UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8364803695

CO-ORDINATED SCIENCES **0654/33**

Paper 3 (Extended) **May/June 2013**

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 pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 32.

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.

This document consists of **30** printed pages and **2** blank pages.

UNIVERSITY of CAMBRIDGE International Examinations

1 Fig. 1.1 shows an experimental car powered by solar panels.

For Examiner's Use

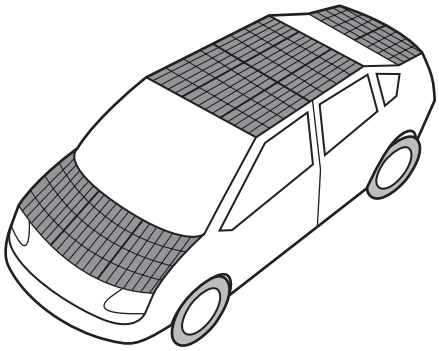


Fig. 1.1

(a) The speed / time graph in Fig. 1.2 shows the motion of the car over a short time.

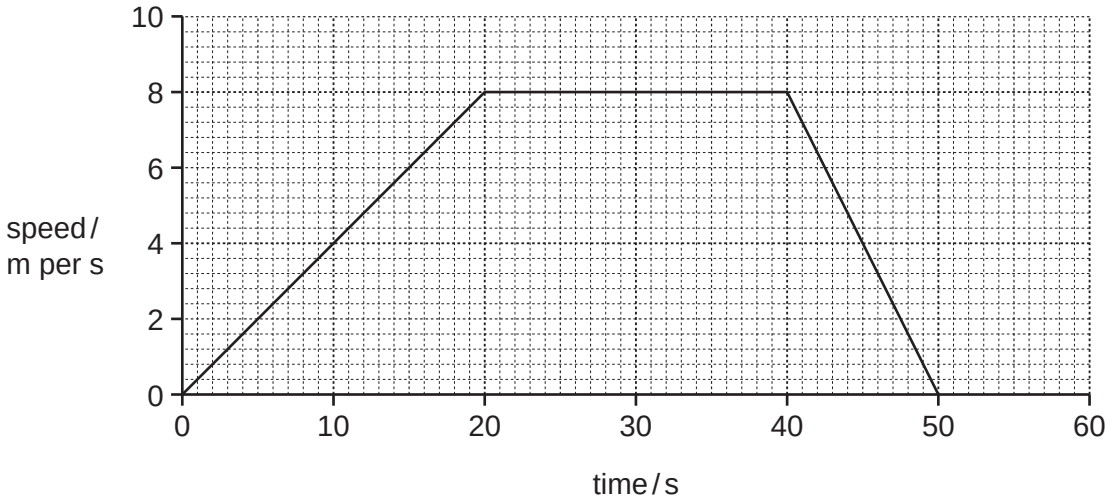


Fig. 1.2

(i) On Fig. 1.2, label **A** at a point when the car was accelerating. [1]

(ii) Calculate the total distance travelled by the car.

Show your working.

..... [2]

(b) The energy output from the solar panels was measured during one day. Fig. 1.3 is a graph of the results.

For Examiner's Use

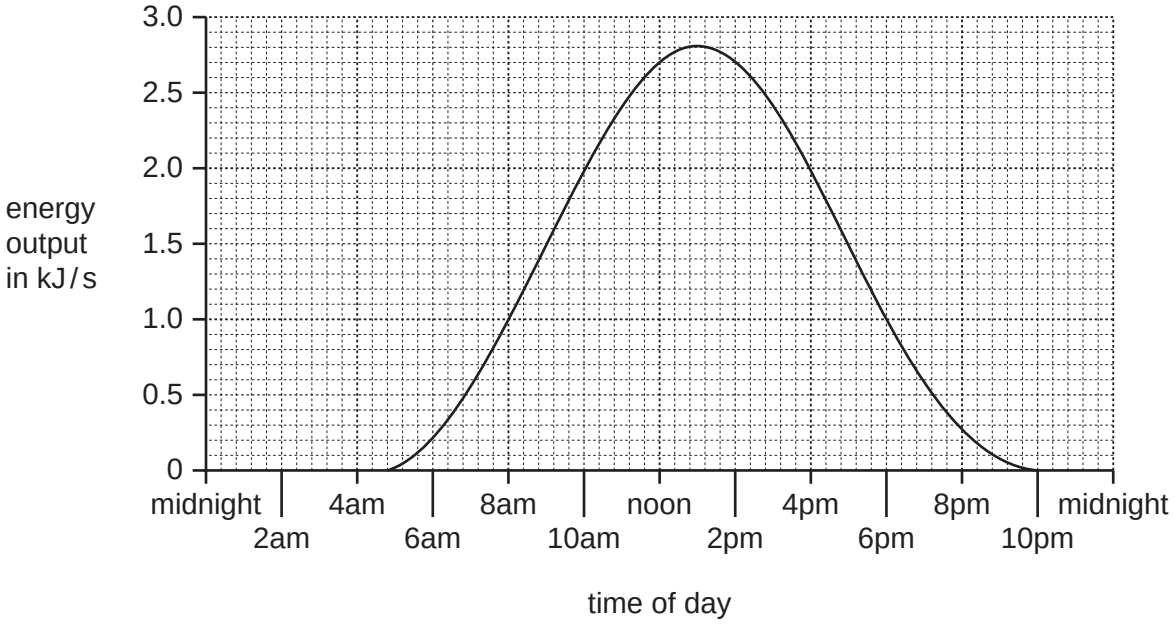


Fig. 1.3

(i) Explain why the energy output from the solar panels varies during the day.

.....

..... [1]

(ii) The motor in the car needs 2000 J/s to move the car at 7 m/s.

Use Fig. 1.3 to calculate the number of hours in the day for which the solar cells generate sufficient electricity to run the car at this speed.

