

Centre Number	Candidate Number	Name
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CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

**CO-ORDINATED SCIENCES**

**0654/03**

Paper 3

October/November 2003

**2 hours**

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 in the spaces provided on the Question Paper.  
You may use a soft pencil for any diagrams, graphs, tables or rough working.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

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.

A copy of the Periodic Table is printed on page 24.

**For Examiner's Use**

1	
2	
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<b>Total</b>	

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.

This document consists of **21** printed pages and **3** blank pages.



1 Explain the following.

- (a) A large piece of wood burns slowly but a cloud of sawdust (small wood particles) may explode if it is ignited.

.....  
 .....  
 .....[2]

- (b) The battery in a personal stereo needs to be replaced regularly but a car battery does not.

.....  
 .....  
 .....[2]

- (c) Water molecules contain oxygen but the glowing splint shown in Fig. 1.1 does not re-light.

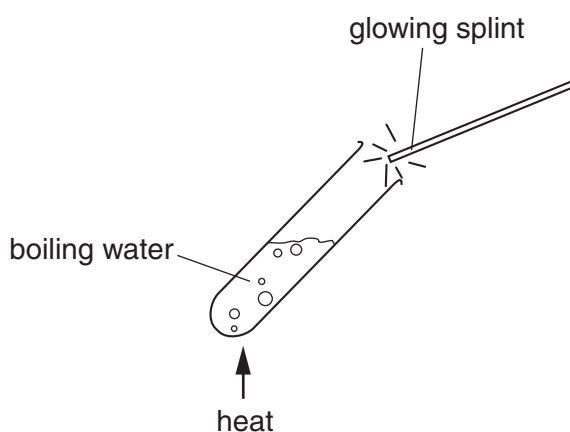


Fig. 1.1

.....  
 .....  
 .....[2]

- (d) Magnesium oxide, MgO, has a very high melting point, but carbon dioxide, CO<sub>2</sub>, has a very low melting point.

.....  
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 .....  
 .....  
 .....  
 .....[3]

- 2 (a) Fig. 2.1 shows a single ray of white light being shone into a triangular glass block (prism).

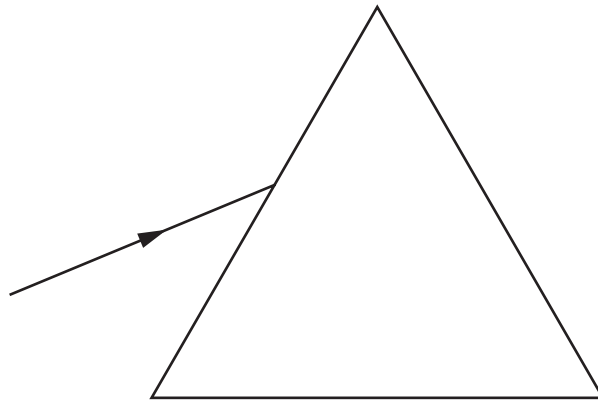


Fig. 2.1

Complete the diagram to show what happens to the ray of light. [3]

- (b) Waves of blue light and waves of red light are both part of the electromagnetic spectrum.

State **one** way in which the waves of blue light differ from the waves of red light.

.....[1]

- (c) Waves of yellow light travel at 300 000 000 m/s and have a wavelength of 0.0000006 m.

Calculate the frequency of the light waves.  
Show your working and state any formula that you use.

.....  
.....[3]

3 (a) A boy's hand accidentally touches a very hot pan. The muscles in his arm contract rapidly, pulling his arm away.

(i) What is the name for this type of automatic response to a stimulus?

.....[1]

(ii) List, in order, the three types of nerve cell along which information passes from the pain receptor in the boy's hand to the muscles in his arm.

1 .....

2 .....

3 .....

[2]

(b) Fig. 3.1 represents the biceps muscle and some of the bones in the boy's arm. He is lifting a mass of 2 kg.

