Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CO-ORDINATED SCIENCES **0654/03**

Paper 3 (Extended)

October/November 2006

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.

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	
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8	
9	
Total	

This document consists of **22** printed pages and **2** blank pages.

1 Fig. 1.1 shows five birds that live in New Zealand.

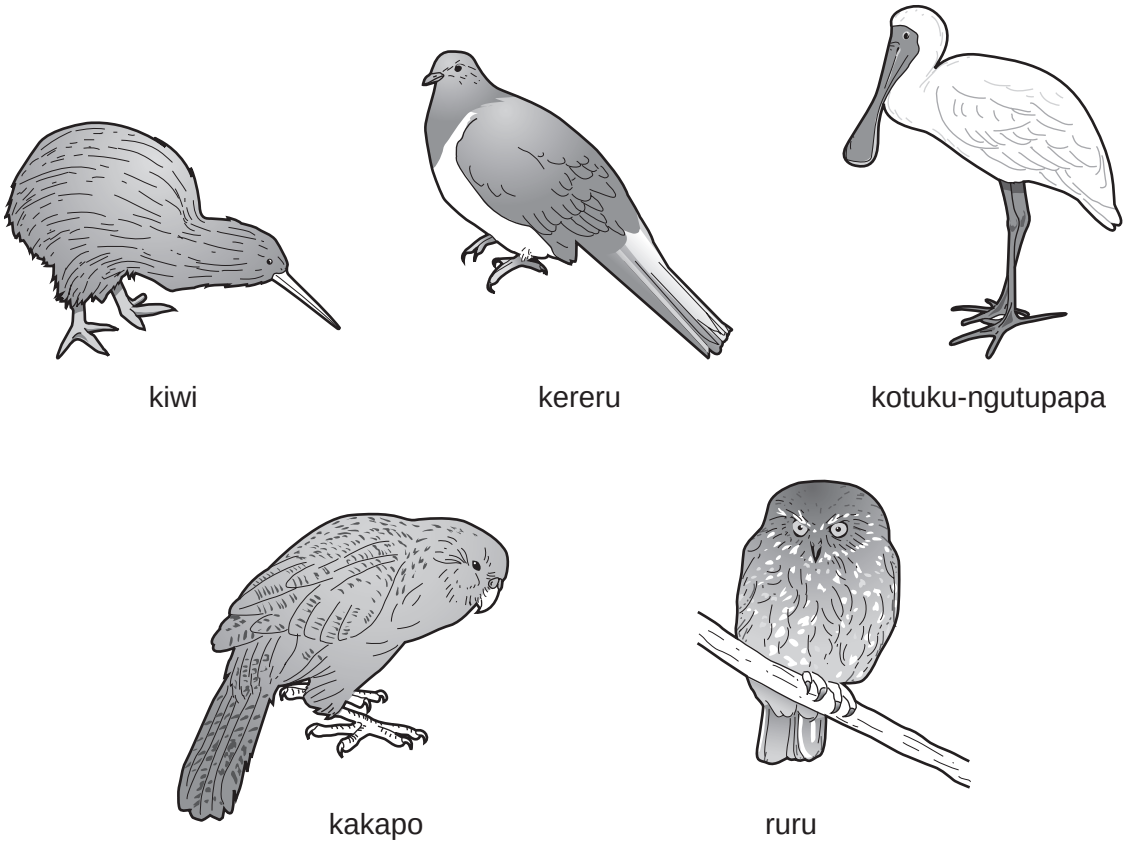

Fig. 1.1

(a) Construct a key that could be used to identify these five birds. The first part of the key has been done for you.

1a	has wings	go to 2
b	no wings	*kiwi*

[4]

(b) Each kind of living organism that is known to exist has been given a binomial. The binomial of the kiwi is *Apteryx mantelli*.

What does a binomial tell you about an organism?

.....

.....

..... [2]

(c) Many of New Zealand's birds cannot fly. They have evolved like this because, before humans arrived in New Zealand, there were no predators on the ground. There was no advantage for birds in being able to fly.

Now cats and other predators have been introduced to New Zealand. They kill and eat the flightless birds. Many species of these birds are in danger of becoming extinct.

Suggest how, over a long period of time, a species of flightless bird might evolve to become able to fly.

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..... [4]

2 Chemical reactions are useful sources of energy. Heat is produced when fuels are burnt, and electrical energy is provided by chemical reactions in cells and batteries.

