| Centre Number | Candidate Number | Name |
|---|---|---|
| | | |

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

**CO-ORDINATED SCIENCES** **0654/03**

Paper 3 Extended

May/June 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.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
You may use a pencil for any diagrams, graphs, tables or rough working.
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 **21** printed pages and **3** blank pages.

1 Blood contains red cells, white cells and plasma.

**(a)** Outline the function of white blood cells.

.....

.....

..... [2]

**(b)** The heart pumps blood around the body. Explain how the heart pushes blood into the arteries.

.....

.....

..... [2]

**(c)** State **one** difference between the structure of arteries and the structure of veins.
Explain how this difference relates to their different functions.

structure .....

function .....

.....

..... [3]

**(d)** Plants do not have a heart to pump fluids around them.
Water is carried through xylem vessels from a plant's roots to its leaves.

Explain why this happens more quickly when it is warm than when it is cold.

.....

.....

.....

..... [3]

**2** **(a)** A student uses a pH sensor connected to a computer to investigate four liquids, **A**, **B**, **C** and **D**. The apparatus is shown in Fig. 2.1.

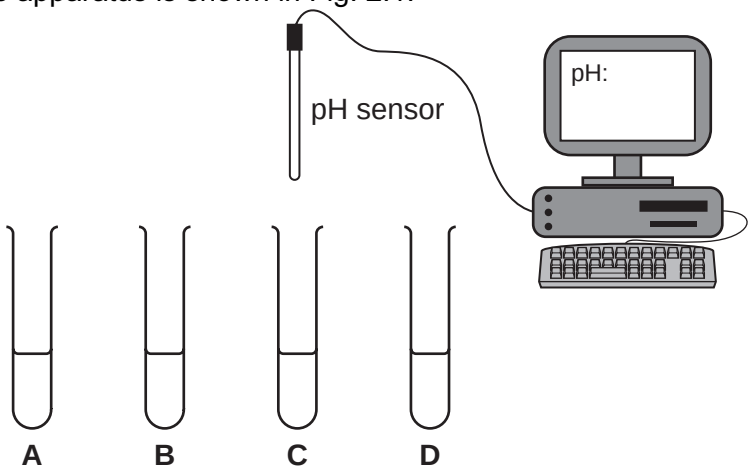



**Fig. 2.1**

The results obtained when the pH sensor was placed into the liquids in the test-tubes are shown in Table 2.1.

**Table 2.1**

| tube | pH |
|---|---|
| **A** | 14.0 |
| **B** | 7.0 |
| **C** | 1.0 |
| **D** | 6.0 |

**(i)** Which liquid in Table 2.1 could be pure water?
Explain your answer.

.....

..... [1]

**(ii)** Which liquid in Table 2.1 would react with iron(II) sulphate to form a green precipitate of iron(II) hydroxide?
Explain your answer.

.....

..... [2]

**(iii)** Which liquid in Table 2.1 contains the highest concentration of $H^+$ ions?
Explain your answer.

.....

..... [1]

**(b)** The student then used a temperature sensor in a second experiment as sh
Fig. 2.2.

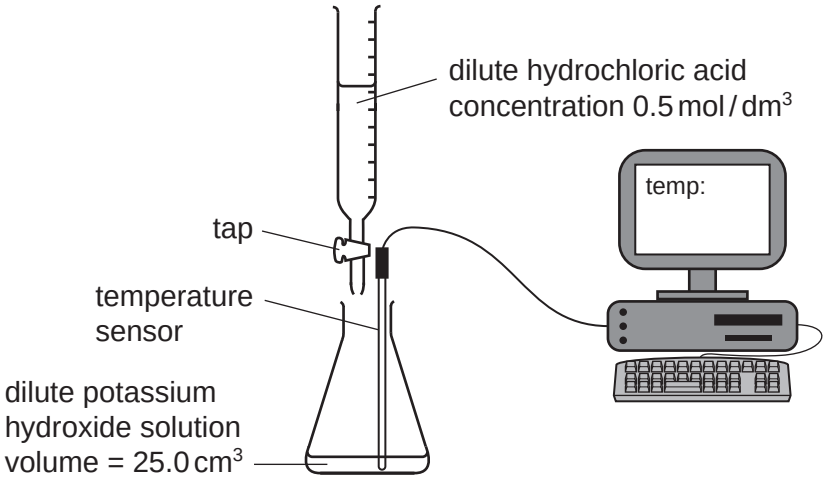



**Fig. 2.2**

The student opened the tap and added the hydrochloric acid slowly to the potassium hydroxide solution. She plotted a graph of the temperature of the mixture against the volume of acid added. Her graph is shown in Fig. 2.3.

