



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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NUMBER

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CO-ORDINATED SCIENCES

0654/21

Paper 2 (Core)

October/November 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 **31** printed pages and **1** blank page.



1 Sodium chloride is obtained from underground deposits in the Earth's crust or from solutions such as sea water.

(a) (i) Explain why the Earth's crust contains the compound sodium chloride and not the uncombined elements sodium and chlorine.

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

(ii) State **one** difference between a compound and an element.

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

(iii) Describe how crystals of sodium chloride could be obtained from a salt solution.

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

(b) (i) Explain the following statements in terms of protons and electrons.

Atoms do **not** have an overall electrical charge.

.....
.....

A potassium ion, K^+ , has a single positive electrical charge.

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

(ii) The chemical formula of the compound calcium nitride is Ca_3N_2 .

Explain the meaning of the numbers in this formula.

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

- (c) Fig. 1.1 shows apparatus used to separate the element lead from the compound lead bromide.

For
Examiner's
Use

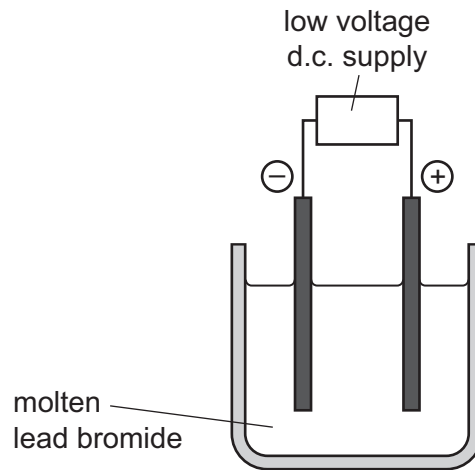


Fig. 1.1

- (i) Name the process shown in Fig. 1.1.

..... [1]

- (ii) Explain why an orange-coloured gas is observed rising from the molten lead bromide during the process.

.....

.....

..... [2]

2 Fig. 2.1 shows the inside of a refrigerator.

The temperature inside the freezing compartment is $-20\text{ }^{\circ}\text{C}$ and the temperature in the rest of the refrigerator is $+5\text{ }^{\circ}\text{C}$.

For
Examiner's
Use

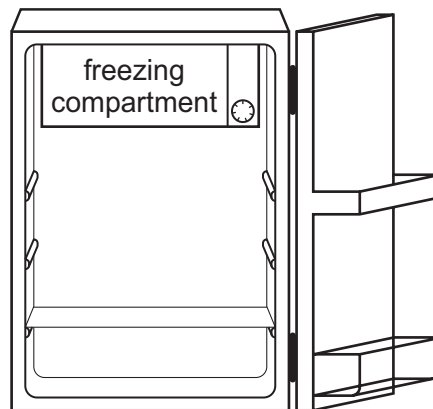


Fig. 2.1

(a) The air in the refrigerator is cooled by convection.

Draw **one** arrow on Fig. 2.1 to show the movement of the air cooled by the freezing compartment. [1]

(b) The volume of air in the refrigerator is 0.15 m^3 .

The density of air is 1.26 kg/m^3 .

Calculate the mass of air in the refrigerator.

State the formula that you use and show your working.

formula

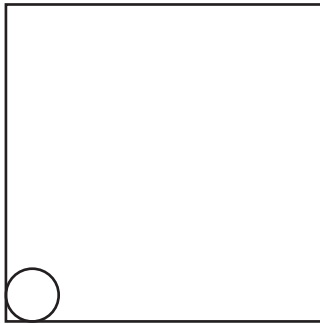
working

..... kg [2]

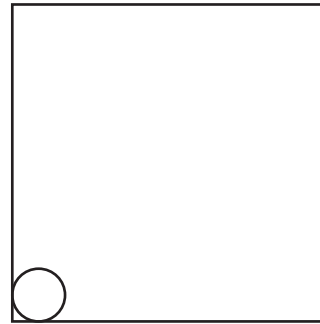
- (c) (i) Complete the diagrams to show the arrangement of water molecules in solid ice and in liquid water.

For
Examiner's
Use

One molecule has been drawn for you in each box. Each diagram should contain at least twelve water molecules.



solid ice



liquid water

[2]

- (ii) Each sentence describes either a solid, a liquid or a gas.

In the right hand column write the letter **S** for solid, **L** for liquid or **G** for gas to match the description.

description	S, L or G
It cannot flow.	
It cannot transfer heat by convection.	
It contains particles which are widely separated.	
It expands the most when heated.	
It fills a closed container.	
It has a fixed volume but not a fixed shape.	

[3]

- 3 The concentration of glucose in the blood does not normally vary much. The hormone adrenaline causes blood glucose concentration to increase.

(a) (i) Define the term *hormone*.

.....

 [2]

(ii) State **one** effect of adrenaline on the body, other than increasing the concentration of glucose in the blood.

..... [1]

- (b) Researchers investigated how adding fibre to foods affected the concentration of glucose in the blood after eating.

Fig. 3.1 shows the results that they obtained for two different types of cornflakes. Cornflakes contain a lot of starch.

