Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6350114800

PHYSICS **5054/21**

Paper 2 Theory **October/November 2017**

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. Answer only one of the two alternative parts in Question 6.

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 **22** printed pages and **2** blank pages.

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Section A

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

Answer only one of the two alternative parts in **Question 6**.

1 Fig. 1.1 shows a painter standing on a wooden plank, directly above the right-hand support.

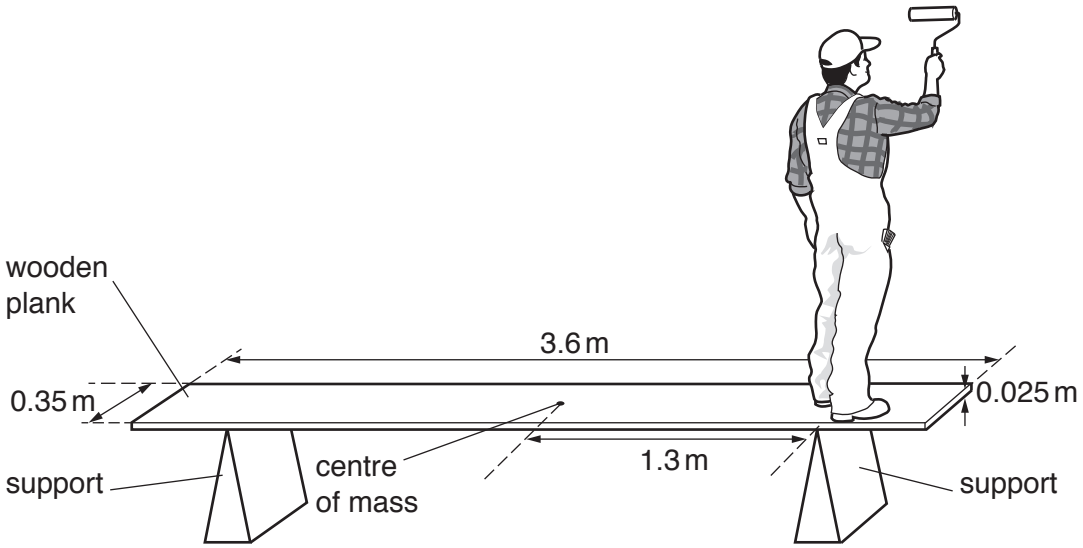


Fig. 1.1

The plank has length 3.6 m, width 0.35 m and thickness 0.025 m.

The gravitational field strength g is 10 N / kg and the mass of the plank is 23 kg.

(a) Calculate the density of the wood from which the plank is made.

density = ... [2]

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(b) The centre of mass of the plank is in the middle of the plank at a distance of 1.3 m from each of the supports.

Calculate

(i) the weight of the plank,

weight = ... [1]

(ii) the moment of the plank about the right-hand support.

moment = ... [2]

(c) The painter moves further to the right along the plank and the plank rotates about the right-hand support.

Explain why the plank rotates.

.....

.....

.....

..... [1]

2 Fig. 2.1 shows a can of compressed air that is being used to blow dust off a computer keyboard.

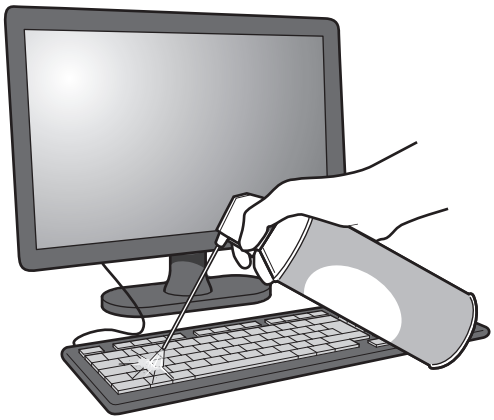


Fig. 2.1

(a) The pressure of the air inside the can is greater than the pressure of the atmosphere.

(i) State what is meant by the term *pressure*.

.....

..... [1]

(ii) Explain, in terms of molecules, why the pressure of the air inside the can decreases as it is used.

.....

.....

.....

.....

.....

..... [3]

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(b) A student uses an inverted measuring cylinder in a water trough to measure the volume that the air occupies at atmospheric pressure. Fig. 2.2 shows the equipment.