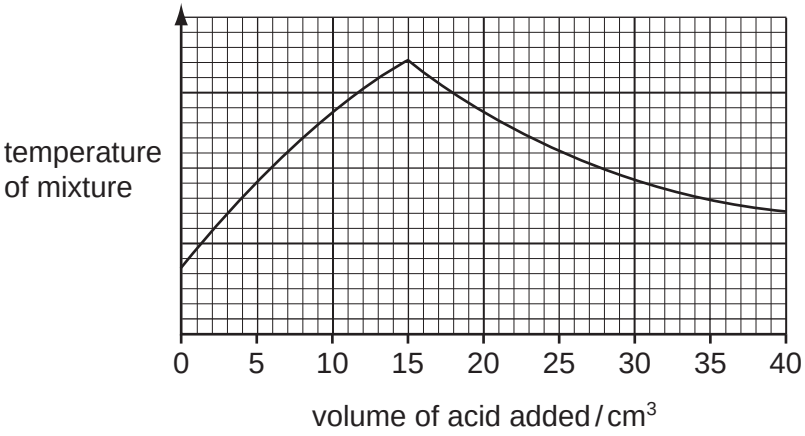



**Fig. 2.3**

The mixture became neutral when 15.0 $cm^3$ of acid had been added.

**(i)** Explain why the temperature of the mixture increased when the acid was first added to the potassium hydroxide solution.

.....

..... [1]

**(ii)** Suggest why the temperature of the mixture decreased once 15.0 $cm^3$ of a[cid] had been added.

.....

.....

..... [2]

The balanced equation for this reaction is

$$HCl\,(aq) + KOH\,(aq) \rightarrow KCl\,(aq) + H_2O\,(l)$$

**(iii)** Show that the number of moles of hydrochloric acid required to neutralise all of the potassium hydroxide was 0.0075.
Show your working.

..... [2]

**(iv)** Calculate the concentration of the potassium hydroxide solution in $mol/dm^3$.
Show your working.

..... [3]

**(v)** Write an ionic equation for the neutralisation of any acid by any alkali.

..... [1]

3 **(a)** Nuclear fission and nuclear fusion are both sources of energy.

**(i)** Apart from releasing energy, in what way are these two processes similar?

.....

..... [1]

**(ii)** In what way are these two processes different?

.....

..... [1]

**(iii)** There are safety concerns about the use of nuclear fission as an energy resource. Describe and explain **one** of these safety concerns.

.....

.....

.....

..... [3]

**(b)** **(i)** The voltage of electricity generated in a power station is increased using transformers for transmission through power lines to the users.

Explain why this is done.

.....

..... [2]

**(ii)** Fig. 3.1 shows a diagram of a simple transformer.

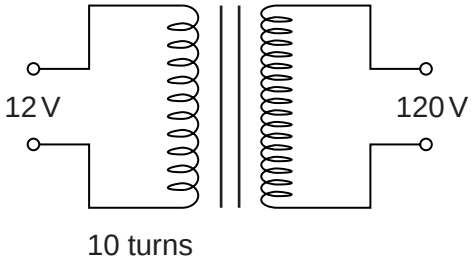



**Fig. 3.1**

Use the equation $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ to calculate the number of turns on the coil in the secondary circuit.

number of turns = ..... [1]

**(iii)** Explain how a transformer changes the voltage of an electrical supply. Your explanation should include the terms *induced current* and *magnetic field*.

.....

.....

.....

.....

..... [3]

**4** Big-horn sheep live on rocky mountain sides in Canada. The males have very large
The size of their horns is caused by their genes.

**(a)** State **one** feature shown in the photograph that is found only in mammals.

.....  [1]

**(b)** **(i)** Name the part of a cell that contains the genes.

.....  [1]

**(ii)** In which cells in the big-horn sheep's body will the gene for horn size be present?

.....  [1]

**(c)** Hunters kill big-horn sheep and keep their horns as trophies. They kill the she the largest horns.

Fig. 4.1 shows how the average size of the horns in a population of big-horn sheep changed between 1970 and 2005.

