UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

7122849423

CO-ORDINATED SCIENCES **0654/31**

Paper 3 (Extended) **October/November 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 24.

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	
1	
2	
3	
4	
5	
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7	
8	
9	
Total	

This document consists of **24** printed pages.

1 **(a)** Fig. 1.1 shows a motor neurone.

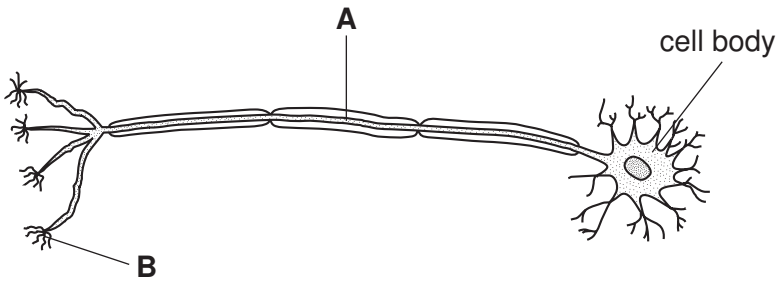


Fig. 1.1

(i) On Fig. 1.1, draw **one** arrow to show the direction in which a nerve impulse travels. [1]

(ii) Name the part of the nervous system in which the cell body of the motor neurone is found.

..... [1]

(iii) Explain how the parts of the motor neurone labelled **A** and **B** adapt the neurone for its function.

A .....

.....

.....

B .....

.....

..... [4]

(b) Almost all cells in the body have a nucleus which contains DNA.

(i) Outline the function of DNA.

.....

.....

..... [2]

(ii) State how the quantity of DNA in the nucleus of a motor neurone would differ from the quantity of DNA in the nucleus of a gamete.

..... [1]

2 **(a)** Fig. 2.1 shows two children playing in a swimming pool.

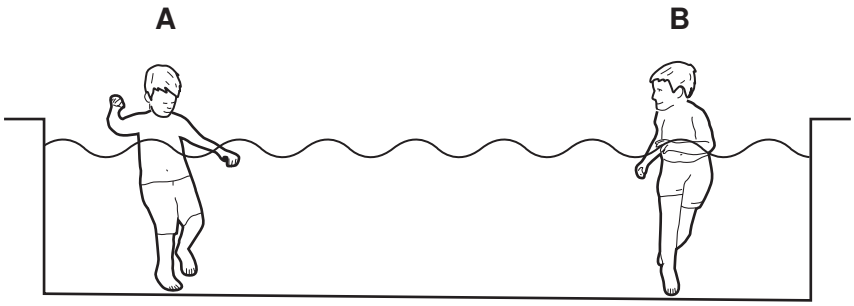


Fig. 2.1

Child **A** makes some small waves on the surface of the water.

(i) In 10 seconds, 5 complete waves pass by child **B** who is standing in the same pool.

Calculate the frequency of the water waves.

Show your working.

..... [1]

(ii) The waves in the pool are transverse waves.

Explain how a transverse wave differs from a longitudinal wave. Draw a diagram if it helps your answer.

.....

.....

..... [2]

(b) The top of a water slide is 10 m above the water in the pool. This is shown in Fig