..... hours [1]

(iii) The solar cells are 20% efficient.

Calculate the solar energy input required to produce 2000 J/s.

State the formula that you use and show your working.

formula

working

..... [2]

(iv) The mass of the car is 750 kg.

Calculate the kinetic energy of the car when it is travelling at 7 m / s.

State the formula that you use and show your working.

formula

working

..... [2]

(c) Fig. 1.4 shows a small photovoltaic cell (solar cell) being investigated.

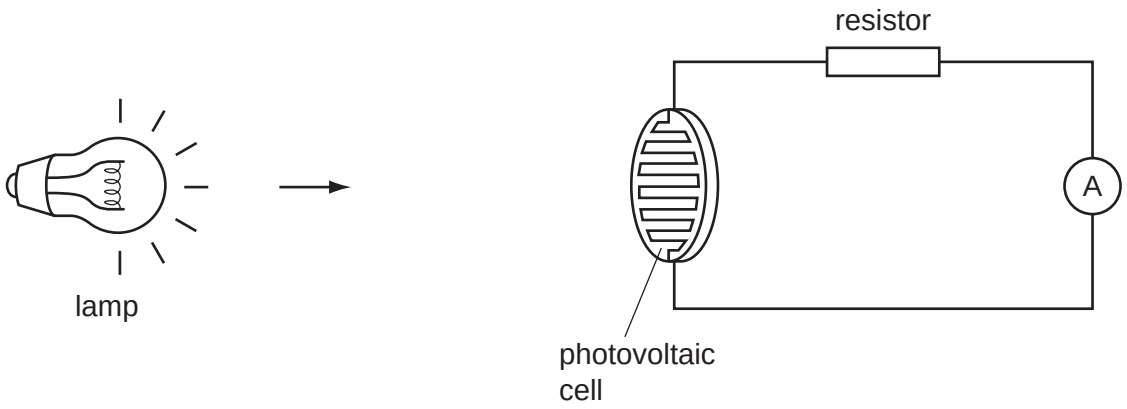


Fig. 1.4

(i) A voltmeter is added to the circuit to measure the voltage across the photovoltaic cell.

Using the correct symbol, draw the voltmeter in the correct position on Fig. 1.4. [1]

(ii) The voltmeter reading is 2.5 V when the ammeter reading is 0.2 A.

Calculate the power output of the photovoltaic cell.

State the formula that you use and show your working.

formula

working

..... [2]

2 Petroleum (crude oil) contains hydrocarbon molecules that have a very wide range of relative formula masses.

Gasoline obtained from petroleum is in great demand for car fuel. Petroleum as it exists in the Earth's crust does not contain enough gasoline to meet this demand.

The yield of gasoline from petroleum can be increased by the process of catalytic cracking.

Fig. 2.1 shows a simplified diagram of catalytic cracking.

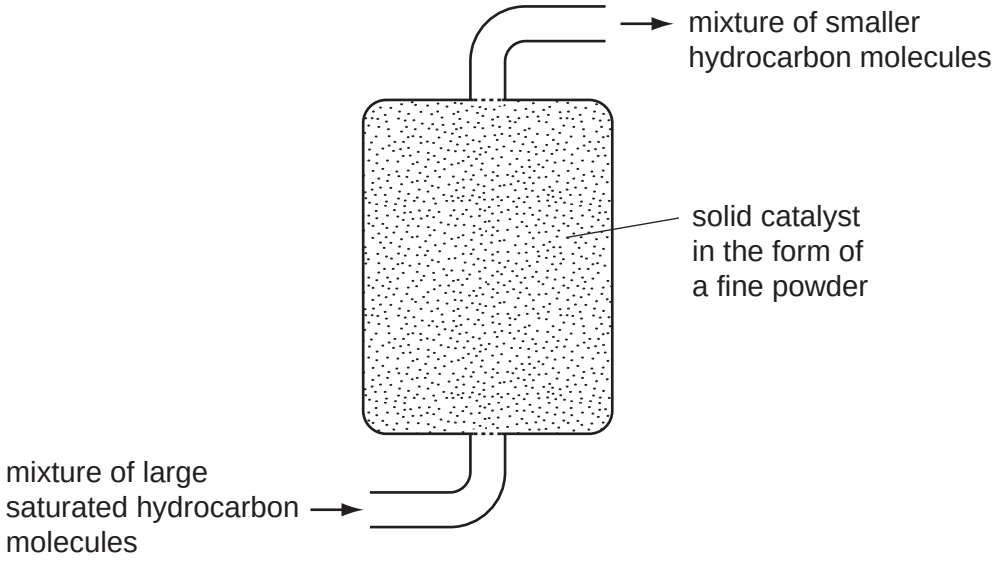


Fig. 2.1

(a) Catalytic cracking produces a mixture of hydrocarbons that contains a higher proportion of gasoline.

Suggest the full name of a process that could be used to separate this gasoline from the other hydrocarbons in the mixture.

.....

[1]

(b) **(i)** Decane, $C_{10}H_{22}$, may be cracked in apparatus like that shown in Fig. 2.1.

A symbolic equation for the cracking of decane is

$$C_{10}H_{22} \longrightarrow \text{one molecule of } \mathbf{X} + C_2H_4$$

Deduce the formula of a molecule of compound **X**.

Explain your answer briefly.

formula of molecule **X** .....

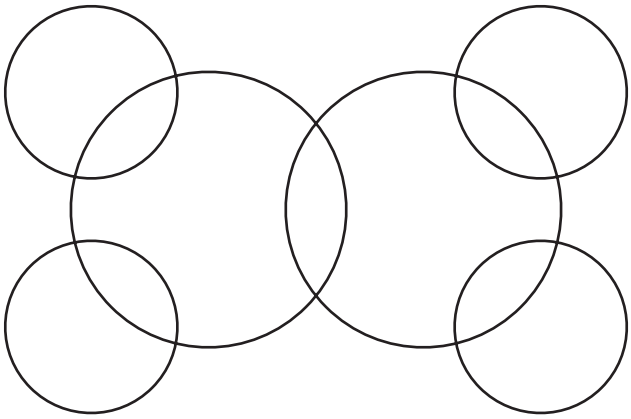
explanation .....

