



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
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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 | |
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| 5 | |
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| 7 | |
| 8 | |
| 9 | |
| 10 | |
| Total | |

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



- 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.

For
Examiner's
Use

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]

(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]

- 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} .

For
Examiner's
Use

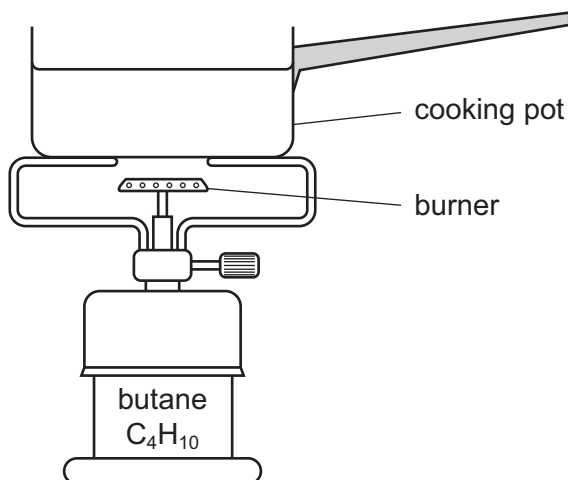


Fig. 2.1

- (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]

(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.

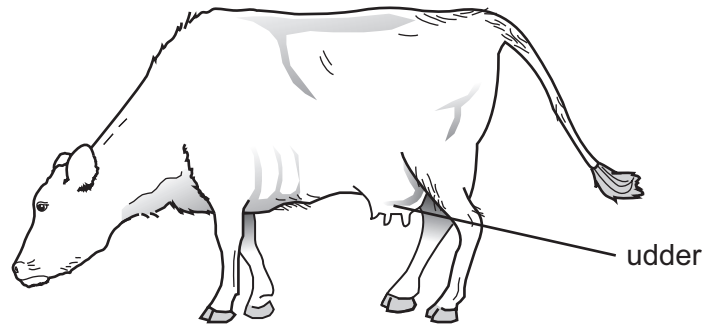
(i) Draw a diagram to show the arrangement of atoms in a typical metal.

[1]

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

.....
..... [2]

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



For
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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.

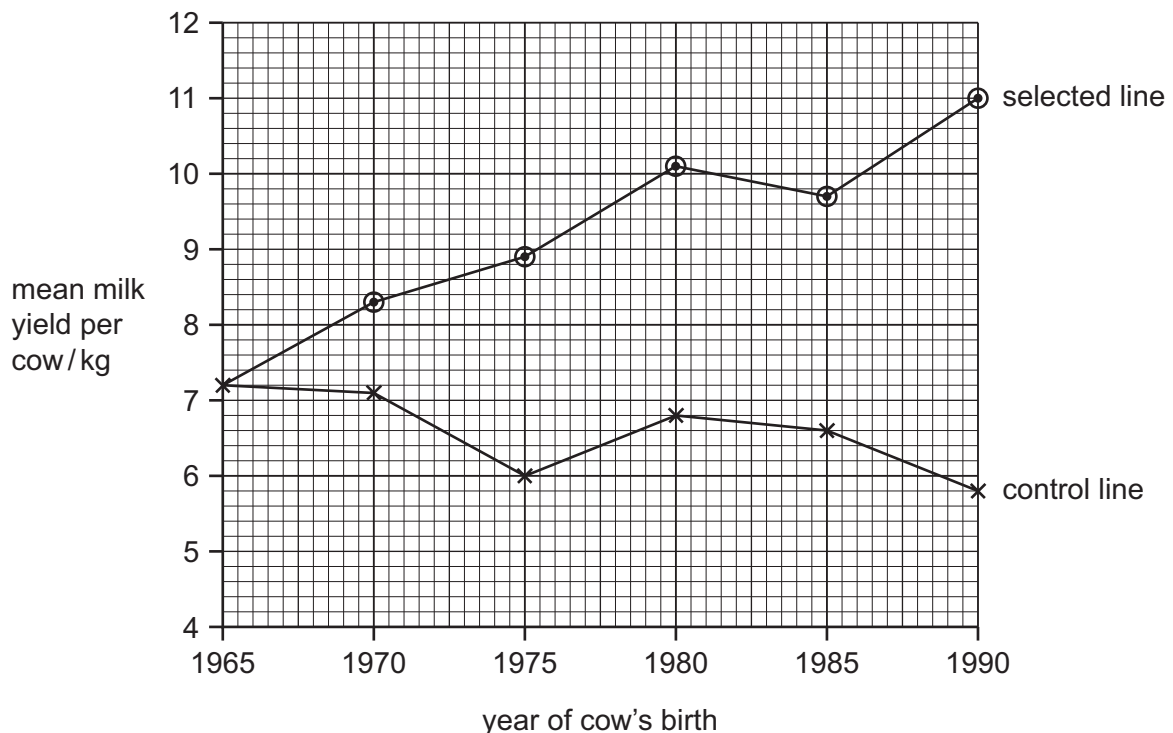


Fig. 3.1

(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.

