UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

3721956087

CO-ORDINATED SCIENCES **0654/03**

Paper 3 (Extended) **October/November 2007**

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	
6	
7	
8	
9	
10	
Total	

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

For Examiner's Use

1 A student compares three different metal wires to see which is the best conductor of electricity. She passes a current of 0.4 A through each wire in turn and measures the voltage required.

Table 1.1 shows her results.

Table 1.1

wire	voltage / V
A	0.3
B	2.6
C	6.2

(a) Which wire is the best conductor of electricity?

Explain your answer.

.....

..... [2]

(b) Calculate the resistance of wire **A**.

State the formula that you use and show your working.

formula used

working

..... [2]

For Examiner's Use

(c) While doing the experiment the student notices that all of the wires get hot.

(i) Calculate the power consumption in wire **C**.

State the formula that you use and show your working.

formula used

working

..... [2]

(ii) Use your answer to **(i)** to suggest which wire gets the hottest.

Give a reason for your answer.

.....

..... [1]

(d) Calculate the quantity of charge which flows through wire **B** in one minute.

State the formula that you use and show your working.

formula used

working

..... [2]

For Examiner's Use

2 Fig. 2.1 shows a small gas burner which can be used to heat water or food contained in a metal cooking pot. The fuel used in this burner is the hydrocarbon butane, C_4H_{10}.

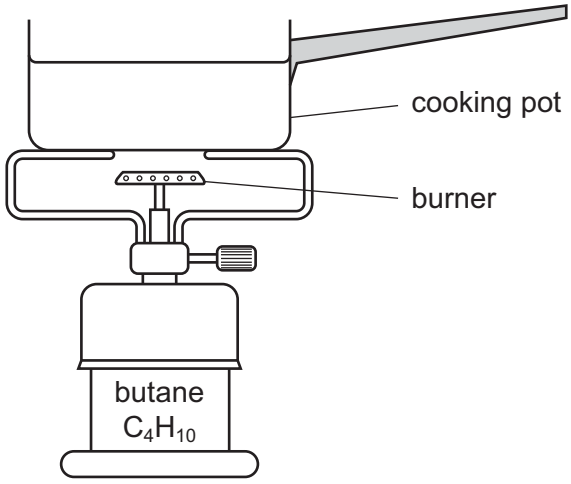


Fig. 2.1

(a) (i) Butane is obtained from crude oil (petroleum). Name the process which is used to separate hydrocarbons in crude oil.

.....

[1]

(ii) Butane is normally a gas at room temperature. In the type of burner shown in Fig. 2.1 butane is stored as a liquid.

Suggest what must be done to gaseous butane to turn it into a liquid.

.....

.....

[1]

(iii) Butane is a member of a homologous series of hydrocarbons called alkanes. The relative formula (molecular) mass of butane is 58.

Draw the graphical (displayed) formula of the alkane whose relative formula mass is 30.

[2]

For Examiner's Use

(b) (i) Explain why the plastic material used to make the handles of cooking pots should be a thermoset and **not** a thermoplastic.

.....

..... [1]

(ii) Explain, in terms of the polymer molecules they contain, why thermoset and thermoplastic materials behave differently when heated. You may draw simple diagrams to help you answer this question.

.....

.....

.....

..... [4]

(c) The body of the cooking pot in Fig. 2.1 is made of metal which can be formed into the correct shape because it is malleable.

(i) Draw a diagram to show the arrangement of atoms in a typical metal.

[1]

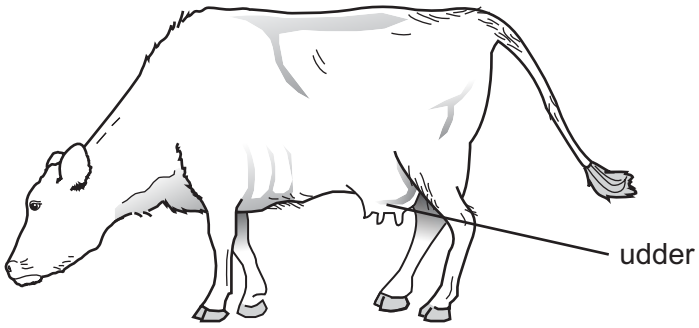
(ii) Use your answer to **(i)** to explain why metals are malleable.

.....

..... [2]

For Examiner's Use

3 Dairy cattle are kept to produce milk. The milk is produced and stored in the cow's udder.



In 1965, a long experiment was begun to find out if artificial selection could increase the milk yield of cows.