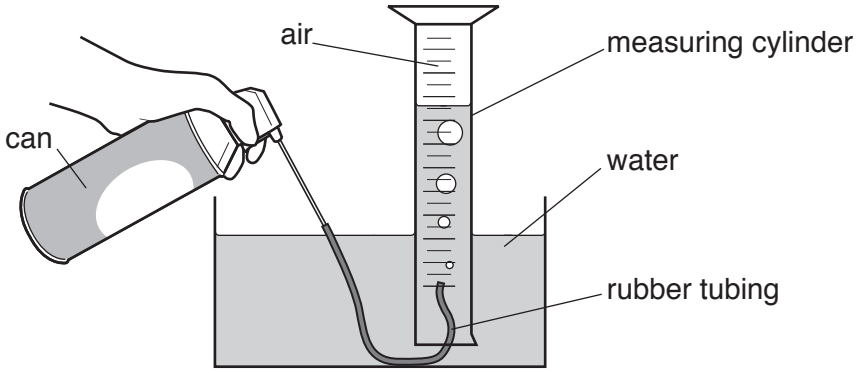


Fig. 2.2 (not to scale)

Initially the inverted measuring cylinder is full of water.

The student presses the top of the can and air passes through the rubber tubing into the inverted measuring cylinder. The air gradually replaces the water in the cylinder until no more air can leave the can. The final temperature of the air is equal to its initial temperature.

The volume of the air inside the can is $1.8 \times 10^{-4}\,m^3$.

The student observes that, at an atmospheric pressure of $1.0 \times 10^5\,Pa$, the total volume of the air in the measuring cylinder, the can and the tubing is now $9.4 \times 10^{-4}\,m^3$.

Determine the original pressure of the air in the can.

pressure = ... [2]

3 Unwanted gold jewellery is heated in a furnace until it melts. Fig. 3.1 shows the liquid gold being poured into a mould to make a gold bar.

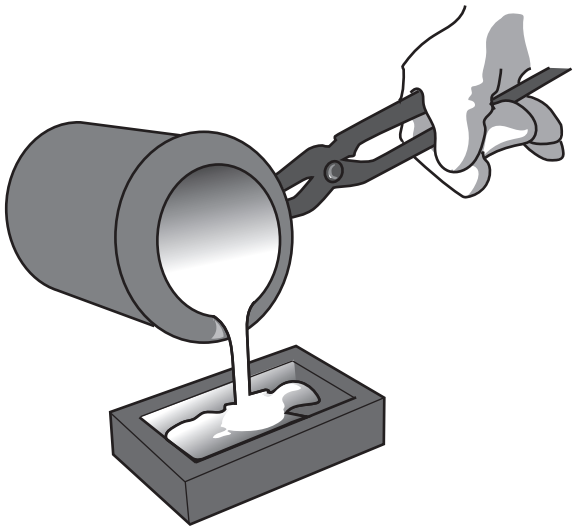


Fig. 3.1

The melting point of gold is 1100 °C.

(a) State two ways in which the molecular structure of gold at 1200 °C differs from its structure at 1000 °C.

1. .....

.....

2. .....

.....

[2]

(b) In the furnace, 0.84 kg of solid gold reaches its melting point.

The furnace continues to supply thermal energy and, after a short time, all the gold melts.

(i) Explain, in terms of the molecules, why thermal energy is needed to melt the gold.

.....

.....

.....

..... [2]

(ii) The specific latent heat of fusion of gold is 64 kJ/kg.

Calculate the thermal energy supplied to melt all the gold.

thermal energy = ... [2]

4 Fig. 4.1 shows a mercury-in-glass thermometer made using a glass capillary tube.

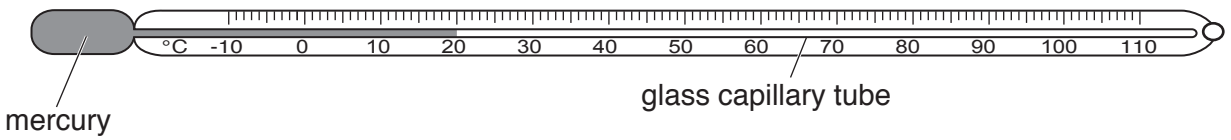


Fig. 4.1

(a) Describe how to check that the 100 °C mark is in the correct position on the thermometer.

.....

.....

.....

..... [3]

(b) Some thermometers contain ethanol instead of mercury.