.....

[2]

(ii) Complete a bonding diagram for ethene to show

- the chemical symbols of each atom,
- how the bonding electrons are arranged in each atom.



[2]

(c) In a combustion experiment, a chemist reacts ethene with excess oxygen.

The balanced symbolic equation for the combustion reaction is

$$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$$

The chemist finds that 480 cm^3 of carbon dioxide, measured at room temperature, have been produced.

(i) Calculate the number of moles of carbon dioxide that were produced. The volume of one mole of carbon dioxide at room temperature has a volume of 24 dm^3.

Show your working.

..... [2]

(ii) Calculate the mass of ethene that the chemist used in his experiment.

Show your working.

For Examiner's Use

..... [3]

For Examiner's Use

3 **(a)** Fig. 3.1 shows a food chain in a forest. The numbers show the energy in three trophic levels in an area of 1 m^2 of forest.

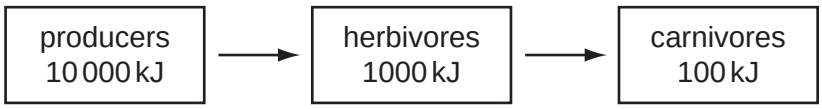


Fig. 3.1

(i) State the form in which energy is transferred from the producers to the herbivores.

..... [1]

(ii) Calculate the percentage of the energy in the producers that is transferred to the carnivores.

..... % [1]

(iii) Describe **two** ways in which energy is lost from the food chain.

1 .....

2 ..... [2]

(b) Explain how deforestation can contribute to global warming.

.....

.....

.....

.....

.....

..... [3]

4 A student added excess magnesium ribbon to dilute hydrochloric acid as shown in Fig. 4.1.

For Examiner's Use

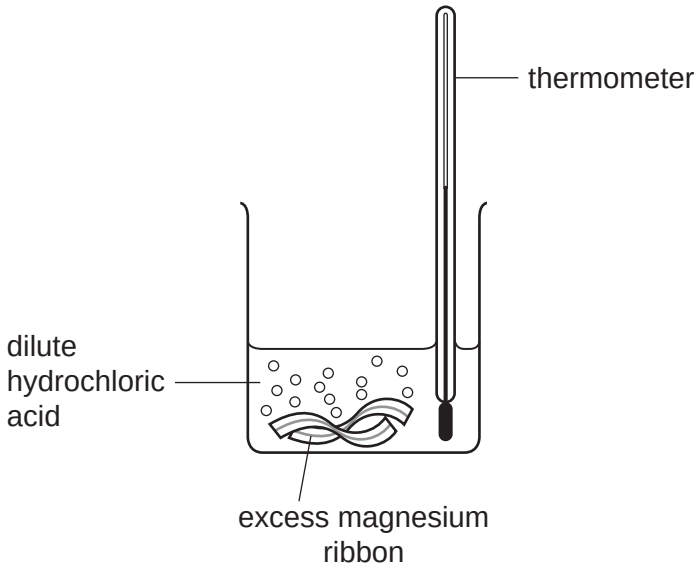


Fig. 4.1

The student observed that a gas was given off and that the temperature of the mixture increased.

(a) (i) Write the balanced symbolic chemical equation for the reaction between magnesium and dilute hydrochloric acid.

.....

[3]

(ii) Explain why the increase in temperature of the mixture is evidence that a chemical change may have occurred.

.....

.....

.....

[2]

(b) The student then set up the apparatus shown in Fig. 4.2.

She investigated the effect of changing temperature on the rate of reaction between magnesium ribbon and dilute hydrochloric acid.

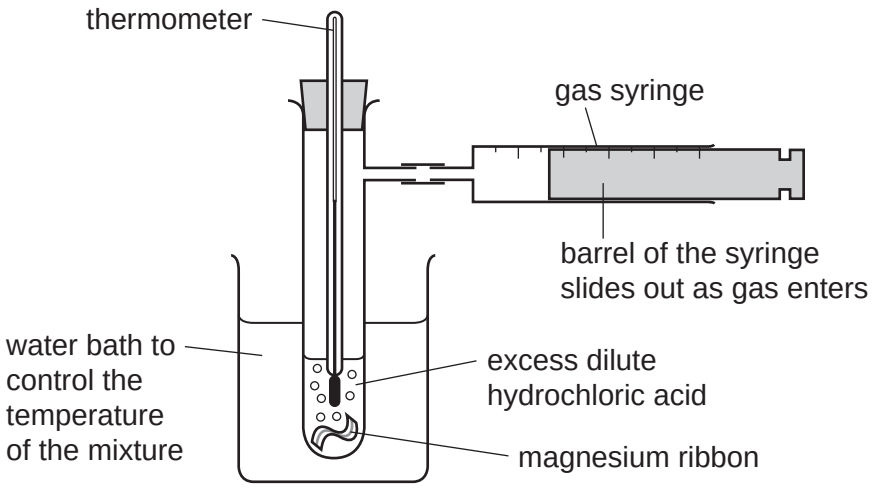


Fig. 4.2

In each experiment, the student timed how long it took for 25.0 cm^3 of gas to collect in the gas syringe.

Some of her measurements are shown in Table 4.1.

Table 4.1

temperature / °C	mass of magnesium / g	acid concentration / mol per dm^3	time to collect 25.0 cm^3 gas / s
10	0.5	1.0	83
22	0.5	1.0	38
32	0.5	1.0	19
40	0.5	1.0	10

(i) Calculate the average rate at which gas was produced at 40 °C.