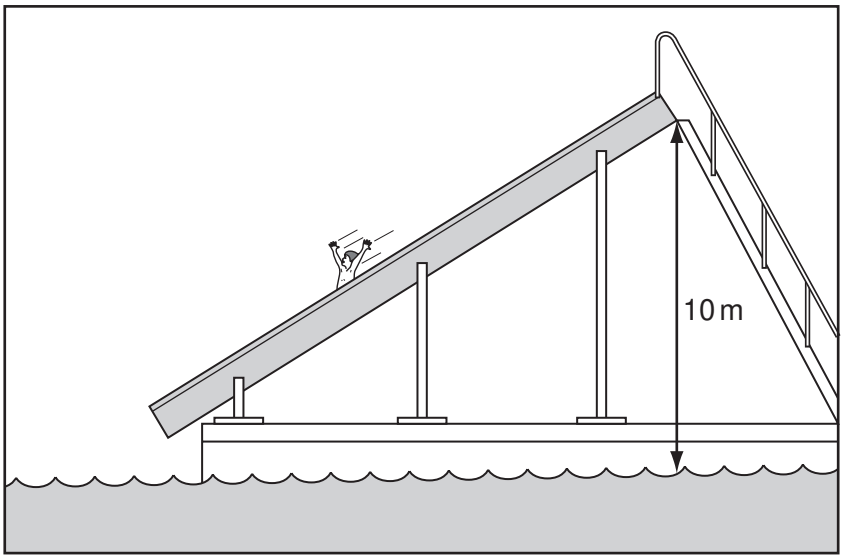


Fig. 2.2

A boy has a mass of 50 kg. He climbs from the pool to the top of the slide. When he slides down and reaches the bottom of the slide, his speed is 12 m / s.

Calculate the kinetic energy of the boy as he reaches the bottom of the slide.

State the formula that you use and show your working.

formula used

working

..... [2]

(c) The boy then climbs to the top of another water slide which is 20 m high.

(i) When the boy is at the top of the slide, does his weight differ from his weight at the top of the 10 m slide?

Explain your answer.

.....

..... [1]

(ii) Suggest how the kinetic energy of the boy at the bottom of the 20 m slid
differ from his kinetic energy at the bottom of the 10 m slide.

Explain your answer.

.....

.....

..... [1]

(d) The mass of water in the pool is 50 000 kg. The specific heating capacity of water is 4200 J / kg °C. The water is heated from 20 °C to 25 °C.

Calculate the energy needed to heat the water.

State the formula that you use and show your working.

formula used

working

..... [3]

3 The manufacture of ammonia and of sulfuric acid are two important industrial process

Fig. 3.1 is a simplified diagram of the type of reaction vessel which is used in bo processes.

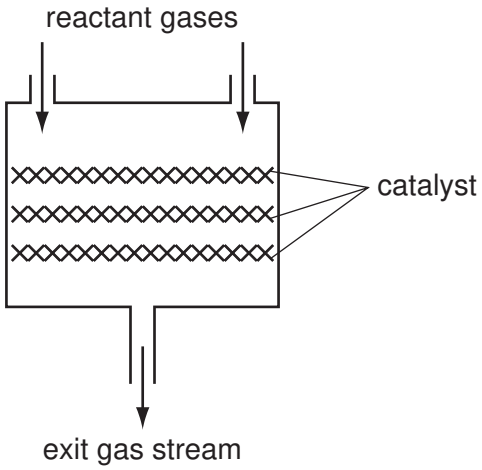


Fig. 3.1

(a) The manufacture of ammonia and of sulfuric acid both involve reversible redox reactions which require a catalyst.

(i) State the purpose of a catalyst.

.....

[1]

(ii) The reactant gases required to make ammonia are nitrogen and hydrogen.

Explain why the exit gas stream contains all three of these gases.

.....

.....

.....

[2]

(iii) The equation below shows one of the reactions involved in the manufacture of sulfuric acid. The equation is not balanced.

Balance the equation.

$$SO_2 + O_2 \rightleftharpoons SO_3$$

[1]

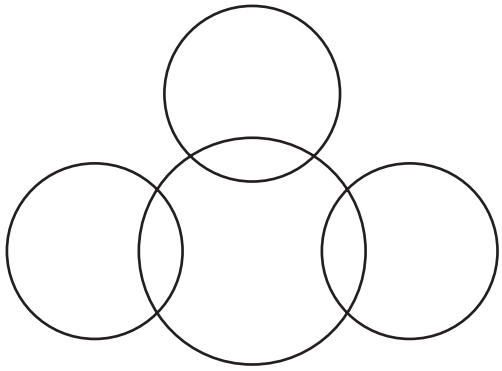
(iv) **Name** the substance which is oxidised in the reaction in **(iii)**.

.....

[1]

(b) Complete the bonding diagram below to show

- the chemical symbols of the elements in a molecule of ammonia,
- the arrangement of the outer electrons of each atom.



[3]

(c) Ammonia reacts with dilute nitric acid to make the salt ammonium nitrate.

$$NH_3 + HNO_3 \longrightarrow NH_4NO_3$$

A student makes a solution containing ammonium nitrate by mixing solutions **A** and **B** as shown in Fig. 3.2.