A second glass capillary tube is identical to the tube in Fig. 4.1, except that it has no markings on the glass. This tube is used to make an ethanol-in-glass thermometer. The volume of the ethanol in this thermometer is equal to the volume of mercury in the thermometer in Fig. 4.1.

The thermal expansion of ethanol is more than that of mercury.

State and explain how the maximum possible range of the ethanol-in-glass thermometer differs from the range of the thermometer in Fig. 4.1.

.....

.....

..... [2]

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5 Some medical processes involve the use of ultrasound.

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

.....

.....

.....

..... [2]

(b) Explain briefly how ultrasound is used in pre-natal scanning.

.....

.....

.....

.....

.....

..... [3]

6 EITHER

The main part of a cathode-ray oscilloscope consists of a glass tube. At one end of the tube, electrons are emitted by a hot metal filament.

(a) State **two** requirements for there to be a continuous flow of electrons in the tube.

1. .....

.....

2. .....

.....

[2]

(b) A microphone detects two pulses of sound. The output is displayed on the screen of an oscilloscope.

Fig. 6.1 shows how the voltage output of the microphone varies with time.

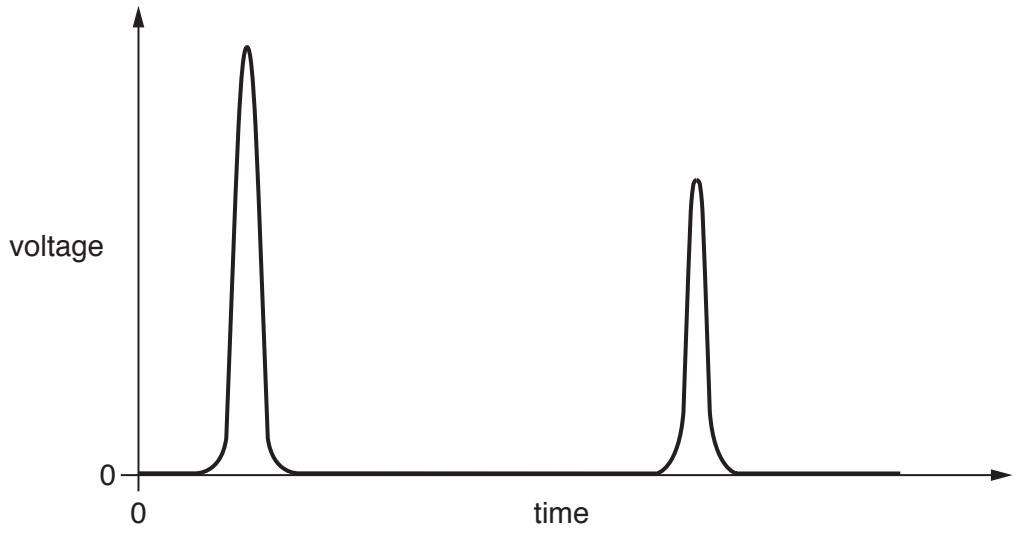


Fig. 6.1

Describe how the time between the two pulses can be determined using the display on the screen of the oscilloscope.

.....

.....

.....

..... [2]

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OR

Many electronic and digital circuits include logic gates. The NAND gate is a type of logic gate.

(a) In the space below, draw the circuit symbol for a NAND gate.

[1]

(b) The two input terminals of a NAND gate are connected to zero voltage (logic state 0) and no energy is supplied to these terminals.

The output of the NAND gate is connected to an LED (light-emitting diode). The output is not zero (it has a logic state of 1) and the LED is glowing brightly.

(i) Energy is supplied to the LED by the NAND gate.

State where this energy comes from.

.....

..... [1]

(ii) Complete the truth table for a NAND gate.

inputs		output
0	0	
0	1	
1	0	
1	1	

[2]

7 An electric circuit consists of a battery, a variable resistor and connecting wires. Sections PQ and QR of the connecting wire are in a region of space where there is a uniform magnetic field.

In Fig. 7.1, the shaded area represents the magnetic field.