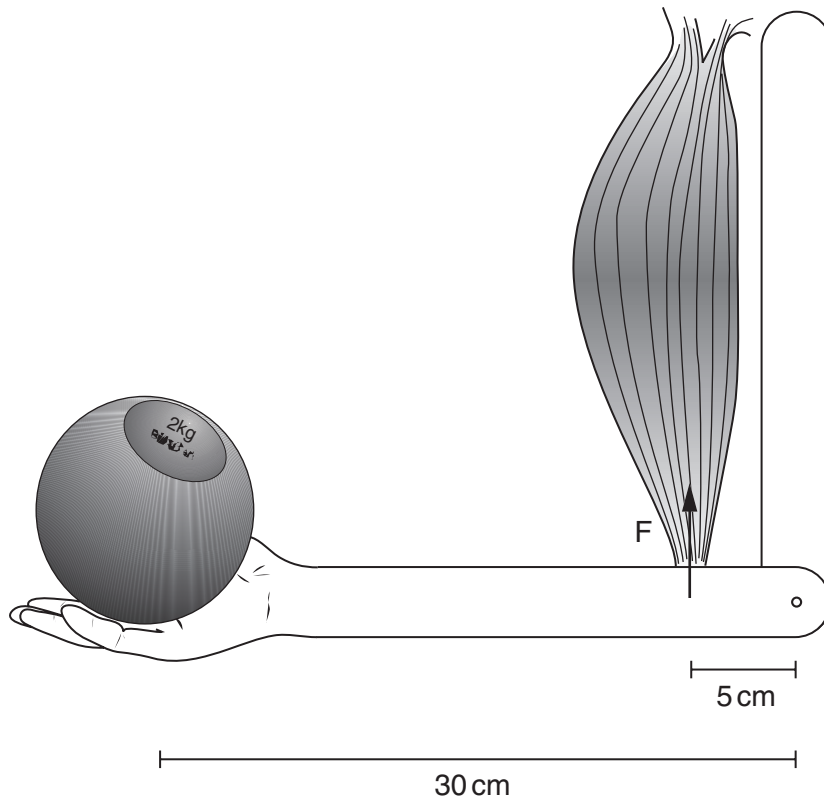


Fig. 3.1

- (i) Calculate the force **F** that must be exerted by the biceps muscle in order to hold the mass steady. Show your working.

..... [3]

- (ii) Describe and explain where the energy comes from which is used by the muscle to produce this force.

.....  
.....  
.....  
.....  
.....[3]

- (iii) The biceps and triceps muscles in the arm are a pair of *antagonistic* muscles. Explain the meaning of this term.

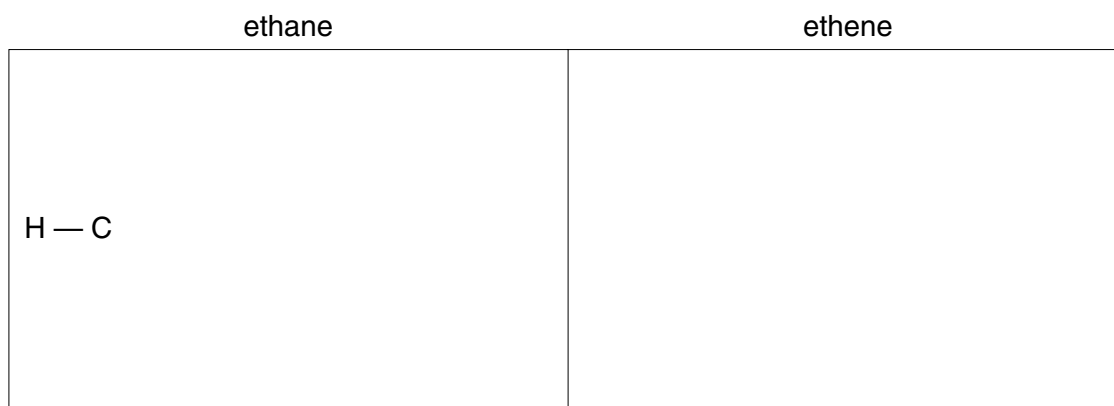
.....  
.....  
.....[2]

4 In the petrochemicals industry, the saturated hydrocarbon ethane,  $C_2H_6$ , is converted into the unsaturated hydrocarbon, ethene,  $C_2H_4$ .

