UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

8210372670

CO-ORDINATED SCIENCES **0654/32**

Paper 3 (Extended) **May/June 2011**

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.
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.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
A copy of the Periodic Table is printed on page 28.

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.

For Examiner's Use	
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7	
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10	
Total	

This document consists of **26** printed pages and **2** blank pages.

UNIVERSITY of CAMBRIDGE International Examinations

1 Guanacos are relatives of camels and live in the Andes mountains in South America. They feed on grasses and other plants. They are hunted by pumas, and young guanacos may be killed by foxes.

Fig. 1.1 shows a guanaco.

Fig. 1.1

(a) (i) State **one** feature, visible on Fig. 1.1, that indicates that guanacos are mammals.

.....

[1]

(ii) State **one** feature, visible on Fig. 1.1, that could help guanacos to avoid being killed by pumas.

.....

[1]

(b) Guanacos can live at very high altitudes, above 4000 metres, where the atmosp
less dense than at sea level.

The blood of a guanaco contains four times as many red blood cells per cm^3 as the blood of a human.

This adapts the guanaco to its environment. Suggest an explanation for this.

.....

.....

..... [2]

(c) Guanacos are an endangered species. Their numbers have fallen because of loss of suitable habitat and because of hunting by humans. Several countries in South America have conservation programmes to try to increase the numbers of guanacos.

In one conservation programme, five male and five female guanacos were introduced into a suitable habitat of about 25 km^2. They were protected from humans.

Fig. 1.2 shows what happened to the guanaco population over the next few years.

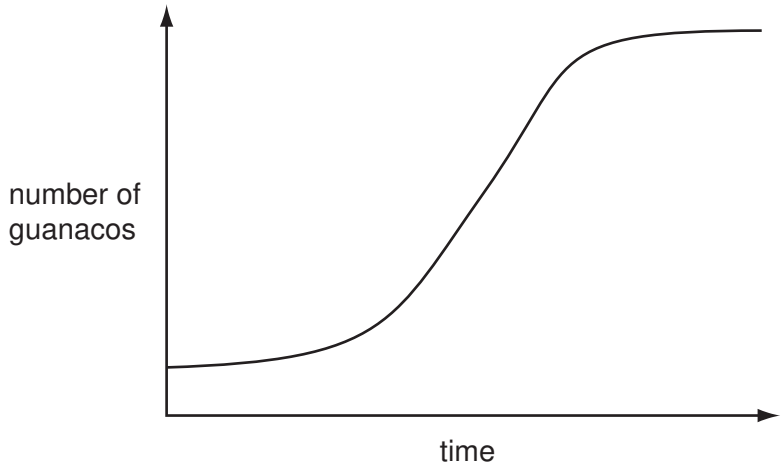

Fig. 1.2

Explain the reasons for the shape of the graph.

.....

.....

.....

.....

..... [3]

(d) People in South America domesticated guanacos at least 6000 years ago. They used artificial selection to produce a breed of guanacos that produced more meat, milk, wool and that were easy to keep as herds. These animals are now called llamas.

Explain how artificial selection could have produced llamas from guanacos.

.....

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.....

..... [4]

2 Lithium and its compounds have many important uses.

The production of lithium metal involves three main stages.

1 Lithium compounds found in the Earth's crust are converted into lithium carbonate, Li_2CO_3.

2 Lithium carbonate is converted into lithium chloride, LiC*l*.

3 Lithium chloride is melted and is electrolysed.

(a) Explain why lithium is never found as the uncombined element in the Earth's crust.

.....

..... [1]

(b) The electron configurations of lithium **ions** and chloride **ions** are shown below.

lithium ion	2
chloride ion	2,8,8

(i) Explain, in terms of protons and electrons, why a lithium ion has a single positive electrical charge but a lithium atom is uncharged (neutral).

.....

.....

.....

..... [2]

(ii) Explain why lithium chloride is a solid with a high melting point.

.....

.....

.....

..... [2]

(c) Suggest a **word** equation for a reaction in which lithium carbonate is converted into lithium chloride.

..... [2]

(d) Fig. 2.1 shows the industrial electrolysis of molten lithium chloride.