In one set of cows, artificial selection for high milk yield was carried out in each generation. These were called the **selected line**.

In the other set, there was no artificial selection. These were called the **control line**.

Both sets of cows were kept under the same conditions.

The mean milk yield from the cows that were born in each year from 1965 to 1990 was calculated. The results are shown in Fig. 3.1.

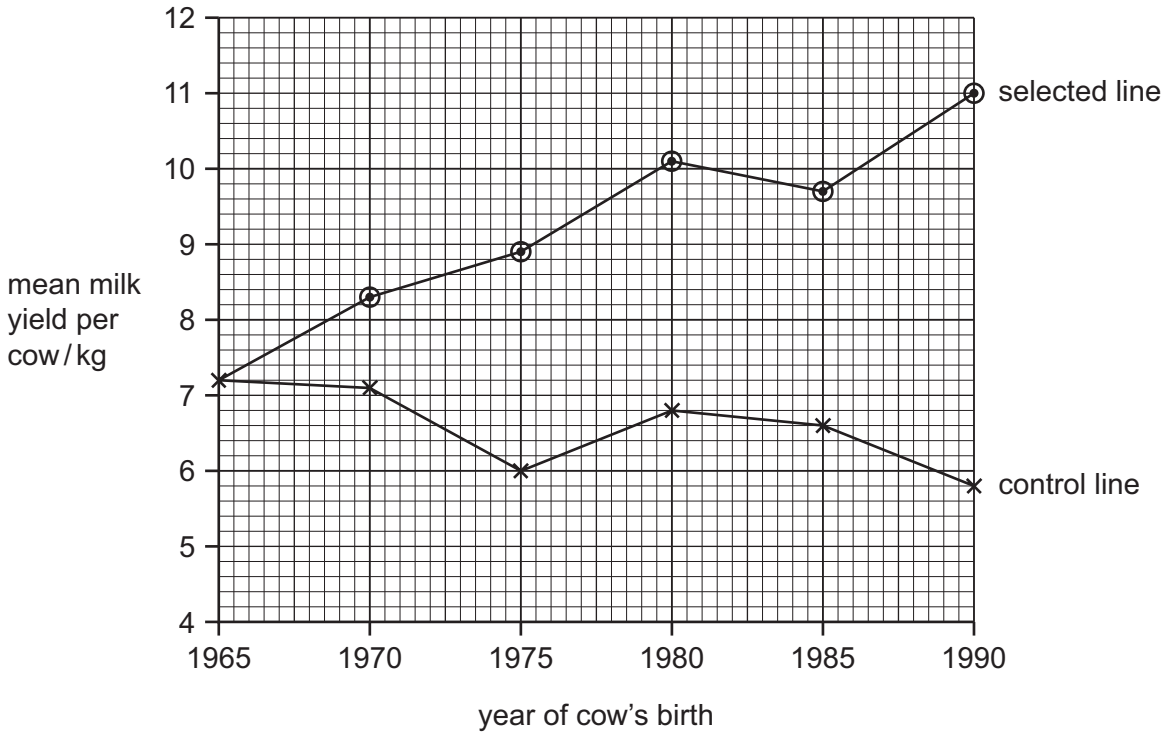


Fig. 3.1

For Examiner's Use

(a) Calculate the change in mean milk yield per cow between 1965 and 1990 for

the selected line, ...

the control line. ..... [2]

(b) Describe how artificial selection would have been carried out in the selected line.

.....

.....

.....

.....

.....

..... [4]

(c) Suggest a reason for the results for the control line.

.....

..... [1]

(d) The researchers also looked at the costs of health treatment in each of the two breeding lines. Table 3.1 shows some of the results.

Table 3.1

health problem	cost of treatment in selected line / $	cost of treatment in control line / $
mastitis (inflammation of the udder)	43	16
lameness	10	6

(i) Suggest an explanation for the results shown in Table 3.1.

.....

.....

.....

..... [2]

(ii) State and explain **one** reason, other than health treatment costs, why it would be more expensive to keep the cows from the selected line than the cows from the control line.

.....

.....

..... [2]

For Examiner's Use

4 **(a)** **(i)** Calculate the speed of a car which travels 320 m in 20 s.

State the formula that you use and show your working.

formula used

working

..... [2]

(ii) The speed of the car is now doubled.