(a) (i) Name the process which converts saturated into unsaturated hydrocarbons.

.....[1]

(ii) Draw the displayed chemical formulae of ethane and ethene. The formula of ethane has been started for you.



[2]

(b) In a typical industrial process it is found that when 1 mole of ethane is used, only 0.9 moles of ethene is produced.

A research scientist studies the conversion of 300 g of ethane into ethene.

(i) Calculate the number of moles of ethane used by the research scientist.  
Show your working.

..... [2]

(ii) State the number of moles of ethene produced.

..... [1]

(iii) Calculate the mass of ethene produced.  
Show your working.

..... [2]

(c) In industry much ethene is converted into ethanol (alcohol).

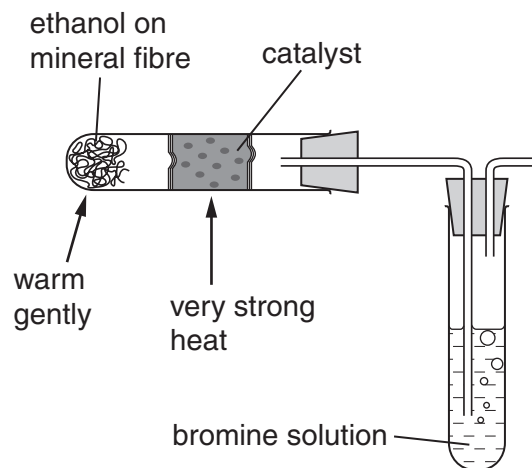
(i) Describe briefly how ethene is converted into ethanol.

.....

.....

.....[2]

(ii) Fig. 4.1 shows apparatus used to study what happens when ethanol vapour is passed over a hot catalyst.



**Fig. 4.1**

During this process, the bromine solution is decolourised.

State and explain what this experiment shows about the type of compound formed when ethanol passes over the hot catalyst.

.....

.....

.....[2]

(d) Ethene may be converted into the thermoplastic material poly(ethene).

Explain, in terms of molecules, what happens when a thermoplastic material such as poly(ethene) is heated.

.....

.....

.....[2]

- 5 Fig. 5.1 shows a tumble dryer. The dryer uses electricity to tumble the clothes and to heat them up.

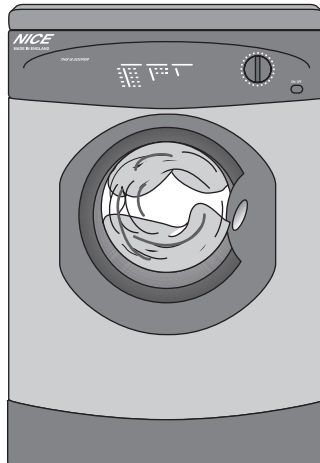


Fig. 5.1

- (a) After the tumble dryer has been used, it is noticed that dust and fluff are sticking to the plastic door. The owner thinks that static electricity is the cause.

- (i) Suggest why a static electrical charge may have been produced in the tumble dryer.

.....  
.....  
.....[2]

- (ii) Name the particles that are transferred when an object gains a static electrical charge.

.....[1]

- (b) When the tumble dryer is used for 30 minutes, 3 600 000 joules of energy are used.

- (i) How many joules of energy are used per second?

..... joules [1]

- (ii) What is the power of the tumble dryer?

.....[1]



- (iii) The voltage supplied to the tumble dryer is 250 V.

Use the equation

$$\text{power} = \text{voltage} \times \text{current}$$

to calculate the current required by the tumble dryer.

.....[2]

- (iv) The heater in the tumble dryer has a resistance of 125  $\Omega$ .