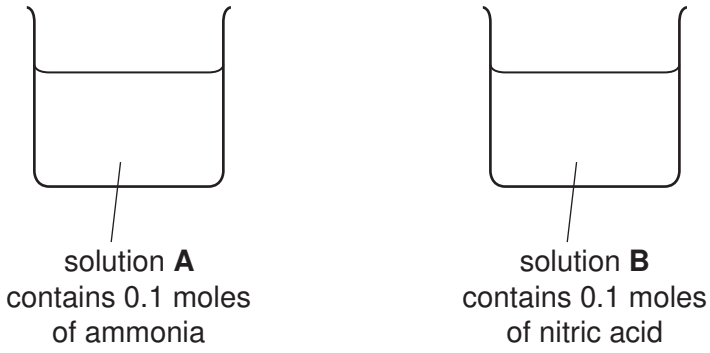


Fig. 3.2

The student then leaves the solution of ammonium nitrate to evaporate completely.

(i) Calculate the mass in grams of ammonium nitrate crystals that she will obtain.

Show your working. [relative atomic masses, A_r: N=14; O=16; H=1]

.....

[2]

(ii) The formula of the ammonium ion is NH_4^+.

Deduce the formula of the nitrate ion.

Show how you obtained your answer.

.....

[2]

4 **(a)** Fig. 4.1 shows a 230 V 60 W light bulb.

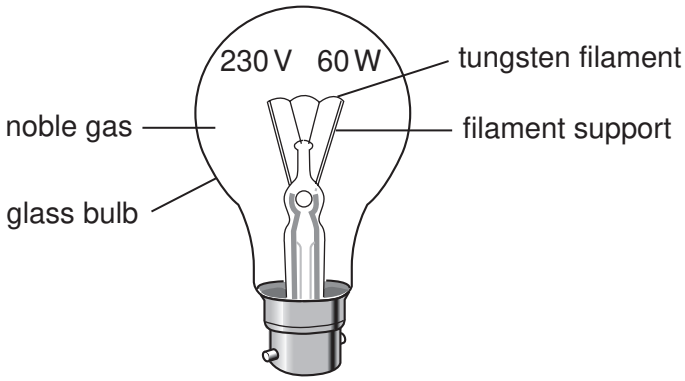


Fig. 4.1

When the light bulb is switched on, the tungsten filament glows white hot at a temperature of 2400 °C.

Explain how thermal energy from the hot tungsten filament is transferred to the rest of the light bulb.

.....

.....

.....

.....

..... [3]

(b) Light bulbs like this are not efficient at converting electrical energy into light energy.

Calculate the percentage efficiency of a 60 W light bulb if 54 W of power is lost from the bulb as heat.

Show your working.

% efficiency = ... [2]

(c) The graph in Fig. 4.2 shows how the current through a different light bulb change
it is switched on.