For
Examiner's
Use

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]

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]

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

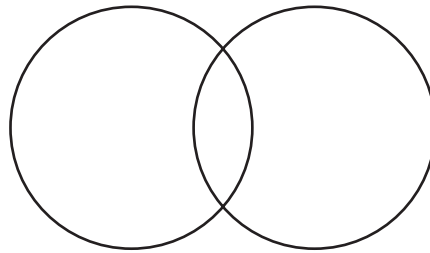
(i) Explain why the nitrogen atoms needed by the plant to make amino acids cannot be obtained directly from the nitrogen molecules in the air.

.....
..... [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.

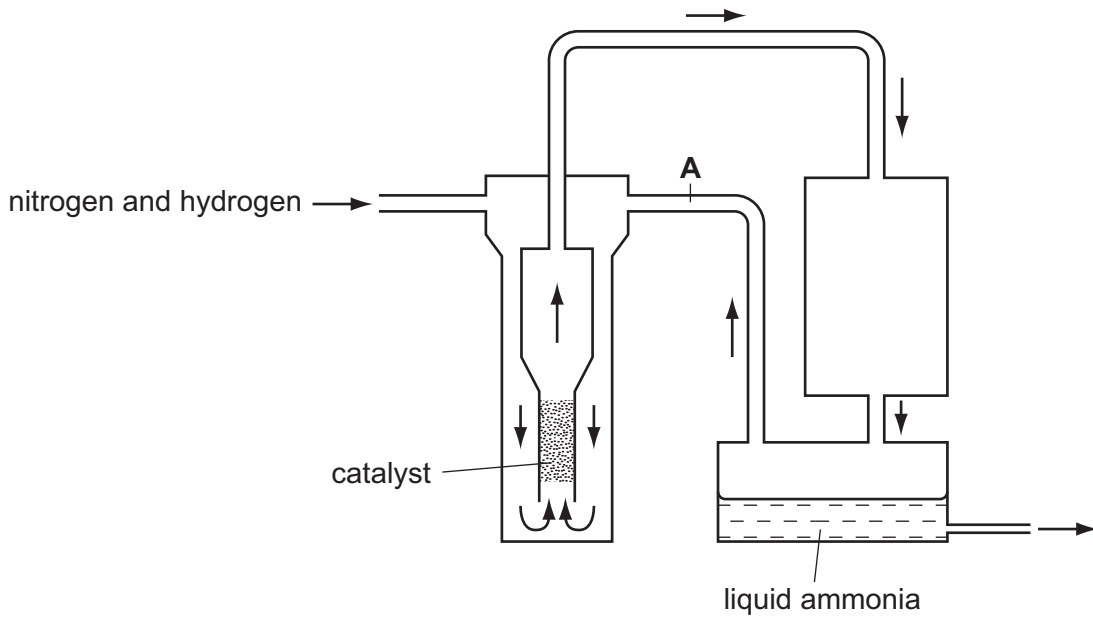


Fig. 5.1

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

Balance the equation.



[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.



Deduce the formula of ammonium sulphate.

Explain your answer.

..... [2]

For
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Use

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

For
Examiner's
Use

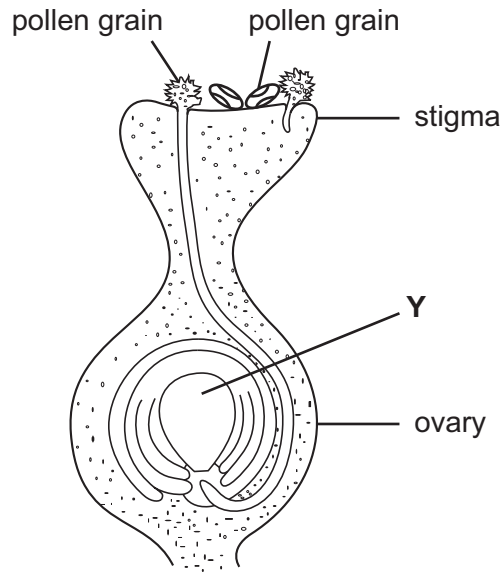


Fig. 6.1

- (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]
-
-
-
-

(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]