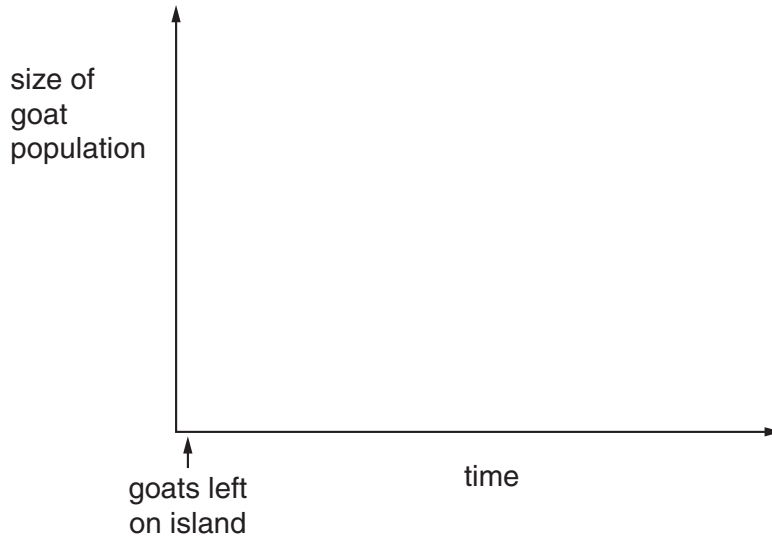
Calculate the current flowing through the heater.  
Show your working and state any formula that you use.

.....[2]

6 In the nineteenth century, a ship travelling across the southern Pacific Ocean stopped at an island to collect fresh water. The sailors left one male goat, **P**, and two female goats, **Q** and **R**, on the island, hoping that they would breed and so provide food if the ship stopped there again.

(a) There were no predators living on the island. The goats were able to feed on grass and other plants, but this food was in a limited supply.

(i) On the axes below, sketch a curve to show what would happen to the size of the goat population on the island over the next few years.



[2]

(ii) On your graph, indicate the point at which food supply became a limiting environmental factor for the goat population. [1]

(b) Goats **P**, **Q** and **R** all had short hair. They were all homozygous for allele **A**. However, a mutation happened in the testes of goat **P**, so that some of its sperm contained a new allele, **a**. Allele **a** was recessive, and coded for long hair.

(i) What is meant by the term *mutation*?

.....  
.....  
.....[2]

(ii) Explain why none of the offspring of goats **P**, **Q** and **R** had long hair.

.....  
.....  
.....[2]

- (iii) In the following year, the offspring from the three original goats bred with each other and with their parents. Some of their offspring did have long hair.

Assuming that no new mutations appeared, explain how this happened. (You may use a genetic diagram if it makes your answer clearer.)

.....  
 .....  
 .....[3]

- (c) The winters on the island were very cold. The goats needed to eat more food in winter to keep themselves warm. The long-haired goats did not need as much food as the short-haired goats.

- (i) Suggest why the long-haired goats did not need as much food as the short-haired goats during the winter.

.....  
 .....  
 .....  
 .....  
 .....[3]

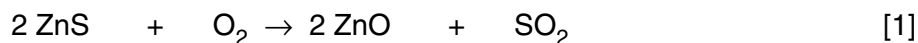
- (ii) Twenty years after the goats were first introduced to the island, almost all of the goat population had long hair. Explain how this would have happened.

.....  
 .....  
 .....  
 .....[3]

- 7 Zinc metal is extracted from rocks containing zinc sulphide, ZnS. There are three main steps in the extraction process.
- step 1            zinc sulphide is converted into zinc oxide  
 step 2            zinc oxide is converted into zinc sulphate  
 step 3            zinc sulphate solution is electrolysed to produce zinc

(a) In step 1, zinc sulphide is heated in air.

- (i) The equation below for this reaction is not balanced. Balance the equation.



- (ii) Suggest why the nitrogen in the air does not react with zinc sulphide.

.....  
 .....[1]

(b) In step 2, zinc oxide, which is a base, is converted into the salt, zinc sulphate.