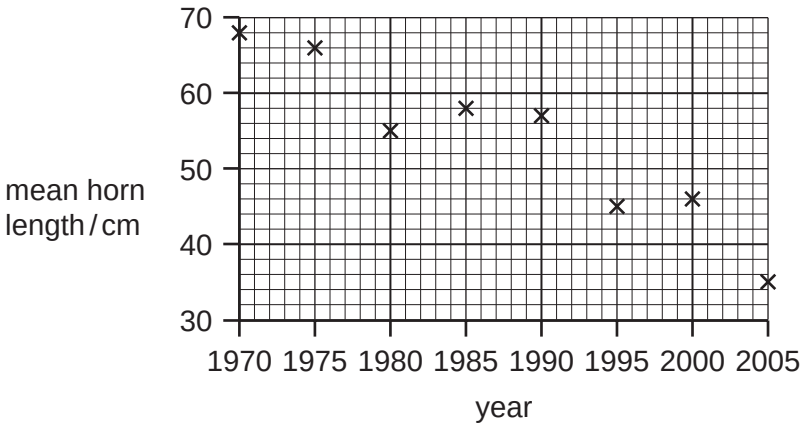



**Fig. 4.1**

Explain how hunting of big-horn sheep could have caused the general trend shown in Fig. 4.1.

.....

.....

.....

.....

..... [4]

**(d)** In summer it may be very hot in the mountains, but in winter it is very cold.

**(i)** Explain how the big-horn sheep's sweat glands can help to keep them cool in summer.

.....

.....

..... [2]

**(ii)** Explain how vasoconstriction can help to keep the sheep warm in winter.

.....

.....

.....

..... [3]

**5** **(a)** Electrical signals can be sent along wires in digital form.

**(i)** Describe what is meant by a *digital* signal.

.....

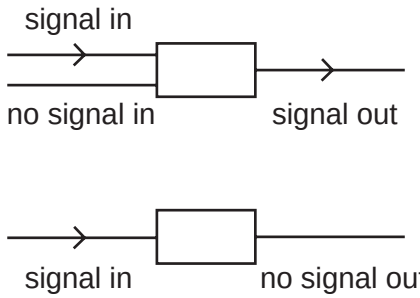
..... [1]

**(ii)** Give **one** advantage of using digital signals rather than analogue signals.

.....

..... [1]

**(b)** Electrical signals can pass in and out of electronic gates.
Identify the gates in Fig. 5.1 below.



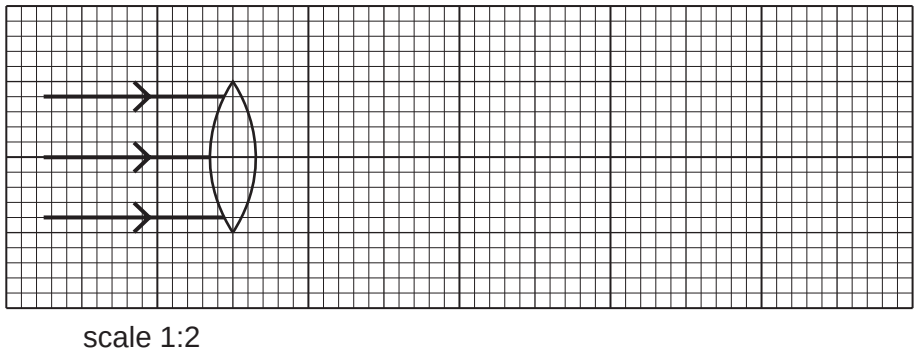

..... gate

..... gate [2]

**Fig. 5.1**

**(c)** Rays of light entering the eye are refracted by the lens.

**(i)** Complete Fig. 5.2 below to show what happens when parallel rays of light are refracted by a lens of focal length 10 cm.




[3]

**Fig. 5.2**

**(ii)** Human eyes are able to detect the three primary colours.
Name these colours.

1. .....

2. .....

3. ..... [1]

**(iii)** These three colours of light are electromagnetic waves. Apart from their colour, state **one** other way in which they differ from each other.

.....

