UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*7889880349*

**CO-ORDINATED SCIENCES** **0654/33**

Paper 3 (Extended) **October/November 2010**

**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 28.

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 **24** printed pages and **4** blank pages.

For Examiner's Use

**1** **(a)** In electrochemical cells (batteries), electrical energy is obtained from chemical reactions.

Fig. 1.1 shows some uses of electrochemical cells.

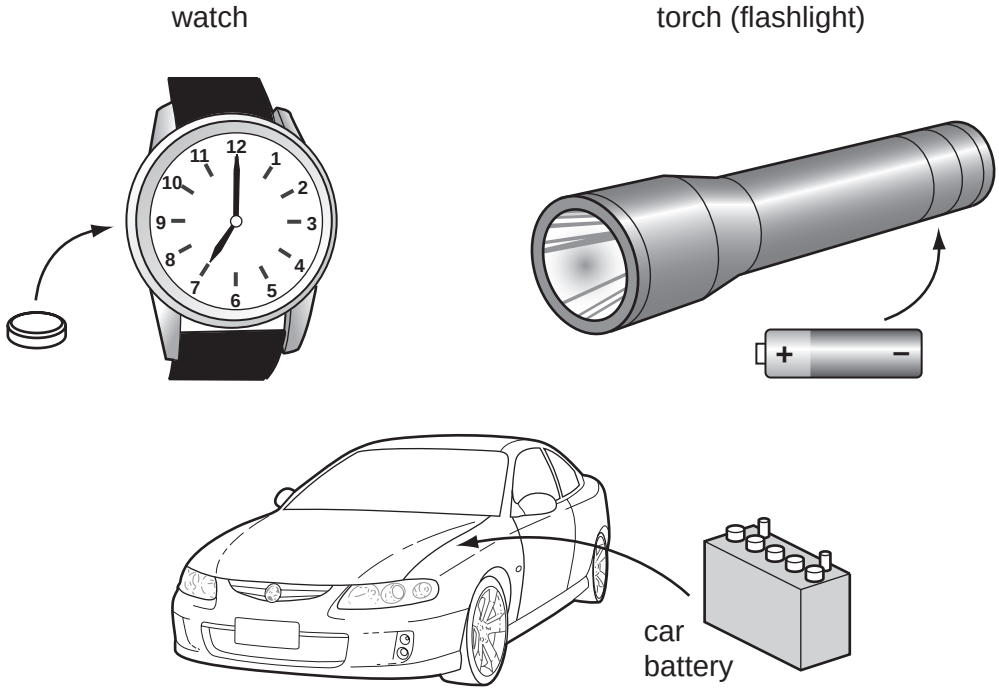


**Fig. 1.1**

**(i)** Small electrochemical cells, like those used in watches and torches (flashlights), stop working and have to be replaced fairly frequently.

Explain what has happened inside the cells to cause them to stop working.

.....

..... [1]

**(ii)** Explain why car batteries may never need to be replaced during the lifetime of the car.

.....

..... [1]

**(b)** Electrical energy may be obtained from an electrochemical cell made by placing metal electrodes into a potato.

Fig. 1.2 shows a diagram of such a cell.

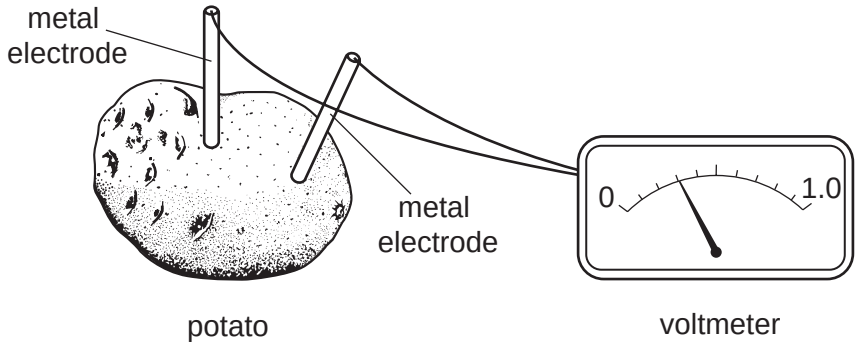


**Fig. 1.2**

A student investigated the use of different metals as electrodes. The metals he used are listed below in order of reactivity.

| | |
|---|---|
| **magnesium** | (most reactive) |
| **zinc** | |
| **lead** | ↓ |
| **copper** | (least reactive) |

**(i)** Suggest why a potato can be used as part of an electrochemical cell.

.....