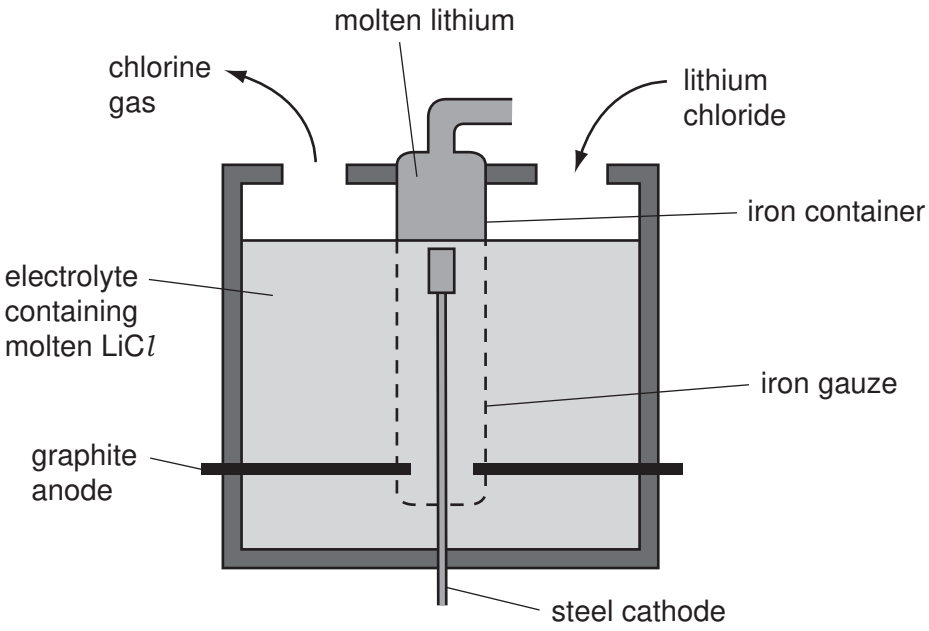


Fig. 2.1

(i) Explain why the electrolyte must be kept molten.

.....

..... [1]

(ii) Describe how the electron configuration of each lithium ion changes when they arrive at the cathode during the electrolysis in Fig. 2.1.

.....

..... [1]

(e) Lithium carbonate is widely used as a drug to treat some types of mental illness.

It is very important that compounds for use as drugs are made to high standards of purity.

State **one** reason for this.

.....

..... [1]

3 **(a)** Fig. 3.1 shows a skier being pulled up a mountain slope by a cable (lift).

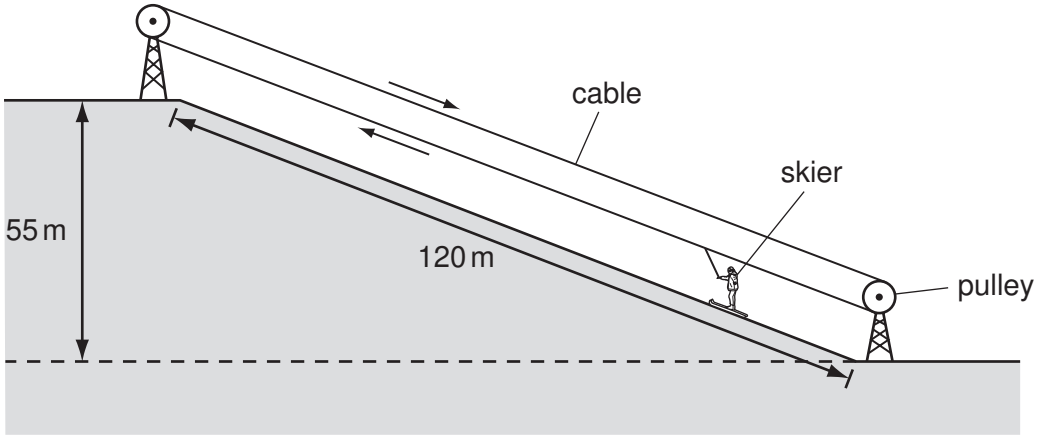


Fig. 3.1

The skier weighs 700 N. She travels 120 m along the slope and rises by a vertical height of 55 m.