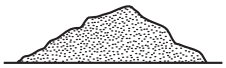
..... [1]

**6** **(a)** The diagrams below show some common raw materials which are chang chemical reactions into useful products.

Choose words from the list to complete each box.

**aluminium** **ammonia** **ceramics** **chlorine**

**glass** **paper** **plastics**

| **raw materials** | | **useful products** |
|---|---|---|
|  silicon(IV) oxide mixed with metal oxides | → | |
|  clay | → | |
|   petroleum (crude oil) | → | |

[3]

**(b)** Explain why silicon (IV) oxide has a very high melting point.
You may draw a diagram if it helps your answer.

.....

.....

.....

..... [2]

**(c)** Petroleum (crude oil) undergoes many processes in order to provide a wide ra useful chemicals.
Some of the alkane molecules from petroleum are cracked on the surface of a h catalyst to produce a mixture of saturated and unsaturated hydrocarbons.
Fig. 6.1 shows a schematic diagram of catalytic cracking.

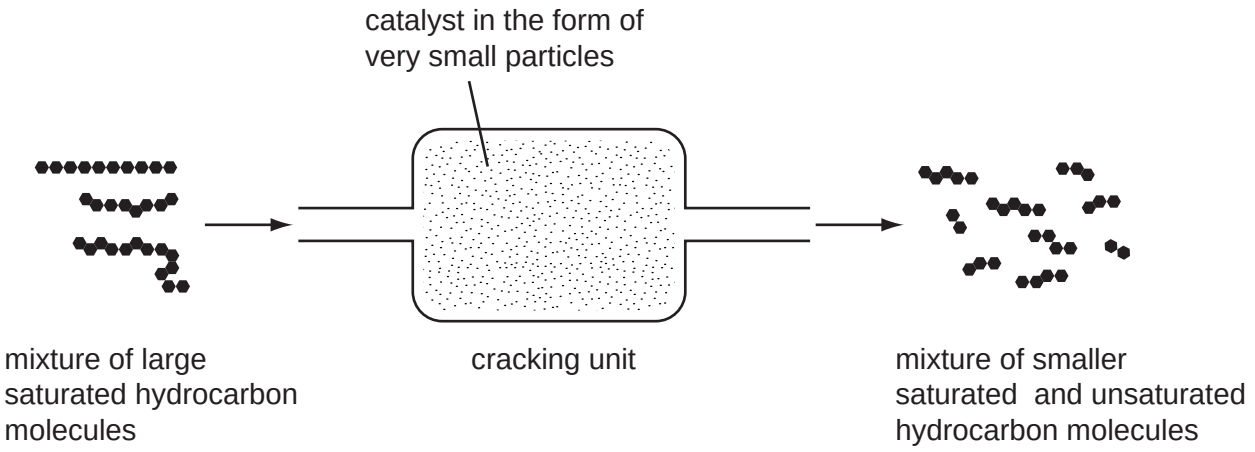



**Fig. 6.1**

**(i)** Name the unsaturated hydrocarbon, produced by cracking, which is used to make ethanol, $C_2H_6O$.

..... [1]

**(ii)** Write a balanced equation for the reaction referred to in **(i)** that produces ethanol.

..... [1]

**(iii)** Describe how a sample of the mixture coming from the cracking unit could be tested to show that it contained unsaturated compounds.

.....

.....

..... [2]

**(iv)** The mixture coming from the cracking unit contains molecules of different sizes. Suggest the name of a process which could be used to separate the mixture into individual substances.

..... [1]

