Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

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PHYSICS **5054/21**

Paper 2 Theory **October/November 2014**

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 **17** printed pages and **3** blank pages.

Section A

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

1 Fig. 1.1 shows a motorcycle during a race.

Fig. 1.1

The motorcycle accelerates along a straight section of the track from a speed of 40 m/s to maximum speed.

Fig. 1.2 is the speed-time graph for the motorcycle along the straight section of the track.

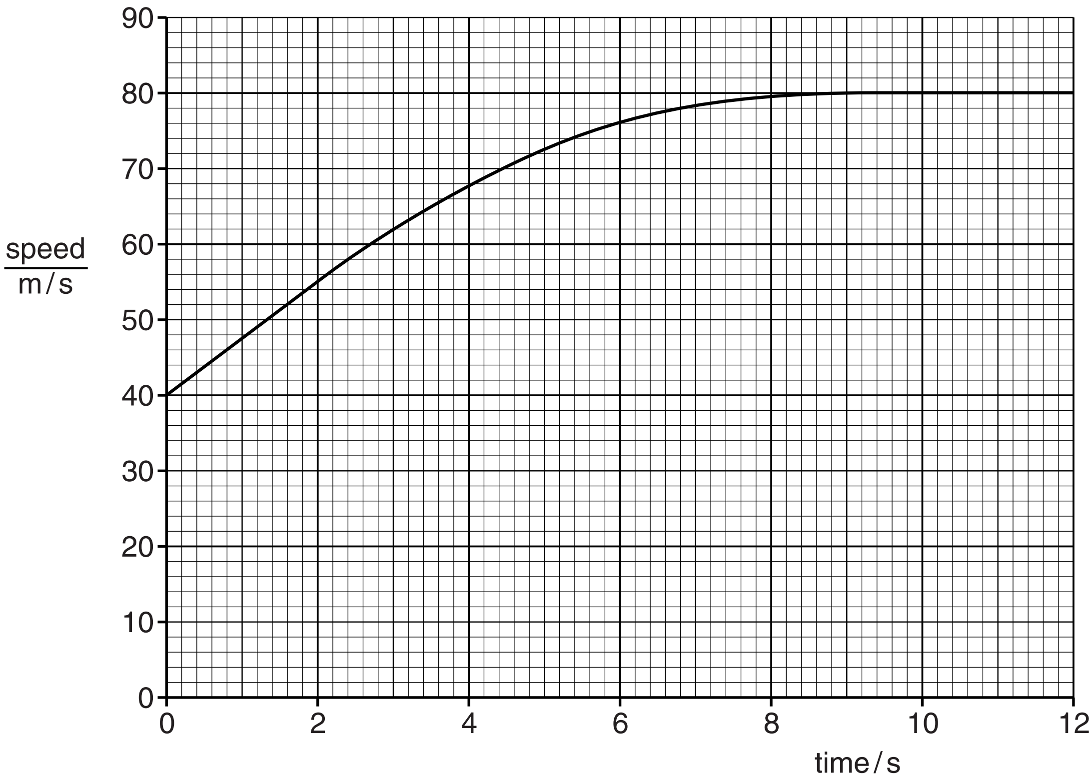

Fig. 1.2

The mass of the motorcycle is 180 kg.

(a) For the time 0 to 2.0 s, determine

(i) the acceleration of the motorcycle,

acceleration = ...[2]

(ii) the resultant force acting on the motorcycle.

force = ...[2]

(b) The driving force acting on the motorcycle remains constant throughout the 12 s spent on the straight section of track.

(i) Using Fig. 1.2, describe how the acceleration of the motorcycle changes during this time.

....

....[1]

(ii) Explain, in terms of the forces acting, why the acceleration changes in this way.

....

....

....

....[3]

2 A student places a metre rule on the edge of a triangular prism. The prism is used as a pivot and the rule balances about the 50 cm mark.

The student then places a block of wood at the 10 cm mark on the rule and an empty measuring cylinder at the 80 cm mark. The rule is still balanced. Fig. 2.1 shows the arrangement.

