Centre Number	Candidate Number	Name

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.

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.

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

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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.

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.....[2]

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

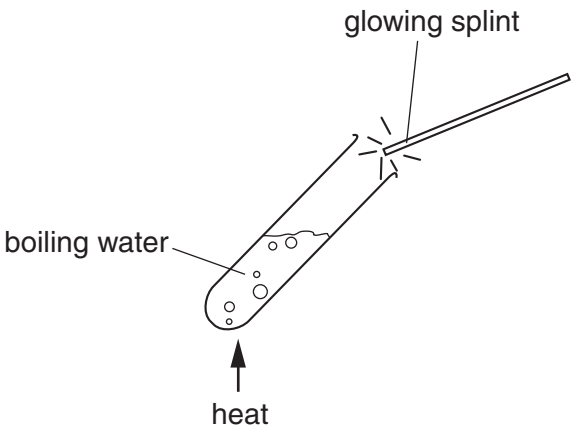

Fig. 1.1

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.....[2]

(d) Magnesium oxide, MgO, has a very high melting point, but carbon dioxide, CO_2, has a very low melting point.

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.....[3]

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

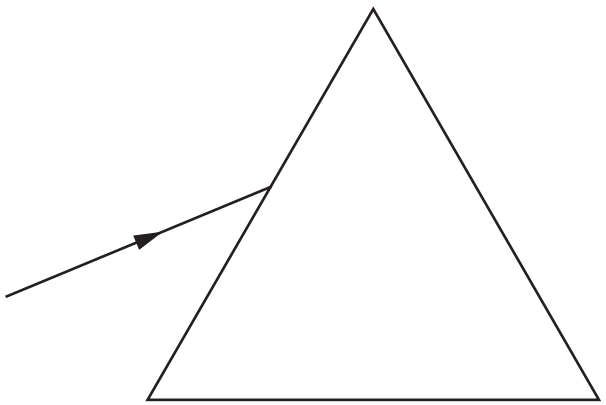

Fig. 2.1

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]

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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.

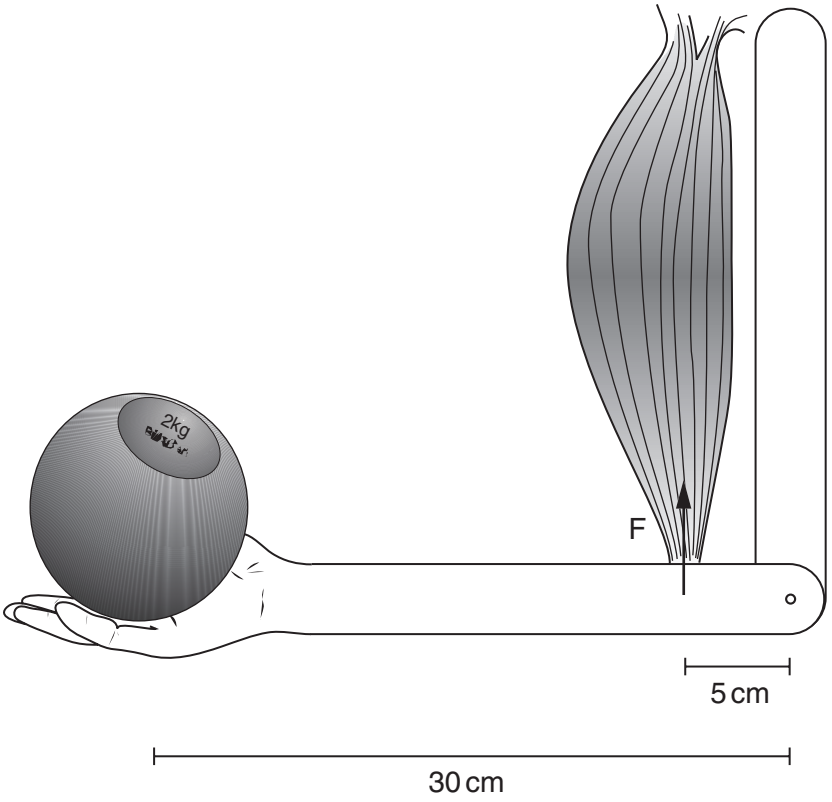

Fig. 3.1

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(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]