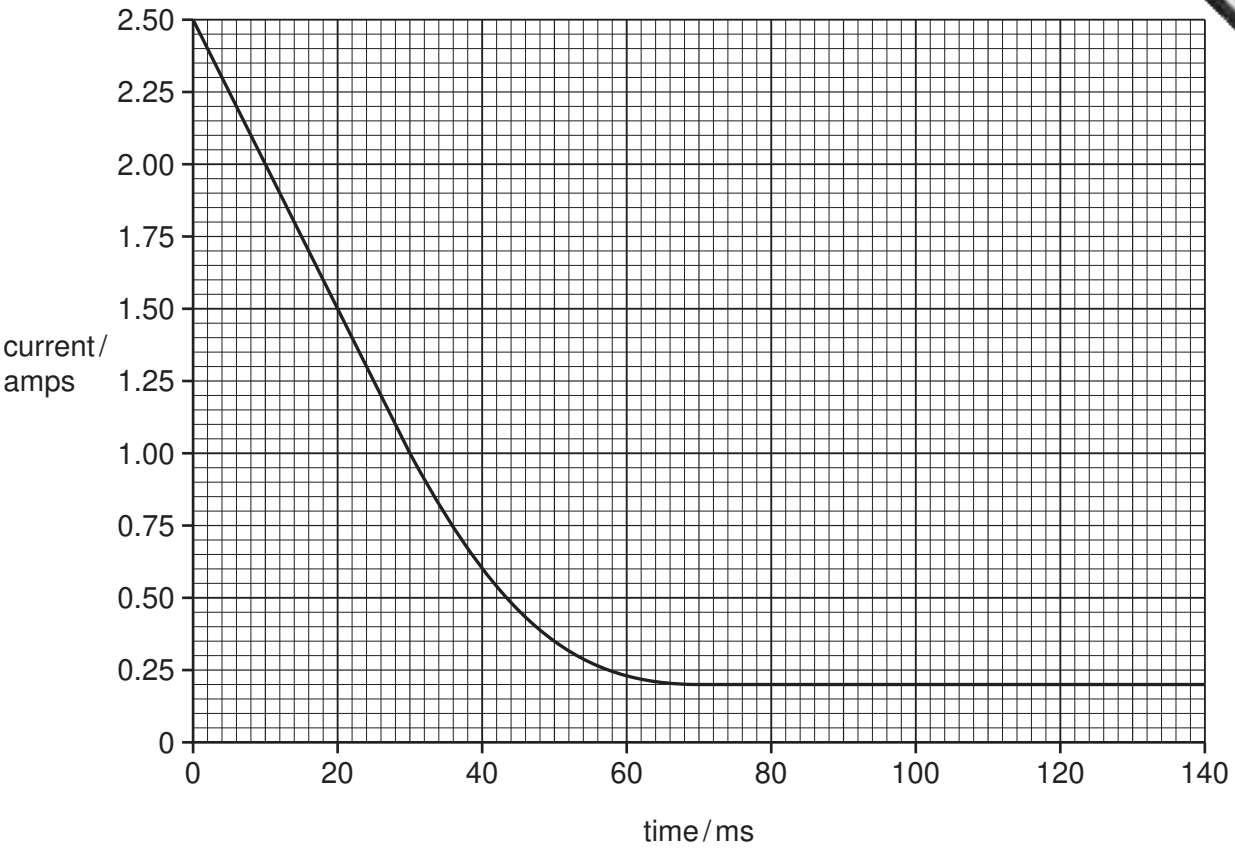


Fig. 4.2

(i) Describe what happens to the current after the bulb is switched on.

.....

.....

..... [2]

(ii) Use the graph to find the current through the light bulb 80 ms after it is switched on.

..... [1]

(iii) The voltage supplied to the bulb is 230 V.

Calculate the power of this light bulb 80 ms after it is switched on.

State the formula that you use and show your working.

formula

working

..... [2]

(d) A lamp with a resistance of 1000 Ω when lit is connected in parallel with another lamp with a resistance of 2000 Ω when lit.

Calculate the combined resistance of these two lamps.

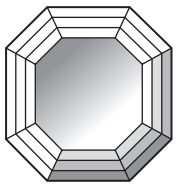
State the formula that you use and show your working.

formula

working

..... [3]

5 Diamonds, sapphires and rubies are found in the Earth's crust and are valua... industrial materials and for making jewellery.



(a) (i) Name the substance from which diamonds are made and explain why this substance is an example of an element and **not** a compound.

substance .....

.....

.....

..... [3]

(ii) The main compound in sapphires and rubies is aluminium oxide.

Explain briefly, in terms of their structures and the energy needed to separate their atoms, why diamond and aluminium oxide are both very hard solids at room temperature.

.....

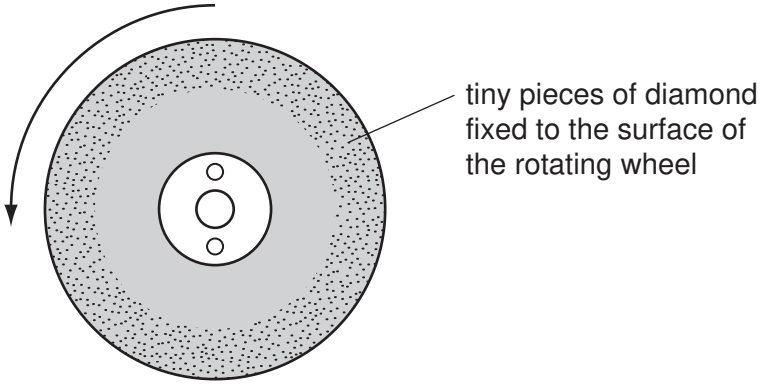
.....