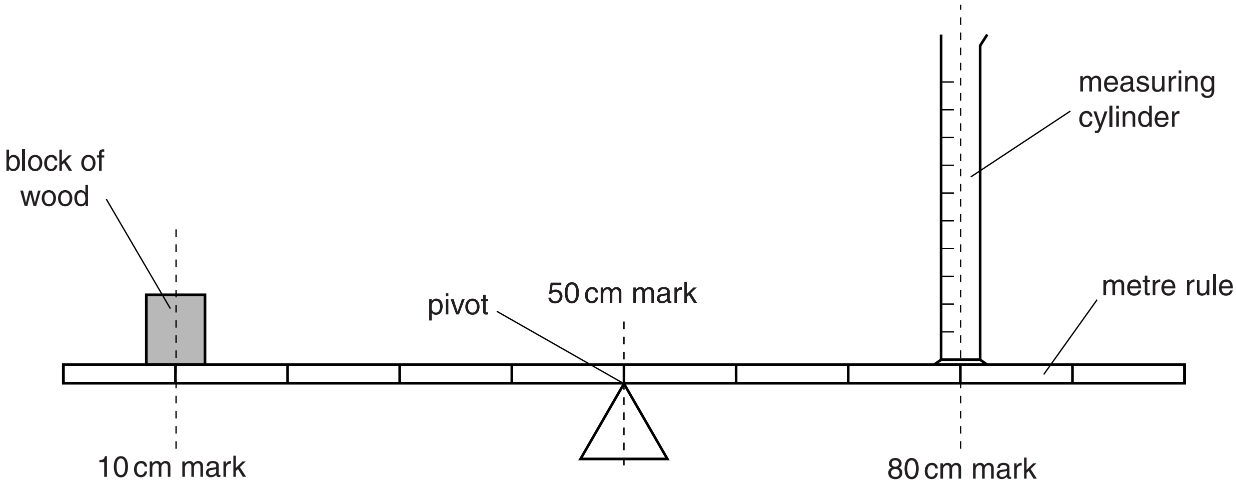

Fig. 2.1 (not to scale)

The student now places a weight of 0.39 N on top of the block of wood. She then starts to pour oil into the measuring cylinder. The rule balances again when there is 60 cm^3 of oil in the measuring cylinder.

The gravitational field strength *g* is 10 N/kg.

(a) Calculate

(i) the weight of the oil in the cylinder,

weight = ...[2]

(ii) the mass of the oil in the cylinder.

mass = ...[1]

(b) Calculate the density of the oil.

density = ...[2]

3 Before a small, inflatable boat is used, air is pumped into its rubber chamber.

Fig. 3.1 shows a man using an air pump to inflate the boat.

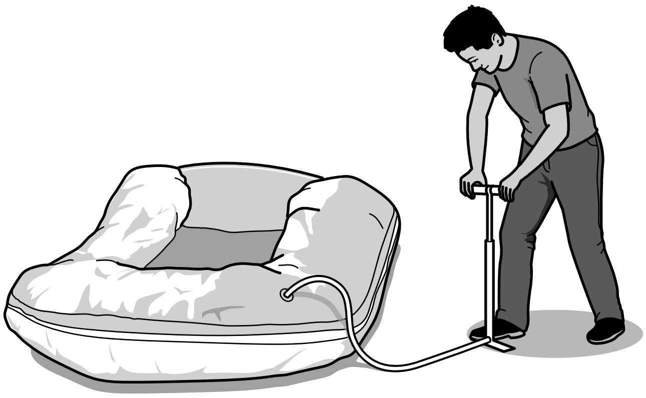

Fig. 3.1

Before the man starts to use the pump, the air in the vertical cylinder of the pump is at atmospheric pressure.

(a) Explain, in terms of molecules, how the air inside the cylinder exerts a pressure.

....

....

....

....[3]

(b) When the boat is fully inflated, a valve is closed trapping the air in the rubber chamber. The air pump is disconnected.