Show your working.

..... cm^3 / s [1]

(ii) State and explain, in terms of the motion of particles, the effect of changing temperature on rate of reaction.

For Examiner's Use

.....

.....

.....

.....

..... [3]

For Examiner's Use

5 **(a)** Visible light and γ-(gamma) radiation are two regions of the electromagnetic spectrum.

(i) State the speed, in km / s, of all electromagnetic waves when travelling through a vacuum.

..... km / s [1]

(ii) Name a region of the electromagnetic spectrum that is used in remote control devices for televisions.

..... [1]

(iii) State **one** way in which the waves in different regions of the electromagnetic spectrum differ from each other.

..... [1]

(b) **Three** of the following statements are true. Tick the correct statements.

Both α-(alpha) radiation and β-(beta) radiation pass easily through the body. ☐

α-radiation damages cells in a very localised area of the body. ☐

Ionisation does not always kill cells – sometimes it causes them to mutate. ☐

Cancer occurs when a large number of cells are killed. ☐

The dose of radiation received depends on the length of exposure. ☐ [2]

(c) Fig. 5.1 shows how the activity of a radioactive isotope varies with time.

For Examiner's Use

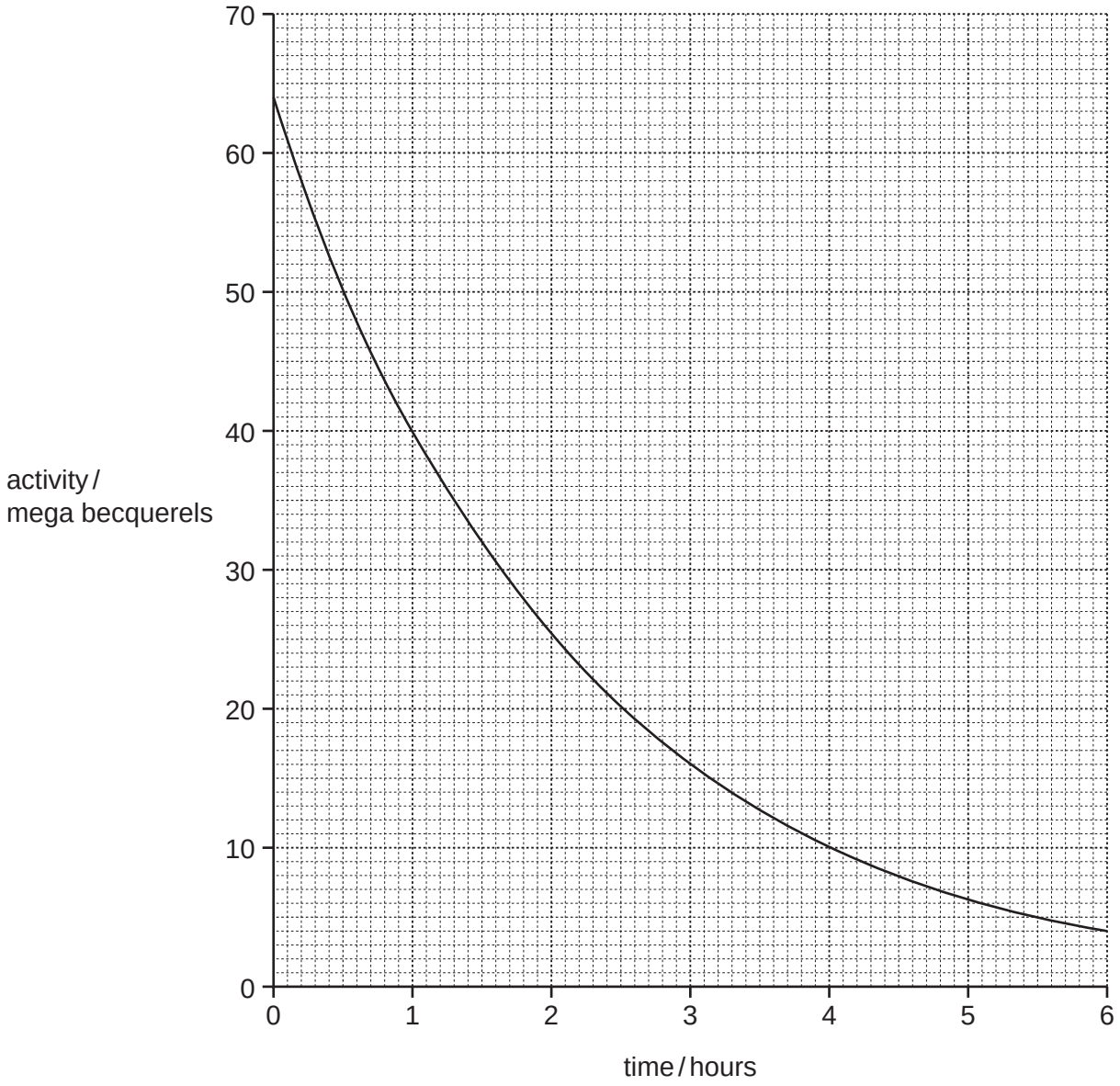


Fig. 5.1

Use Fig. 5.1 to estimate the half-life of this radioactive isotope. Give your answer in minutes.

Show your working.

..... minutes [2]

(d) Table 5.1 shows the half-life and type of radiation given out by four different radioactive isotopes.

Table 5.1

radioactive isotope	half-life / days	radiation given out
bismuth-210	5.0	β
polonium-210	138.0	α and γ
radon-222	3.8	α
iodine-131	8.0	β and γ

(i) A sample of each isotope has the same count rate on day 1. Which sample will have the highest count rate on day 30?

Explain your answer.

isotope ..... because .....