(a) Underline the **two** fossil fuels in the list below.

animal faeces (dung)	**coal**	**hydrogen**
methane	**uranium**	**wood**

[1]

(b) Assume that gasoline consists of the hydrocarbon heptane, C_7H_{16}.
The mass of 1 dm^3 of heptane is 684 g.

The balanced equation for the complete combustion of heptane is

$$C_7H_{16} + 11\ O_2 \longrightarrow 7\ CO_2 + 8\ H_2O$$

(i) Calculate the number of moles of heptane in 1 dm^3.

Show your working.

..... [2]

(ii) A car uses on average 1 dm^3 of gasoline to travel a distance of 20 km.

Find the theoretical mass of carbon dioxide which the car will produce in travelling 20 km.

Show your working.

..... [3]

(iii) Suggest **one** reason why the actual mass of carbon dioxide which the car will produce will differ from your answer to **(ii)**.

.....

..... [1]

(c) Fig. 2.1 shows a cell which is providing electrical energy.

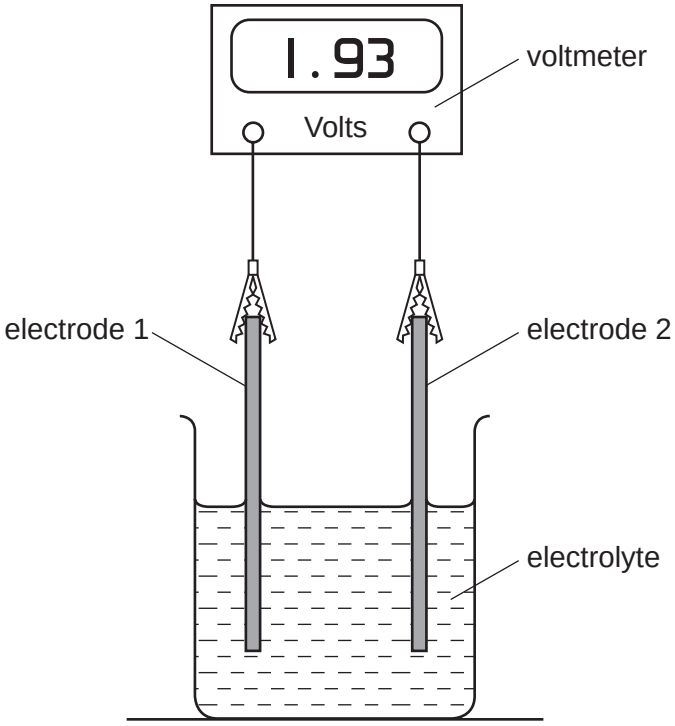

Fig. 2.1

(i) A student sets up apparatus similar to that in Fig. 2.1. She has electrodes made of magnesium, iron and copper from which to choose.

Explain which electrodes she should choose so that the cell provides the greatest amount of electrical energy.

.....

.....

.....

..... [3]

(ii) A car battery is designed to last for many years, but a torch battery will often need to be replaced.

Explain this difference.

.....

.....

.....

..... [2]

3 **(a)** To find the density of an object you need to measure its mass and volume.

(i) Describe how the volume of a small irregular object can be measured.

.....

.....

..... [2]

(ii) A small tent has a mass of 4 kg and packs tightly into a bag of volume 16 dm^3.

Calculate the density of the packed tent.

Show your working and state the formula that you use.

formula used

working

..... [2]

(b) The tent of mass 4 kg is carried a vertical distance of 1000 m up a mountain.

Calculate the work done on the tent.

The gravitational field strength of the Earth is 10 N / kg.

Show your working and state the formula that you use.

formula used

working

..... [2]

(c) The packed tent rubbed against the man's clothing as he carried it, and the fabric acquired a negative static charge.

Explain how this happened.

.....

.....

.....

.....

..... [3]

(d) After it rained, the outside of the tent became wet.

Describe in terms of particles how this water can evaporate.

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.....

.....