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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.

ethane	ethene
H — C	

[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]

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

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

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.....[2]

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

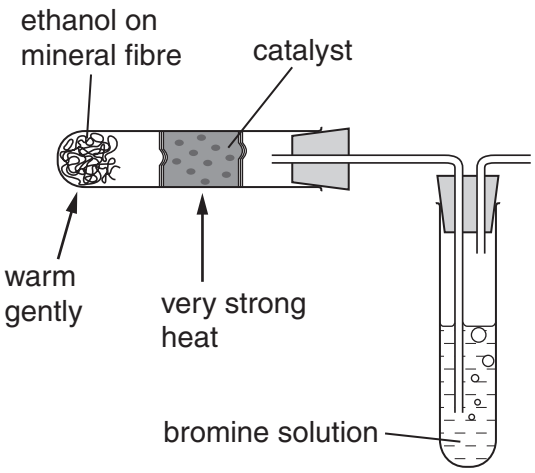

Fig. 4.1

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.

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.....[2]

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

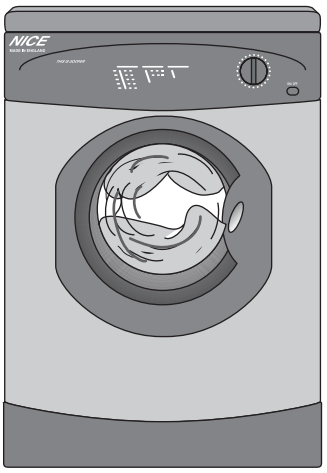

Fig. 5.1

(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]

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

Use the equation

power = voltage × current

to calculate the current required by the tumble dryer.

.....[2]

(iv) The heater in the tumble dryer has a resistance of 125 Ω.

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

.....[2]

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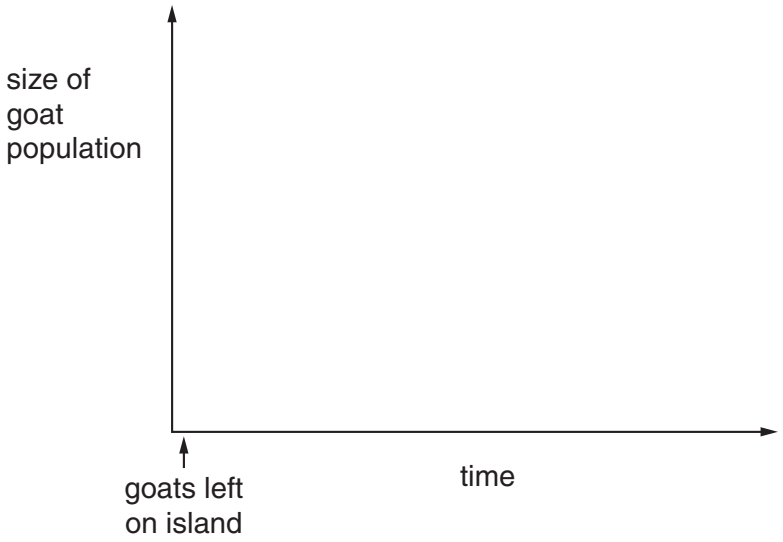
6 In the nineteenth century, a ship travelling across the southern Pacific Ocean stopped at an island to collect fresh water. The sailors left one male goat, **P**, and two female goats, **Q** and **R**, on the island, hoping that they would breed and so provide food if the ship stopped there again.

(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]

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(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.

.....

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.....

.....[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]

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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.

$$2\ ZnS + O_2 \rightarrow 2\ ZnO + SO_2$$ [1]

(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, Zn^{2+}. Fig. 7.1 shows a simplified diagram of part of the apparatus used for this electrolysis.

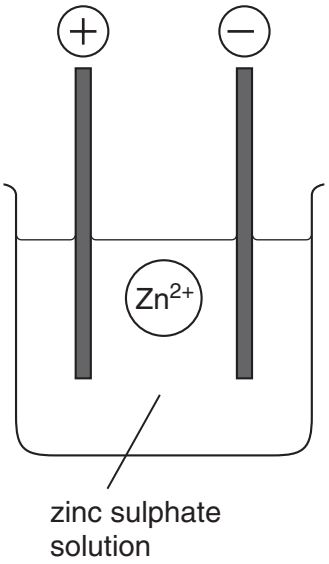

Fig. 7.1

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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.