Explain why the momentum doubles but the kinetic energy of the car is four times greater.

.....

.....

.....

.....

..... [3]

(b) A car headlamp has a power rating of 60 W.

(i) Calculate the current through the headlamp when the voltage across it is 12 V.

State the formula that you use and show your working.

formula used

working

..... [2]

(ii) State how many joules of energy will be converted every second in the headlamp.

..... [1]

For Examiner's Use

5 **(a)** Amino acids are compounds found in all living organisms.
The chemical formula of a typical amino acid is $C_2H_5O_2N$.

(i) Explain why the nitrogen atoms needed by the plant to make amino acids cannot be obtained directly from the nitrogen molecules in the air.

.....

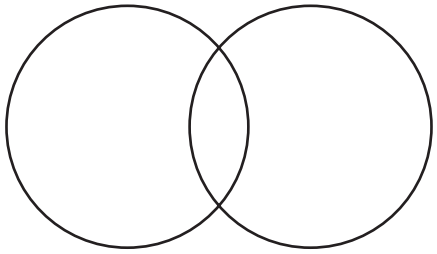
..... [1]

(ii) Explain the meaning of the term *nitrogen fixation*.

.....

..... [1]

(iii) Complete the bonding diagram below to show the arrangement of the outer electrons of each atom in a molecule of nitrogen.



[2]

(b) Fig. 5.1 shows a diagram of industrial apparatus which is used to make ammonia.

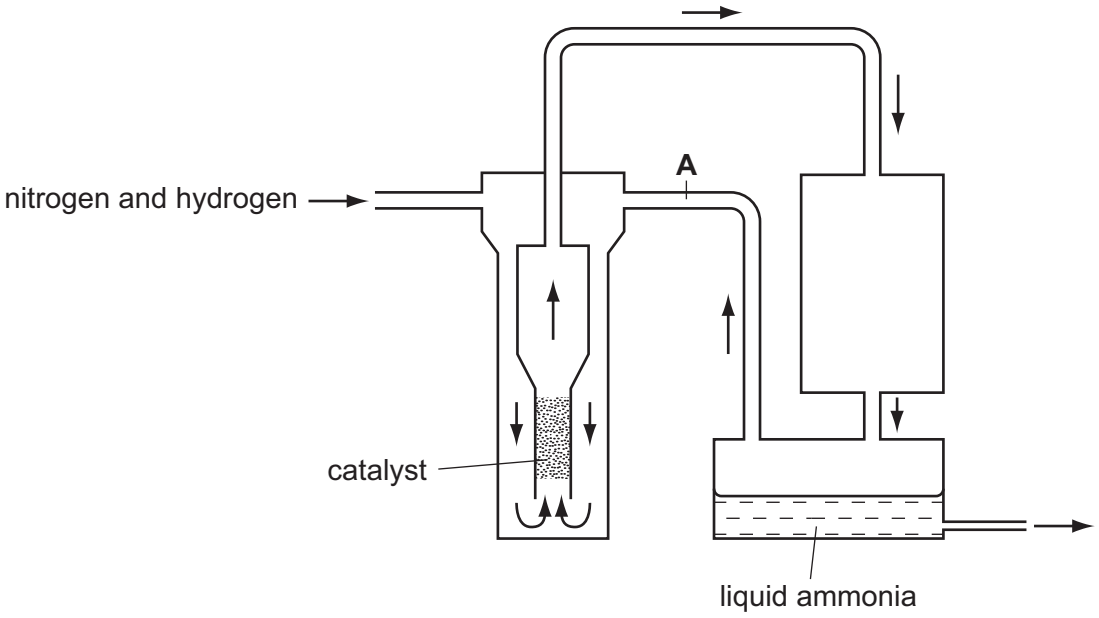


Fig. 5.1

For Examiner's Use

(i) The symbolic equation below for the formation of ammonia is not balanced.

Balance the equation.

$$N_2 \quad + \quad H_2 \quad \rightleftharpoons \quad NH_3$$

[1]

(ii) Name **two** substances flowing through the apparatus at point **A**.

..... [1]

(ii) The catalyst in Fig. 5.1 is made mainly of iron.

Suggest why the catalyst is made in the form of a large number of small pieces.

.....

..... [1]

(c) Ammonia is used to make the salt ammonium sulphate.
The formulae of the ions in this salt are shown below.

NH_4^+ SO_4^{2-}

Deduce the formula of ammonium sulphate.

