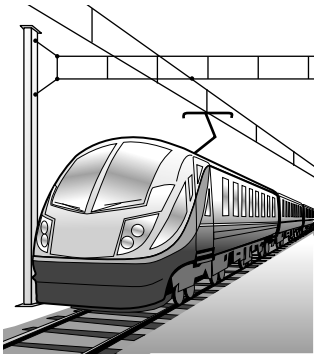

Fig. 10.1

The train is initially at rest. The electric motor exerts a constant force and the train accelerates. Its acceleration decreases until the train reaches a speed of 40 m/s.

The train then continues at this constant speed.

(a) (i) On the axes in Fig. 10.2, sketch a speed-time graph for the train.

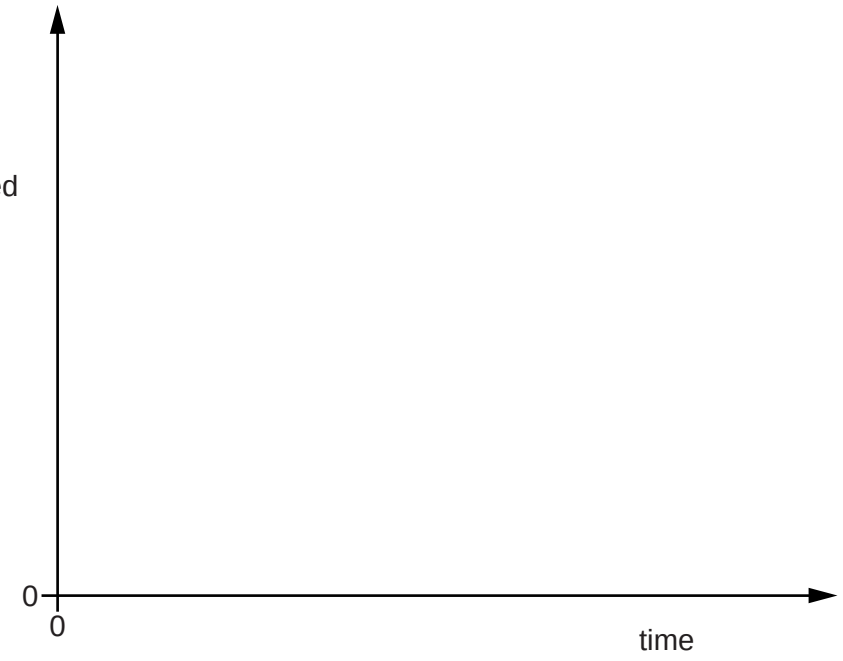

Fig. 10.2

[3]

(ii) Describe how the speed-time graph for the train is used to determine the distance travelled by the train when it is accelerating.

.....

.....

.....[2]

(b) Explain, in terms of the forces acting,

For Examiner's Use

(i) why the acceleration of the train decreases,

.....

.....

.....[2]

(ii) why the train eventually reaches constant speed.

.....

.....[1]

(c) **(i)** Calculate the kinetic energy of the train when it is travelling at a speed of 40 m/s.

kinetic energy = ...[3]

(ii) As the train accelerates to 40 m/s, electrical energy supplied to the motor is converted into kinetic energy of the train. The efficiency of this process is 0.40 (40 %).

Calculate the electrical energy supplied to the motor.

energy = ...[2]

(iii) The electrical energy is generated in an oil-fired power station. Chemical energy in oil is converted into the electrical energy supplied to the motor.

Suggest two places where energy is lost as heat in this process.

1. .....

2. .....

[2]

11 A metal filament lamp is connected to a power supply. The electromotive force (e.m.f.) produced by the supply can be varied. Fig. 11.1 is the circuit diagram.

For Examiner's Use

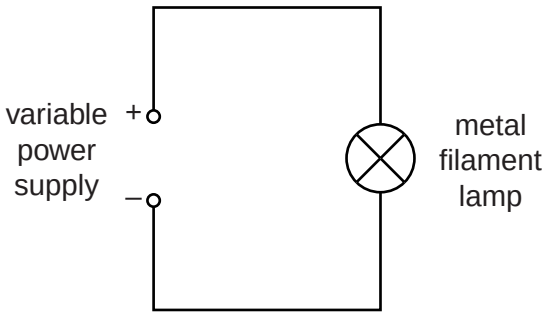

Fig. 11.1

(a) State what is meant by *electromotive force (e.m.f.)*.