..... [3]

4 Fig. 4.1 shows the bones and muscles associated with the elbow joint.

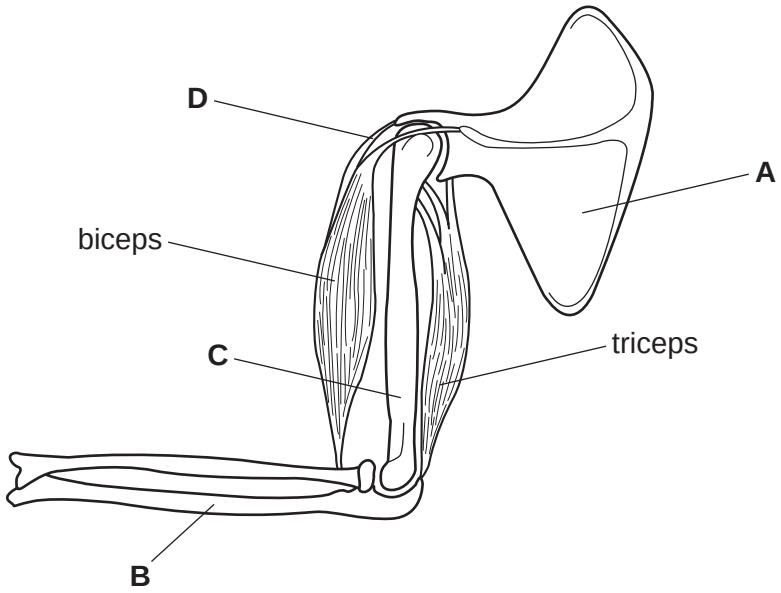


Fig. 4.1

(a) Name structures **A** to **D**.

A .....

B .....

C .....

D ..... [2]

(b) Describe how the biceps and the triceps work together to straighten the arm at the elbow joint.

.....

.....

.....

..... [3]

(c) (i) On Fig. 4.1, draw an accurate labelling line to show where synovial fluid is present, and label it **F**. [1]

(ii) State the function of synovial fluid.

.....

..... [1]

(d) Nerve impulses are carried to the muscles by motor neurones.

(i) Where is the cell body of a motor neurone found?

..... [1]

(ii) Describe how the structure of a motor neurone is related to its function.

.....

.....

.....

..... [3]

5 Fig. 5.1 shows an experiment similar to one carried out in the middle of the last century.

A mixture of the gases methane, CH_4, ammonia, NH_3, and water vapour was placed in the flask. Electrical sparks provided energy which caused chemical reactions to occur.

The mixture of products can be analysed using paper chromatography.