..... [1]

**(ii)** State the pair of metals from the list that would produce the highest voltage when used as the electrodes.

Explain your answer.

.....

.....

..... [2]

*For Examiner's Use*

**(c)** Some modern cars, known as hybrids, have two engines.

One of these engines uses hydrocarbon fuel (gasoline) which is combusted (burned) to provide the energy required to move the car.

The second engine is a powerful electric motor which uses energy provided by an electrochemical cell.

When the car moves away from rest and continues to move slowly, the electric motor drives the car and the combustion engine is switched off.

**(i)** Heptane, $C_7H_{16}$, is an alkane found in gasoline.

Complete the balanced symbolic equation below for the combustion of heptane.

$$C_7H_{16} + \text{.....} \rightarrow 7CO_2 + 8H_2O$$ [2]

**(ii)** Suggest why there could be an improvement to the environment, particularly in towns and cities, if hybrid cars replaced ordinary cars.

.....

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.....

.....

..... [3]

*For Examiner's Use*

**2** **(a)** Fig. 2.1 is a photograph of a plant tissue seen through a light microscope.

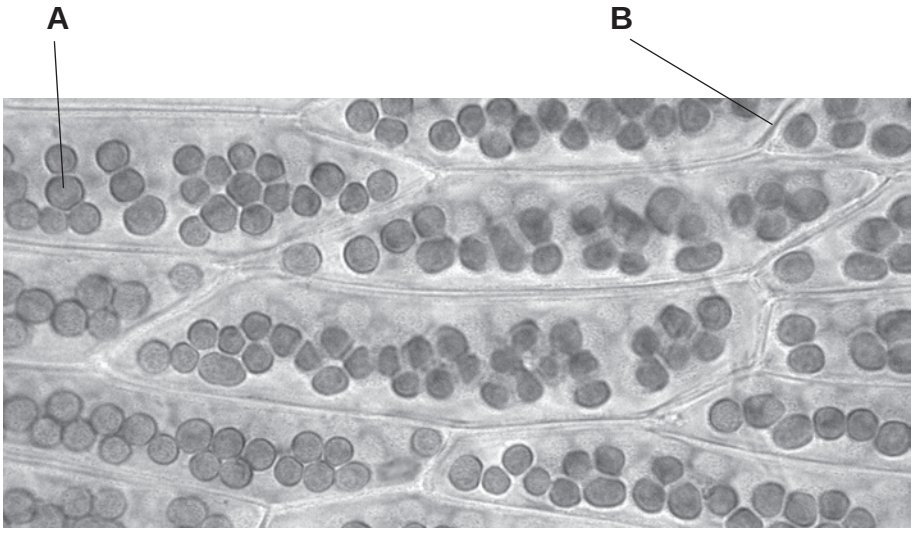


**Fig. 2.1**

**(i)** Name the structures labelled **A** and **B**.

**A** .....

**B** ..... [2]

**(ii)** Describe **two** ways in which the cells in Fig. 2.1 differ from animal cells.

1 .....

2 ..... [2]

For Examiner's Use

**(b)** Fig. 2.2 shows apparatus that was used to investigate transpiration. The two pieces of apparatus were set up and left in the same conditions for 24 hours. The levels of water at the start and end of the 24 hours are shown on the diagram.

