Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

PHYSICS **5054/02**

Paper 2 Theory

October/November 2004

1 hour 45 minutes

Candidates answer on the Question Paper.
Additional Materials: answer paper.

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.

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 on the lined pages provided and, if necessary, continue on the separate answer paper provided.

At the end of the examination, fasten the separate answer paper securely to the Question Paper.
The number of marks is given in brackets [ ] at the end of each question or part question.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

For Examiner's Use	
Section A	
Q8	
Q9	
Q10	
Total	

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

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Section A

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

1 Fig. 1.1 shows a simplified speed-time graph for a train that travels between two stations.

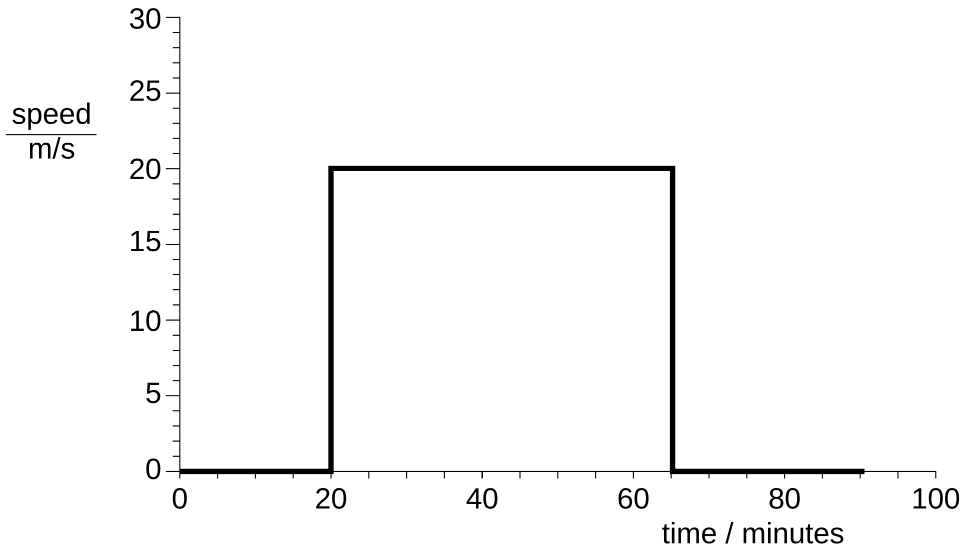

Fig. 1.1

(a) Describe the motion of the train.

....

....

....

....

....[2]

(b) Calculate the distance travelled by the train between the two stations.

distance = …………………….. [2]

(c) Another train travels between the same two stations on a parallel track. This train travels at a constant speed. It starts its journey at time t = 0 and finishes at t = 90 minutes.

On Fig. 1.1, draw the speed-time graph for this train. [2]

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2 Fig. 2.1 shows a water manometer used to measure the pressure inside a gas pipe.