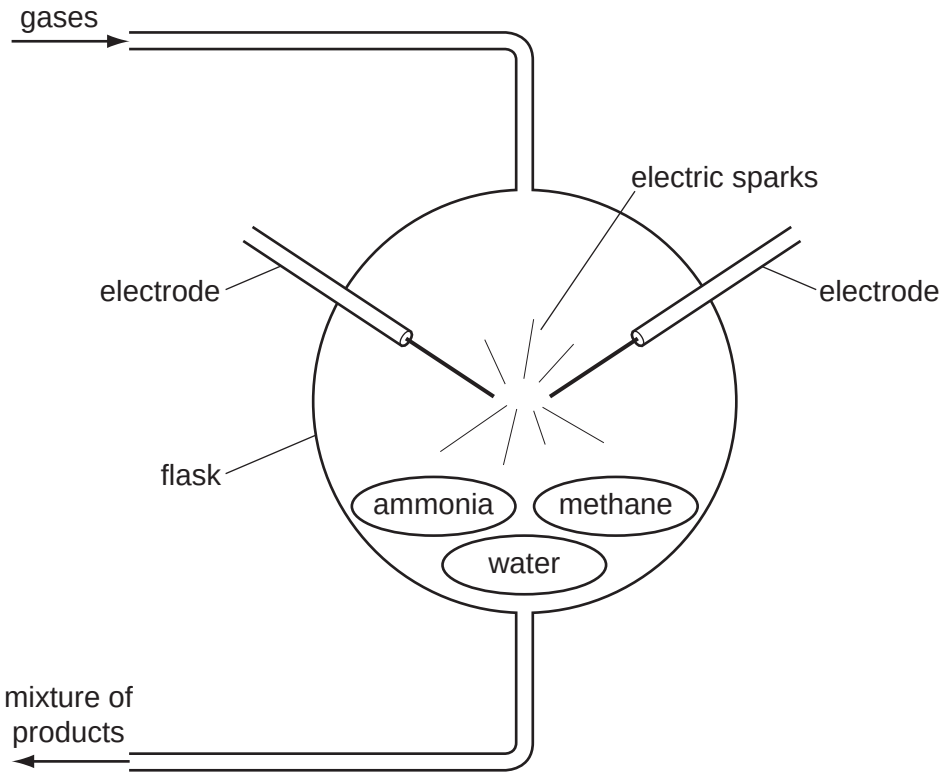


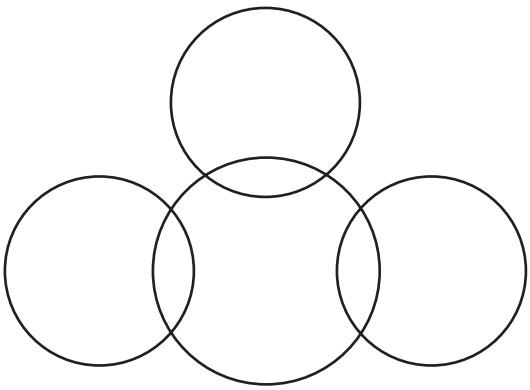
Fig. 5.1

(a) (i) Name the element which is combined in all three of the compounds present at the start of the experiment.

..... [1]

(ii) 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.



[2]

(b) (i) A student carried out paper chromatography to identify some of the products from the experiment in Fig. 5.1.

Four known compounds, glycine, alanine, cysteine and lactic acid, were used for comparison.

His results are shown in Fig. 5.2.

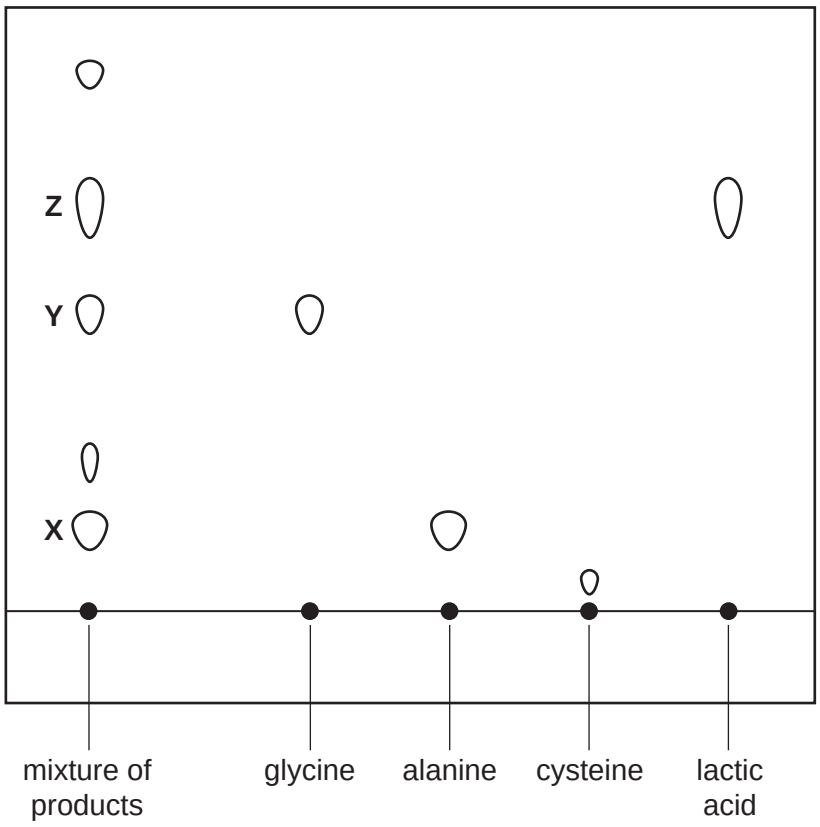


Fig. 5.2

Use the results in Fig. 5.2 to name compounds **X**, **Y** and **Z**, which were present in the mixture of products.

X is .....

Y is .....

Z is .....

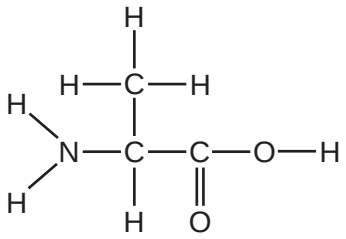
Explain how you identified **X**, **Y** and **Z**.

.....

.....

..... [2]

(ii) The graphical formula of compound **Y** is shown below.



Write the molecular formula of compound **Y**.