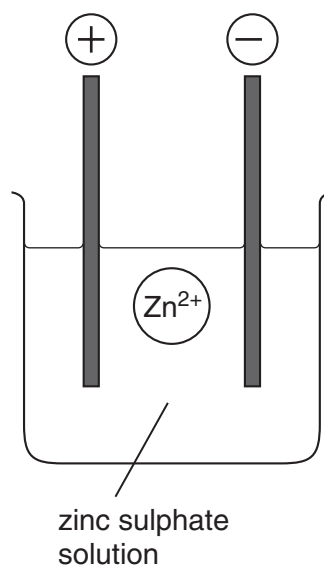
- (i) Write a **word** equation for this reaction.

.....[2]

- (ii) Name this type of chemical reaction in (i).

.....[1]

(c) In step 3, concentrated zinc sulphate solution is electrolysed. Zinc sulphate solution is an electrolyte containing aqueous zinc ions,  $\text{Zn}^{2+}$ . Fig. 7.1 shows a simplified diagram of part of the apparatus used for this electrolysis.



**Fig. 7.1**

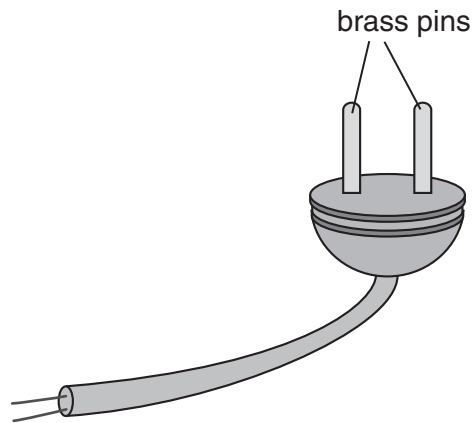
Describe how the zinc ion shown in Fig. 7.1 is changed into a zinc atom during electrolysis.

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.....  
.....  
.....  
.....[4]

(d) Describe what is observed when excess sodium hydroxide solution is added to zinc sulphate solution.

.....  
.....  
.....[2]

(e) Fig. 7.2 shows a two-pin electrical plug.



**Fig. 7.2**

The pins are subjected to forces whenever the plug is connected to the electrical supply socket.

Explain why brass, and not a pure metal such as copper, is used to make the plug pins. You should draw diagrams of the atomic arrangement in both copper and brass to help your explanation.

.....

.....

.....[3]