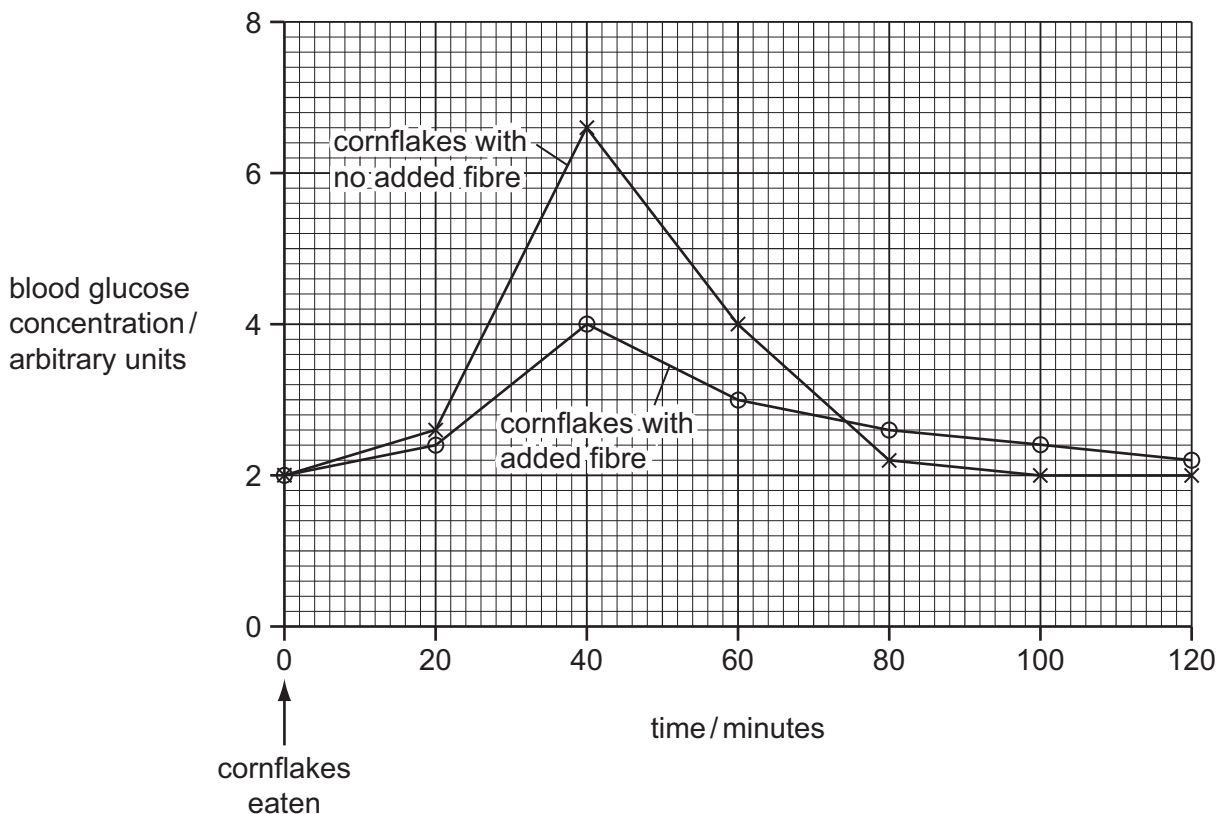


Fig. 3.1

Use the information in Fig. 3.1 to help you to answer the following questions.

For
Examiner's
Use

- (i) Describe how the blood glucose concentration changed after eating cornflakes with no added fibre.

.....
.....
.....
.....
..... [3]

- (ii) Suggest explanations for the changes in blood glucose concentration.

.....
.....
.....
..... [3]

- (iii) Describe how adding fibre to the cornflakes affected the changes in blood glucose concentration after eating.

.....
.....
.....
..... [3]

- (c) Outline **one** other way in which fibre in the diet affects health.

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

- 4 Fig. 4.1 shows a period in the Periodic Table. Four elements are represented by letters which are not their usual chemical symbols.

For
Examiner's
Use

group number	1	2	3	4	5	6	7	0
	W	X					Y	Z

Fig. 4.1

- (a) (i) State and explain which of the elements **W**, **X**, **Y** and **Z** are poor conductors of electricity.

element(s)

explanation

..... [2]

- (ii) One of the elements shown in Fig. 4.1 is **not** expected to form a compound with any of the others.

State and explain which **one** of the elements this is.

element

explanation

..... [2]

- (b) Fig. 4.2 shows the melting points of four metallic elements from the same group of the Periodic Table.