..... [1]

(iii) Explain how the formula of compound **Y** shows that all three of the compounds in the mixture at the start of the experiment in Fig. 5.1 must have been involved in its formation.

.....

.....

.....

..... [2]

(c) Some of the compounds in the mixture of products from the experiment in Fig. 5.1 are amino acids. In the laboratory, amino acids can be made to undergo condensation polymerisation.

Describe briefly what occurs when amino acids form condensation polymers.

.....

.....

..... [2]

(d) A solution of lactic acid may be neutralised by reaction with alkali.

Complete the **word** equation below which describes neutralisation of any acid by any alkali.

..... ions + ... ions ⟶ ..... [2]

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6 Fig. 6.1 shows the apparatus used to test the thickness of some paper at a paper making factory.

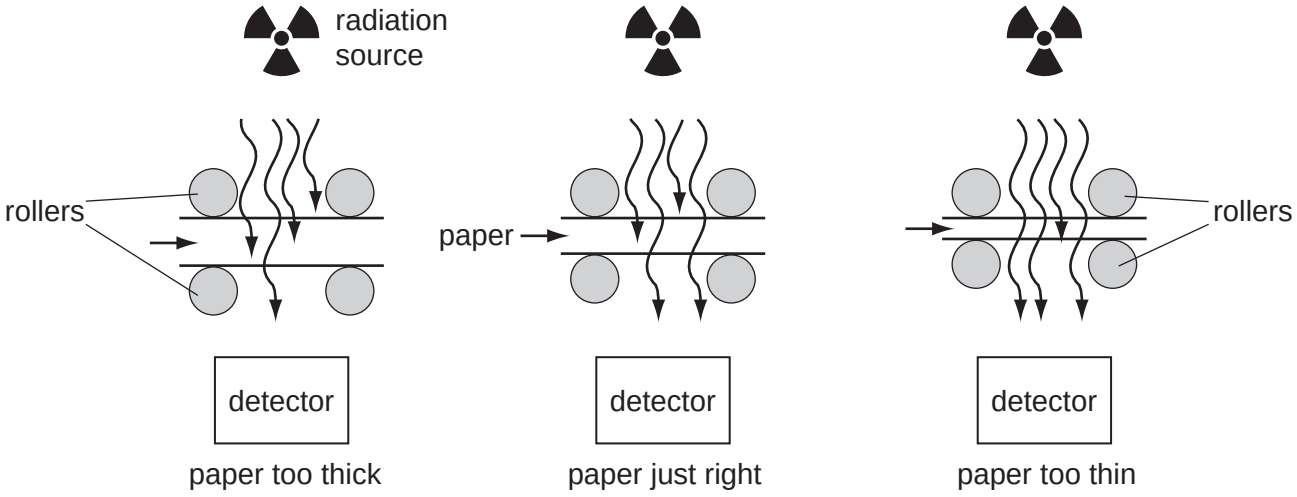


Fig. 6.1

The radioactive source gives out beta radiation. The source is placed above the moving sheet of paper and the detector below it.

(a) Name the part of an atom from which beta radiation comes.

..... [1]

(b) Explain why alpha radiation and gamma radiation are both unsuitable for this test.

alpha radiation .....

.....

gamma radiation .....

..... [2]

(c) The readings on the detector over a period of eight seconds are given in Table 6.2.

Table 6.2

time in seconds	0	1	2	3	4	5	6	7	8
total count	0	80	160	240	330	420	530	660	810
count in 1 second interval	0	80	80	80	90	90			

(i) Complete Table 6.2. [1]

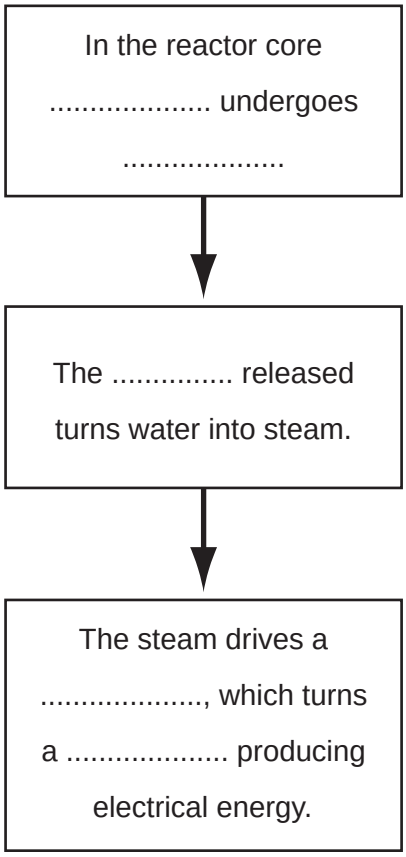
(ii) Use the data in Table 6.2 to describe what is happening to the thickness of the paper.
Give a reason for your answer.