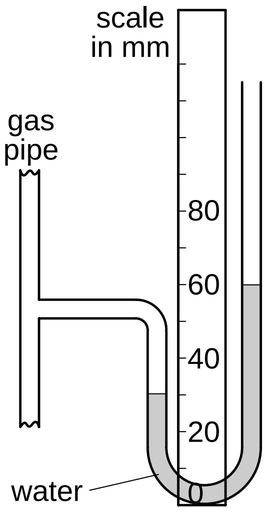

Fig. 2.1

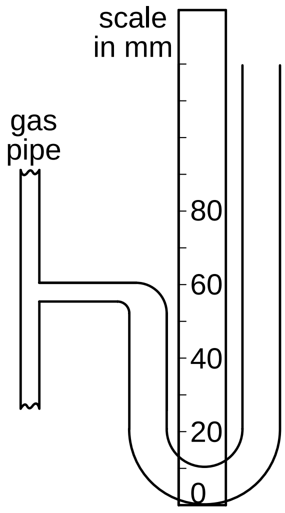

Fig. 2.2

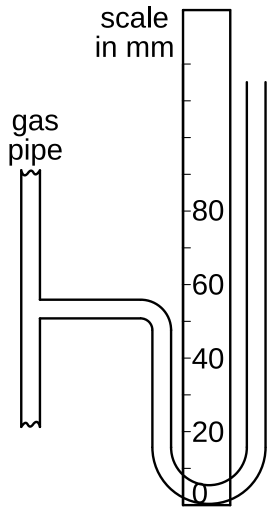

Fig. 2.3

(a) State whether the pressure inside the gas pipe in Fig. 2.1 is larger than or smaller than atmospheric pressure.

....[1]

(b) The manometers shown in Figs. 2.2 and 2.3 are connected to the same gas pipe at the same pressure as shown in Fig. 2.1.

On Figs. 2.2 and 2.3, draw the levels of the liquid in each manometer if

(i) the manometer in Fig. 2.2 contains water and has tubes with twice the diameter of Fig. 2.1,

(ii) the manometer in Fig. 2.3 contains a liquid with density half that of water.

[2]

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(c) The manometer shown in Fig. 2.4 has its top end sealed.

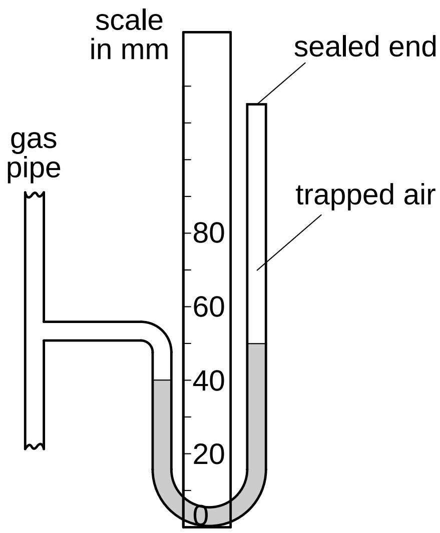

Fig. 2.4

Explain why the water levels are different in Figs. 2.4 and 2.1, even though the pressure in the gas pipe is the same.

....

....

....

....[2]

3 A pole-vaulter runs along a track, reaching a maximum speed of 8.4 m/s. At the end of the track, he places a pole into the ground as shown in Fig. 3.1, and uses the pole to push himself vertically upwards.

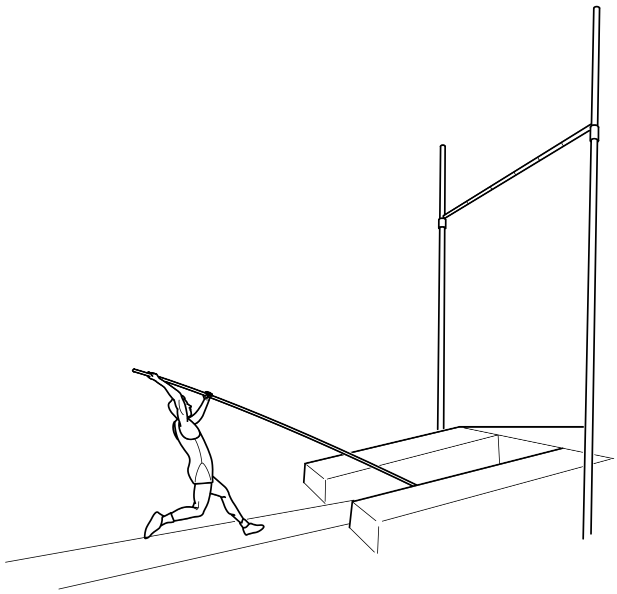

Fig. 3.1

(a) When the pole-vaulter runs along the track, there is a constant forward force on him of 320 N and a backwards resistive force that varies with his speed as shown in Fig. 3.2.