For
Examiner's
Use

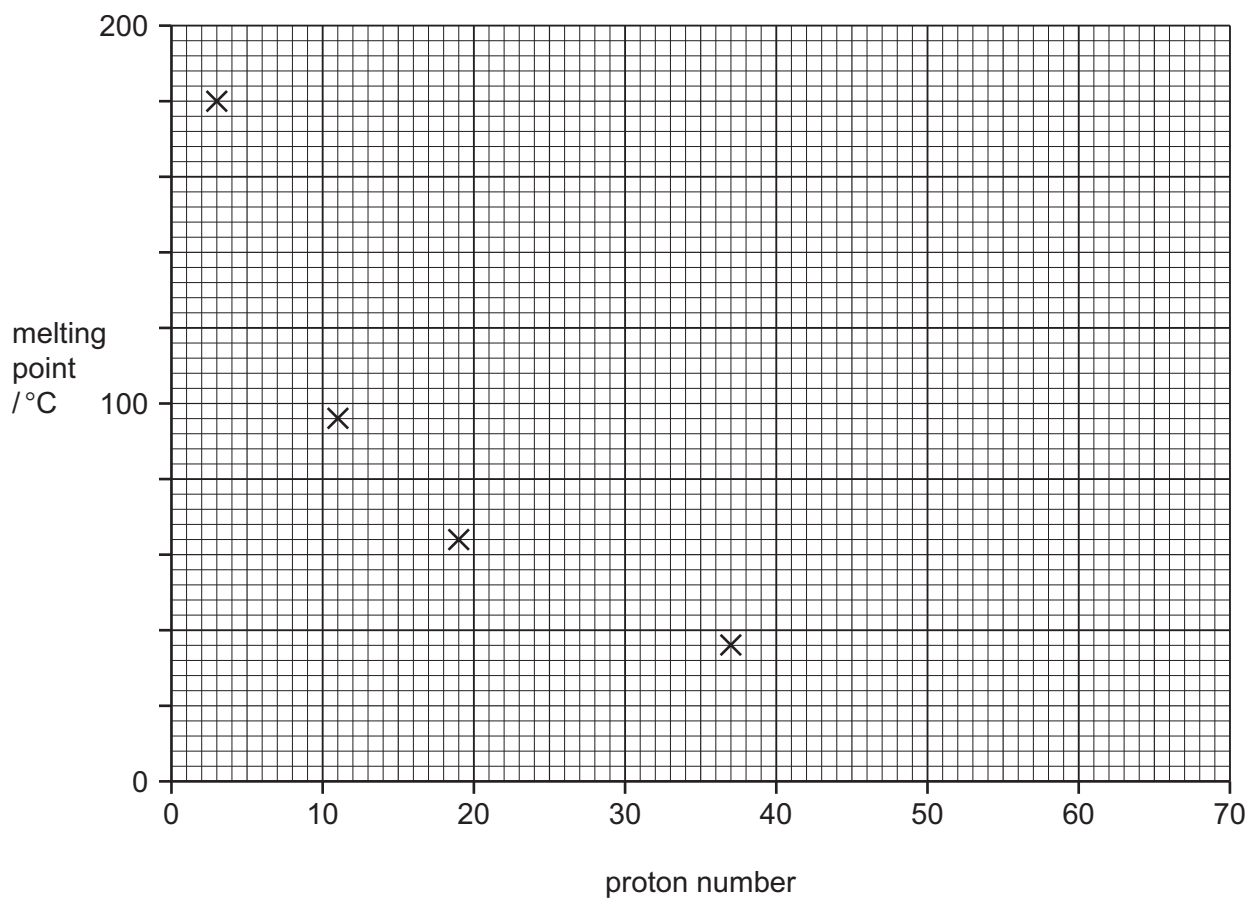


Fig. 4.2

- (i) State the number of the group that contains the elements whose melting points are shown in Fig. 4.2.

Explain your answer briefly.

group number

explanation

..... [2]

- (ii) Use the Periodic Table on page 32 to name the element in Fig. 4.2 that has the lowest melting point.

..... [1]

(c) Many elements combine with oxygen to form oxides.

- (i) A student is given a soluble white solid which she knows is either an oxide of a metal or an oxide of a non-metal.

Describe how the student can use the apparatus and materials shown in Fig. 4.3 to find out whether the solid is a metal oxide or a non-metal oxide.

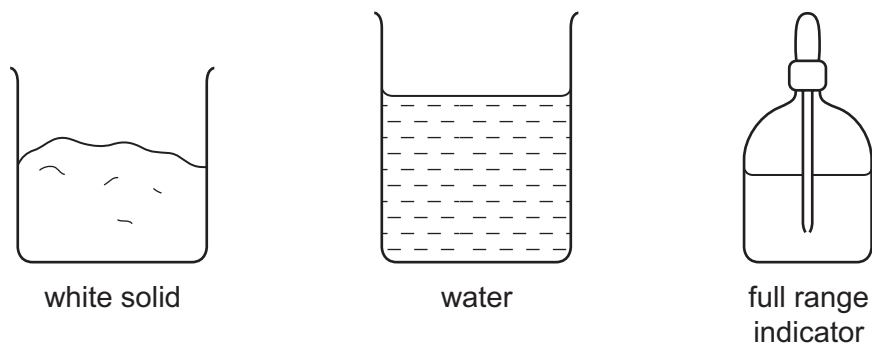


Fig. 4.3

.....

 [2]

- (ii) Copper oxide is a black solid which is insoluble in water.

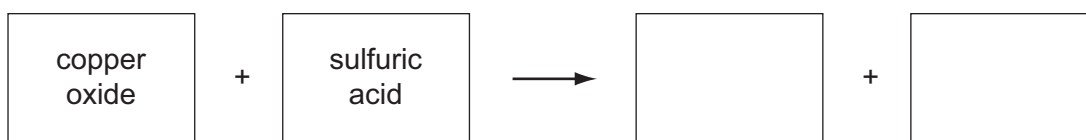
The student added excess dilute sulfuric acid to some copper oxide, and warmed the mixture.

The copper oxide disappeared and a clear blue solution remained.

State **one** observation which shows that a chemical change has occurred.

.....
 [1]

- (iii) Complete the **word** chemical equation for the reaction between copper oxide and dilute sulfuric acid.



[2]

Please turn over for Question 5.

5 Fig. 5.1 shows a solar-powered vehicle which travelled 3000 km in 30 hours.

For
Examiner's
Use

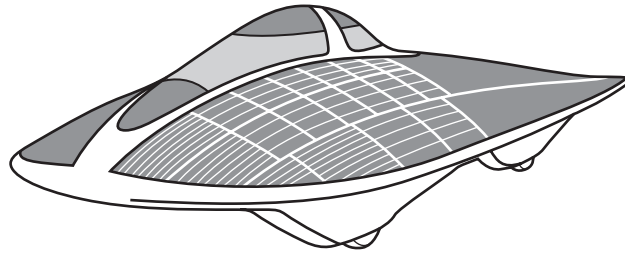


Fig. 5.1

(a) Calculate the average speed of the vehicle in km/hr.

State any formula that you use and show your working.

formula

working

..... km/hr [2]

(b) Fig. 5.2 shows a speed/time graph for part of the journey.