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.....[2]

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

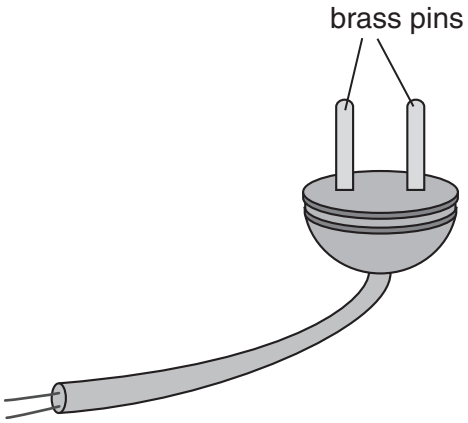

Fig. 7.2

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.

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.....[3]

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(Question 8 can be found on page 16)

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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.

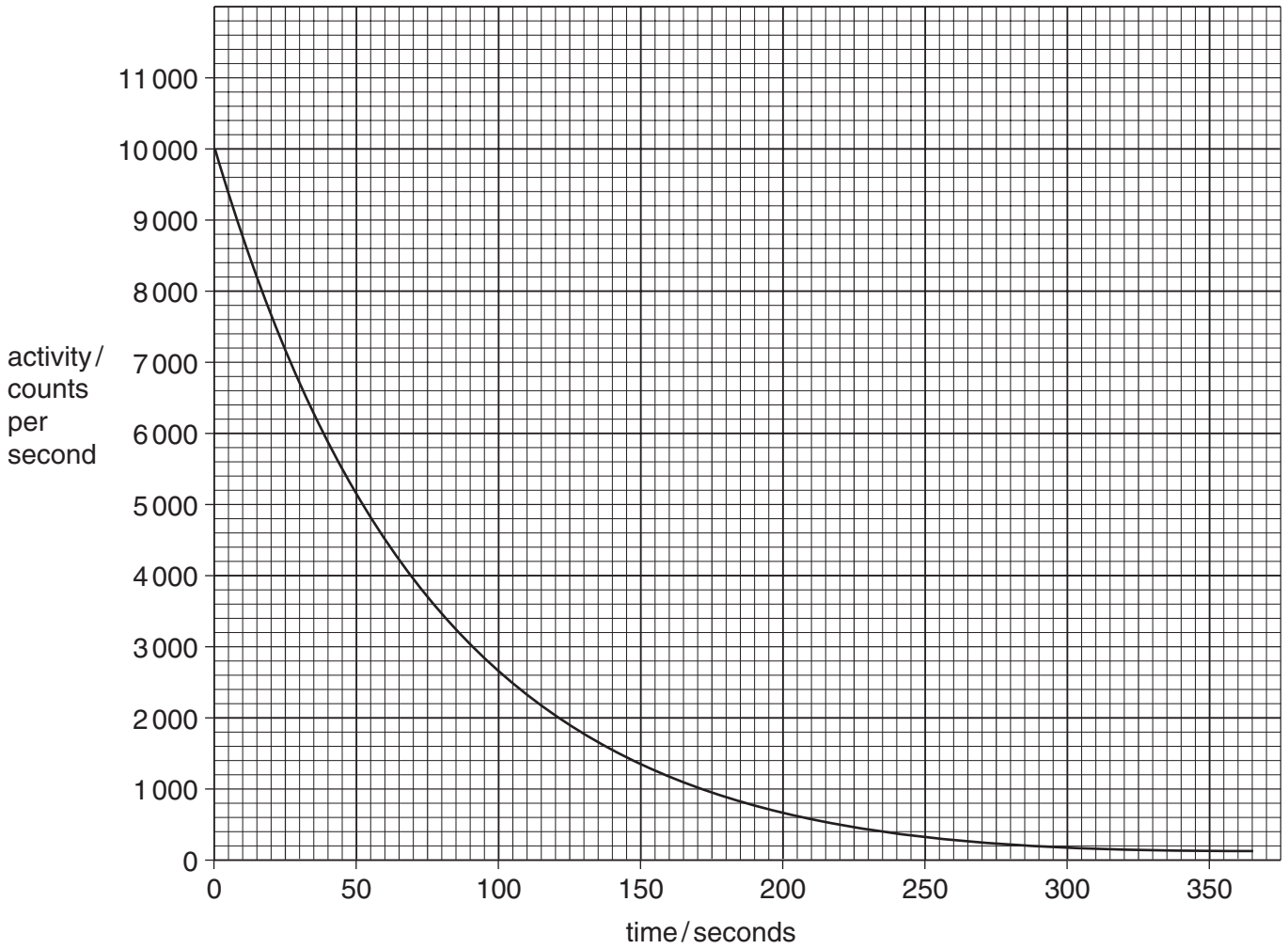

Fig. 8.1

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

.....[1]

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(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.

.....

.....

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.....[3]

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

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.....

.....[3]

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

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.....[3]

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

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.....

.....[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.

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.....[2]

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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.

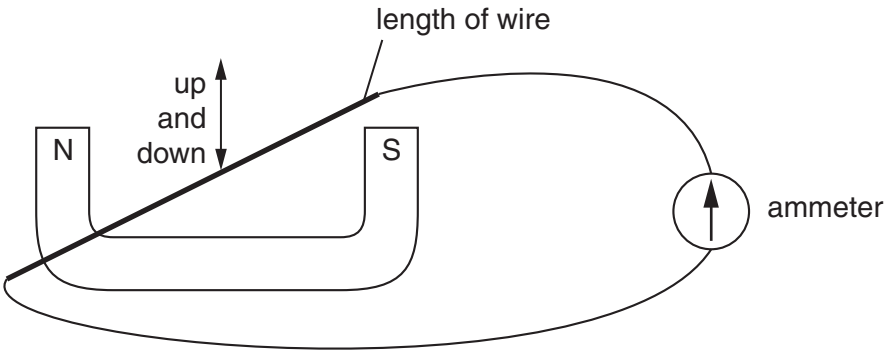

Fig. 10.1