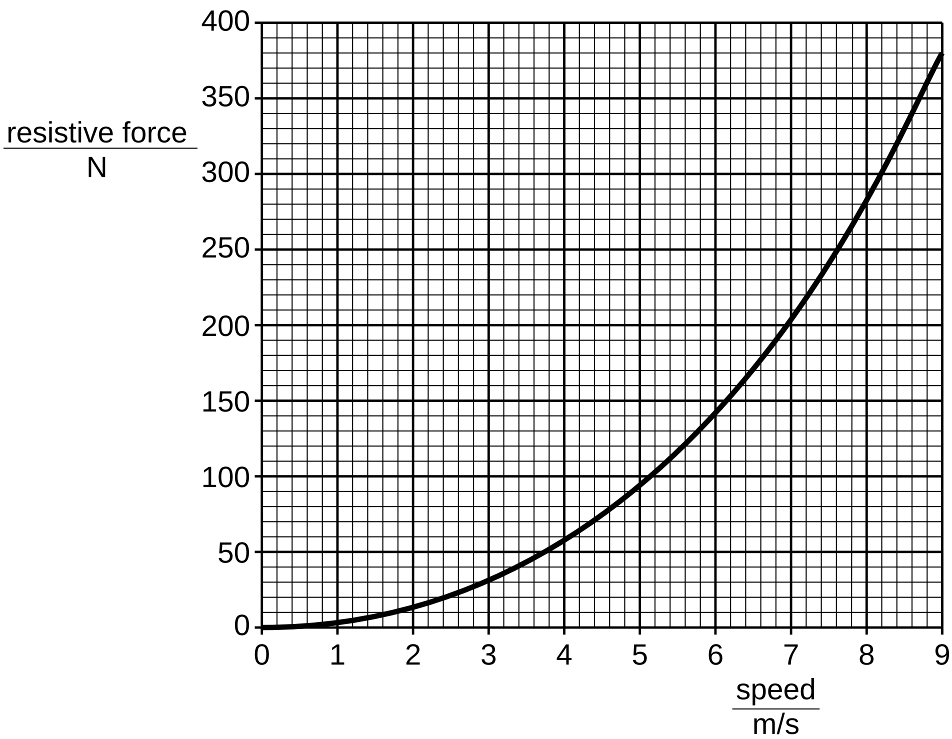

Fig. 3.2

Explain why the maximum speed that he can reach is 8.4 m/s.

....

....[1]

(b) The mass of the pole-vaulter is 60 kg.

(i) Calculate the maximum kinetic energy of the pole-vaulter as he runs along the track. State clearly the formula that you use.

kinetic energy = ………………….

(ii) The pole is used to convert all this kinetic energy into gravitational potential energy. Calculate the height through which the pole-vaulter rises. Give your answer to an appropriate number of significant figures. The gravitational field strength is 10 N/kg.

height = ……………………….

[6]