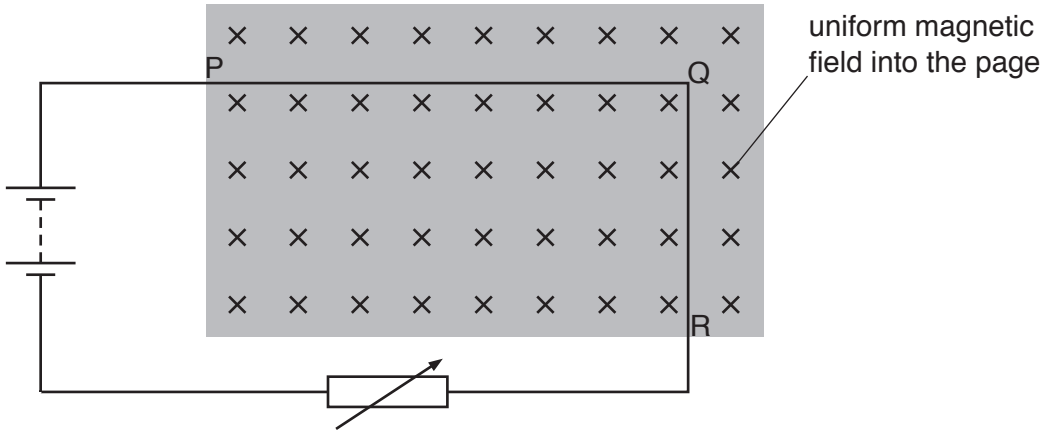


Fig. 7.1

The direction of the magnetic field is into the page.

A current-carrying wire in a magnetic field can experience a force.

(a) In the table, mark **one** tick (✓) in each column to indicate the force on PQ and the force on QR.

	section PQ	section QR
no force on this section		
a force towards the top of the page		
a force towards the bottom of the page		
a force out of the page		
a force into the page		
a force towards the left of the page		
a force towards the right of the page		

[2]

(b) The battery in the circuit in Fig. 7.1 is reversed.

State and explain the effect of this on PQ and QR.

.....

.....

.....

..... [2]

(c) The variable resistor is adjusted and the current in the circuit decreases.

Suggest one effect of decreasing the current.

.....

..... [1]

8 A sample of the radioactive isotope radon-222 decays by the emission of alpha-particles.

(a) As alpha-particles travel through air, the air is ionised.

(i) Describe the composition of an alpha-particle.

.....

.....

..... [1]

(ii) Explain how an alpha-particle ionises air.

.....

.....

..... [2]

(iii) State how the relative ionising effect of alpha-particles compares with that of

1. beta-particles,

.....

2. gamma rays.

.....
[1]

(b) The half-life of radon-222 is 3.3×10^5 s.

The number of radon-222 atoms in the sample is 4.8×10^4.

(i) Determine the time that it takes for the number of radon-222 atoms in this sample to decrease to 1.5×10^3.

time = ... [3]

(ii) Suggest one reason why, in practice, the time for the number of radon-222 atoms to decrease to 1.5×10^3 may differ slightly from the value obtained in **(b)(i)**.

.....

..... [1]

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Please turn over for Section B.

Section B

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

9 Fig. 9.1 shows a large container ship travelling at constant speed in a straight line.

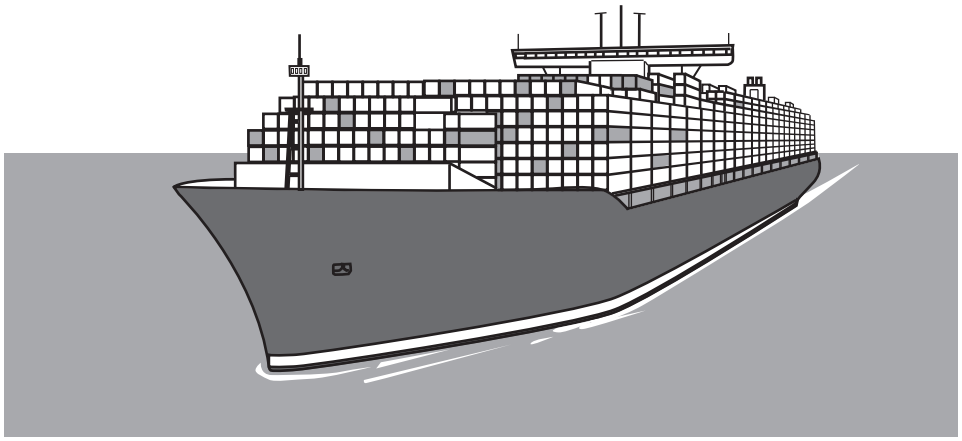


Fig. 9.1

The resistive force acting on the ship is 2.8×10^6 N.