.....

..... [2]

(iii) Sapphires and rubies for use in jewellery must be cut and polished by grinding them on a rotating wheel.

Suggest why the surface of the rotating wheel is covered with small pieces of diamond.



.....

..... [1]

(b) Aluminium may be obtained by the electrolysis of a molten mixture co
aluminium ions, Al^{3+}, and oxide ions, O^{2-}.

Fig. 5.1 shows a simplified diagram of this process.

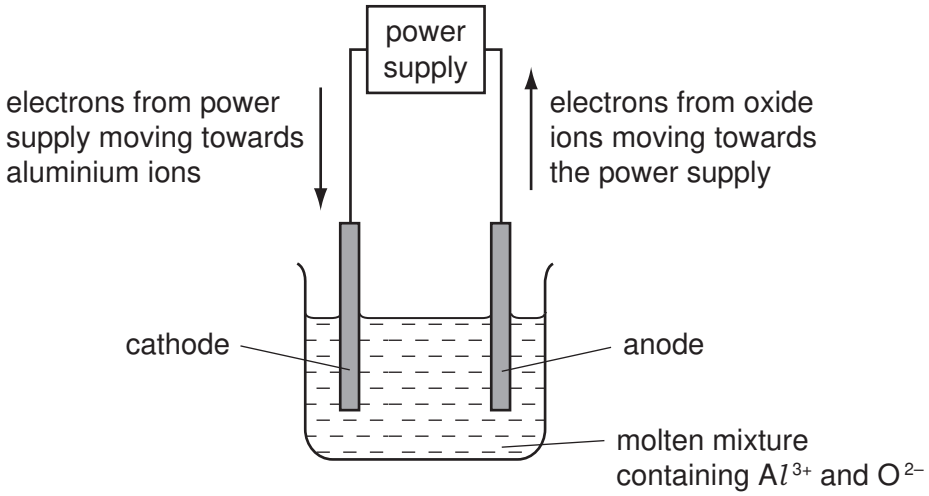


Fig. 5.1

When the circuit is completed, electrons move in the directions shown in Fig. 5.1 and ions are converted into uncharged atoms at the surfaces of the electrodes.

(i) Explain briefly why oxygen atoms are formed at the anode and **not** the cathode.

.....

..... [1]

(ii) Explain why, when **six** electrons move around the circuit, **two** aluminium atoms and **three** oxygen atoms are formed.

.....

.....

.....

.....

.....

..... [3]

6 **(a)** Table 6.1 shows some information about enzymes found in the human alim canal.

Complete the table.

Table 6.1

enzyme	one site of production	substrate	product
	salivary glands		
			amino acids
	pancreas		fatty acids and glycerol

[4]

(b) Describe how the small intestine is adapted for the efficient absorption of digested nutrients.

.....

.....

..... [2]

(c) The nutrients absorbed in the small intestine are transported in the blood to the liver.

(i) Name the blood vessel that transports blood from the small intestine to the liver.

..... [1]

(ii) The liver converts any excess amino acids to a nitrogenous waste product.

Name this waste product. ..... [1]

(iii) Name the organs that excrete this waste product.

..... [1]

(d) The liver converts excess glucose in the blood into glycogen. The glycogen is stored in cells in the liver. Glycogen is an insoluble polysaccharide.

(i) Using your knowledge of osmosis, suggest why liver cells store glycogen and not glucose.

.....

.....

.....

..... [2]

(ii) When body cells need glucose, liver cells convert some of their stored glycogen back into glucose. The cells then release the glucose into the blood.

Explain fully why body cells need glucose.

.....

.....

.....

..... [3]

7 **(a)** Fig. 7.1 shows a speed-time graph for the performance of an athlete in a race.