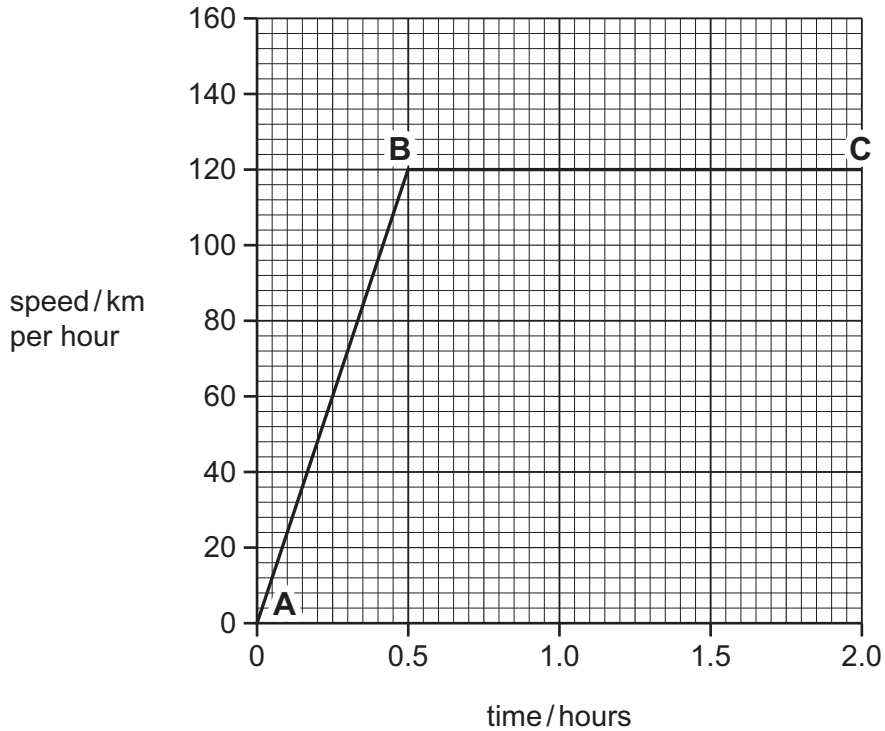


Fig. 5.2

(i) Describe the movement of the vehicle between **A** and **B**.

..... [1]

(ii) Calculate the distance travelled between **B** and **C**.

State the formula that you use and show your working.

formula

working

..... km [2]

(c) Fig. 5.3 shows the energy flow diagram for the solar-powered vehicle.

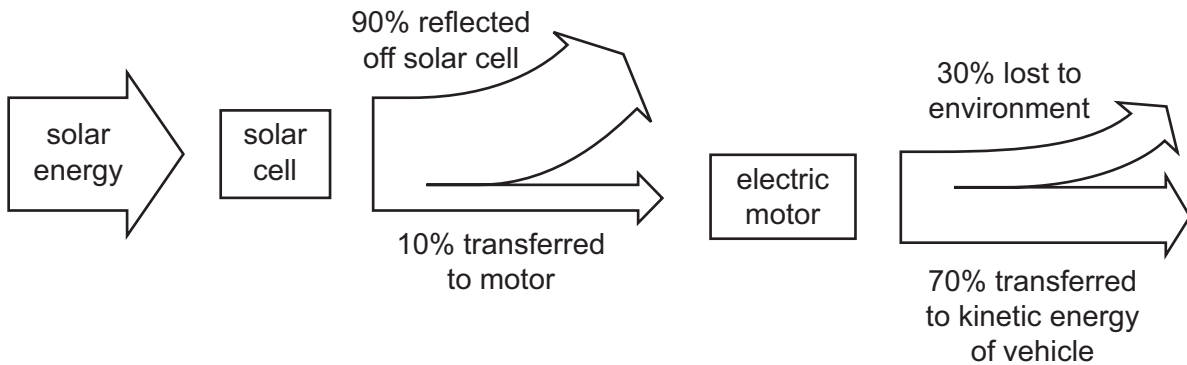


Fig. 5.3

(i) During part of the journey, the **solar cell** receives 1 000 000 joules of solar energy.

Calculate the number of joules transferred as kinetic energy to the **vehicle**.

Show your working.

..... J [2]

(ii) Write down the useful energy change which occurs in an electric motor.

..... energy to energy [1]

(d) Solar energy is a renewable energy source.

(i) Name **one** other renewable energy source.

..... [1]

(ii) Describe **one** advantage to the environment of using solar energy as a renewable energy source.

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

(e) The vehicle has mirrors to help the driver see behind him. The driver sees a car in his mirror as shown on Fig. 5.4.

Use Fig. 5.4 to describe **two** characteristics of an image seen in this mirror that are similar to the characteristics of an image seen in a plane mirror.

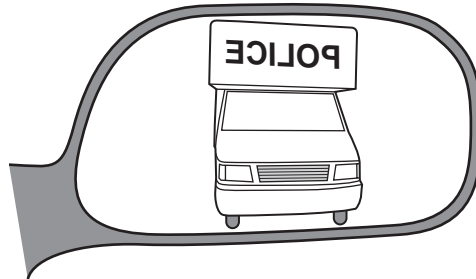


Fig. 5.4

1

2

..... [2]

- (f) Sunlight can be focused onto smaller areas of a solar panel to improve its efficiency.

Fig. 5.5 shows two parallel rays of sunlight being focused by a lens. The lens has a focal length of 5 cm.

Complete the diagram to show the rays of sunlight being focused by the lens.