Calculate the work done lifting the skier from the bottom to the top of the slope.

You should ignore the work done against friction.

State the formula that you use and show your working.

formula used

working

..... [2]

(b) Skiers use a ski pole in each hand to help control their motion. The ski poles wo
when they only go into the snow for a few centimetres.

Fig. 3.2 shows a skier using ski poles.

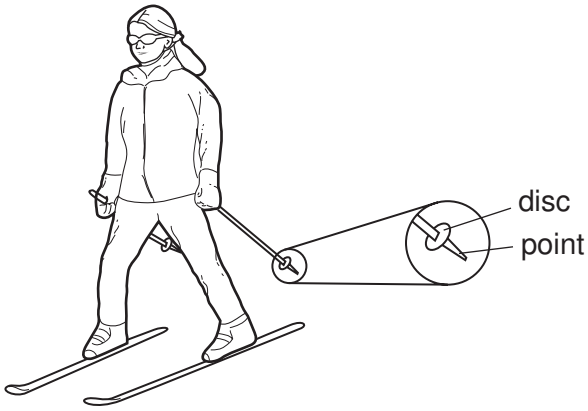


Fig. 3.2

Explain, in terms of pressure, force and area, why the ski pole has a pointed end and a large disc a few centimetres above this.

.....

.....

.....

..... [2]

(c) Explain why a skier keeps the lower surface of her skis smooth and well polished.

.....

..... [1]

4 Fig. 4.1 shows underground layers of sedimentary rocks. The diagram is not dr scale. Some of these rock layers are permeable and contain fossil fuels trapped i them.

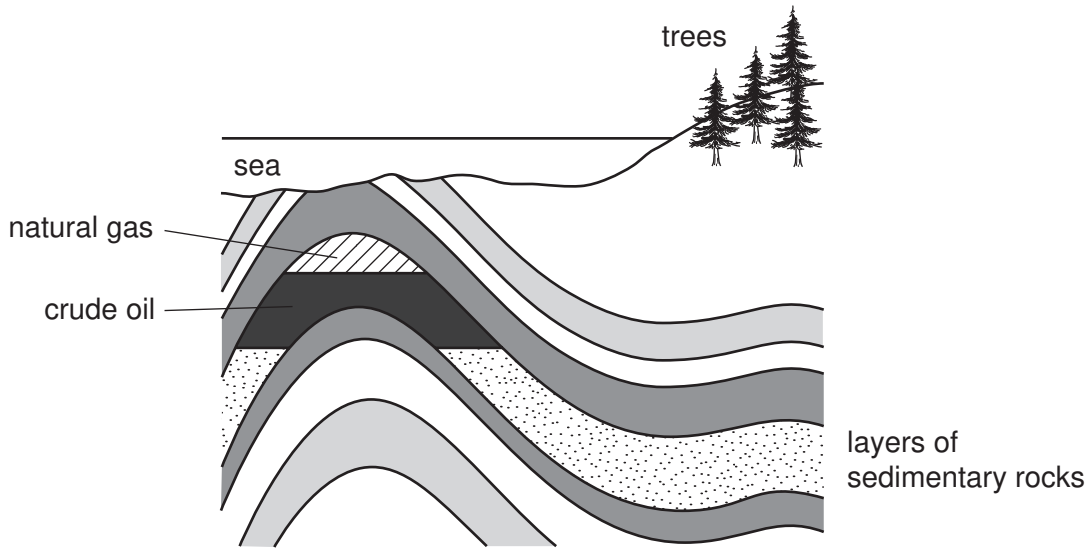


Fig. 4.1

(a) (i) Wood obtained from trees and compounds obtained from crude oil and natural gas can both be used as fuels.

State **two** reasons why crude oil and natural gas are examples of *fossil fuels* but wood is not.

1 .....

.....

2 .....

..... [2]

(ii) Fossil fuels contain mainly hydrocarbons. Wood contains cellulose which is a carbohydrate.

Name an element which is combined in carbohydrate molecules but **not** in hydrocarbons.

..... [1]

(b) The molecular formulae of three hydrocarbon molecules are shown below.

CH_4 C_6H_{14} $C_{12}H_{26}$

(i) Draw the graphical (displayed) formula of C_6H_{14}.