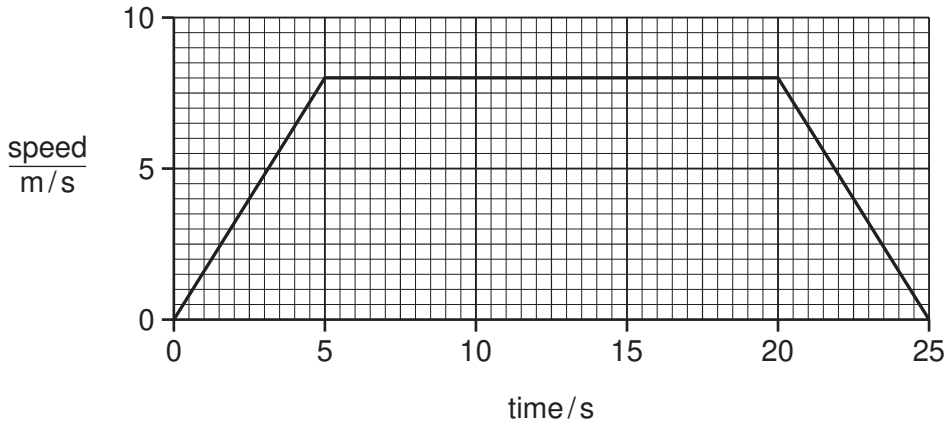


Fig. 7.1

Calculate the distance the athlete travelled between 0 and 25 seconds.

Show your working.

..... [3]

(b) Another athlete in the race has a mass of 70 kg. Her initial forward acceleration was $1.5\,m/s^2$.

Calculate the force needed to give this acceleration.

State the formula that you use and show your working.

formula

working

..... [2]

(c) The power output of the athlete is 600 W.

Calculate the amount of work done by the athlete over 5 seconds.

Show your working.

..... [2]

(d) After the race, the athletes are sweating. The sweat evaporates from the surface of their skin.

Describe the process of evaporation in terms of particles.

.....

.....

.....

.....

..... [3]

8 **(a)** Table 8.1 shows some properties of three solid elements **A**, **B** and **C**.

Table 8.1

element	density	electrical conductivity
A	low	high
B	low	low
C	high	high

One of the elements in Table 8.1 is a transition metal.

Suggest and explain which element, **A**, **B** or **C**, has properties that are typical of a transition metal.

element .....

explanation .....

..... [1]

(b) The diagram in Fig. 8.1 is a common way of showing how the atoms are arranged in a small cross-section of a metallic element.

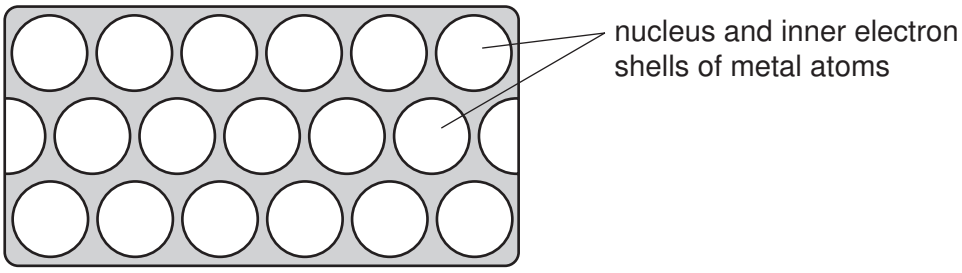


Fig. 8.1

(i) State briefly what the shaded area between the atoms in Fig. 8.1 represents.

.....

..... [1]

(ii) A metal such as copper is malleable because layers of atoms slip past one a
when a force is applied to the metal.

Explain why bronze, an alloy of copper and tin, is **less** malleable than copper. You should draw a simple diagram to help you to answer this question.

.....

.....

..... [3]

(c) Fig. 8.2 shows two electrical cells, **X** and **Y**, in which copper is used as one of the electrodes. The same electrolyte is used in both cells.