Explain your answer.

..... [2]

For Examiner's Use

6 Fig. 6.1 shows two pollen tubes growing from pollen grains on the stigma of an insect-pollinated flower.

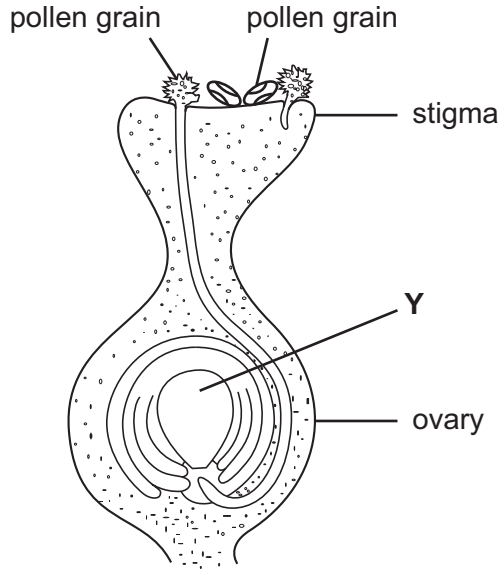


Fig. 6.1

(a) On Fig. 6.1, use a label line to carefully label a pollen tube. [1]

(b) (i) Name the structure that passes down the pollen tube.

..... [1]

(ii) Describe what happens when this structure reaches the part labelled **Y**.

.....

.....

.....

..... [3]

For Examiner's Use

(c) The pollen grains from which pollen tubes are growing, shown in Fig. 6.1, came from the anthers of other flowers on the same plant as this flower.

Is this an example of asexual reproduction or sexual reproduction?

Explain your answer.

type of reproduction .....

explanation .....

..... [1]

(d) Two of the pollen grains shown in Fig. 6.1 have **not** grown pollen tubes. These pollen grains were blown by the wind onto the stigma of this flower from a different species of plant.

State two ways in which the flower from which these pollen grains were blown would differ from the flower whose stigma and ovary are shown in Fig. 6.1.

1. .....

.....

2. .....

..... [2]

(e) After the events shown in Fig. 6.1, ovaries develop into fruits, which help to disperse the seeds inside them.

Draw a fruit that is dispersed by animals. Label the fruit to explain how it is adapted for animal dispersal.

[3]

For Examiner's Use

7 **(a)** Iodine-123 and iodine-131 are radioactive isotopes of iodine that are used to treat patients in medicine. Iodine-123 emits gamma radiation and has a half-life of 13.6 hours. Iodine-131 emits both beta and gamma radiation and has a half-life of 8 days.

(i) What is the meaning of the term isotope?

.....

.....

[1]

(ii) State and explain two reasons why it would be safer for a patient to use iodine-123 rather than iodine-131.

1. .....

.....

2. .....

.....

.....

[4]

(b) Americium-241 has a proton number of 95 and a nucleon (mass) number of 241.

What are the proton number and nucleon number of the atom formed when one atom of americium-241 emits one alpha particle?

proton number .....

nucleon number ..... [2]

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Please turn over for question 8

For Examiner's Use

8 Fig. 8.1 shows three cells in a leaf.

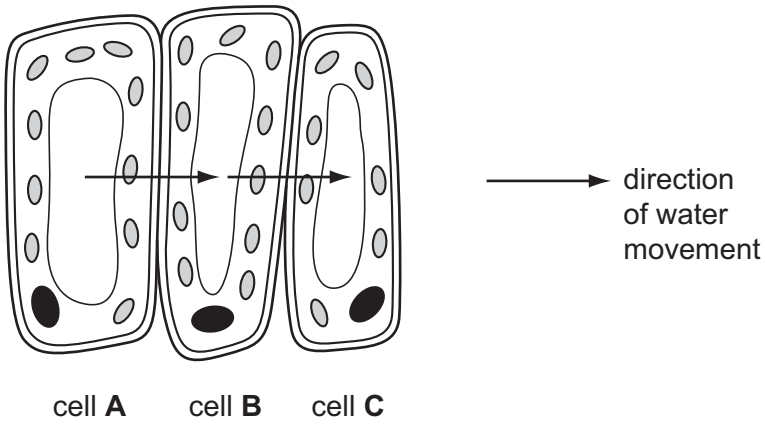

Fig. 8.1

(a) Name the tissue in which these cells are found.