[1]

(ii) All of the molecules shown above are members of the homologous series of alkanes.

State **one** similarity and **one** difference in the properties of the pure substances which contain these molecules.

similarity .....

.....

difference .....

..... [2]

(c) In a car engine, the combustion of hydrocarbons produces a mixture of very hot waste (exhaust) gases.

These gases are released from the car into the atmosphere, and some of them cause pollution because they are poisonous.

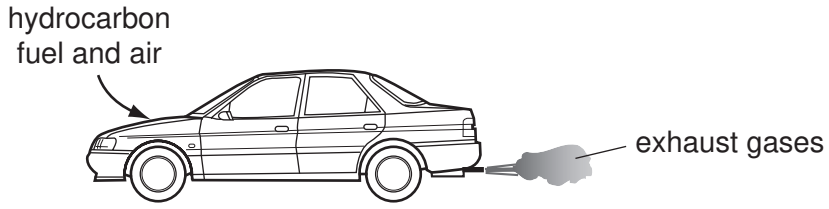


Table 4.1 shows information about some of the gases in a car's exhaust.

Table 4.1

substance in exhaust gases	% by volume
nitrogen	67
carbon dioxide	12
water vapour	0.05
oxygen	11
carbon monoxide	9
hydrocarbons (unburnt fuel)	0.2

(i) Suggest why the exhaust gas mixture contains a significant amount of nitrogen.

.....

.....

..... [2]

(ii) In all modern cars, the hot exhaust gases pass through a catalytic converter before they are released into the atmosphere.

Carbon monoxide and hydrocarbons are oxidised by oxygen as the exhaust gases pass through the catalytic converter.

State the purpose of the catalyst which is present inside the converter.

.....

..... [1]

(iii) Catalytic converters help to reduce the air pollution caused by car exhaust gases.

Use the information given in Table 4.1 and your answer to **(ii)** to explain how they do this.

.....

.....

.....

..... [3]

5 **(a)** Nuclear reactors in power stations produce energy through nuclear fission.

When uranium-235 is used in a reactor, the fission is started by a neutron hitting a uranium-235 atom. This results in two other atoms being produced and two neutrons released.

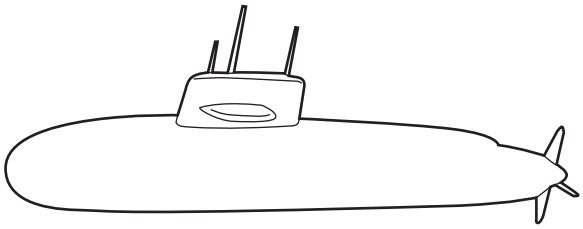
$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{144}_{56}Ba + {}^{90}_{36}Z + 2\,{}^{1}_{0}n$$

neutron — 2 neutrons

Use the Periodic Table on page 28 to identify atom **Z**.

atom **Z** is ..... [1]

(b) A nuclear reactor can also be used to power a submarine.



Radiation is released during nuclear fission. The reactor has to be shielded to protect the crew from this radiation.

(i) Suggest **one** material which could shield a nuclear reactor to stop radiation escaping.

..... [1]

(ii) Describe how being exposed to ionising radiation can affect the human body.

.....

.....

..... [2]

(c) A nuclear reactor produces nuclear waste.

Waste from a nuclear reactor contains a radioactive isotope with a half-life of 100 years.

A sample of the waste gives a count rate of 3200 counts per minute.

(i) Explain the meaning of the term *isotope*.

.....

.....

..... [2]

(ii) Calculate the time taken for the count rate of this sample of waste to drop to 400 counts per minute.

Show your working.