(a) The speed of the ship is 9.7 m/s.

(i) Calculate the work done against the resistive force on the ship in 1.0 s.

work done = ... [2]

(ii) The engines are powered by oil.

State the energy transfer that is taking place when the ship is travelling at constant speed.

.....

..... [2]

(b) The mass of the ship is 2.2×10^8 kg. The engines are switched off and the resistive force causes the ship to decelerate.

(i) Calculate the initial deceleration of the ship.

deceleration = ... [2]

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(ii) As the speed of the ship decreases, its deceleration changes.

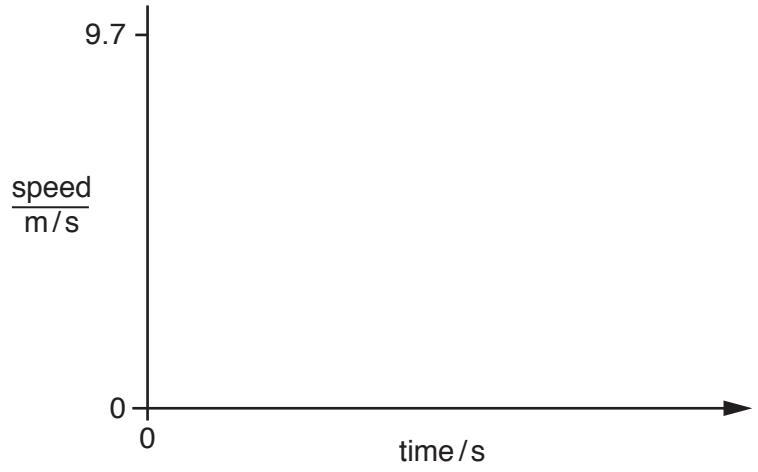
1. Suggest and explain how the deceleration changes.

.....

.....

..... [2]

2. On Fig. 9.2, sketch a possible speed-time graph for the ship as it decelerates to rest.



[2]

Fig. 9.2

3. Explain how the distance travelled by the ship may be determined from the speed-time graph.

.....

.....

..... [2]

(c) When the ship is travelling at a different speed, energy is being supplied to the engines at a rate of 33 MJ / s. The efficiency of the engines is 0.36 (36%).

(i) State a relationship that defines *efficiency*.

.....

..... [1]

(ii) Calculate the rate at which energy is wasted in the engines.

rate at which energy is wasted = ... [2]

10 Fig. 10.1 represents the electromagnetic spectrum.

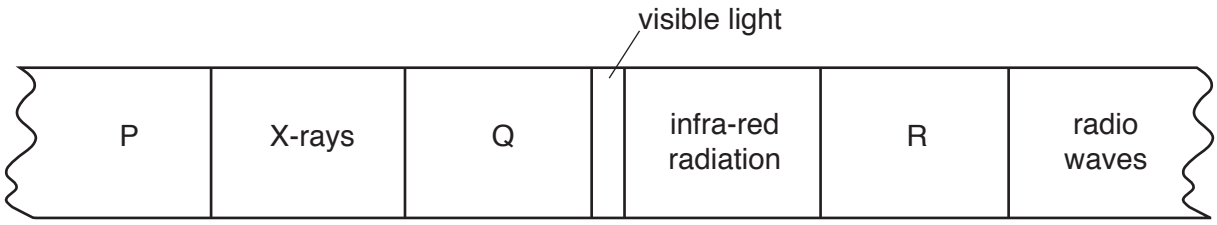


Fig. 10.1

(a) State the name of the component of the electromagnetic spectrum that is found in region

(i) P, ...

(ii) Q, ...

(iii) R. .....

[2]

(b) On Fig. 10.1, mark a tick (✓) in all of the boxes that represent the components with frequencies greater than the frequencies of visible light. [1]

(c) The speed of electromagnetic radiation in a vacuum is 3.0×10^{8} m/s.

A television remote controller uses infra-red radiation of wavelength 9.4×10^{-7} m.

(i) Calculate the frequency of this radiation.

frequency = ... [3]

(ii) Explain how infra-red radiation is used in television remote controllers.

.....

.....

.....

..... [2]

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(d) Fig. 10.2 shows a ray of green light in air striking the side of a glass prism.