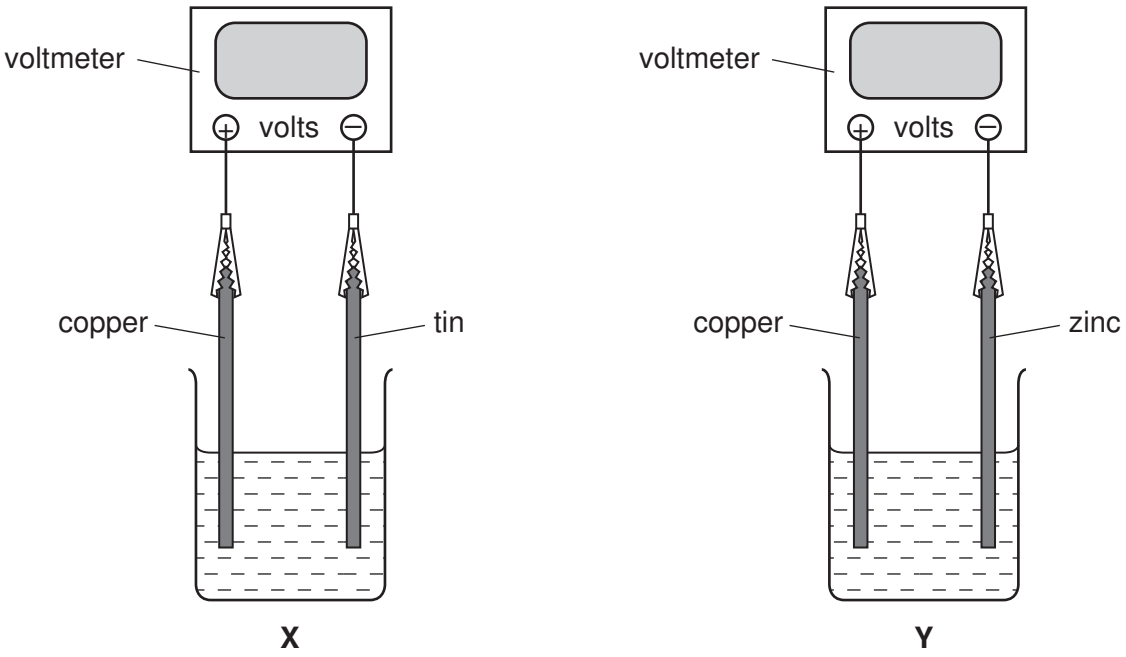


Fig. 8.2

The relative reactivity of the three metals involved in these cells is shown below.

zinc	(most reactive)
tin	
copper	(least reactive)

Explain which cell has the **lower** voltage.

cell .....

explanation .....

.....

.....

..... [2]

(d) Catalytic converters are used in the exhaust systems of modern cars to red pollution.

Fig. 8.3 shows where the catalytic converter is located in a car.

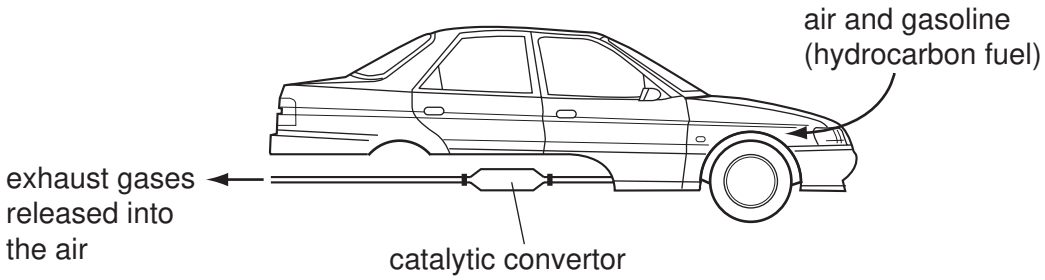


Fig. 8.3

When the fuel burns in the engine, a mixture of exhaust gases is produced. This mixture passes through the converter before being released into the air.

(i) The following word equation shows how two polluting gases, carbon monoxide, CO, and nitrogen monoxide, NO, react together on the surface of the catalyst inside the converter.

carbon monoxide	+	nitrogen monoxide	→	carbon dioxide	+	nitrogen

Construct a balanced, symbolic equation for this reaction.

..... [2]

(ii) Suggest why polluting gases are removed more efficiently when the catalytic converter is hot.

.....