..... [2]

6 Fig. 6.1 shows some of the bones and muscles in the human arm.

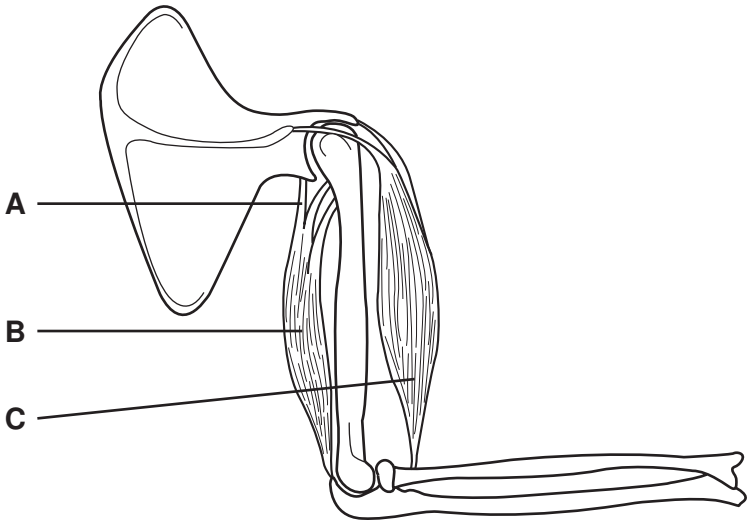


Fig. 6.1

(a) Name the structure **A**.

A ..... [1]

(b) Explain how the structures shown in Fig. 6.1 can cause the arm to straighten.

.....

.....

.....

..... [3]

(c) Muscles **B** and **C** are antagonistic muscles.

Explain why a pair of antagonistic muscles, rather than a single muscle, is required to move the arm at the elbow joint.

.....

.....

..... [2]

(d) Bone is made up of the mineral calcium phosphate, and a protein called collag
many people, the mineral content of bone increases up to about the age of 20,
which it remains approximately constant until about the age of 50.

A study was carried out in Brazil into the mineral content of the leg bones of school children between the ages of 10 and 19 years. The mineral content was measured as the mass of mineral per cm^3 of bone. Some of the results are shown in Fig. 6.2.

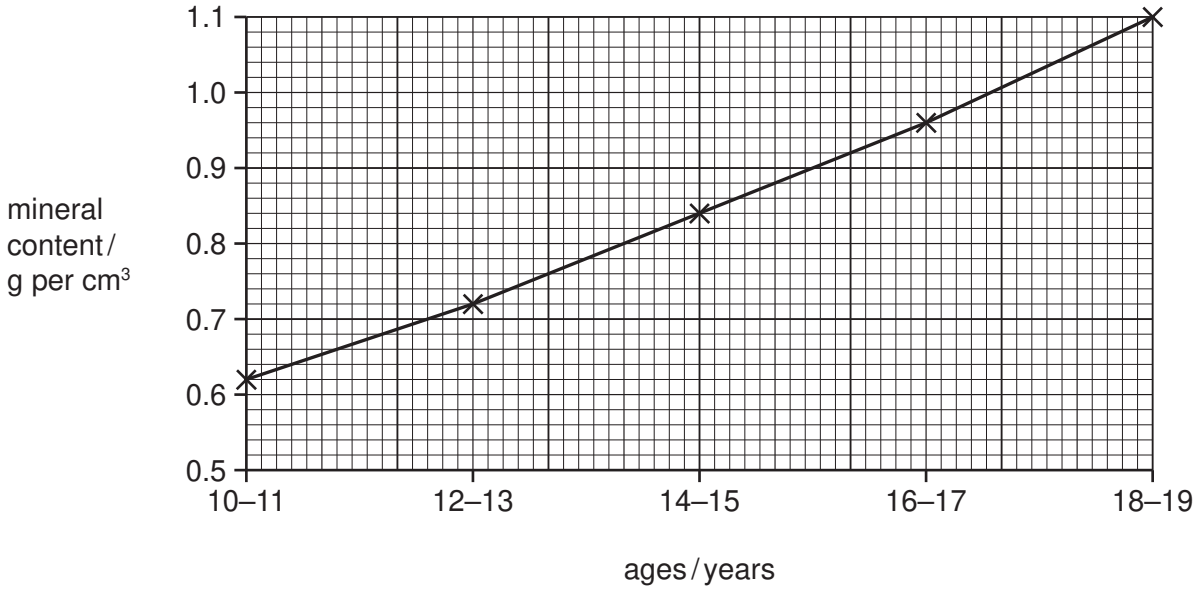


Fig. 6.2

(i) Describe how the mineral content of bone changes between the ages of 10 and 19 years.