..... [1]

(ii) Which isotopes in Table 5.1 give out radiation which is the most ionising?

Explain your answer.

isotopes ..... and .....

because .....

..... [1]

(e) A radioactive source has a half-life of 6 hours. For which of the following uses might this source be suitable?

Explain your answer.

A to monitor the thickness of paper as it is made in a factory.

B to inject into a person as a medical tracer.

C to make a smoke alarm work.

use(s) .....

explanation .....

.....

..... [3]

For Examiner's Use

6 Fig. 6.1 shows a fetus and the placenta, through which it obtains oxygen and nutrients from the mother's blood.

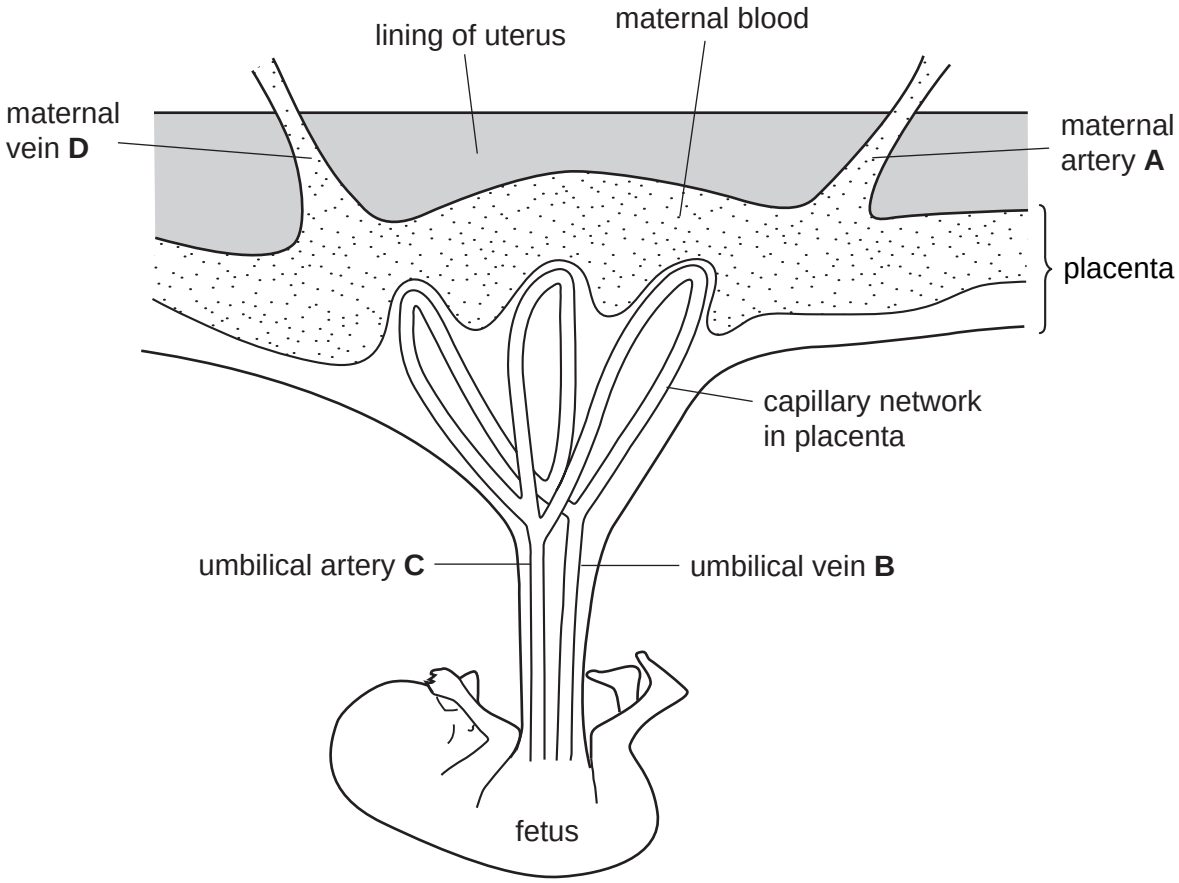


Fig. 6.1

(a) Using your knowledge of arteries and veins, draw arrows on Fig. 6.1 to show the direction of blood flow in vessels **A**, **B**, **C** and **D**. [2]

(b) Inside the placenta, the mother's blood is brought close to the fetus's blood. This allows substances to move between the mother and the fetus.

(i) Name **one** substance that passes from the fetus's blood to the mother's blood.

..... [1]

(ii) Name **two** useful substances, other than oxygen, that pass from the mother's blood to the fetus's blood.

1 ..... 2 ..... [2]

(c) Oxygen passes from the mother's blood to the fetus's blood in the placenta.

(i) Describe how oxygen is carried in the mother's blood.

.....

.....

..... [2]

(ii) In an adult, oxygen enters the blood from the alveoli in the lungs.

Table 6.1 shows information about the gas exchange surface in the lungs and in the placenta. (1 μm = 0.001 mm)

Table 6.1

feature	lungs	placenta
distance across the surface / μm	0.5	3.5
total surface area / m^2	55	16
rate of blood flow / cm^3 per minute	5000	600 (mother's side) 300 (fetus's side)

Explain why more oxygen can be absorbed per minute across the lungs than across the placenta.

Use your knowledge of gas exchange surfaces, and the information in Table 6.1, in your answer.

.....

.....

.....

.....

.....

.....

..... [4]

7 **(a)** Explain briefly why copper is sometimes found uncombined in the Earth's crust but metals like sodium and magnesium are never found uncombined.

.....

.....

..... [2]

(b) Fig. 7.1 shows a simple diagram of the structure of bronze.