The man sits on the side of the boat. The volume of the rubber chamber decreases and the pressure of the air in the rubber chamber increases. The temperature of the air stays constant.

Explain, in terms of molecules, why the pressure increases.

....

....

....[2]

4 Ripple tanks are often used to illustrate wave motion.

(a) Describe what is meant by *wave motion* in a ripple tank.

....

....

....[2]

(b) When describing wave motion, state what is meant by

(i) *frequency*,

....[1]

(ii) *wavelength*.

....

....[2]

(c) A water wave in a ripple tank strikes a barrier. Fig. 4.1 shows some wavefronts of the incident wave.

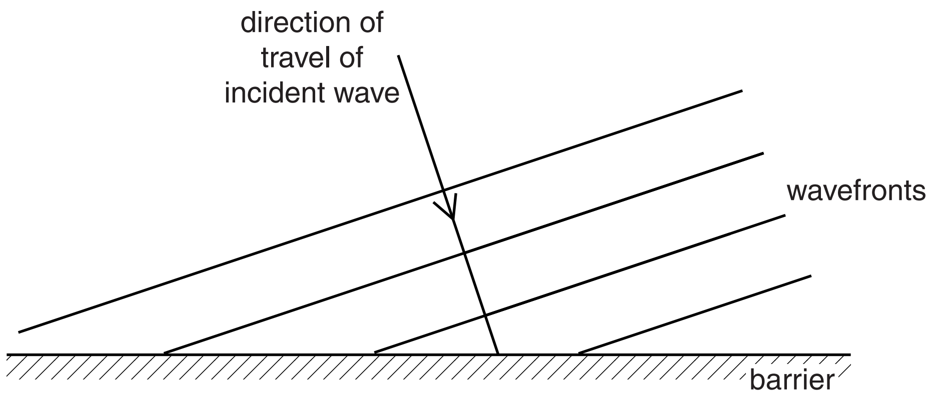

Fig. 4.1

The water wave hits the barrier and is reflected. Three of the wavefronts in Fig. 4.1 have already hit the barrier. The reflected parts of these wavefronts are not shown.

On Fig. 4.1, draw the reflected parts of these three wavefronts. [3]

5 The device shown in Fig. 5.1 uses the reflection of ultrasound to measure distances.

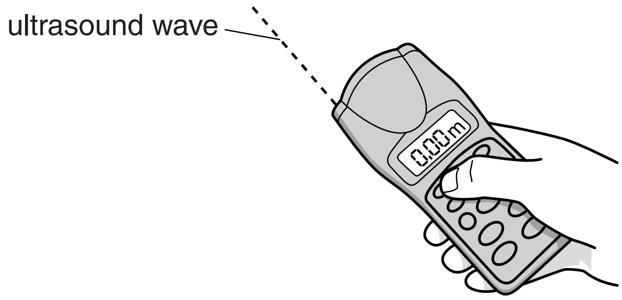

Fig. 5.1

(a) State what is meant by *ultrasound*.

....

....

....[2]

(b) Fig. 5.2 shows a builder using the ultrasound device to measure the width of a room.

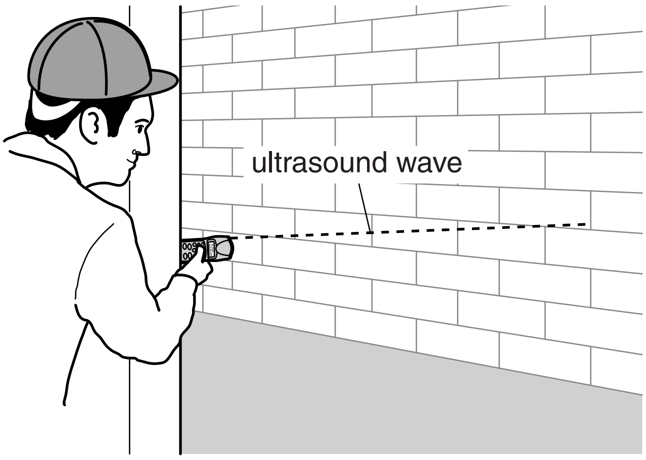

Fig. 5.2

The ultrasound device is placed against one wall and it emits an ultrasound wave that reflects back from the opposite wall.