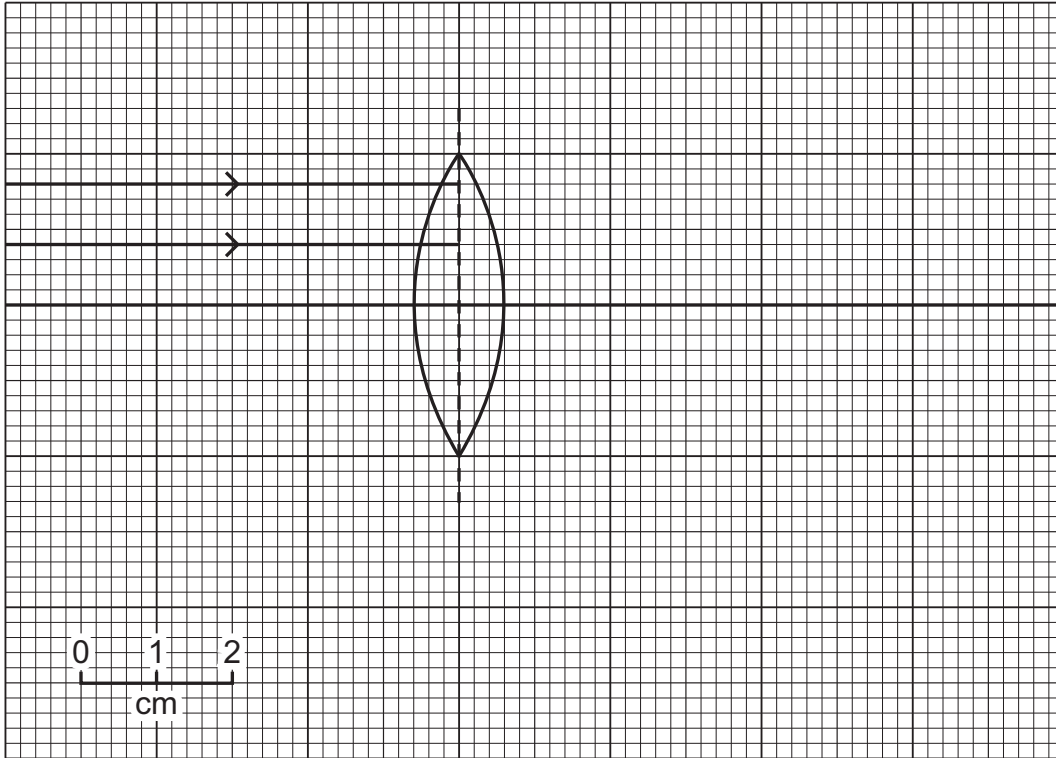


Fig. 5.5

[2]

For
Examiner's
Use

6 Fig. 6.1 shows a section through the heart.

For
Examiner's
Use

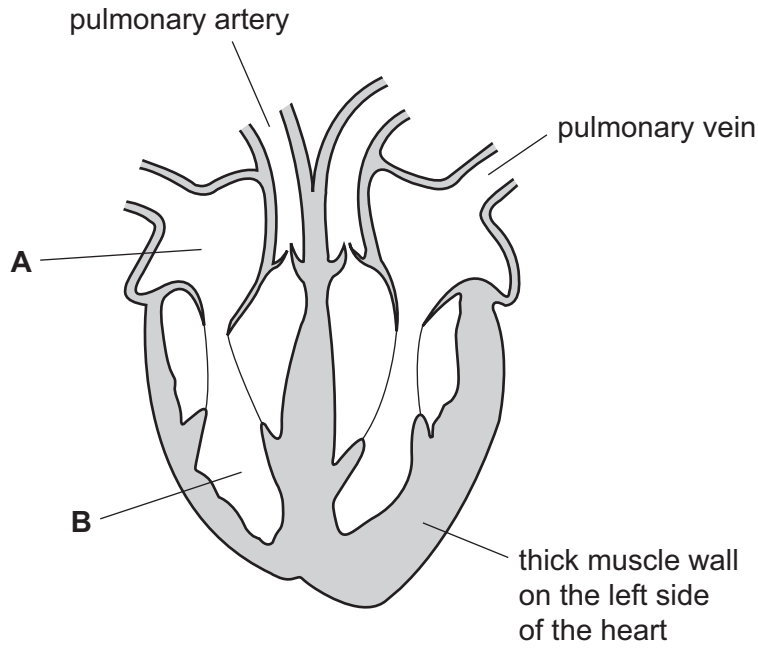


Fig. 6.1

(a) (i) Name the parts labelled **A** and **B**.

A

B [2]

(ii) The walls of the heart are made of muscle.

Explain how this muscle pushes blood out of the heart.

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

(iii) Explain why the muscle wall on the left side of the heart, labelled on Fig. 6.1, is thicker than on the right side.

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

(b) (i) Describe **two** differences between the contents of a pulmonary artery and a pulmonary vein.

1

.....

2

..... [2]

(ii) Describe **two** differences between the structure of the wall of a pulmonary artery and the wall of a pulmonary vein.

1

.....

2

..... [2]

*For
Examiner's
Use*

7 Zirconium is a metallic element found in Period 5 of the Periodic Table.

(a) Zirconium metal is made into several different types of alloy.

State the meaning of the term *alloy*.

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

(b) A large piece of zirconium does not burn in air but zirconium powder burns rapidly, forming zirconium oxide.

(i) Suggest the **word** chemical equation for the reaction that occurs when zirconium burns in air.

..... [1]

(ii) The mass of zirconium oxide formed is greater than the mass of zirconium burned.

Explain this in terms of atoms.

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

(iii) Suggest why zirconium powder burns rapidly but a large piece of zirconium does not.

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

(c) Fig. 7.1 shows information about five different types of zirconium atoms.

For
Examiner's
Use

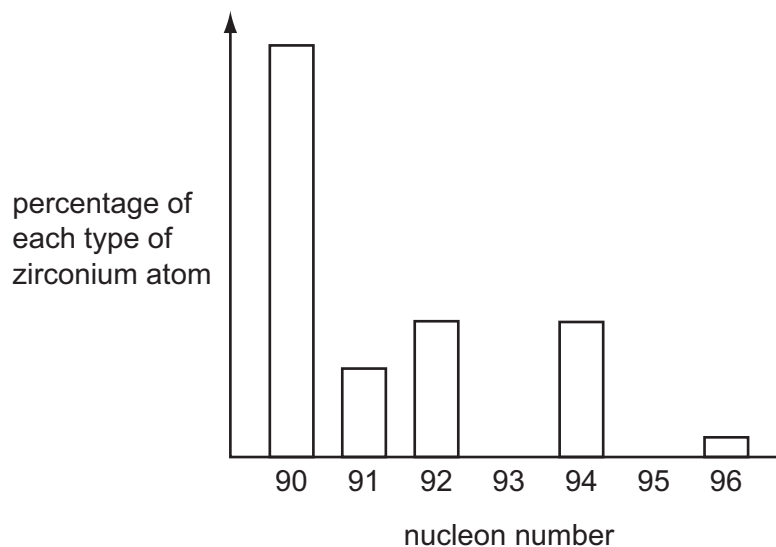


Fig. 7.1

(i) Use the Periodic Table on page 32 to find the proton number of zirconium.

proton number of zirconium = [1]

(ii) Complete Table 7.1 showing the numbers of protons and neutrons in two of the zirconium atoms in Fig. 7.1.

Table 7.1

atom	number of protons	number of neutrons
Zr-90		
Zr-96		

[2]

(iii) State the scientific word that is used to refer to atoms of the same element that have different numbers of neutrons.