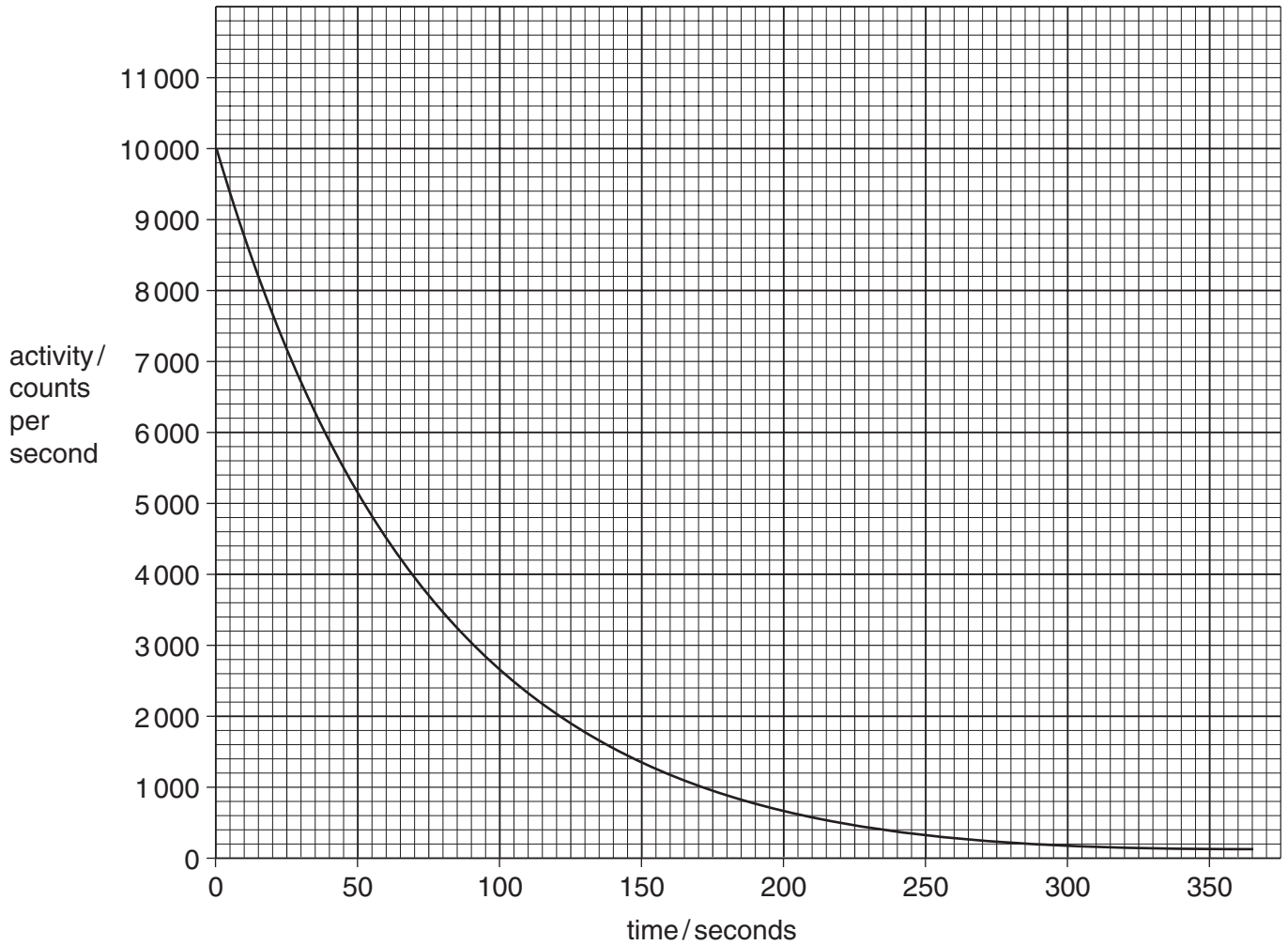
**(Question 8 can be found on page 16)**

8 Radon is a radioactive gas. It escapes from underground rocks and causes part of natural background radiation.

(a) State **one** other natural source of background radiation.

.....[1]

(b) A sample of radon-220 was investigated to find its half-life. The activity of the isotope was measured every 30 seconds for 6 minutes. Fig. 8.1 shows the results.



**Fig. 8.1**

(i) Use the graph to work out the activity of the isotope after 100 seconds.

.....[1]



(ii) Use the graph to calculate the half-life of the isotope. Show your working on the graph.

.....[2]

(iii) There are several isotopes of radon.  
Explain the meaning of the word *isotope*.

.....  
.....[2]

(c) Radon-220 has a short half-life and emits alpha particles.

(i) Suggest why the presence of radon gas in buildings could be a health hazard.

.....  
.....[2]

(ii) When an atom of radon-220 has emitted an alpha particle, how many protons and how many neutrons remain in the atom?  
Explain your answers.

.....  
.....  
.....  
.....[3]

9 (a) Describe the differences between the *cell membrane* and *cell wall* of a plant cell.

.....  
.....  
.....  
.....[3]

(b) (i) Explain how water enters the root hairs of a plant.

.....  
.....  
.....  
.....[3]

(ii) Describe how the water is transported from the roots to the leaves.

.....  
.....  
.....  
.....[2]

(c) If a plant loses more water from its leaves than it can take up through its roots, its stems and leaves become soft and begin to droop.

Explain why this happens.

.....  
.....  
.....  
.....[2]

10 (a) A length of wire is attached to a sensitive ammeter as shown in Fig. 10.1. The wire is moved up and down between the two poles of the magnet.