**7** Fig. 7.1 shows three aeroplanes at an airport.

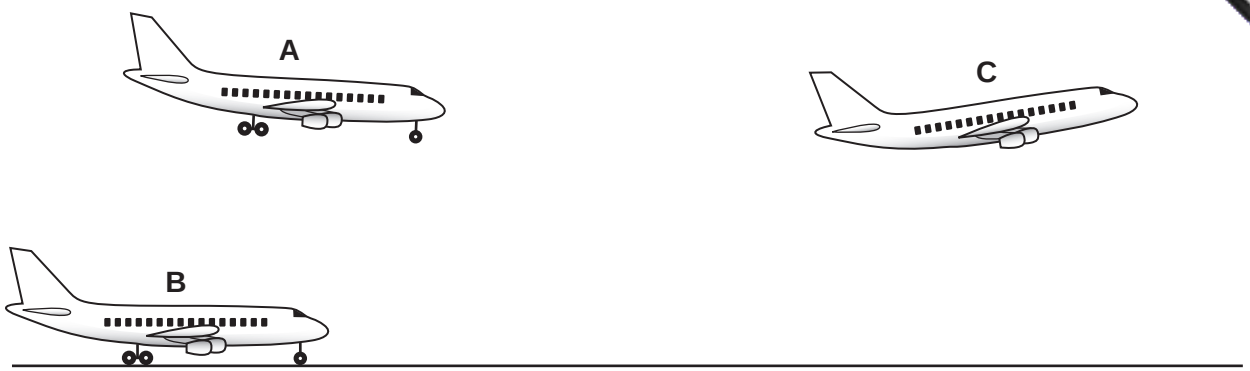



**Fig. 7.1**

**(a)** Aeroplane **A** is moving at a constant velocity towards the main runway.
Aeroplane **B** is stationary, waiting for take off.
Aeroplane **C** has just taken off and is accelerating.

**(i)** Which, if any, of the aeroplanes has zero momentum?

Explain your answer.

.....

..... [1]

**(ii)** The momentum of one of the aeroplanes is changing.

State which aeroplane and explain your answer.

.....

..... [1]

**(b)** Fig. 7.2 shows a speed-time graph for aeroplane **C**.

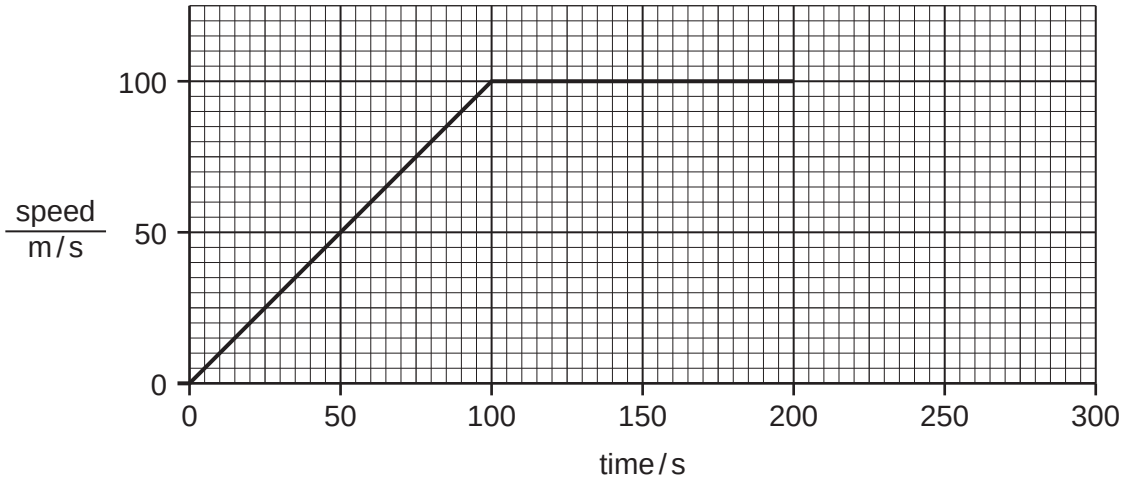



**Fig. 7.2**

Calculate the distance covered by the aeroplane in the first 200 seconds.
Show your working.

.....  [2]

**(c)** The mass of aeroplane **C** is 120 000 kg.
Calculate the kinetic energy of the aeroplane as it travels at 100 m/s.

Show your working and state the formula that you use.

formula used

working

.....  [3]

**8** In many parts of the world, cattle are farmed to provide meat and milk for human cattle may be fed on maize. This information can be shown as a food chain.

**maize** → **cattle** → **humans**

**(a)** The arrows in the food chain represent the flow of energy along the chain.

Explain how the maize plants obtain their energy.

.....

.....

.....

..... [3]

**(b)** Fig. 8.1 is a pyramid of biomass for this food chain.

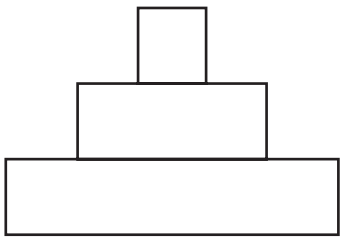


**Fig. 8.1**

**(i)** State the meaning of the term *biomass*.

.....