.....

.....

..... [2]

(ii) From the age of about 50 years onwards, the mineral content of bone gradually decreases. If the mineral content of a person's bones becomes very low, a condition called osteoporosis occurs, in which the bones lose their strength and break very easily.

Use this information, and the data in Fig. 6.2, to suggest why it is important for a teenager to have a diet containing plenty of dairy products such as milk and cheese.

.....

.....

..... [2]

(e) The human skeleton also contains cartilage.

(i) State **one** difference between the properties of bone and cartilage.

.....

..... [1]

(ii) State precisely where cartilage is found in the human arm shown in Fig. 6.1, and describe its function.

.....

.....

..... [2]

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Please turn over for Question 7.

7 Fig. 7.1 shows a crane for use on building sites.

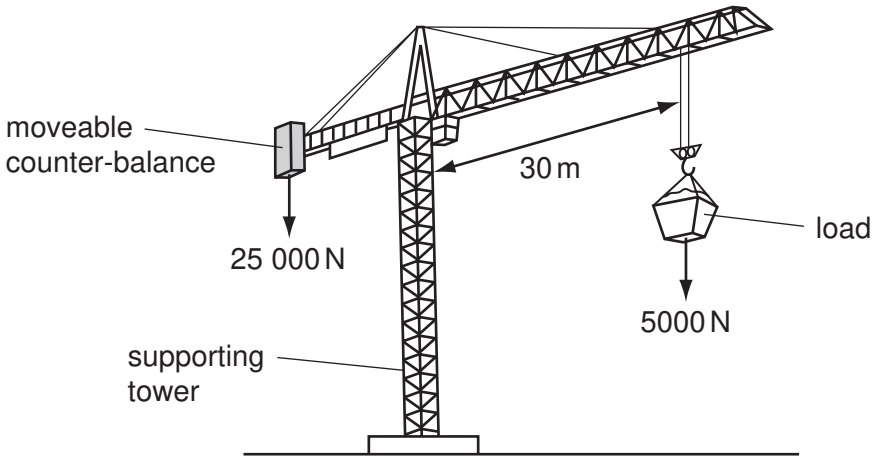


Fig. 7.1

(a) Explain in terms of forces why the crane needs a counter-balance.

.....

.....

..... [2]

(b) The crane in Fig. 7.1 is balanced.

Calculate the moment of the load about the crane's supporting tower. Then calculate the distance of the counterbalance from the crane's supporting tower.

State the formula that you use for your calculations and show your working.

formula used

working

moment of load .....

distance of counterbalance ..... [3]

(c) A brick falls from the crane and hits the ground at a speed of 40 m / s. The air resi
on the brick can be ignored.

(i) The acceleration due to gravity is 10 m / s^2.

Calculate the time of the fall.

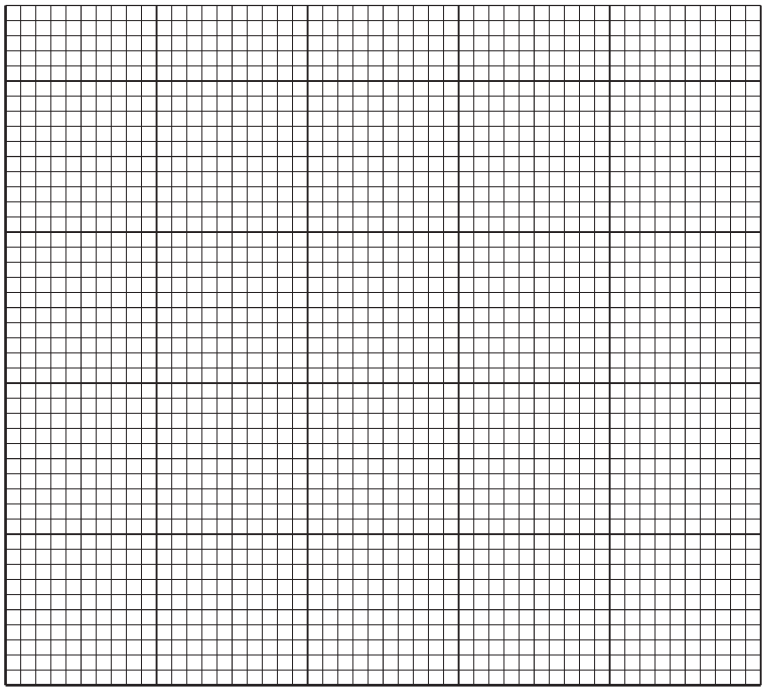
State the formula that you use and show your working.

formula used

working

..... [2]

(ii) On the grid below, draw the speed-time graph for the falling brick.