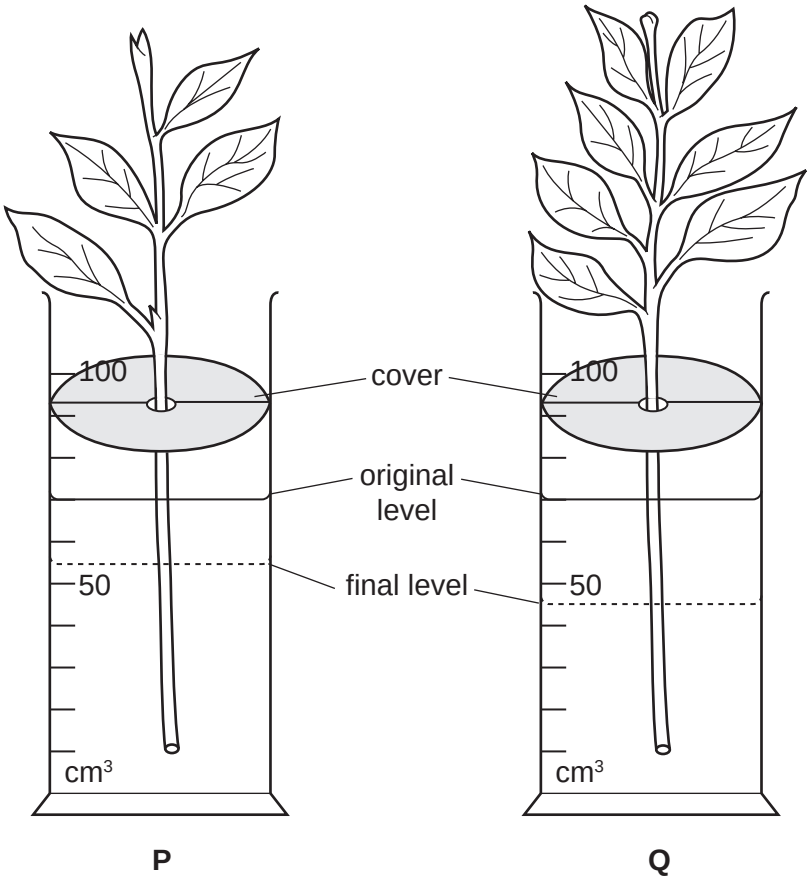


**Fig. 2.2**

**(i)** Suggest why the level of water went down more in **Q** than in **P**.

.....

.....

.....

..... [3]

**(ii)** Predict the results that would be obtained if apparatus **Q** was left in the same position for the next 24 hours, but at a higher temperature.

Explain your prediction.

.....

.....

.....

..... [3]

*For Examiner's Use*

**3** **(a)** The isotope protactinium-234 undergoes radioactive decay by emitting beta radiation. Protactinium-234 has a half-life of 105 seconds.

**(i)** Explain the meaning of the terms *radioactive decay* and *half-life*.

radioactive decay .....

.....

half-life .....

..... [2]

**(ii)** 0.400 mg of protactinium-234 decays until 0.025 mg remain.

Calculate how long this takes.

Show your working.

..... [2]

**(b)** Apart from nuclear weapons and nuclear power, describe **one** practical use of radioactive isotopes.

.....

.....

.....

..... [2]