4 Fig. 4.1 shows an air bubble in water. The rays of light are incident on the air bubble.

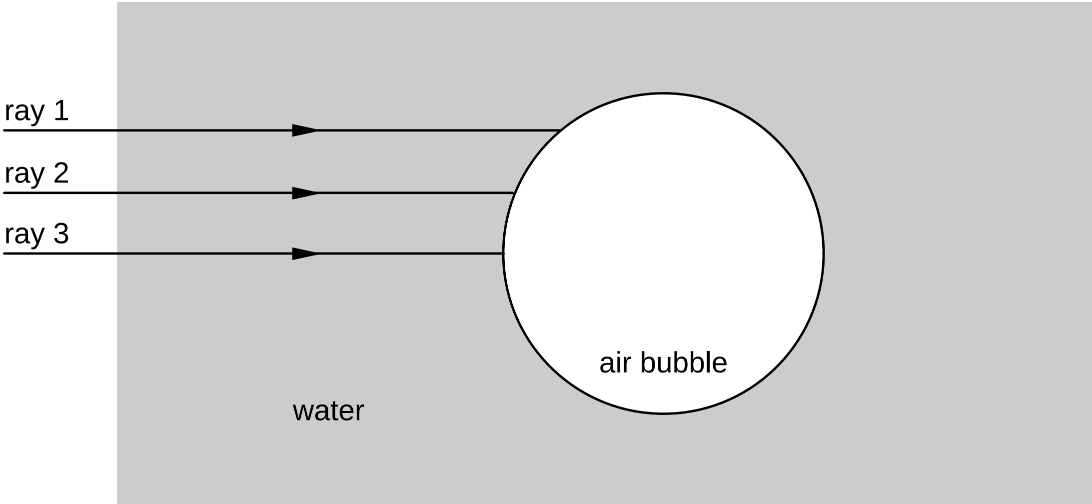

Fig. 4.1

The angle of incidence of ray 1 on the air bubble is greater than the critical angle.
The angle of incidence of ray 2 on the air bubble is less than the critical angle.
Ray 3 is perpendicular to the surface of the bubble.

The angle of incidence of ray 2 on the air bubble is 27° and the angle of refraction of ray 2 inside the air bubble is 37°.

(a) On Fig. 4.1, at the point where ray 1 meets the air bubble, mark

(i) the normal to the surface,

(ii) the angle of incidence.

[2]

(b) Complete Fig. 4.1 to show how all three rays continue after they meet the air bubble. [3]

(c) (i) Define what is meant by the *refractive index* of water.

....

....

....

(ii) Calculate the refractive index of water.

refractive index = ………………

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[2]

5 Fig. 5.1 shows part of a long, thin spring used to demonstrate a transverse wave.

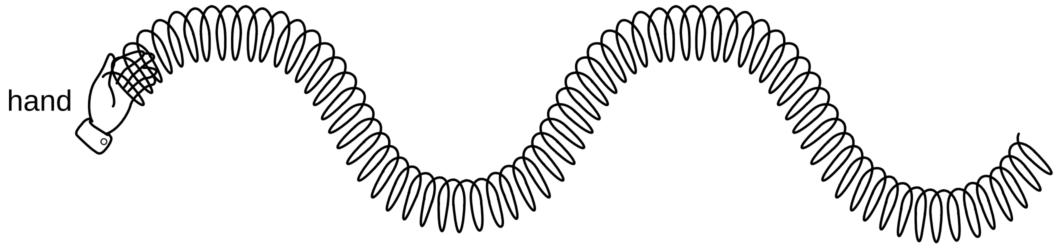

Fig. 5.1

The wave shown in Fig. 5.1 has a frequency of 4.0 Hz.

(a) **(i)** On Fig. 5.1, mark the direction the hand must move to make a transverse wave.

(ii) Describe how the hand must move to make a transverse wave of frequency 4.0 Hz.

....

....

....
[2]

(b) The speed of the wave is 0.80 m/s. Calculate its wavelength.
State clearly the formula that you use.

wavelength = ……………….. [3]

(c) State what must be done to double the wavelength of the wave on the spring.

....

....

....[1]

6 An experiment to show charging by induction uses a metal sphere mounted on an insulated support. The sphere is initially uncharged and is shown in Fig. 6.1.

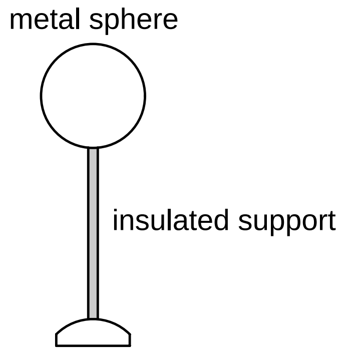

Fig. 6.1

(a) A negatively charged rod is brought near the sphere, as shown in Fig. 6.2.

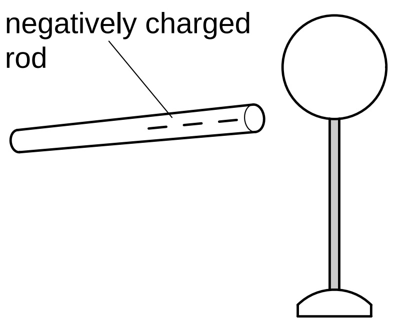

Fig. 6.2

(i) State and explain the movement of electrons in the sphere that occurs as the rod is brought near.