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

8 Fig. 8.1 shows three cells in a leaf.

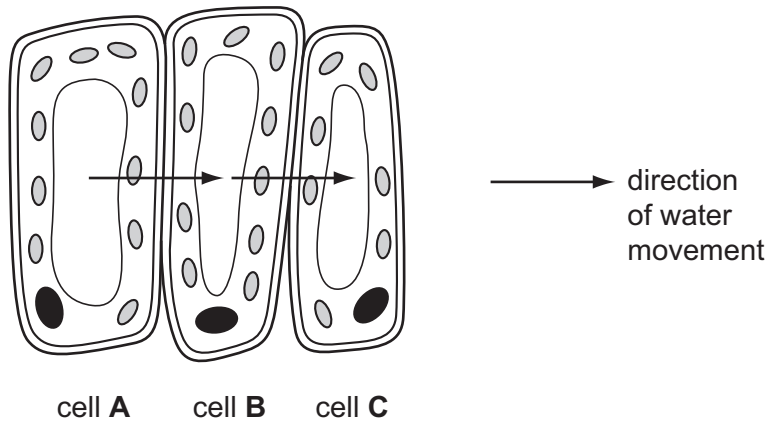


Fig. 8.1

For
Examiner's
Use

(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]

(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]

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]

(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.

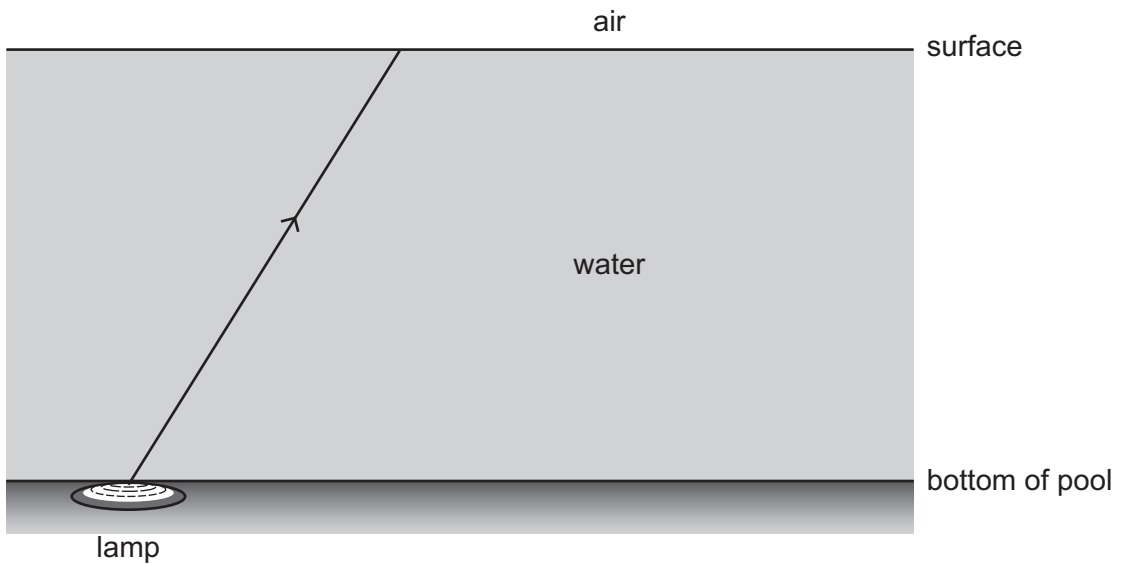


Fig. 9.1

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 cm³ of dilute sulphuric acid as shown in Fig. 10.1.

For
Examiner's
Use

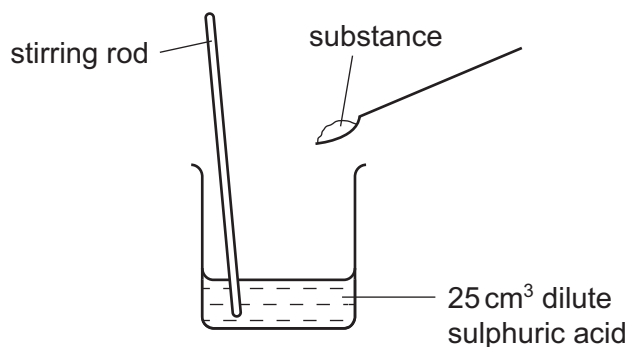


Fig. 10.1

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

Table 10.1

| substance | observations |
|-----------|---|
| A | <ul style="list-style-type: none"> • gas given off which turns limewater milky • colourless solution formed |
| B | <ul style="list-style-type: none"> • gas given off which burns with a squeaky pop when ignited • colourless solution formed |
| C | <ul style="list-style-type: none"> • 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.