The time between sending out the ultrasound wave and receiving the reflection is 0.030 s. The speed of ultrasound in air is 340 m/s.

Calculate the distance between the device and the opposite wall.

distance = ...[2]

6 The base of a storm cloud is negatively charged. Fig. 6.1 shows the cloud above flat ground.

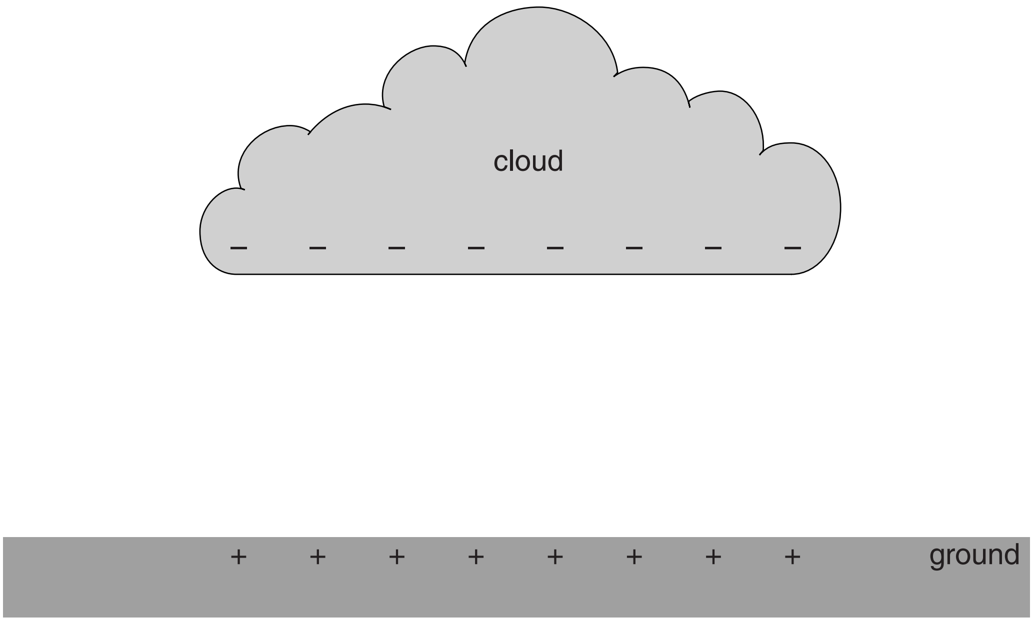

Fig. 6.1

(a) The cloud causes the ground beneath it to become positively charged.

Explain, in terms of the particles involved, how the ground becomes positively charged.

....

....

....[2]

(b) In the space between the negative charge on the cloud and the positive charge on the ground, there is an electric field.

State what is meant by an *electric field*.

....

....[1]

(c) A lightning strike takes place. In 0.0015 s, a charge of 180 C passes between the cloud and the ground.

Calculate the average current in the lightning strike.

current = ...[2]

7 A straight length of copper wire lies horizontally between the poles of a U-shaped magnet. Fig. 7.1 shows the two ends of the wire connected to a very sensitive, centre-zero ammeter.