.....

.....

..... [2]

(d) Complete the flow chart using suitable words, to show the stages of generating electrical energy in a nuclear power station.



[3]

(e) A transformer at a power station steps up the voltage from 25 000 V to 400 000 V.

Use the equation

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

to calculate the number of turns on the primary coil if there are 20 000 turns on the secondary coil.

Show your working.

..... [2]

7 Fig. 7.1 shows a yeast cell. Yeast is a kind of fungus.

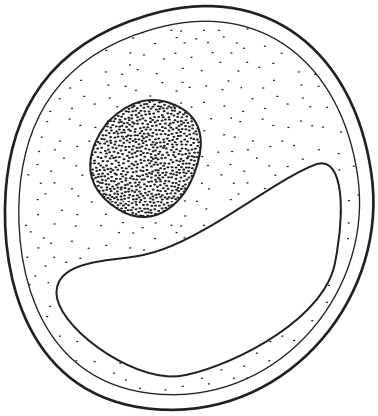


Fig. 7.1

(a) State two differences between a yeast cell and an animal cell.

1. .....

2. ..... [2]

(b) Some yeast cells were added to a solution of glucose in a conical flask.

While the yeast population was growing in the flask, bubbles of gas were produced from the solution. The gas was thought to be carbon dioxide.

(i) Describe how you could test the gas to confirm that it was carbon dioxide.

.....

.....

..... [2]

(ii) Explain why carbon dioxide was produced.

.....

.....

..... [2]

(c) The number of yeast cells in one cm^3 of the solution described in **(b)** was measured every hour for a period of 12 hours. Fig. 7.2 shows the results.