..... [1]

8 (a) Complete Table 8.1 below by drawing the circuit symbol for each electrical component.

For
Examiner's
Use

Table 8.1

name of component	circuit symbol
open switch	
resistor	
voltmeter	
fuse	

[2]

(b) Fig. 8.1 shows an electrical hazard.

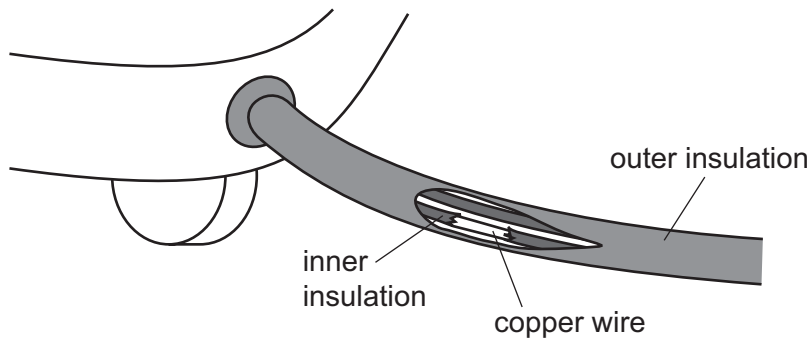


Fig. 8.1

State the hazard.

.....

.....

Explain why this situation is dangerous.

.....

.....

[2]

(c) In the circuit shown in Fig. 8.2 the reading on ammeter A_3 is 0.5 A.

(i) State the current readings on ammeters A_1 and A_2 .

For
Examiner's
Use

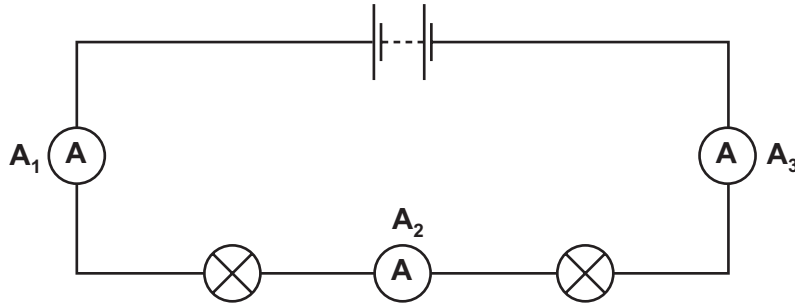


Fig. 8.2

A_1 A

A_2 A

[1]

(ii) Each lamp in the circuit has a resistance of $5\ \Omega$.

Calculate the combined resistance of the two lamps in the circuit.

State the formula that you use and show your working.

formula

working

..... Ω [2]

(d) Fig. 8.3 shows how the resistance of an electrical component in a circuit changes with temperature.

For
Examiner's
Use

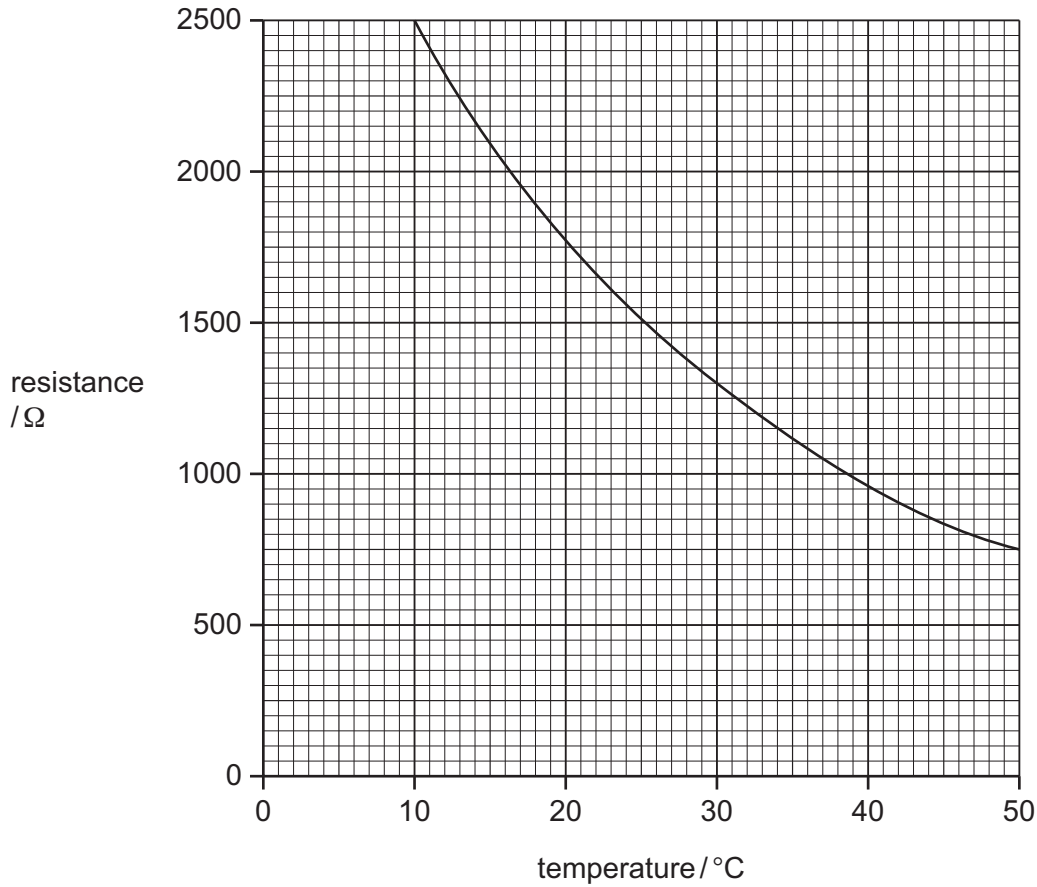


Fig. 8.3

(i) Write down the equation that shows how resistance is related to potential difference and current.

..... [1]

(ii) State the resistance of the component at 30 °C. Ω [1]

(iii) Calculate the current that passes through the component at 30 °C when it is connected to a 12 V power supply.