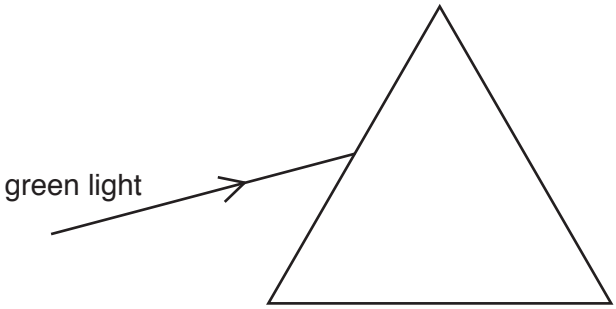


Fig. 10.2 (not to scale)

The refractive index of the glass for green light is 1.5.

(i) On Fig. 10.2,

1. draw the normal for this ray,

2. mark the angle of incidence with a letter *i*.

[1]

(ii) This angle of incidence is 57°.

Calculate the angle of refraction in the glass.

angle of refraction = ... [2]

(iii) State what happens, as the light enters the glass, to the light's

1. frequency,

.....

2. speed,

.....

3. wavelength.

.....

[2]

(iv) On Fig. 10.2, draw the path taken by the light as it passes through the glass and into the air. [2]

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[Turn over

11 **(a)** Fig. 11.1 shows a negatively charged rod close to an uncharged metal sphere that is mounted on an insulating stand.

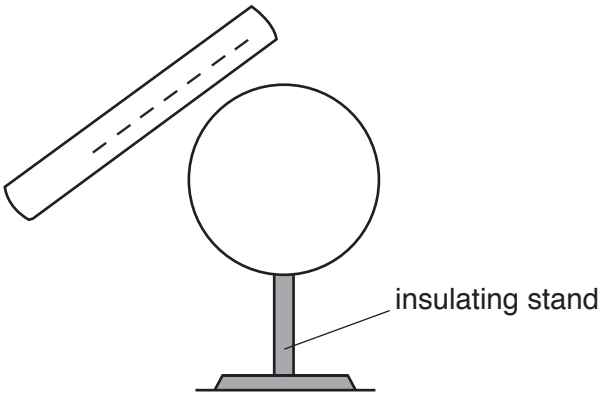


Fig. 11.1

(i) Suggest a material for the insulating stand.

..... [1]

(ii) On Fig. 11.1, draw the distribution of charges on the sphere. [2]

(iii) A metal wire connected to earth is touched against the sphere.

1. Explain what happens to the charge on the sphere.

.....

.....

.....

.....

.....

..... [3]

2. The earth wire remains in contact with the sphere.

Describe what happens in the wire as the rod is moved away.

.....

.....

..... [1]

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(b) A circuit contains a 7.5 V d.c. power supply and three resistors.

Fig. 11.2 is the circuit diagram.

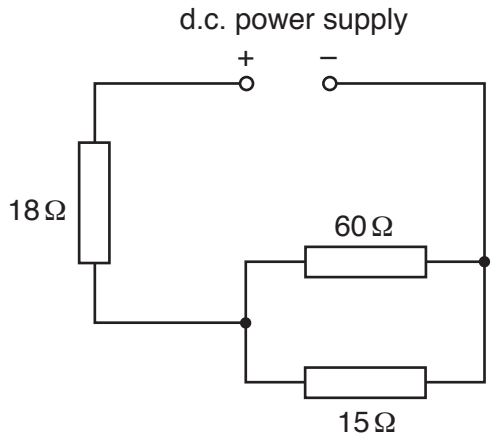


Fig. 11.2

(i) Determine the total resistance of the circuit.

resistance = ... [3]

(ii) Calculate the current in the power supply.

current = ... [2]

(iii) There is a different current in each of the three resistors in the circuit in Fig. 11.2.

Underline the resistor in which the current is

1. the largest,

15 Ω resistor **18 Ω resistor** **60 Ω resistor**

2. the smallest.

15 Ω resistor **18 Ω resistor** **60 Ω resistor**

[1]

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(iv) The 7.5 V d.c. power supply is made from five 1.5 V cells.

In the space below, draw a diagram that shows how the cells are arranged.

[1]

(v) The 18 Ω resistor is made of metal.

State and explain what happens to the current in this resistor as its temperature increases.

.....

.....

..... [1]

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