[3]

(iii) The brick has a mass of 2 kg.

Calculate the kinetic energy of the brick as it hits the ground.

State the formula that you use and show your working.

formula used

working

..... [2]

(iv) State the value of the potential energy of the brick, before it fell from the crane.

Explain your answer.

potential energy .....

explanation .....

..... [2]

8 **(a)** Name the part of a flower that carries out each of the following functions.

(i) attracts insects to the flower ..... [1]

(ii) makes pollen ..... [1]

(b) Complete the table to describe the differences between the stigmas of insect-pollinated and wind-pollinated flowers.

feature	insect-pollinated flower	wind-pollinated flower
shape of stigma		
position of stigma		

[2]

(c) Describe what happens after pollen has landed on the stigma of a flower, ending with the formation of a zygote.

.....

.....

.....

.....

.....

..... [4]

(d) The cells in the petals of most flowers do not contain chlorophyll and cannot photosynthesise.

Suggest how the cells in flowers obtain sugars and other nutrients.

.....

.....

.....

..... [2]

9 A student investigated the relative reactivity of four metals **A**, **B**, **C** and **D**, by compar
rate at which these metals reacted in dilute acid.

The pieces of metal had the same surface area, and dilute hydrochloric acid was the only
acid used in the experiment.

Fig. 9.1 shows what the student observed during the experiment.

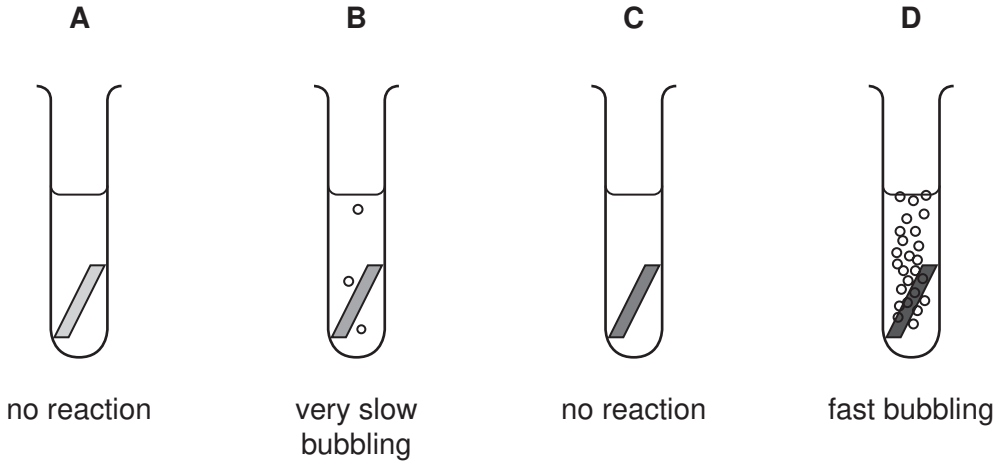


Fig. 9.1

(a) (i) State and explain **one** of the variables, other than the surface area of the pieces of metal and the acid used, that the student must keep the same if her assessment of relative reactivity is to be reliable.

variable .....

explanation .....

.....

..... [3]

(ii) Predict and explain what is observed if a lighted splint is held over the test-tube in which metal **D** is reacting.

.....

.....

..... [2]

(b) The student took some larger pieces of the same metals, **A**, **B**, **C** and **D**, and them to make the two electrochemical cells shown in Fig. 9.2.

The student set up the cells so that the negative electrode in both cells was on the left hand side as shown in Fig. 9.2.