....

....

....

....

(ii) On Fig. 6.2, draw the charges on the metal sphere.

[3]

(b) The metal sphere is now touched at point A by a wire connected to earth, as shown in Fig. 6.3.

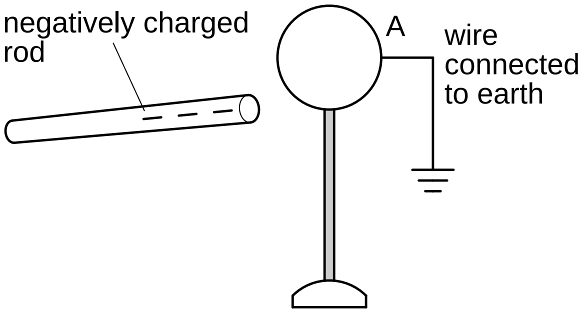

Fig. 6.3

On Fig. 6.3, draw the charges on the metal sphere. [1]

(c) The wire connected to earth is removed. Then the negatively charged rod is also removed, as shown in Fig. 6.4.

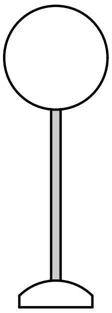

Fig. 6.4

On Fig. 6.4, draw the charges on the metal sphere. [1]

(d) The support is made from an insulator.
State one material that may be used to make the support.

....[1]

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7 Fig. 7.1 shows high voltage cables used to transmit electrical energy.

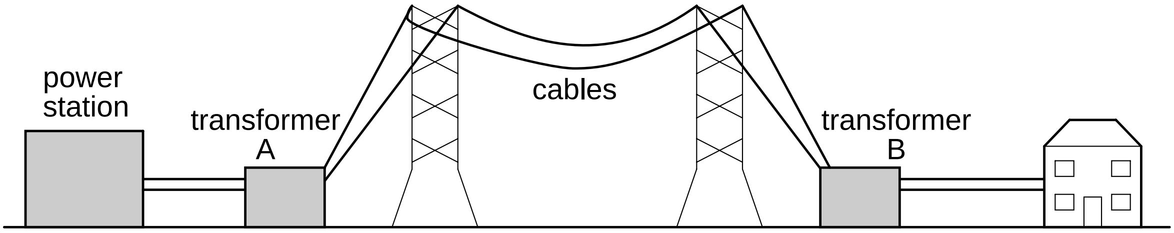

Fig. 7.1

(a) State the purpose of transformer B.

....[1]

(b) In the space below, draw a labelled diagram to show the structure of transformer B.

[3]

(c) (i) Explain why high voltages are used to transmit electrical power.

....

....

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....

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(ii) Fig. 7.2 shows how the loss of thermal energy from a cable varies with the thickness of the cable.

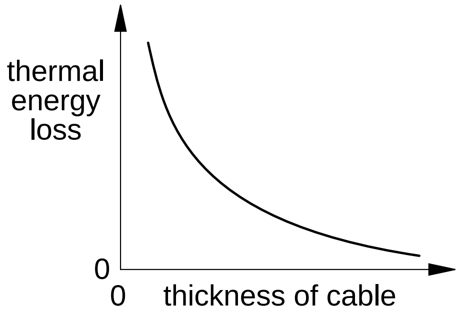

Fig. 7.2

Explain why the loss of thermal energy is less if the cable is thicker.

....

....

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....

....
[4]

Section B

Answer **two** questions from this section.

Use the lined pages provided and, if necessary, continue on the separate answer paper available from the Supervisor.

8 A heat pipe is a device that transmits thermal energy along its length. It can transmit energy thousands of times faster than a solid copper rod. Fig. 8.1 shows a heat pipe attached to black metal fins. The fins absorb energy from the Sun. The sealed pipe transmits this energy along its length into a tank of cold water.