*For Examiner's Use*

**4** **(a)** Fig. 4.1 shows the percentage of people living in Australia who have blood groups O, A, B and AB.

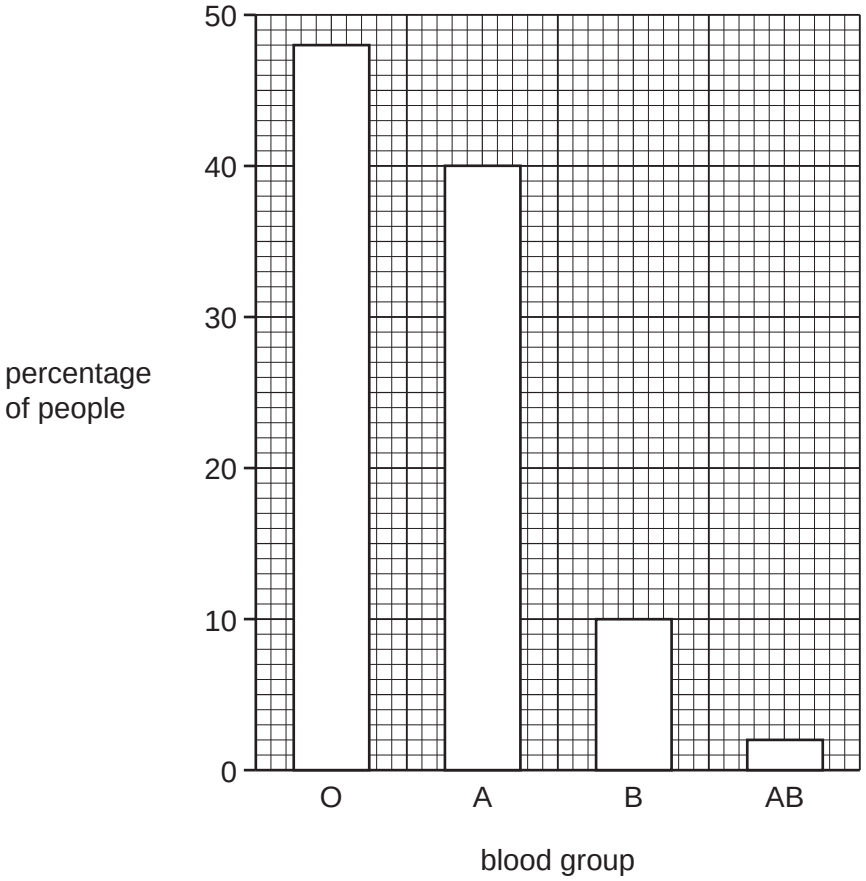


**Fig. 4.1**

**(i)** Blood groups in humans show discontinuous variation.

Explain what is meant by *discontinuous variation*.

.....

.....

..... [2]

**(ii)** Use the information in Fig. 4.1 to suggest whether a person's blood group is caused by their genes, their environment, or both genes and environment.

Explain your answer.

.....

.....

..... [2]

*For Examiner's Use*

**(b) (i)** Give **one** example of continuous variation in humans.

.....

[1]

**(ii)** On the axes below, sketch a graph to show continuous variation in the feature you have given in **(b)(i)**.

Label the axes on your graph.

[3]

**(c)** All species show variation in some of their characteristics.

Explain why this variation is important in evolution. You may like to use an example to help your explanation.

.....

.....

.....

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.....

.....

[4]

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*For Examiner's Use*

**5** **(a)** Fig. 5.1 shows a simple circuit containing two identical lamps.

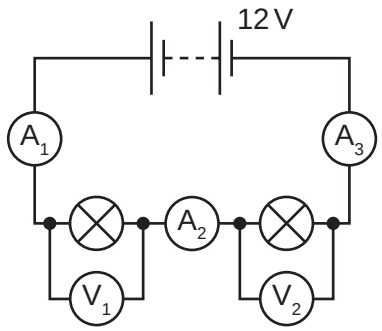


**Fig. 5.1**

Ammeter $\mathbf{A}_1$ reads 0.30 A.

Write down the readings on

ammeter $\mathbf{A}_2$ .....

ammeter $\mathbf{A}_3$ .....

voltmeter $\mathbf{V}_1$ .....

voltmeter $\mathbf{V}_2$ ..... [2]

For Examiner's Use

**(b)** A student investigated the relationship between the potential difference across a lamp and the current in the lamp.

Fig. 5.2 shows a graph of the results of this investigation.