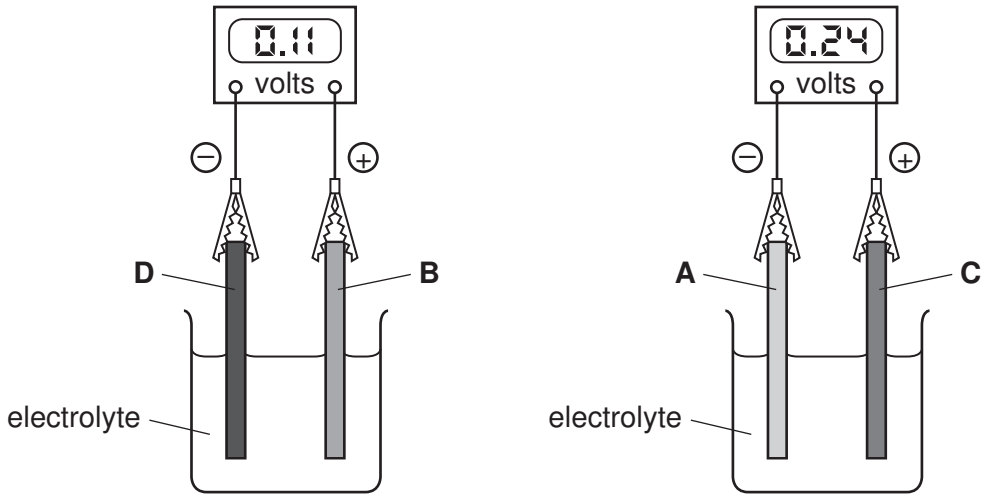


Fig. 9.2

The student had an idea that the electrode made of the **more reactive** metal would always be the **negative** electrode in an electrochemical cell.

(i) Use the information in Fig. 9.1 and Fig. 9.2 to explain how the experimental evidence supports the student's idea.

.....

.....

..... [2]

(ii) Use the information in Fig. 9.1 and Fig. 9.2 to suggest which of the four metals, **A**, **B**, **C** or **D**, is the **least** reactive.

metal .....

reason .....

.....

..... [2]

(c) Draw a labelled diagram of the bonding in a typical metal. Your diagram does **no** to show more than 12 atoms.

For iner's

Use your diagram to help you to explain why metals are good conductors of electricity.

.....

.....

..... [2]

10 (a) Optical fibres are used to see inside the human body. Light is sent along some fibres to enable doctors to see what is there.

(i) Fig. 10.1 shows an optical fibre with a ray of light travelling down part of it.

Draw the path of the ray of light as it travels down the fibre.

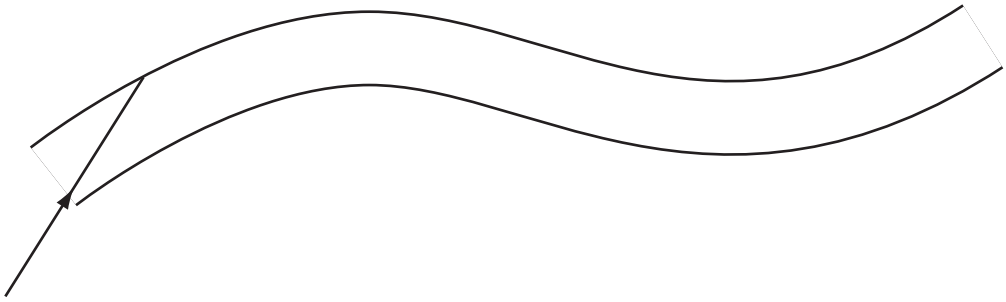


Fig. 10.1

[2]

(ii) Suggest why optical fibres are now replacing metal wires as the method by which telephone signals are sent.

.....

..... [1]

(b) Table 10.1 shows the likely effects of an electric current passing through the body.

Table 10.1

current / amperes	effect on the human body
0.001	none
0.003	tingling
0.010	muscular spasm
0.100	fatal if it passes through the heart

A person touched a live wire connected to a 250 V supply. The path to earth through the body had a high resistance of 20 000 Ω.

Calculate the current that passes through the person.

What effect will this have on the person's body?

State the formula that you use and show your working.

formula used

working

current = ...

effect on the body ..... [3]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	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** Sulfur 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 †															

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

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

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.).