Show your working.

..... A [2]

Please turn over for Question 9.

- 9 Chinchillas are mammals with thick grey fur. Chinchillas are often kept as pets.

For
Examiner's
Use



People try to breed chinchillas with unusual fur.

- (a) A rare allele of the gene that determines fur colour, **A**, is dominant to the normal allele, **a**. Table 9.1 shows the possible fur colours arising from these two alleles.

Table 9.1

genotype	colour
AA	zygote does not develop
Aa	white
aa	normal grey

- (i) State the biological term for the observed effect produced by the genotype.

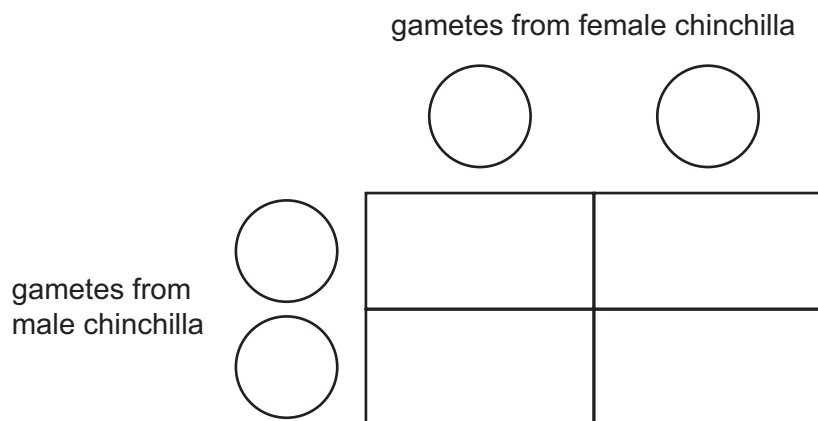
..... [1]

(ii) A breeder has two white chinchillas.

Complete the genetic diagram to show the genotypes of the offspring that would be produced when these two chinchillas are bred together.

genotype of parents and

gametes  and   and 



[3]

(iii) State the ratio of fur colour that you would expect in the offspring resulting from this cross.

Explain your answer.

ratio of normal grey fur : white fur = :

explanation

..... [2]

(b) Wild chinchillas live in rocky places in the Andes mountains, where it gets cold at night.

For
Examiner's
Use

(i) Suggest how the chinchilla's fur can help it to maintain a constant body temperature.

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

(ii) Suggest why almost all the chinchillas found in the wild have normal grey fur colour rather than white fur.

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

10 Ethene, C_2H_4 , is a gaseous, unsaturated hydrocarbon.

(a) Explain the meanings of both words in the term *unsaturated hydrocarbon*.

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

(b) A sample of ethene was bubbled through bromine solution.

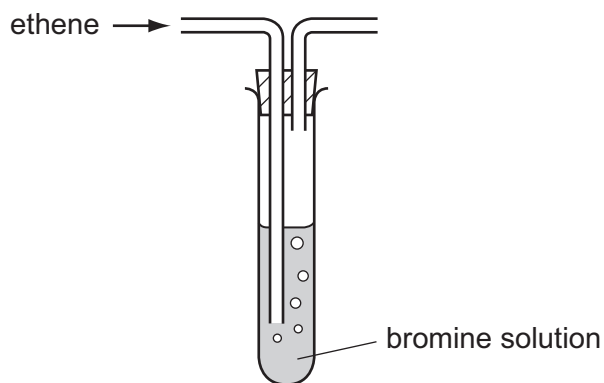


Fig. 10.1

Describe the colour change that is observed when ethene reacts with bromine.

from to [1]

For
Examiner's
Use

- (c) Propane, C_3H_8 , is a gaseous hydrocarbon used as a fuel.

Fig. 10.2 shows a cross-section through a small furnace (kiln) in which items of pottery are being heated by a propane burner. The temperature inside the kiln is $950^\circ C$.

For
Examiner's
Use

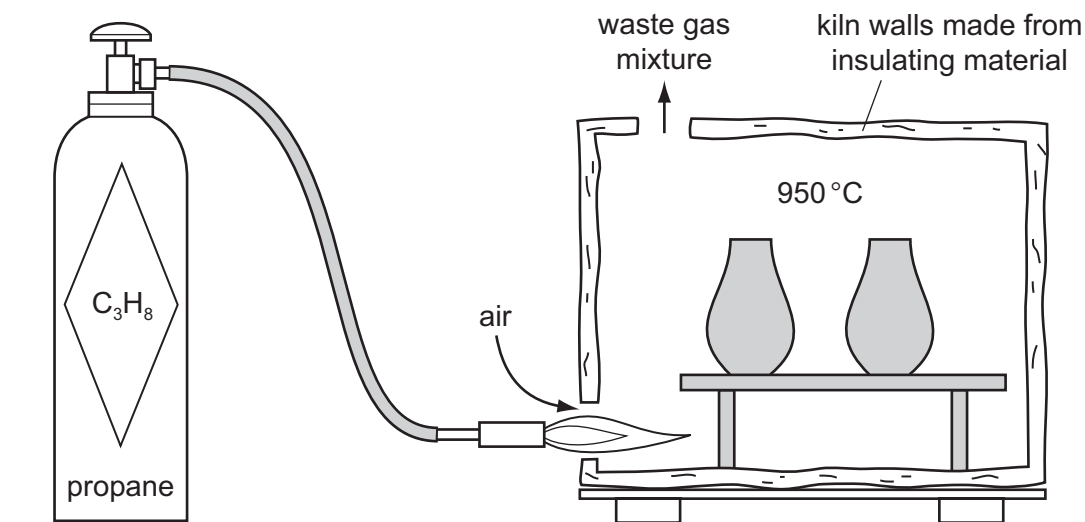


Fig. 10.2

- (i) State which information from Fig. 10.2 shows that the combustion of propane is exothermic.

Explain your answer.

.....

 [2]

- (ii) Explain why the waste gas mixture contains high concentrations of carbon dioxide and water vapour.