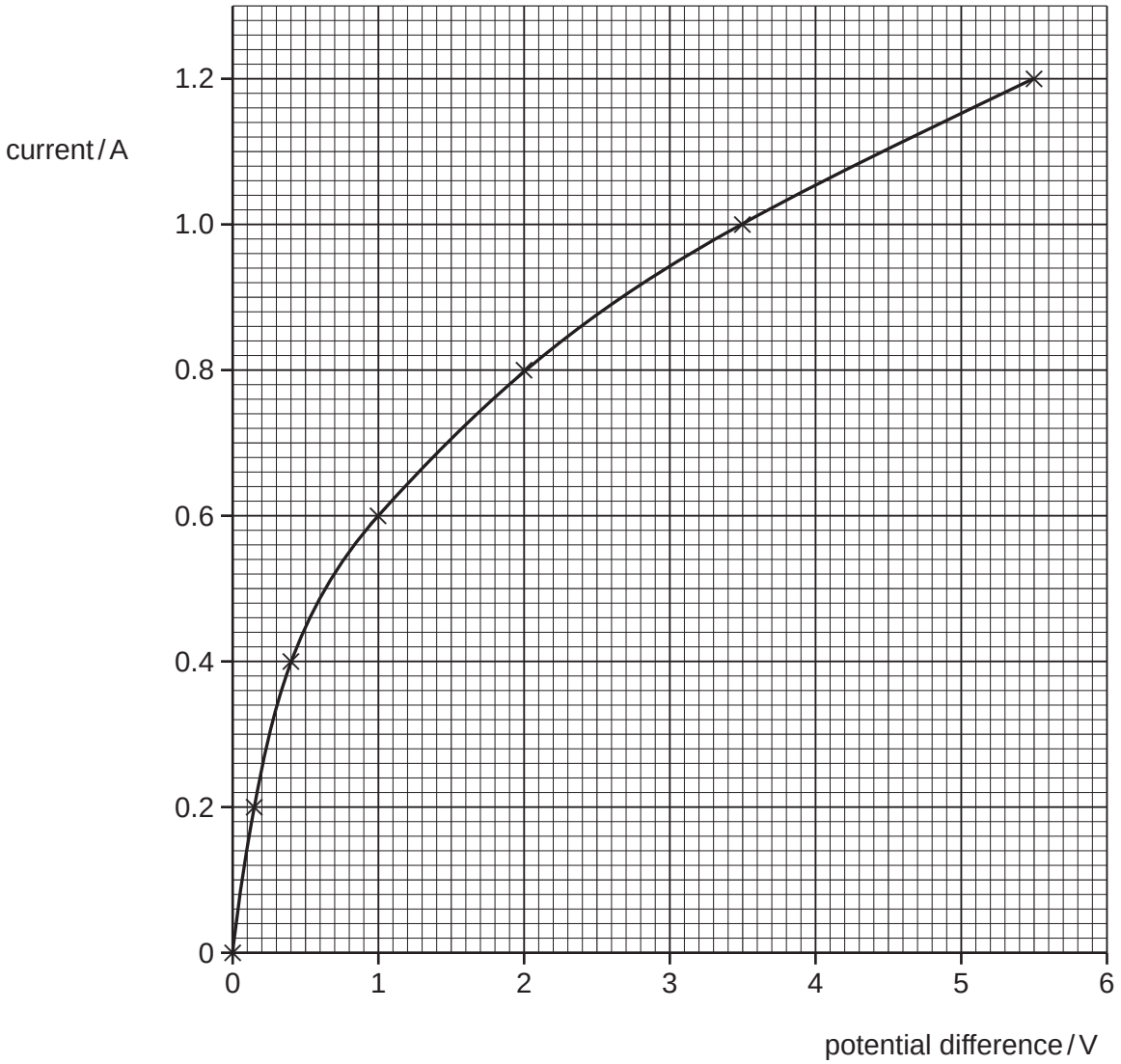


**Fig. 5.2**

**(i)** Calculate the resistance of the lamp when the current was 0.6 A.

State the formula that you use and show your working.

formula used

working

..... [2]

**(ii)** Explain why the lamp does not obey Ohm's law.

.....

.....

..... [2]

**(iii)** On Fig. 5.2, sketch a line which could have been obtained if the lamp did obey Ohm's law. [1]

**(c)** Fig. 5.3 shows a soft iron ring. Two coils **X** and **Y**, each of 400 turns, are wound around the ring. Coil **X** is connected to a power supply and coil **Y** is connected to a 6 V lamp.

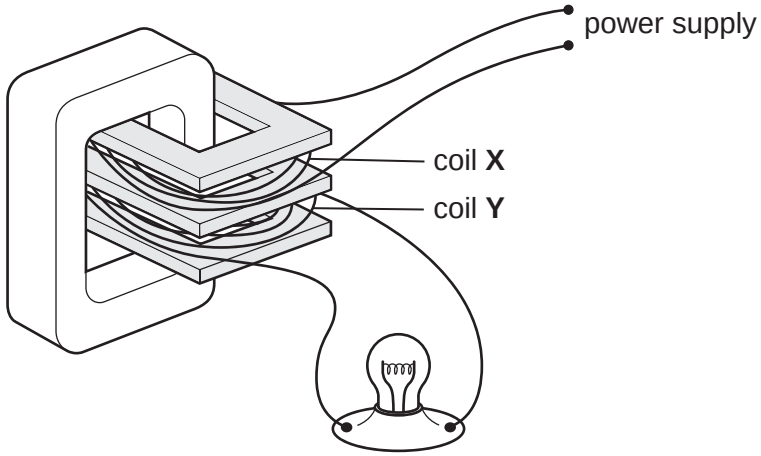


**Fig. 5.3**

Describe and explain what happens to the lamp when

the power supply is 6 V d.c.,

.....