..... [1]

**(ii)** Write the letter **C** in the level or levels in this pyramid that represent the consumers. [1]

**(iii)** Explain why the pyramid is this shape.

.....

.....

.....

..... [2]

**(c)** Explain why farmers may spray pesticides onto growing maize crops.

.....

.....

..... [2]

**(d)** There is more than enough food in the world to feed everyone, but in many places people cannot get enough to eat.

Describe **one** example of a problem of inadequate diet in a named part of the world and suggest a solution to this problem.

.....

.....

.....

..... [3]

**9** Growing crops take up several elements they need from the soil.
The chemical symbols of three of these elements are N, P and K.

**(a) (i)** One of these elements, when uncombined, is a metal.
Name this element.

..... [1]

**(ii)** State which **two** of these elements have the same number of electrons in the outer shells of their atoms.
Explain your answer briefly.

elements ..... and .....

explanation .....

..... [2]

**(b)** In industry, nitrogen from the atmosphere is used to make ammonia. Ammonia is used to make the salts ammonium nitrate and ammonium phosphate, which are added to soil used for growing crops.
Fig. 9.1 shows a diagram of the industrial process used to make ammonia.

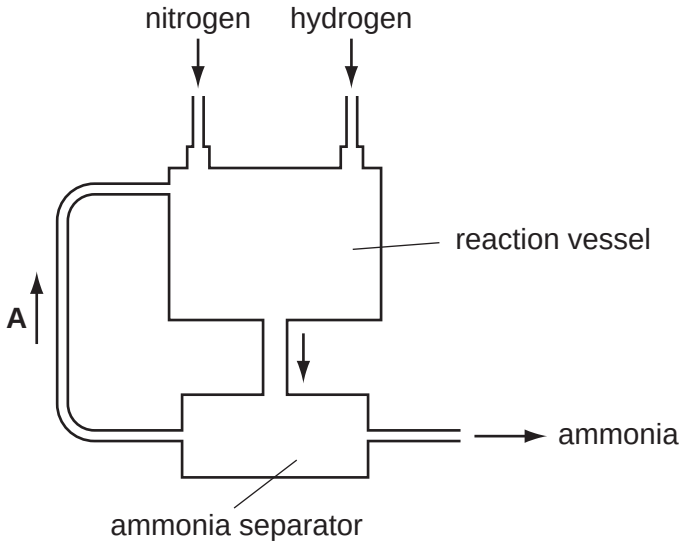



**Fig. 9.1**

**(i)** The equation for the formation of ammonia is shown below.

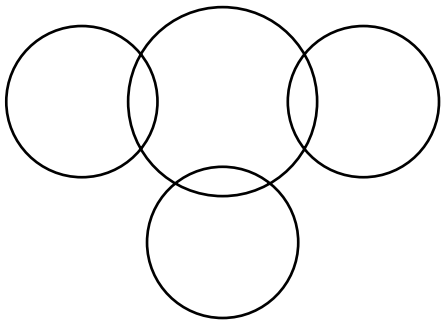
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Name the two **main** gases in the mixture flowing through pipe **A**.

..... and ..... [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]

**(iii)** The chemical formula of ammonium phosphate is $(NH_4)_3PO_4$.
The formula and charge of the ammonium ion is $NH_4^+$.

Deduce the formula and charge of the phosphate ion.
Explain your answer.

.....

..... [2]

**(iv)** The gas mixture inside the reaction vessel in Fig. 9.1 is kept at a high temperature.
Explain the effect this has on the rate of the reaction that produces ammonia.

.....

.....

.....

..... [2]

**10** **(a)** Explain why the pressure inside a car tyre increases as the tyre gets hotter.

.....

.....

.....

..... [2]

**(b)** Explain why snow skis have a large surface area.

.....

.....

.....

..... [2]

**(c)** Explain why an earthquake taking place inside the Earth can be detected on the surface.

.....

.....

.....

..... [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 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 Lawr 10 |

*58-71 Lanthanoid series
90-103 Actinoid series

Key

| | |
|---|---|
| a | a = relative atomic mass |
| X | X = atomic symbol |
| b | b = proton (atomic) number |

The volume of one mole of any gas is 24 $dm^3$ at room temperature and pressure (r.t.p.).