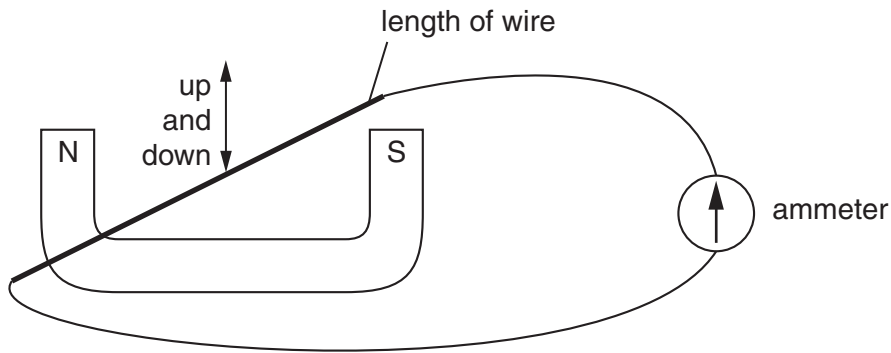


Fig. 10.1

Fig. 10.2 shows the ammeter scale and pointer with zero in the middle.

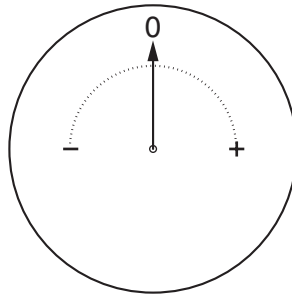


Fig. 10.2

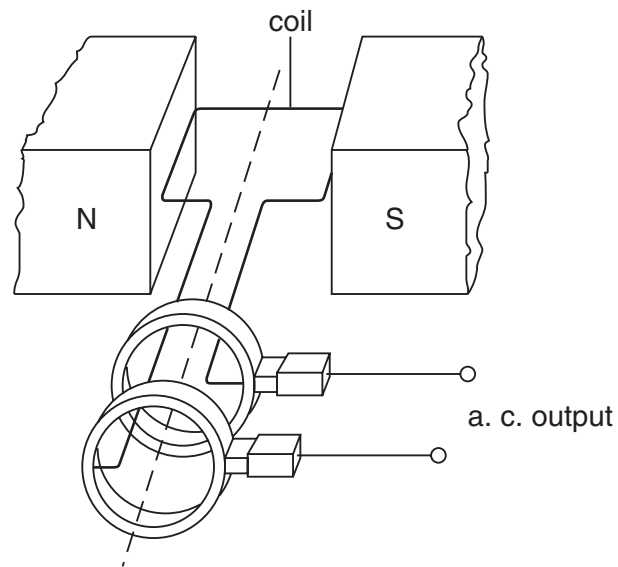
Describe how the pointer will move when the wire is moved downwards and then upwards between the poles of the magnet.

.....

.....

.....[2]

- (b) Fig. 10.3 shows a simple a.c. generator. It consists of a coil of wire rotating between the poles of a permanent magnet. The output is fed to an external circuit through brushes making contact with two slip rings.



**Fig. 10.3**

State two factors on which the size of the output current depends.

1. ....
2. .... [2]