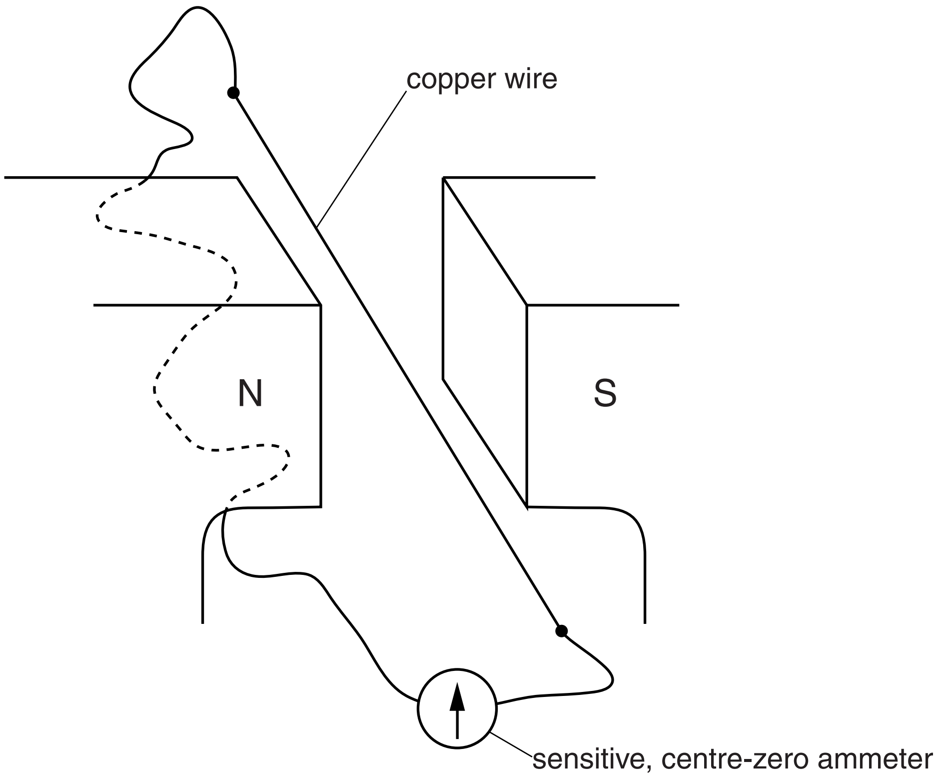

Fig. 7.1

The copper wire is moved upwards slowly between the two magnetic poles. The needle on the ammeter deflects to the right.

(a) Explain why the needle on the ammeter deflects.

....

....

....[2]

(b) The wire is moved downwards very quickly between the two magnetic poles.

State what happens to the needle on the ammeter.

....

....[1]

(c) State what happens to the needle on the ammeter when the copper wire is moved horizontally between the two poles.

....

....[1]

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8 The nuclide notation for the radioactive isotope boron-12 is $^{12}_{5}B$.

(a) In the space below, draw a labelled diagram to illustrate the structure of a neutral atom of this isotope. Show all the particles in the atom.

[4]

(b) As boron-12 decays, it emits a beta-particle. A new atom is produced.

Determine

(i) the proton number (atomic number) of the new atom,

proton number = ...[1]

(ii) the nucleon number (mass number) of the new atom.

nucleon number = ...[1]