.....
 [2]

- (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.

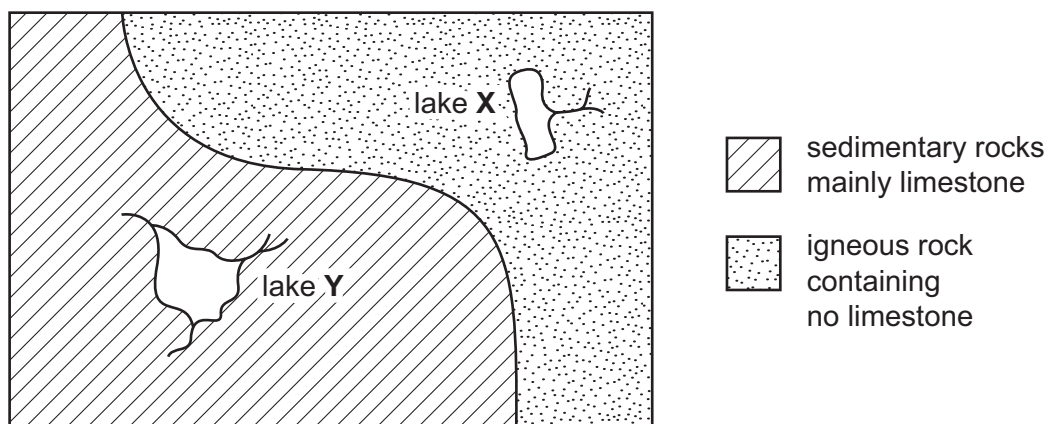


Fig. 10.2

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 dm³.

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

Show your working.

For
Examiner's
Use

..... [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.

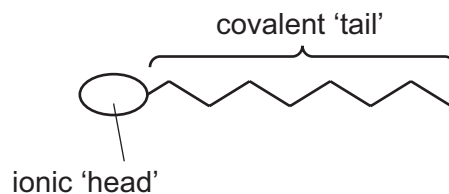


Fig. 10.3

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 | | | | | | | | | | | | | | | | | | |
| 7 Li Lithium 3 | 9 Be Beryllium 4 | 1 H Hydrogen 1 | 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 | 56 Fe Iron 26 | 55 Mn Manganese 25 | 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 | 101 Ru Ruthenium 44 | 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 | 186 Os Osmium 76 | 186 Os Osmium 76 | 184 W Tungsten 74 | 195 Pt Platinum 78 | 197 Au Gold 79 | 201 Hg Mercury 80 | 204 Tl Thallium 81 | 207 Pb Lead 82 | 209 Bi Bismuth 83 | 210 Po Polonium 84 | 210 At Astatine 85 | 210 Rn Radon 86 | | | | | | | | | | | | |
| 226 Ra Radium 88 | 227 Ac Actinium 89 | | | | | | | | | | | | | | | | | | | | | | | | |
| *58-71 Lanthanoid series | | | | | | | | | | | | 140 Ce Cerium 58 | 141 Pr Praseodymium 59 | 144 Nd Neodymium 60 | 150 Sm Samarium 62 | 152 Eu Europium 63 | 157 Gd Gadolinium 64 | 162 Dy Dysprosium 66 | 165 Ho Holmium 67 | 167 Er Erbium 68 | 169 Tm Thulium 69 | 173 Yb Ytterbium 70 | 175 Lu Lutetium 71 | | |
| †90-103 Actinoid series | | | | | | | | | | | | 232 Th Thorium 90 | 232 Pa Protactinium 91 | 238 U Uranium 92 | 238 Np Neptunium 93 | 238 Pu Plutonium 94 | 238 Am Americium 95 | 238 Cm Curium 96 | 238 Bk Berkelium 97 | 238 Cf Californium 98 | 238 Es Einsteinium 99 | 238 Fm Fermium 100 | 238 Md Mendelevium 101 | 238 No Nobelium 102 | 238 Lr Lawrencium 103 |

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

Key

| | | | | |
|---|----------|--|--|--|
| a | X | | | |
| | | | | |
| b | | | | |

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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