**DATA SHEET**  
**The Periodic Table of the Elements**

		Group																																	
		I	II	III	IV	V	VI	VII	0																										
		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%; text-align: center;">1</td> <td style="width: 10%; text-align: center;"><b>H</b> Hydrogen 1</td> <td colspan="8"></td> <td style="width: 10%; text-align: center;">4</td> <td style="width: 10%; text-align: center;"><b>He</b> Helium 2</td> </tr> </table>										1	<b>H</b> Hydrogen 1									4	<b>He</b> Helium 2												
1	<b>H</b> Hydrogen 1									4	<b>He</b> Helium 2																								
7	<b>Li</b> Lithium 3	9	<b>Be</b> Beryllium 4	11	<b>Na</b> Sodium 11	12	<b>C</b> Carbon 6	13	<b>Al</b> Aluminium 13	14	<b>Si</b> Silicon 14	15	<b>P</b> Phosphorus 15	16	<b>S</b> Sulphur 16	17	<b>Cl</b> Chlorine 17	18	<b>Ar</b> Argon 18																
19	<b>K</b> Potassium 19	20	<b>Ca</b> Calcium 20	21	<b>Sc</b> Scandium 21	22	<b>Ti</b> Titanium 22	23	<b>V</b> Vanadium 23	24	<b>Cr</b> Chromium 24	25	<b>Mn</b> Manganese 25	26	<b>Fe</b> Iron 26	27	<b>Co</b> Cobalt 27	28	<b>Ni</b> Nickel 28	29	<b>Cu</b> Copper 29	30	<b>Zn</b> Zinc 30	31	<b>Ga</b> Gallium 31	32	<b>Ge</b> Germanium 32	33	<b>As</b> Arsenic 33	34	<b>Se</b> Selenium 34	35	<b>Br</b> Bromine 35	36	<b>Kr</b> Krypton 36
37	<b>Rb</b> Rubidium 37	38	<b>Sr</b> Strontium 38	39	<b>Y</b> Yttrium 39	40	<b>Zr</b> Zirconium 40	41	<b>Nb</b> Niobium 41	42	<b>Mo</b> Molybdenum 42	43	<b>Tc</b> Technetium 43	44	<b>Ru</b> Ruthenium 44	45	<b>Rh</b> Rhodium 45	46	<b>Pd</b> Palladium 46	47	<b>Ag</b> Silver 47	48	<b>Cd</b> Cadmium 48	49	<b>In</b> Indium 49	50	<b>Sn</b> Tin 50	51	<b>Sb</b> Antimony 51	52	<b>Te</b> Tellurium 52	53	<b>I</b> Iodine 53	54	<b>Xe</b> Xenon 54
55	<b>Cs</b> Caesium 55	56	<b>Ba</b> Barium 56	57	<b>La</b> Lanthanum 57	72	<b>Hf</b> Hafnium 72	73	<b>Ta</b> Tantalum 73	74	<b>W</b> Tungsten 74	75	<b>Re</b> Rhenium 75	76	<b>Os</b> Osmium 76	77	<b>Ir</b> Iridium 77	78	<b>Pt</b> Platinum 78	79	<b>Au</b> Gold 79	80	<b>Hg</b> Mercury 80	81	<b>Tl</b> Thallium 81	82	<b>Pb</b> Lead 82	83	<b>Bi</b> Bismuth 83	84	<b>Po</b> Polonium 84	85	<b>At</b> Astatine 85	86	<b>Rn</b> Radon 86
87	<b>Fr</b> Francium 87	88	<b>Ra</b> Radium 88	89	<b>Ac</b> Actinium 89	†																													

140	<b>Ce</b> Cerium 58	141	<b>Pr</b> Praseodymium 59	142	<b>Nd</b> Neodymium 60	143	<b>Pm</b> Promethium 61	144	<b>Sm</b> Samarium 62	145	<b>Eu</b> Europium 63	146	<b>Gd</b> Gadolinium 64	147	<b>Tb</b> Terbium 65	148	<b>Dy</b> Dysprosium 66	149	<b>Ho</b> Holmium 67	150	<b>Er</b> Erbium 68	151	<b>Tm</b> Thulium 69	152	<b>Yb</b> Ytterbium 70	153	<b>Lu</b> Lutetium 71
90	<b>Th</b> Thorium 90	91	<b>Pa</b> Protactinium 91	92	<b>U</b> Uranium 92	93	<b>Np</b> Neptunium 93	94	<b>Pu</b> Plutonium 94	95	<b>Am</b> Americium 95	96	<b>Cm</b> Curium 96	97	<b>Bk</b> Berkelium 97	98	<b>Cf</b> Californium 98	99	<b>Es</b> Einsteinium 99	100	<b>Fm</b> Fermium 100	101	<b>Md</b> Mendelevium 101	102	<b>No</b> Nobelium 102	103	<b>Lr</b> Lawrencium 103

\*58-71 Lanthanoid series  
†90-103 Actinoid series

**Key**

a	<b>X</b>
b	<b>X</b>

a = relative atomic mass  
X = atomic symbol  
b = proton (atomic) number

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).