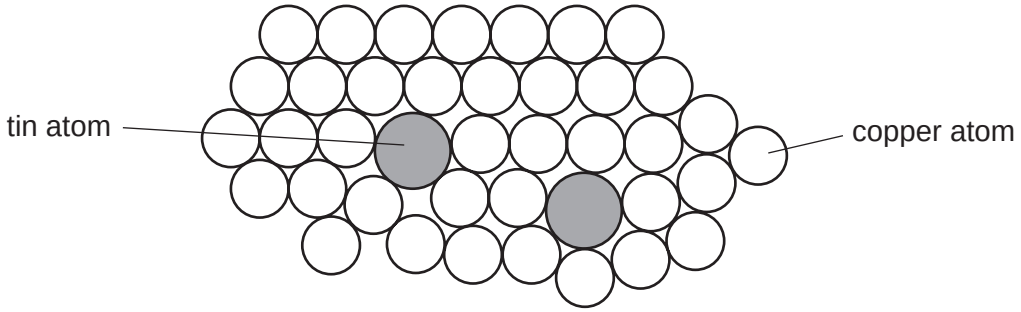


Fig. 7.1

(i) State the general name of materials such as bronze.

..... [1]

(ii) Predict and explain briefly whether bronze would be a harder or a softer material than copper.

prediction .....

.....

.....

..... [2]

(iii) Suggest, with a reason, whether bronze should be described as a mixture or as a compound.

.....

.....

..... [1]

(c) Fig. 7.2 shows two electrolysis processes (cells) connected in series with a d.c. electrical power supply.

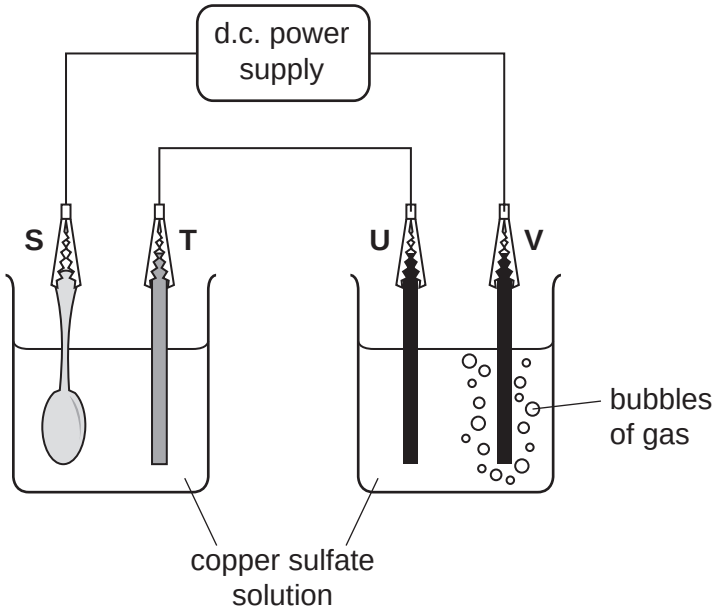


Fig. 7.2

Electrode **S** is a steel spoon which is being electroplated with a thin layer of metallic copper.

Electrodes **U** and **V** are made of carbon in the form of graphite.

The electrolyte in both processes is aqueous copper sulfate, which contains copper ions, Cu^{2+} and sulfate ions, SO_4^{2-}.

(i) Describe and explain, in terms of ions, electrons and atoms, what happens to cause a layer of copper atoms to build up on the surface of electrode **S**.

.....

.....

.....

.....

..... [4]

(ii) Name a gas that is contained in the bubbles rising from the surface of electrode **V**.

..... [1]

(iii) Electrode **T** is made of a piece of copper which shows no visible change during the time that electrode **S** is being electroplated.

A student knows, however, that electrode **T** slowly dissolves.

Suggest how the student could obtain experimental evidence that some of the copper in electrode **T** had dissolved.

.....

.....

..... [2]

For Examiner's Use

8 Fig. 8.1 shows a washing machine. When the door is closed and the machine is switched on, an electric motor rotates the drum and clothes.

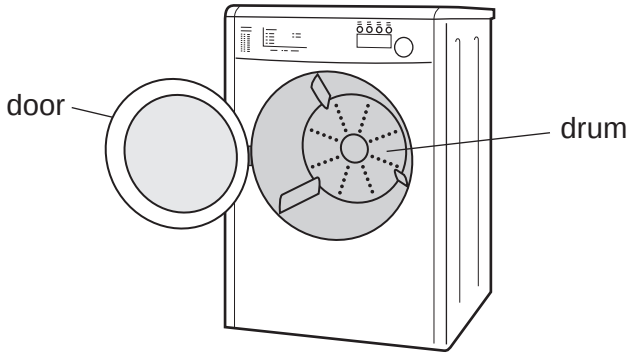


Fig. 8.1

(a) The instruction booklet for the washing machine contains this information.

wash cycle	average power during wash cycle / kW	time taken to run cycle / minutes
fast	1.1	40
cool	1.2	90
hot	1.5	110

(i) Use the information to calculate the energy transferred in joules to the washing machine during the **fast** wash cycle.

State the formula that you use and show your working.

formula

working

..... J [3]

For Examiner's Use

(ii) Explain why reducing the amount of energy used by washing machines could reduce the amount of carbon dioxide emitted into the atmosphere.

.....

.....

.....

.....

.....

..... [2]

(b) (i) A current of 3 A passes through the heating element when the voltage across it is 220 V.

Calculate the resistance of the heating element.

State the formula that you use and show your working.

formula

working

..... [2]

(ii) The heating element uses this current for 12 minutes.

Calculate the electric charge which passes through the heating element in this time.