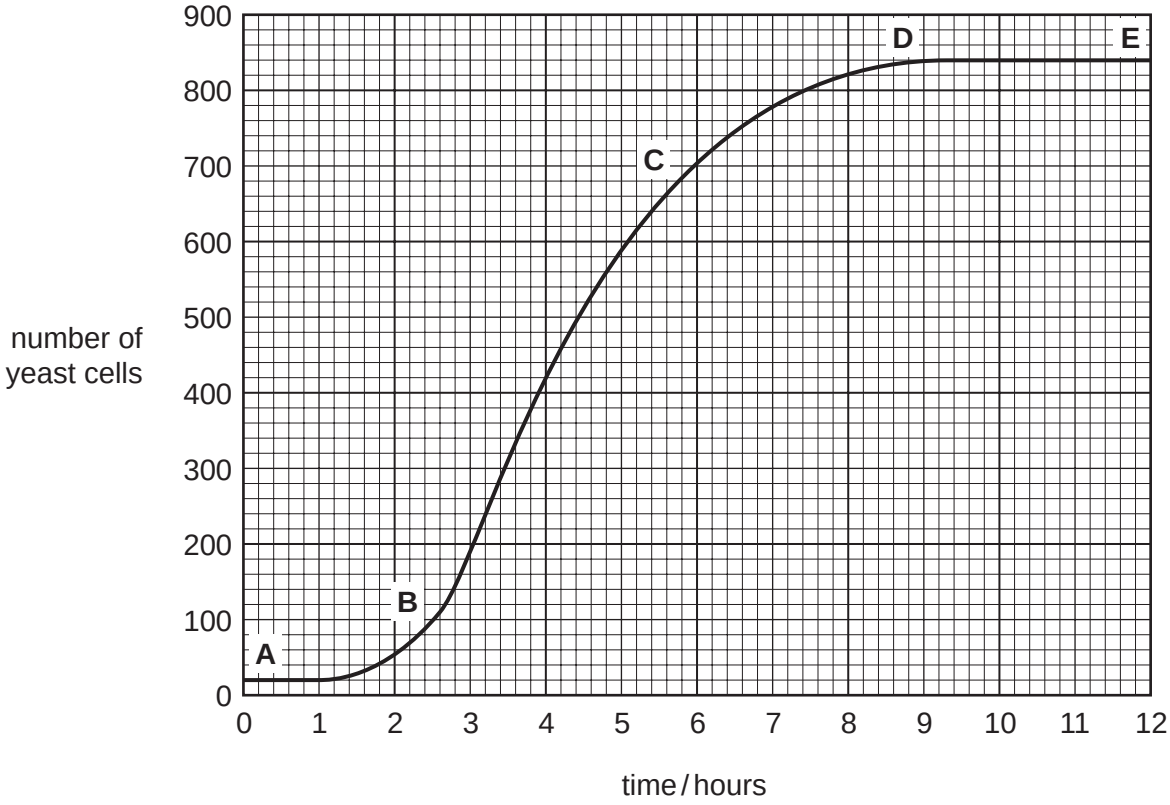


Fig 7.2

(i) Between which points was the fastest rate of reproduction of the yeast?

..... [1]

(ii) Between which points was the rate of reproduction equal to the death rate?

..... [1]

(iii) On Fig. 7.2, mark the point at which a limiting factor began to affect the growth of the yeast population. [1]

(iv) Suggest **one** limiting factor that could be having this effect.

..... [1]

(v) Outline how you could test your suggestion.

.....

.....

..... [2]

8 **(a)** Fig. 8.1 shows an experiment set up by a student to investigate the conditions needed for iron to rust.

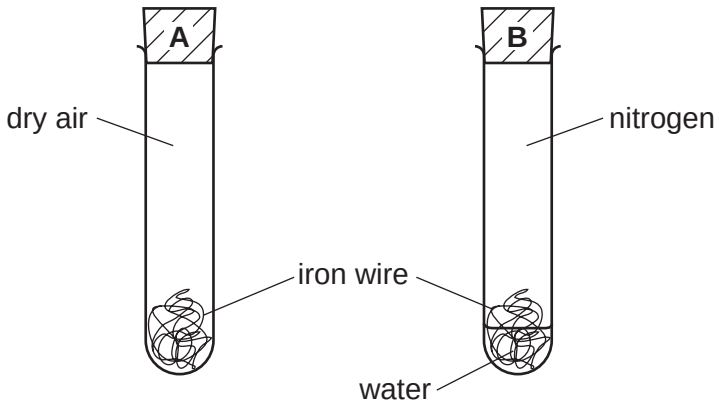


Fig. 8.1

Explain whether or not the iron wire in each of tube **A** and tube **B** is expected to rust.

.....

.....

.....

..... [3]

(b) When the mineral chromite, $FeCr_2O_4$, is heated with carbon, an alloy of iron and chromium called ferrochrome is formed. The balanced equation for this reaction is shown below.

$$FeCr_2O_4 + 4C \rightarrow \underbrace{Fe + 2Cr}_{\text{ferrochrome}} + 4CO$$

Why is it possible to conclude that the reaction above occurs at a very high temperature?

.....

.....

..... [2]

(c) Chromite is used to make the ionic compound chromium oxide, Cr_2O_3.

This reacts with sulphuric acid to make an electrolyte containing chromium ions. This is used in a process which deposits a thin layer of chromium metal onto steel objects.

(i) The symbol and charge of an oxide ion is O^{2-}.

Deduce the charge on the chromium ions in Cr_2O_3.

Explain your answer.

.....

.....

..... [2]

(ii) Suggest the **word** equation for the reaction between chromium oxide and sulphuric acid.

..... [1]

(iii) Chromium metal is deposited onto a steel object by making the object one of the electrodes in electrolysis.

Explain why the steel object should be made the cathode in this electrolysis.

.....

.....

..... [1]

9 Fig. 9.1 shows a circuit used to test two different lamps, **C** and **D**.

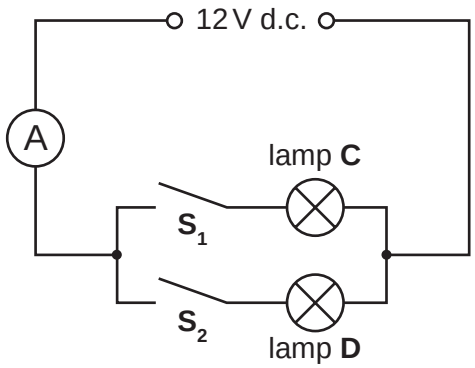


Fig. 9.1

(a) (i) When switch S_1 only is closed, a current of 2 A flows through lamp **C**.