Section B

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

9 Fig. 9.1 shows the dam and reservoir of a hydroelectric power station.

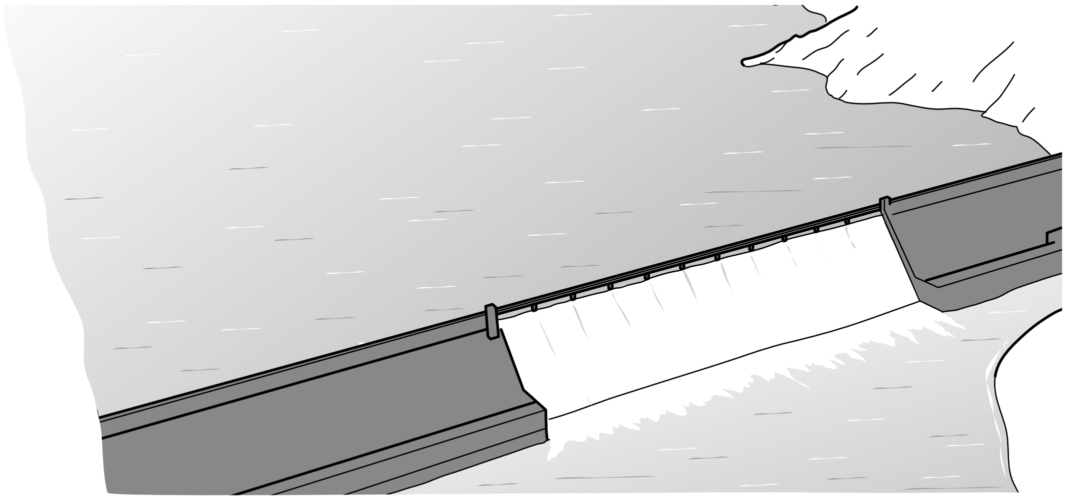

Fig. 9.1

A hydroelectric power station uses a renewable energy source.

(a) State two other renewable energy sources.

1. ....

2. ....
[2]

(b) When the power station operates at full capacity, the electrical power output is 6.8×10^9 W.

(i) **1.** Calculate the electrical energy output of the power station if it operates at full capacity for one year.

energy = ...[1]

2. Suggest why, in practice, the power station does not operate at full capacity throughout the year.

....

....[1]

(ii) The water surface in the reservoir that supplies the hydroelectric power station is at a vertical height of 170 m above the turbines. In one hour, 1.6×10^{10} kg of water flows from the reservoir through the turbines. The gravitational field strength *g* is 10 N / kg.

1. Calculate the gravitational potential energy that is converted into other forms of energy in one hour.

energy = ... [2]

2. Calculate the efficiency of the power station when operating at full capacity.

efficiency = ... [2]

3. Suggest two reasons why the efficiency of the power station is less than 1.0 (100%).

1. ....

2. ....
[2]

(c) Before the electrical energy is transmitted along power lines, the voltage is increased to a very large value.

(i) State and explain why a very high voltage is used to transmit electrical energy over long distances.

....

....

....

.... [3]

(ii) State the name of the device that is used to increase the voltage.

.... [1]

(iii) Explain why the generators in the power station must be a.c. (alternating current) generators.

....

.... [1]

10 The casing of an electric kettle is made of white plastic. Fig. 10.1 shows the heating element positioned in the base of the kettle.

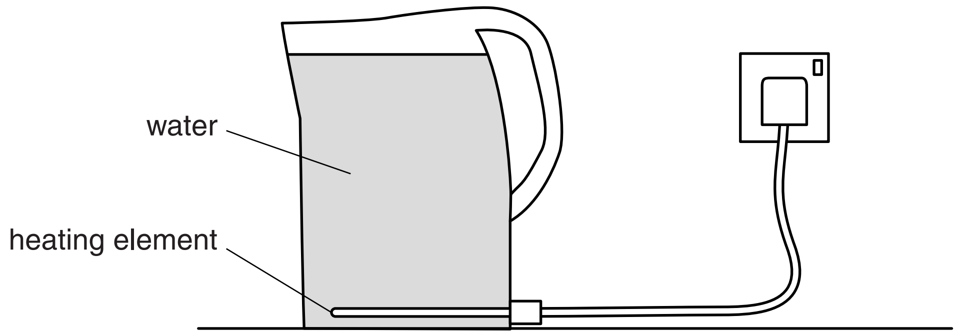

Fig. 10.1

(a) **(i)** The heating element supplies thermal energy to the water at the bottom of the kettle.

Describe and explain how the thermal energy is transferred throughout the water.

....

....

....

....[3]

(ii) Explain why a kettle with its heating element in the water at the top of the kettle does not heat the water uniformly.

....

....[1]

(b) The kettle is powered by a 230 V supply. It is switched on for 3.5 minutes and there is a current of 9.6 A in the heating element.

(i) Calculate the thermal energy produced in the heating element in this time.

thermal energy = ...[2]

(ii) The kettle contains 1.6 kg of water that was at an initial temperature of 22 °C.
The specific heat capacity of water is 4200 J / (kg °C).

Calculate the maximum possible temperature of the water.

temperature = ...[3]

(iii) Suggest one reason why the temperature of the water, after 3.5 minutes, is less than the value calculated in **(b)(ii)**.