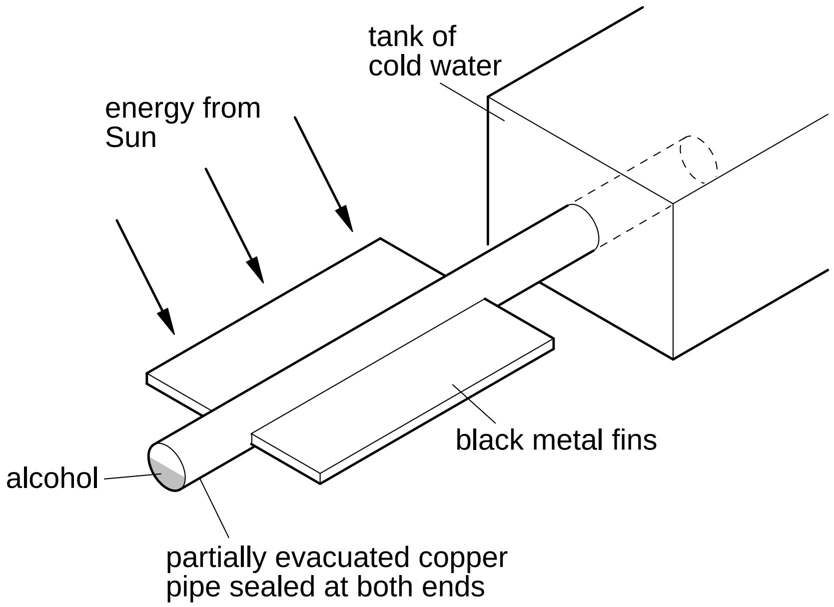

Fig. 8.1

Thermal energy from the fins is conducted through the walls of the copper pipe and causes the alcohol to boil. The boiling creates a higher pressure. At the end of the copper pipe in contact with cold water, the alcohol condenses and creates a lower pressure. The liquid alcohol runs along the pipe to be boiled again. There is little change in the temperature of the alcohol.

(a) **(i)** Describe how molecules in the copper conduct energy to the alcohol.

(ii) Explain how boiling and condensation within the heat pipe cause the transfer of energy.

(iii) Explain why the heat pipe is able to transfer energy at a fast rate.

[4]

(b) In one minute, a mass of 25 g of alcohol condenses at the end of the heat pipe. The specific latent heat of vaporisation of alcohol is 840 J/g.

(i) Define *specific latent heat of vaporisation*.

(ii) Calculate the amount of energy released when 25 g of alcohol condenses. You may neglect any change in the temperature of the alcohol.

(iii) Calculate the maximum rise in temperature that the energy calculated in **(ii)** produces when used to heat 500 g of cold water. The specific heat capacity of water is 4.2 J/(g °C).

[6]

(c) Black surfaces absorb and emit infra-red radiation better than white surfaces.

(i) Describe an experiment that shows black surfaces absorb radiation better than white surfaces.

(ii) Describe an experiment that shows black surfaces emit radiation better than white surfaces at the same temperature.

[5]