State the formula that you use and show your working.

formula

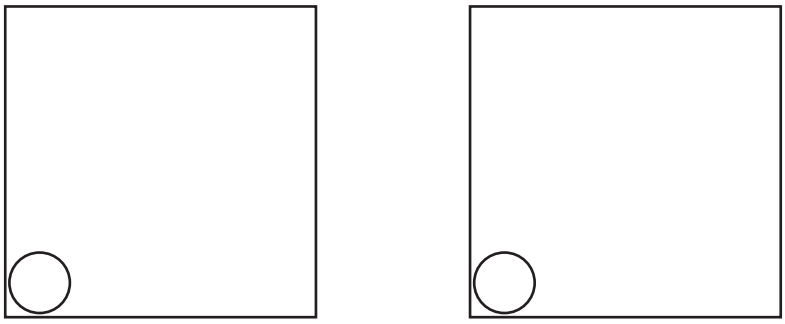
working

..... [2]

(c) Inside the washing machine, some of the water evaporates when the washing machine is being used.

(i) During evaporation, water changes state from liquid to gas.

Complete the diagrams to show the arrangement of particles in a liquid and in a gas.



liquid gas

[3]

(ii) Explain, in terms of particles, the process of evaporation.

.....

.....

.....

..... [3]

9 Fig. 9.1 shows a pitcher plant, which grows in Malaysia and Indonesia.

For Examiner's Use

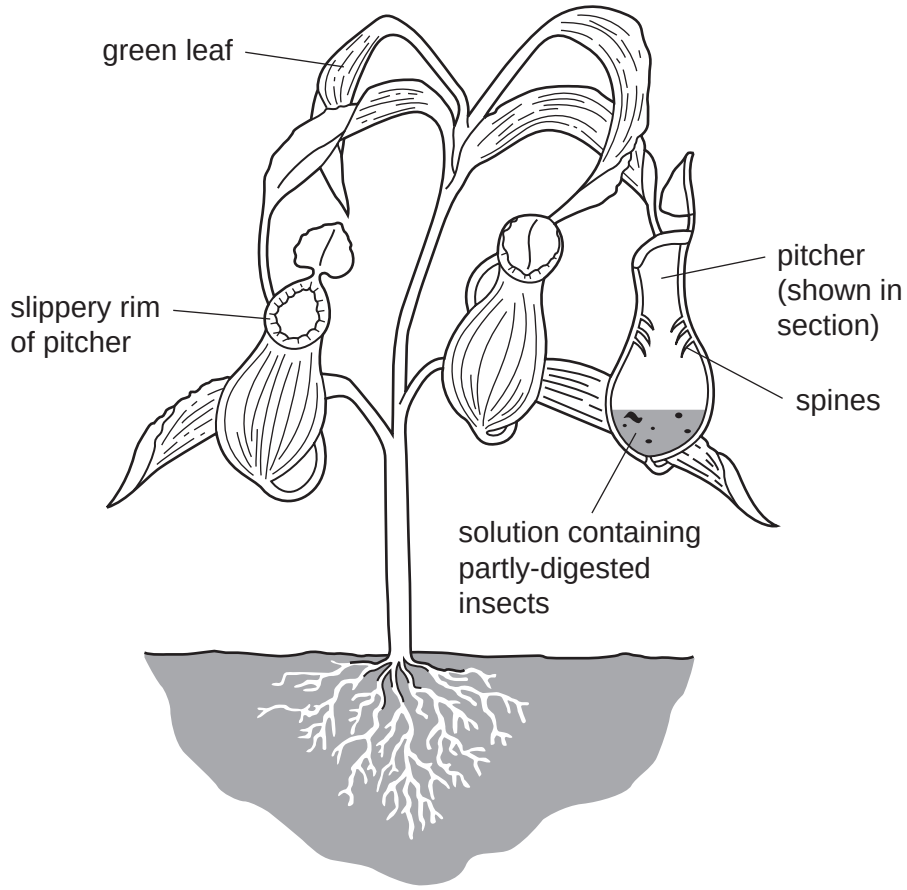


Fig. 9.1

(a) The leaves of pitcher plants carry out photosynthesis, using carbon dioxide and water to make carbohydrates. They obtain carbon dioxide and water in the same way as other plants.

(i) Describe how the leaves obtain carbon dioxide.

.....

.....

.....

..... [3]

(ii) Describe how the leaves obtain water.

.....

.....

.....

..... [3]

(b) Pitcher plants grow where the concentration of nitrate ions in the soil is very low. Most plants need nitrate ions to make amino acids and proteins.

Pitcher plants use a different way of obtaining amino acids. They trap insects in their pitchers, and produce a solution that digests the proteins in the insects' bodies.

(i) Define the term *digestion*.

.....

.....

..... [2]

(ii) Suggest what is present in the solution that the pitcher plant produces inside its pitchers, to enable digestion to take place.

.....

.....

..... [2]

(c) A scientist investigated why insects visit the pitchers.

She took several identical Petri dishes.

- She placed a piece of the rim of a pitcher, *or* a small amount of solution from inside the pitcher *or* water, on one side of the dish.
- She put a small amount of water on the other side, as shown in Fig. 9.2.
- She then placed either an ant or a fruit fly in the centre of the dish. She recorded which side of the dish the insect moved to.

She repeated this 19 more times with each type of insect, using a different insect each time.

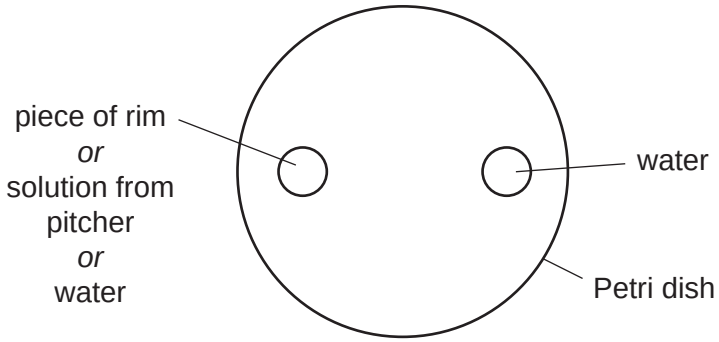


Fig. 9.2

Table 9.1 shows her results.