.....

the power supply is 6 V a.c.

.....

..... [3]

*For Examiner's Use*

**6** Table 6.1 shows some properties of five elements, **P** to **T**. The code letters are **not** the chemical symbols of the elements.

**Table 6.1**

| element code letter | melting point / °C | boiling point / °C | conduction of electricity | number of outer electrons in an atom |
|---|---|---|---|---|
| **P** | −89 | −186 | insulator | 8 |
| **Q** | −39 | 357 | conductor | 2 |
| **R** | −7 | 58 | insulator | 7 |
| **S** | 181 | 1342 | conductor | 1 |
| **T** | 114 | 184 | insulator | 7 |

Answer the following questions, using **only** the code letters of the elements shown in Table 6.1.

**(a) (i)** State and explain which element is very unreactive.

element .....

explanation .....

..... [1]

**(ii)** State and explain which element is a metal and a liquid at a room temperature of 20 °C.

element .....

explanation .....

.....

..... [2]

**(iii)** Elements **R** and **T** are halogens.

Use information from Table 6.1 to state and explain which of these elements has the greater proton number.

element .....

explanation .....

.....

..... [2]

For Examiner's Use

**(b)** Fig. 6.1 shows atoms of the two elements, **R** and **S**. Only the outer electron shells are shown.

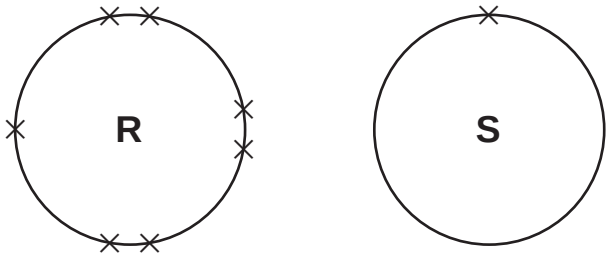


**Fig. 6.1**

Elements **R** and **S** react vigorously together to form an ionic compound.

The compound that forms has a very high melting point.

**(i)** Describe, in terms of electrons, how ionic bonds are formed between atoms of **R** and **S**.

.....

.....

.....

..... [2]

**(ii)** Explain, in terms of structure and the forces between ions, why the compound containing **R** and **S** is a solid with a high melting point.

.....

.....

.....

..... [3]

**(c)** Suggest the process which is used to extract the element potassium from its compounds.

*For Examiner's Use*

Give a reason for your choice of process.

.....

.....

..... [2]

*For Examiner's Use*

**7** Fig. 7.1 shows the driving force acting on a car of mass 1200 kg travelling at a constant speed of 18 m / s.

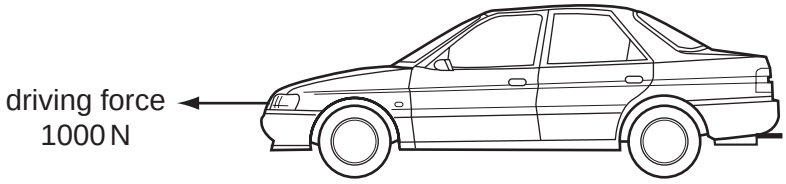


**Fig. 7.1**

**(a)** Calculate the amount of work done by the driving force in one minute.

Show your working.

..... [2]

**(b)** The car when travelling at 18 m / s is stopped using a braking force of 10 000 N.

**(i)** Calculate the deceleration of the car.

State the formula that you use and show your working.

formula used

working

..... [2]

**(ii)** Calculate the time needed for the car to stop.

State the formula that you use and show your working.

formula used

working

..... [2]

**(c)** Fig. 7.2 shows a car on a hydraulic lift in a garage. The total weight being lifted is 18 000 N. The lift uses four large pistons. Each large piston has an area of 0.03 $m^2$. The smaller piston **X** has an area of 0.01 $m^2$.