Calculate the resistance of lamp **C**.

Show your working and state the formula that you use.

formula used

working

..... [2]

(ii) Calculate the energy transfer per second in lamp **C** when switch S_1 only is closed.

formula used

working

..... [2]

(iii) When both switches S_1 and S_2 are closed, the ammeter reading is 6 A.

Calculate the current flowing through lamp **D**.

..... [1]

(b) Fig. 9.2 shows how the current through lamp **C** varies if the applied voltage is changed.

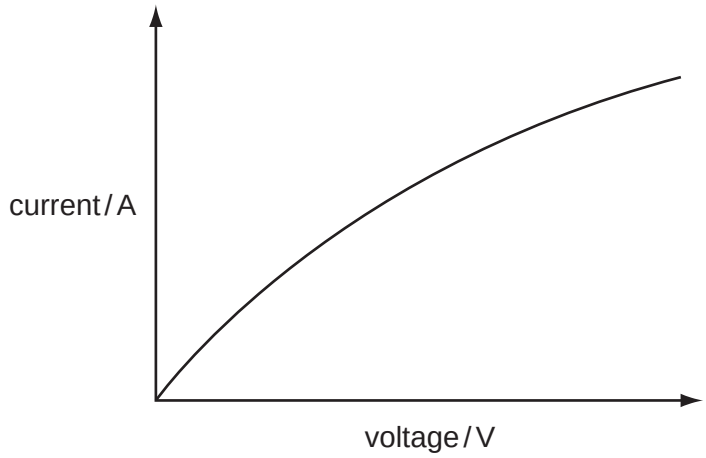


Fig. 9.2

If Ohm's Law is obeyed, the current through a component is directly proportional to the voltage across it.

(i) On Fig. 9.2, draw a line to show the voltage / current relationship for a component which obeys Ohm's Law. [1]

(ii) Suggest why the lamp **C** does not obey Ohm's Law when the voltage is increased.

.....

.....

..... [2]

(c) An electric food mixer has a 3 speed control switch and an on / off switch. This is produced using two identical resistors as shown in Fig. 9.3.

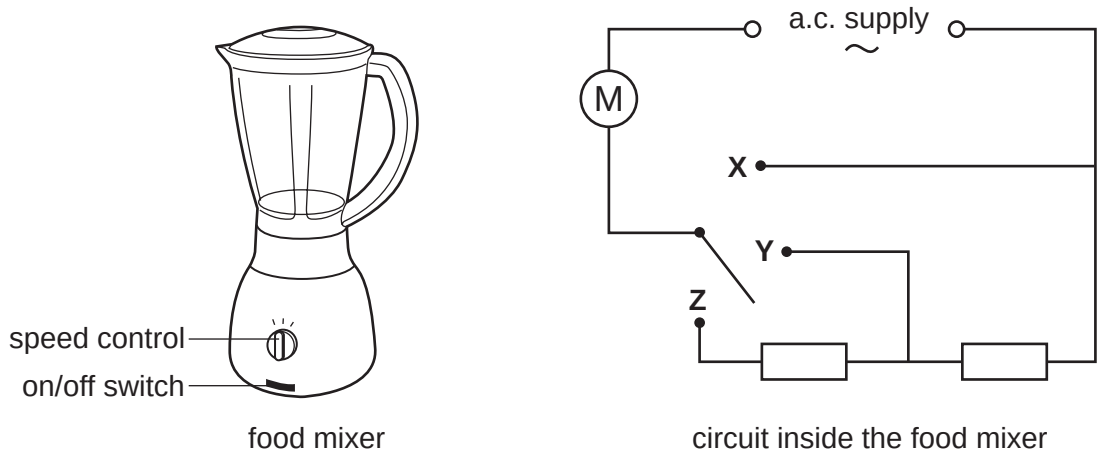


Fig. 9.3

(i) The circuit diagram does not show the on / off switch. On the circuit drawn in Fig. 9.3, write the letter **S** to show where the switch should be. [1]

(ii) The speed control can be set on **X**, **Y** or **Z**. Which position gives the lowest speed and which position gives the highest speed?
Explain your answer.

.....

.....

.....

..... [2]

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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 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 Radius 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.).