....

....[1]

(c) Explain one advantage of

(i) using plastic for the casing of a kettle,

....

....[1]

(ii) choosing white as the colour for the outside of the casing.

....

....[1]

(d) The kettle is switched on again and the water reaches its boiling point. It starts to boil and the kettle remains switched on.

(i) State the meaning of *boiling point*.

....

....[1]

(ii) Explain, in terms of molecules, what happens to the thermal energy that is supplied when the water is boiling.

....

....

....[2]

11 A student makes a 2.0V battery by connecting two cells of electromotive force (e.m.f.) 2.0V in parallel. The battery, an ammeter with different ranges and three different resistors are used to set up the circuit shown in Fig. 11.1.

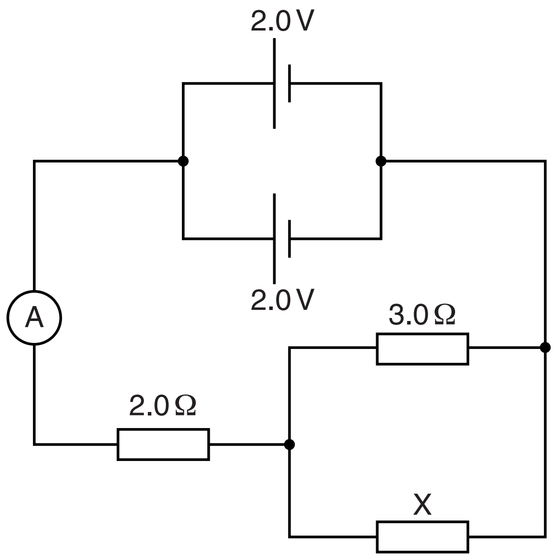

Fig. 11.1

(a) **(i)** Explain what is meant by *electromotive force*.

....

....

....[2]

(ii) State one advantage of using two cells in parallel rather than using a single 2.0V cell.

....

....[1]

(b) Resistor X and the 3.0Ω resistor have a combined resistance that is equal to 2.0Ω.

Calculate

(i) the total resistance of the circuit,

total resistance = ...[1]

(ii) the resistance of X.

resistance of X = ...[2]

(c) **(i)** Determine the reading of the ammeter.

reading = ...[2]

(ii) Suggest a suitable range for the ammeter.

....[1]

(d) The current in the 2.0 Ω resistor is I_2.
The current in the 3.0 Ω resistor is I_3.
The current in X is I_X.

State the equation that relates I_2, I_3 and I_X.

....[1]

(e) State the potential difference (p.d.) across

(i) the 2.0 Ω resistor,

p.d. = ...[1]

(ii) the 3.0 Ω resistor.

p.d. = ...[1]

Question 11 continues on page 18.

(f) The student sets up a second circuit using a variable d.c. power supply, an ammeter and a 12V metal filament lamp. The circuit is shown in Fig. 11. 2.

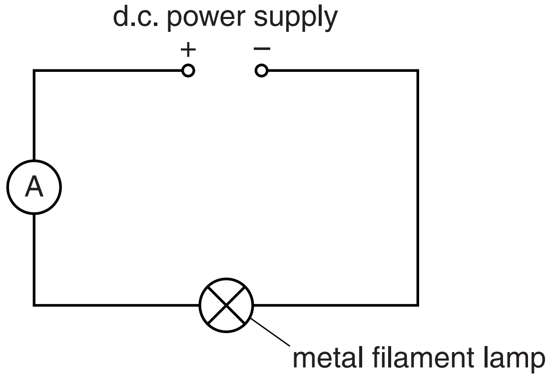

Fig. 11.2

The d.c. power supply is set to 12V and the ammeter reading is 1.5A.

The student changes the e.m.f. of the d.c. power supply to 6.0V. The lamp dims and the ammeter reading changes.

(i) State and explain what happens to the resistance of the metal filament of the lamp.

....

....

....[2]

(ii) State whether the new ammeter reading is less than, equal to or greater than 0.75A.

....[1]

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