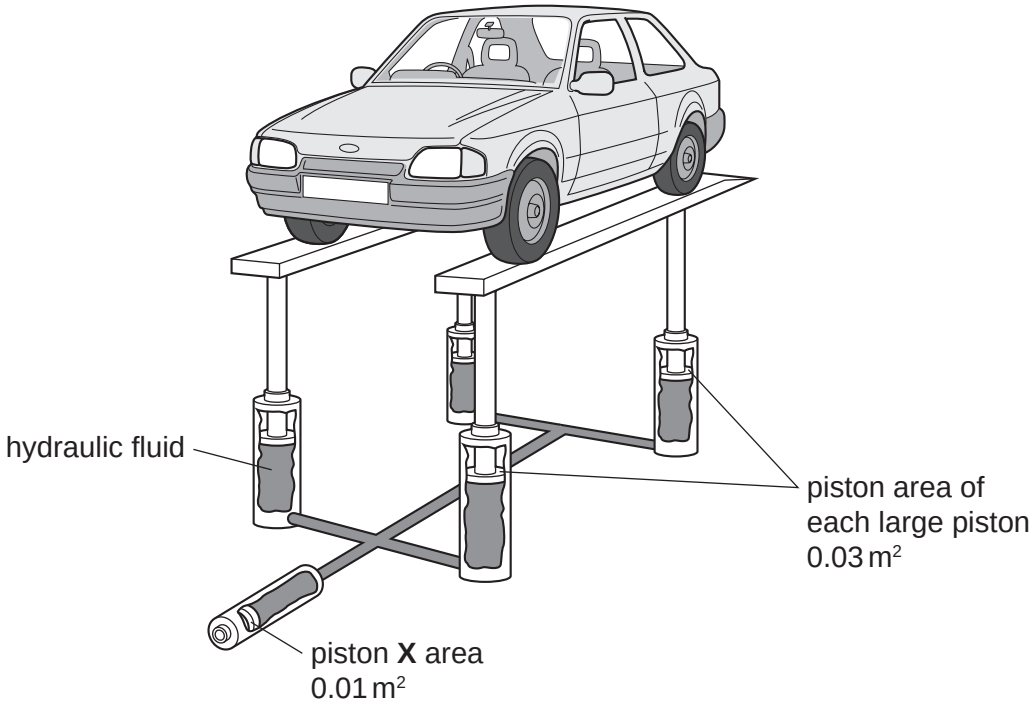


**Fig. 7.2**

**(i)** Calculate the total area of the four large pistons.

..... [1]

**(ii)** Use the formula

pressure = force / area

to calculate the pressure in the hydraulic fluid used in the lift.

Show your working.

..... [1]

**(iii)** This pressure is caused by piston **X**.

Calculate the minimum force which piston **X** must exert to lift the car.

Show your working.

*For Examiner's Use*

..... [1]

*For Examiner's Use*

**8** Fig. 8.1 shows a section through the human thorax.

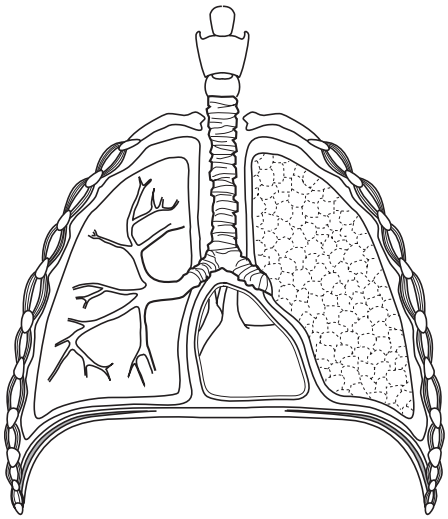

**Fig.8.1**

**(a)** On the diagram, use a label line and the appropriate letter to indicate:

**A** a muscle that contracts to bring about inspiration (breathing in)

**B** an area where gas exchange takes place

**C** a structure that rises during expiration (breathing out) [3]

**(b)** Describe the pathway taken by blood as it passes from the heart to the lungs and back to the heart again.

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.....

.....

..... [3]

**(c)** Describe how the blood transports oxygen.

.....

.....

..... [2]

**(d)** Describe how oxygen is supplied to a developing fetus in its mother's uterus.

*For Examiner's Use*

.....

.....

.....