.....[1]

(b) Describe **one** feature, shown in Fig. 8.1, which indicates that these cells are adapted for photosynthesis.

.....

.....

.....[2]

(c) The arrows in Fig. 8.1 show the direction in which water is moving between these cells.

(i) Name the process by which the water is moving.

.....[1]

For Examiner's Use

(ii) What does the movement of water suggest about the relative concentration of cell sap in cells **A**, **B** and **C**?

Explain your answer.

.....

.....

..... [2]

(d) (i) Describe how water is transported from the roots of the plant to the cells shown in Fig. 8.1.

.....

.....

..... [2]

(ii) Explain how the rate of water transport to the leaves would be affected if the day became very hot and sunny.

.....

.....

..... [2]

(e) Outline two ways in which the tissues in a leaf are supported.

1. .....

.....

2. .....

..... [2]

For Examiner's Use

9 Some children are swimming in a swimming pool.

(a) The children make some small waves on the surface of the water.

(i) Are these waves longitudinal or transverse?

Explain your answer.

.....

..... [1]

(ii) The waves are travelling at a speed of 0.5 m / s and with a frequency of 2 Hz.

Calculate the wavelength of these waves.

State the formula that you use and show your working.

formula used

working

..... [2]

(b) The mass of water in the pool is 60 000 kg.

The specific heating capacity of water is 4200 J / kg °C. The water is heated from 25 °C to 30 °C.

Calculate the energy needed to do this.

State the formula that you use and show your working.

formula used

working

..... [2]

For Examiner's Use

(c) When the children leave the pool, the water on their bodies evaporates.

Explain how this evaporation takes place in terms of water particles.

.....

.....

..... [2]

(d) There is a lamp at the bottom of the pool. Fig. 9.1 shows a ray of light from the lamp travelling up to the surface.

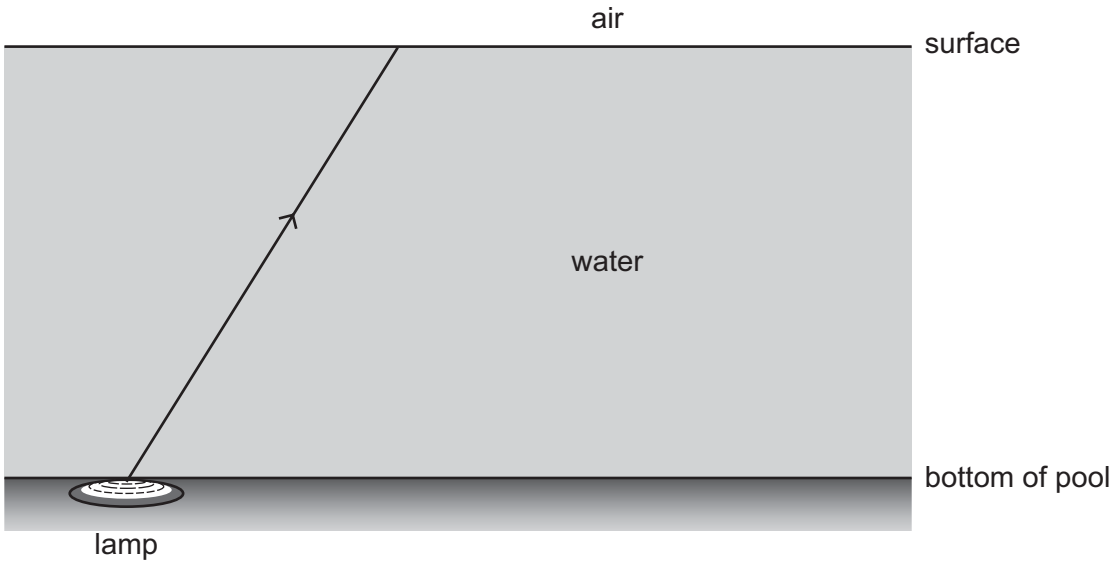

Fig. 9.1

The ray of light passes through the surface of the water and up into the air.

On the diagram, draw the path of the ray as it leaves the water and goes through the air. [2]

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10 A student added three substances, **A**, **B** and **C**, to three separate beakers each with 25 cm^3 of dilute sulphuric acid as shown in Fig. 10.1.