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

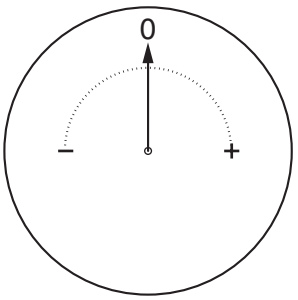

Fig. 10.2

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

.....

.....

.....[2]

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(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.

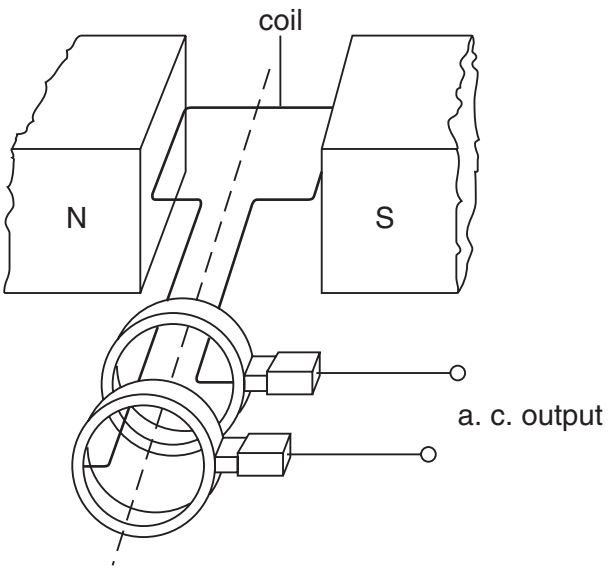

Fig. 10.3

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

1. .....

2. .....[2]

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(c) The generator at a power station produces a large current at a low voltage. The voltage is increased by a transformer before the electricity is distributed through power lines to distant places.

Describe how a transformer changes the voltage of the electrical output from the power stations.
Your answer **must** include the following terms.

primary coil	**secondary coil**
primary voltage	**secondary voltage**
induced current	**changing magnetic field**

Include a diagram in your answer.

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.....[5]

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DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulphur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

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

Key

a
X
b

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

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

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