For Examiner's Use

Table 9.1

substance on left side of dish	substance on right side of dish	insects	number of insects that moved to each side	
			left	right
piece of rim	water	ants	16	4
		fruit flies	14	6
solution from pitcher	water	ants	4	16
		fruit flies	8	12
water	water	ants	10	10
		fruit flies	9	11

(i) Suggest why the scientist placed water on both sides of some dishes.

.....

..... [1]

(ii) Use information in Table 9.1 to describe how the responses of the insects to a stimulus help them to avoid being caught in the pitchers.

.....

.....

..... [1]

(iii) Pitcher plants have several features that help them to catch insects in their pitchers.

Use information in Fig. 9.1 and Table 9.1 to explain how they do this.

.....

.....

.....

.....

..... [3]

For Examiner's Use

10 (a) When wood is burnt, a solid material known as wood ash remains.

Wood ash contains calcium carbonate and potassium compounds which can be used to improve the quality of soil.

(i) Explain briefly how calcium carbonate and potassium compounds could improve the quality of soil.

calcium carbonate .....

.....

.....

.....

potassium compounds .....

.....

.....

..... [3]

(ii) The chemical formula of potassium carbonate is K_2CO_3.
Potassium is in Group 1 of the Periodic Table.

Predict and explain the formula and charge of the carbonate ion.

Show your working.

..... [2]

For Examiner's Use

(b) Soil quality is also improved by the addition of nitrogen compounds such as ammonium nitrate. Nitrogen compounds are made industrially using ammonia, NH_3, which is produced from nitrogen and hydrogen in the Haber process.

Fig. 10.1 shows a simplified flow diagram of part of the Haber process.

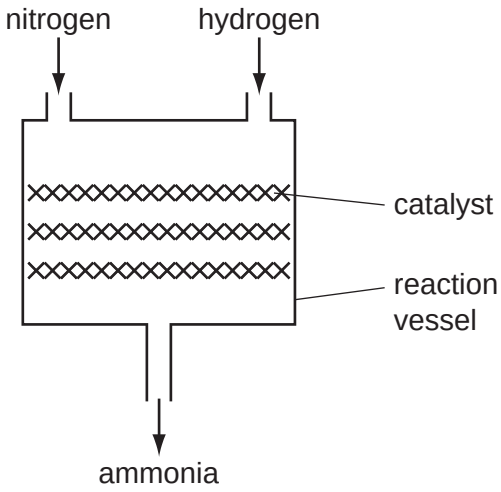


Fig. 10.1

(i) Name the main substance in the catalyst shown in Fig. 10.1.

.....[1]

(ii) Explain briefly why a catalyst is required in the reaction vessel.

.....

.....[1]

(iii) Name the substance that neutralises ammonia to produce ammonium nitrate.

.....[1]

11 **(a)** Complete the graph in Fig. 11.1 to show how enzyme activity is affected by temperature. You should include a scale on the 'temperature' axis.

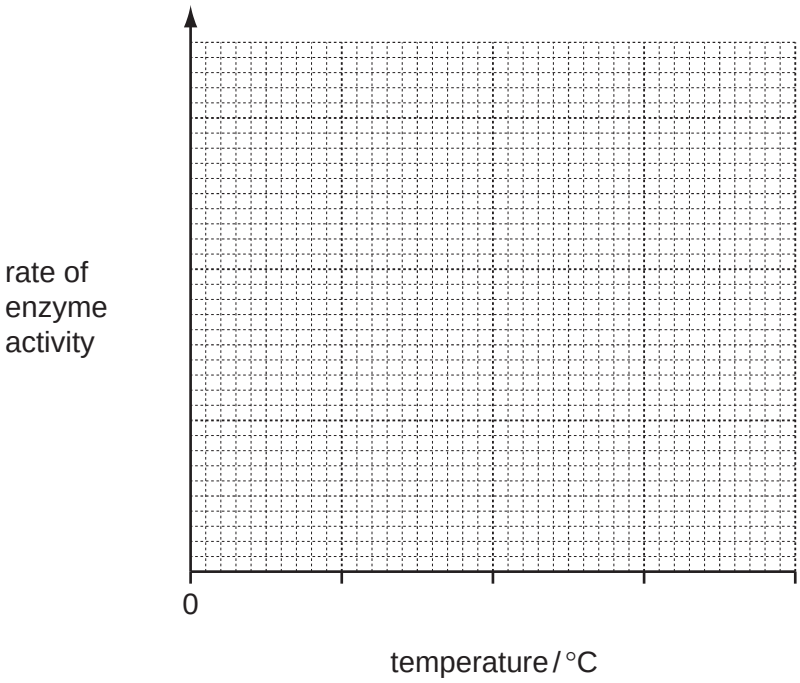


Fig. 11.1

[3]

(b) The internal body temperature of a human is kept constant, allowing enzymes to work efficiently. Fig. 11.2 outlines how receptors and effectors are involved in this process.

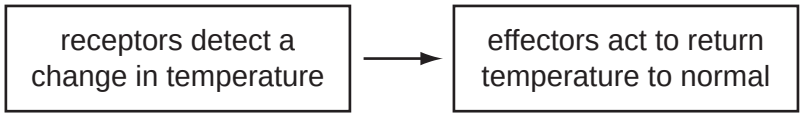


Fig. 11.2

(i) State **one** place in the body where receptors detect a change in body temperature.

..... [1]

(ii) Explain how the muscles can help to return a low body temperature to normal.

.....

.....

..... [2]

(iii) This control mechanism involves negative feedback.

Explain what is meant by the term *negative feedback*.

.....

.....

..... [2]

For Examiner's Use

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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 †															

*58-71 Lanthanoid series	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
†90-103 Actinoid series	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

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.).