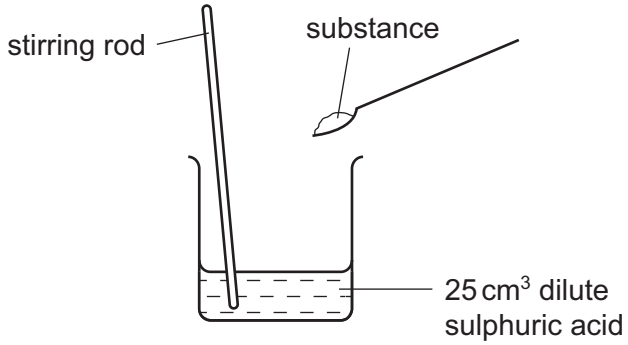

Fig. 10.1

The observations which the student made are shown in Table 10.1.

Table 10.1

substance	observations
A	• gas given off which turns limewater milky • colourless solution formed
B	• gas given off which burns with a squeaky pop when ignited • colourless solution formed
C	• no gas given off • blue solution formed

(a) (i) Explain which **one** of the substances, **A**, **B**, or **C**, could have been magnesium carbonate.

.....

..... [2]

(ii) Explain which **one** of the substances, **A**, **B**, or **C**, has reacted with sulphuric acid according to the equation below.

$$H_2SO_4 + CuO \longrightarrow CuSO_4 + H_2O$$

.....

..... [2]

[Turn over

(b) Sulphuric acid occurs in acid rain which forms when rain falls through polluted air. Acid rain may collect in lakes causing harm to plant and animal life.

Fig. 10.2 shows two lakes, **X** and **Y**, situated in an area known to be affected by acid rain. The water draining into the lakes flows over different types of rock as shown.

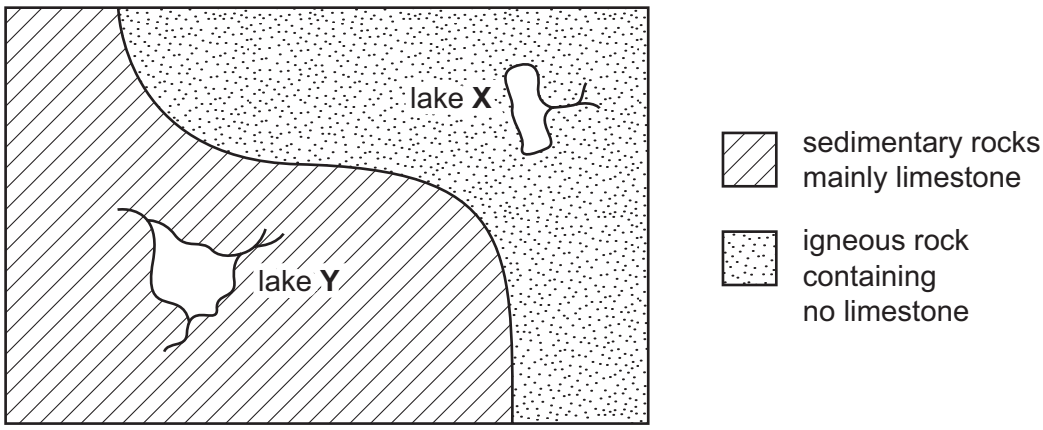

Fig. 10.2

Water samples from lakes **X** and **Y** were tested and the concentration of sulphuric acid in the samples is shown below.

lake	concentration of sulphuric acid / moles per dm^3
X	0.01
Y	0.0005

(i) Suggest and explain why the concentrations of sulphuric acid in the two lakes are different.

.....

.....

..... [2]

(ii) The volume of water in lake **X** is 10 000 000 dm^3.

Calculate the total mass of sulphuric acid in lake **X**.

Show your working.

..... [3]

(c) Sulphuric acid is one of the substances used in the manufacture of detergents. Detergents help to remove grease from clothes.

Fig. 10.3 shows a simplified diagram of a typical detergent molecule. One end of the molecule has the properties of an ionic compound, and the rest of the molecule has the properties of a covalent compound.

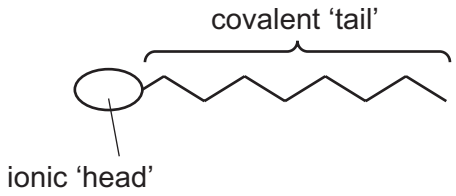

Fig. 10.3

Describe and explain briefly how detergent molecules help to remove grease from clothes. You may draw simple diagrams to help you to answer this question.

.....

.....

.....

..... [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** 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.).