9 Fig. 9.1 is a diagram of a simple d.c. motor.

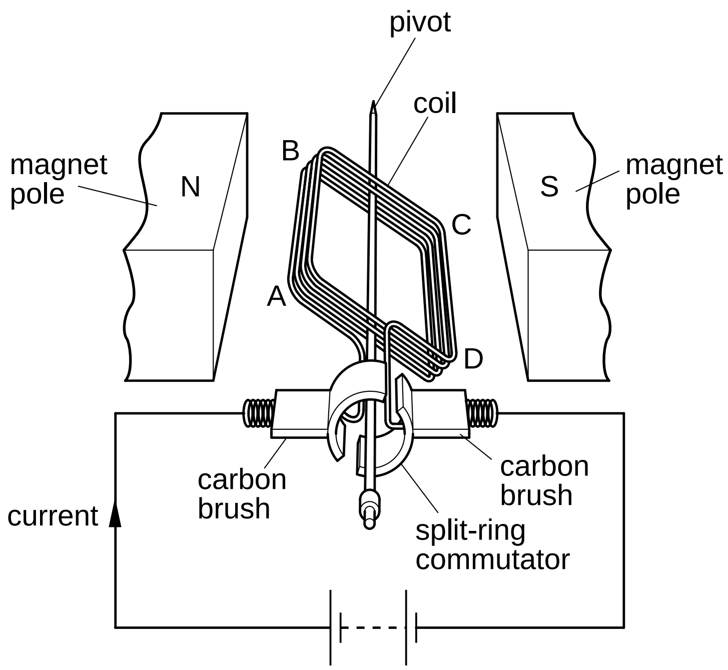

Fig. 9.1

The gap between the two halves of the split-ring commutator is so wide that a carbon brush can only touch one half of the split-ring at any time. This protects the circuit. It also means that sometimes the motor will not start when switched on.

The coil is rotated by vertical forces that act downwards on side AB and upwards on side CD. The current causes a constant force of 3.0 N on each side. The moment created by these forces varies as the coil turns. The moment is a maximum when the coil is horizontal.

The distances AD and BC are both 0.065 m.

(a) Explain why

(i) the carbon brushes must **not** be allowed to touch both halves of the split-ring at the same time,

(ii) sometimes the motor does **not** start when switched on, even if there is no friction.

[3]

(b) **(i)** Define the *moment of a force*.

(ii) Calculate the value of the maximum moment created on the coil.

(iii) Explain why the moment is a maximum when the coil is horizontal.

(iv) Sketch a graph to suggest how the moment acting on the coil varies with time as the coil rotates at constant speed. Label each axis. On the time axis, mark clearly the time taken for one revolution of the coil.

[7]

(c) **(i)** State the measurements you would make in order to find the electrical power input to the motor and state how your measurements are used to find the electrical power.

(ii) Draw a diagram of the circuit you would use to make these measurements.

[5]

10 A doctor uses a radioactive isotope, iodine-131, to find the volume of blood in a patient's body. Information about iodine-131 is given in Fig. 10.1.

proton (atomic) number	53
nucleon (mass) number	131
radiation emitted	beta-particles and gamma-rays

Fig. 10.1

(a) **(i)** Describe the structure of an atom of iodine-131.

(ii) The radioactive decay equation below shows an iodine-131 nucleus decaying into a xenon nucleus (Xe). Copy the equation and insert the proton number and the nucleon number of the xenon nucleus.

$$^{131}_{53}\text{I} \longrightarrow \text{Xe} + \beta$$

[5]

(b) Describe the differences between beta-particles and gamma-rays. [3]

(c) The doctor uses a sample of iodine-131 that initially produces a count rate of 144 000 per second.

The whole sample is injected into the patient's arm. Nine small samples of blood, each of volume 2.0 cm^3, are taken from the other arm at 2 minute intervals.

Fig. 10.2 shows the count rates from the nine samples.

sample number	1	2	3	4	5	6	7	8	9
time after injection / min	2	4	6	8	10	12	14	16	18
count rate / per second	0	4	12	18	28	40	38	36	40

Fig. 10.2

(i) State **two** reasons why different count rates are obtained from the nine samples.

(ii) Calculate the average value of the count rates from the last four samples.
This is the average count rate from a volume of 2.0 cm^3 of blood.

(iii) Using your answer to **(ii)**, determine the volume of blood in the patient's body, which has a total count rate of 144 000 per second.

(iv) Sample number 9 is kept.
The count rate is measured again after 16 days.
Estimate the value obtained, given that the half-life of iodine-131 is 8.0 days.

[6]

(d) Describe **one** precaution that the doctor must take when handling this radioactive source. [1]

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