.....

.....

.....[2]

(b) Add appropriate circuit symbols to Fig. 11.1 to show the position of

(i) an ammeter that measures the current in the circuit, [1]

(ii) a voltmeter that measures the voltage across the lamp. [1]

(c) A student adds meters to the circuit and makes measurements of the current and voltage. He then plots the current/voltage graph shown in Fig. 11.2.

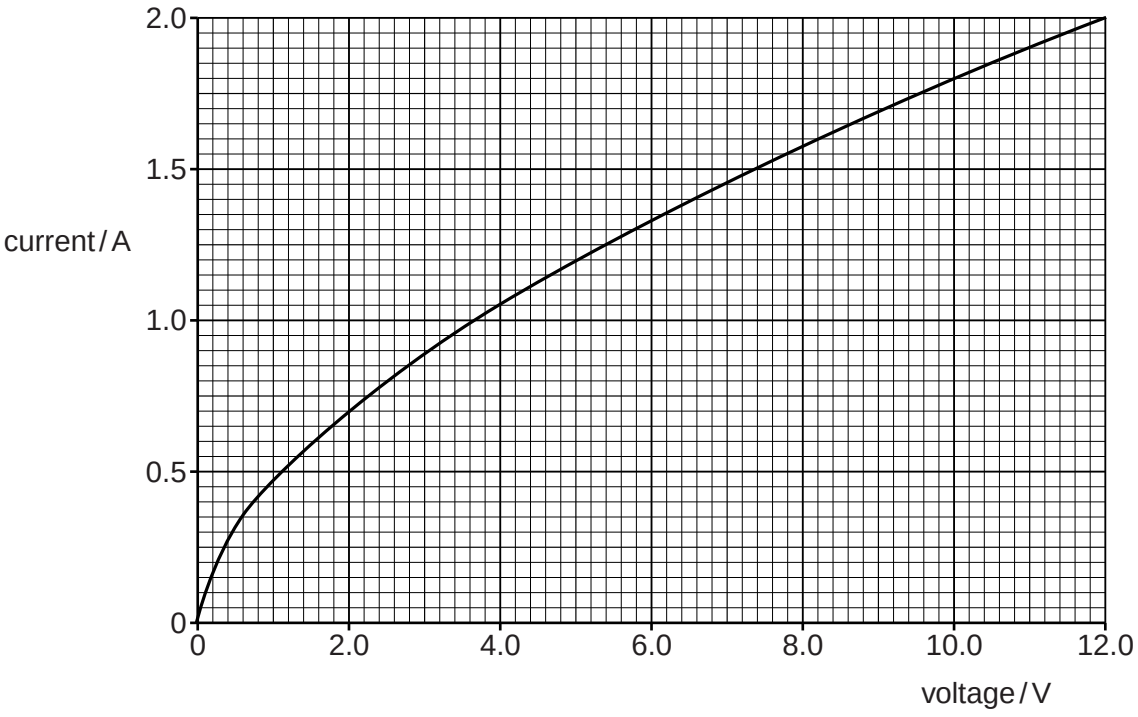

Fig. 11.2

(i) Using values from Fig. 11.2, calculate the resistance of the lamp when the current is 0.70 A. Give your answer to an appropriate number of significant figures.

resistance = ...[3]

(ii) State what, if anything, happens to the resistance of the lamp as the voltage increases.

.....

.....[1]

(d) In normal use, the lamp is connected to a 12V supply.

Use Fig. 11.2 to determine the power of the lamp when it is used in this way.

power = ...[2]

(e) When connected to a 12V supply, thermionic emission occurs in the lamp.

(i) Describe what is meant by *thermionic emission*.

.....

.....

.....[2]

(ii) Thermionic emission is used in a cathode-ray oscilloscope (c.r.o.) tube.

1. State why air must be removed from the tube of the c.r.o.

.....

.....[1]

2. A voltage is connected across the Y-plates in the c.r.o.

State and explain the effect on the trace on the screen.

.....

.....

.....[2]

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