..... [1]

(iii) Suggest and explain **one** type of atmospheric pollution, caused by car exhaust gases, which is **not** reduced by the use of catalytic converters.

.....

.....

..... [2]

9 The golden lion tamarin, *Leontopithecus rosalia*, is a species of monkey that lives in
in Brazil. Its diet includes fruits and nectar from trees. Its predators include snakes, ban
rats and owls.

(a) (i) In the space below, construct a food web including golden lion tamarins.

[3]

(ii) Using your knowledge of energy flow through food chains, explain why predators such as owls are usually rarer than the prey on which they feed.

.....

.....

.....

..... [2]

(b) Golden lion tamarins are important for the dispersal of seeds from many d… species of trees. They eat the fruits and then egest the seeds in their faeces.

An investigation was carried out into the distances that golden lion tamarins dispersed seeds from trees.

Fig. 9.1 shows the results of a study in which the distances of the tamarins' faeces from one tree were measured.

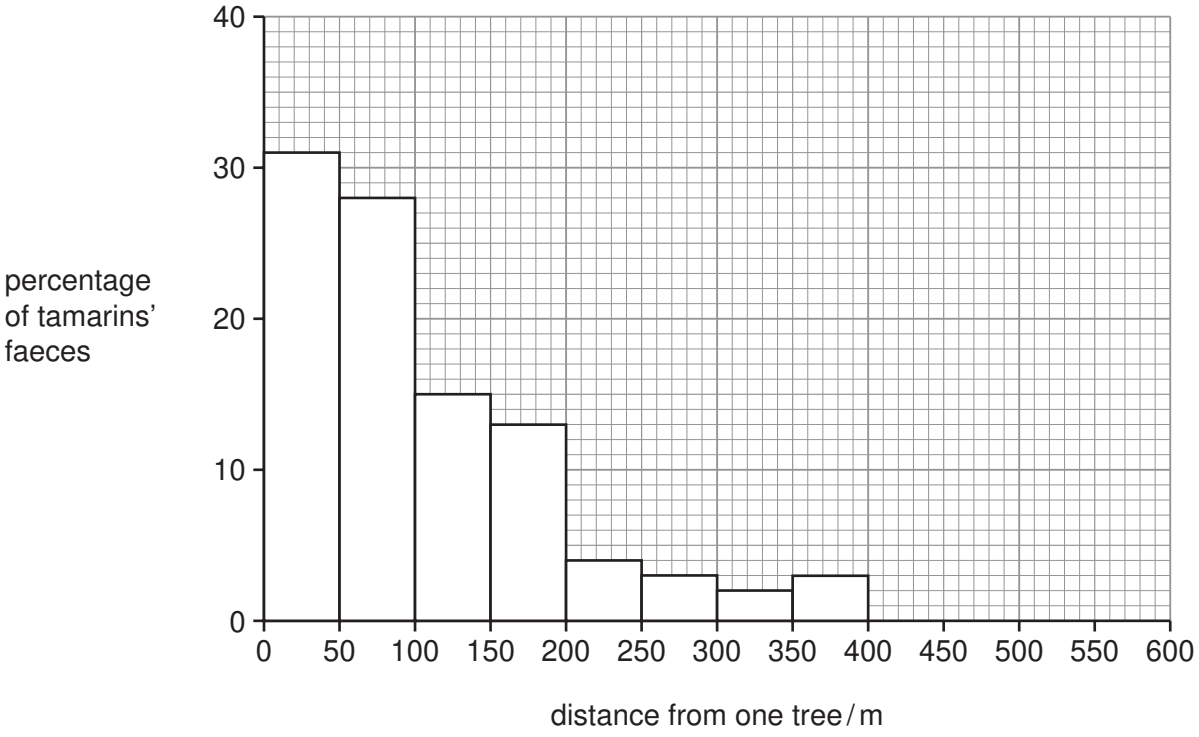


Fig. 9.1

(i) Describe the distribution of golden lion tamarin faeces in relation to this tree.

.....

.....

..... [2]

(ii) Suggest how the dispersal of seeds away from the tree in golden lion tamarin faeces could benefit the young plants that grow from the seeds.

.....

.....

.....

.....

..... [3]

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.).