..... [3]

*For Examiner's Use*

**9** Nitrogen compounds in soil are taken up by growing crops.

Fig. 9.1 shows two ways in which nitrogen compounds may be added to soil used for growing crops.

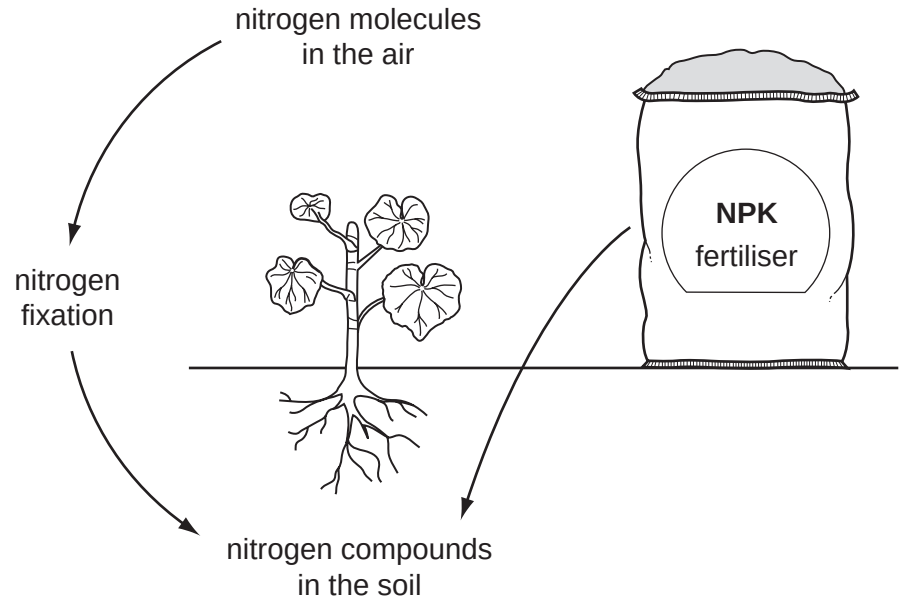


**Fig. 9.1**

**(a) (i)** State the meaning of the term *nitrogen fixation* and describe briefly **one** way in which this can occur.

.....

.....

.....

..... [3]

**(ii)** Explain why nitrogen molecules taken directly from the air **cannot** be used by most growing crops.

.....

..... [1]

*For Examiner's Use*

**(b)** The nitrogen in NPK fertiliser exists in the form of compounds such as the salts ammonium nitrate, $NH_4NO_3$, and diammonium phosphate, $(NH_4)_2HPO_4$.

Diammonium phosphate may be obtained by reacting ammonia with phosphoric acid.

The balanced symbolic equation for this reaction is

$$2NH_3 + H_3PO_4 \rightarrow (NH_4)_2HPO_4$$

**(i)** State the number of moles of diammonium phosphate which are produced when 0.1 mol of ammonia react.

..... [1]

**(ii)** The relative formula mass of diammonium phosphate is 132.

Calculate the mass of diammonium phosphate which is produced when 0.1 mol of ammonia reacts.

Show your working.

..... [2]

**(c)** Plants produce glucose which provides energy during respiration.

Excess glucose is stored in the plant in the form of starch.

**(i)** Outline, in terms of molecules, what happens when glucose is changed into starch.

.....

.....

..... [2]

**(ii)** Glucose is soluble in water but starch is insoluble.

Describe and explain the difference in appearance between a solution of glucose and the sol (colloid) which forms when starch is dispersed in water.

.....

.....

.....

..... [3]

*For Examiner's Use*

**10 (a)** An athlete of mass 70 kg is running at a speed of 10 m / s in a sprint race.

Calculate the athlete's kinetic energy.

State the formula that you use and show your working.

formula used

working

..... [3]

**(b)** At the end of the race, evaporation helps to cool the athlete.

**(i)** Use the idea of particles to explain how evaporation helps the athlete to cool down.

.....

.....

..... [2]

**(ii)** At the end of a long race, an athlete may be wrapped in a shiny foil blanket to prevent him cooling down too quickly.

Explain how the shiny foil blanket helps to reduce energy losses. Use ideas about conduction, convection and radiation in your answer.

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..... [3]

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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 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 † | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 = 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.).