.....
 [1]

- (iii) The waste gases may also contain some carbon monoxide.

Suggest a reason for this.

.....
 [1]

- (iv) Explain why it is much safer to use a kiln like the one in Fig. 10.2 outside in the open air.

.....
 [1]

11 X-rays and γ (gamma)–rays are both forms of electromagnetic radiation. They are also both forms of ionising radiation and are used in the treatment of cancer.

For
Examiner's
Use

(a) State the meaning of the term *ionising radiation*.

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

(b) Name the radiation that comes between X-rays and visible light in the electromagnetic spectrum. Give **one** use for this radiation.

radiation

use

..... [2]

(c) (i) Electromagnetic waves are transverse waves. Water waves are also transverse.

Draw a diagram of a transverse wave on the axes below.

Label the amplitude and wavelength on your diagram.



[3]

(ii) Sound waves are **not** transverse waves.

State the type of wave motion demonstrated by sound waves.

..... [1]

12 (a) Fig. 12.1 shows a plant cell.

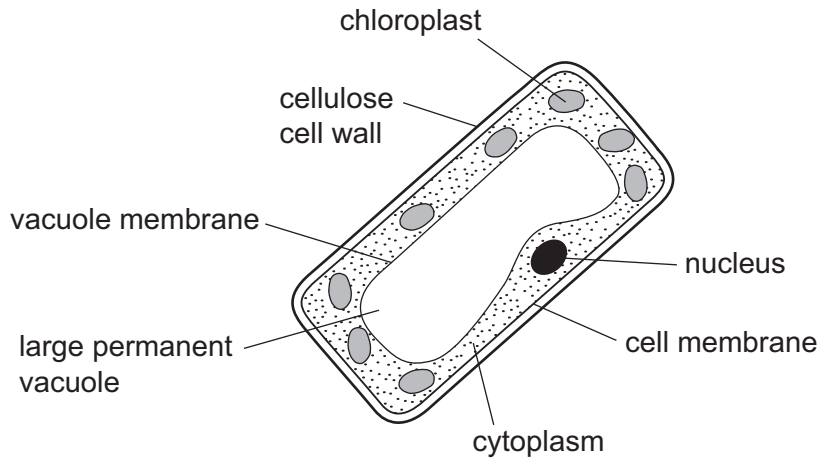


Fig. 12.1

(i) Name the tissue in the leaf in which this type of cell is found.

..... [1]

(ii) Describe how photosynthesis is carried out in this cell.

.....

.....

.....

.....

.....

.....

..... [3]

(b) About one tenth of the Earth's surface is covered by forests in which much photosynthesis takes place.

Explain how extensive deforestation could harm the environment.

.....

.....

.....

.....

.....

..... [3]

DATA SHEET
The Periodic Table of the Elements

		Group																																				
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI																										
		1 H Hydrogen 1										4 He Helium 2																										
7 Li Lithium 3	9 Be Beryllium 4											19 F Fluorine 9																										
23 Na Sodium 11	24 Mg Magnesium 12	5 B Boron 5	6 C Carbon 6	7 N Nitrogen 7	8 O Oxygen 8	9 Ne Neon 10	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 Si Silicon 14	15 P Phosphorus 15	16 S Sulfur 16	17 Cl Chlorine 17	18 Ar Argon 18																								
39 K Potassium 19	40 Ca Calcium 20	27 Al Aluminium 13	28 Si Silicon 14	29 Sc Scandium 21	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	51 In Indium 49	52 Tl Thallium 81	53 I Iodine 53	54 Xe Xenon 54																							
85 Rb Rubidium 37	88 Sr Strontium 38	45 Sc Scandium 21	46 Ti Titanium 22	47 V Vanadium 23	48 Cr Chromium 24	49 Mn Manganese 25	50 Fe Iron 26	51 Co Cobalt 27	52 Ni Nickel 28	53 Cu Copper 29	54 Zn Zinc 30	65 Ga Gallium 31	66 Ge Germanium 32	67 As Arsenic 33	68 Se Selenium 34	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86															
133 Cs Caesium 55	137 Ba Barium 56	89 Y Yttrium 39	90 Zr Zirconium 40	91 Nb Niobium 41	92 Mo Molybdenum 42	93 Tc Technetium 43	94 Ru Ruthenium 44	95 Rh Rhodium 45	96 Pd Palladium 46	97 Ag Silver 47	98 Cd Cadmium 48	106 Pd Palladium 46	107 Pt Platinum 78	108 Au Gold 79	112 Cd Cadmium 48	113 In Indium 49	114 Sn Tin 50	115 Sb Antimony 51	116 Te Tellurium 52	117 I Iodine 53	118 Xe Xenon 54	119 Fr Francium 87	120 Ra Radium 88	121 Ac Actinium 89	122 Th Thorium 90	123 Pa Protactinium 91	124 U Uranium 92	125 Np Neptunium 93	126 Pu Plutonium 94	127 Am Americium 95	128 Cm Curium 96	129 Bk Berkelium 97	130 Cf Californium 98	131 Es Einsteinium 99	132 Fm Fermium 100	133 Md Mendelevium 101	134 No Nobelium 102	135 Lr Lawrencium 103
140 Ce Cerium 58	141 Pr Praseodymium 59	142 Nd Neodymium 60	143 Pm Promethium 61	144 Sm Samarium 62	145 Eu Europium 63	146 Gd Gadolinium 64	147 Tb Terbium 65	148 Dy Dysprosium 66	149 Ho Holmium 67	150 Er Erbium 68	151 Tm Thulium 69	152 Yb Ytterbium 70	153 Lu Lutetium 71	154 Th Thorium 90	155 Pa Protactinium 91	156 U Uranium 92	157 Np Neptunium 93	158 Pu Plutonium 94	159 Am Americium 95	160 Cm Curium 96	161 Bk Berkelium 97	162 Cf Californium 98	163 Es Einsteinium 99	164 Fm Fermium 100	165 Md Mendelevium 101	166 No Nobelium 102	167 Lr Lawrencium 103											

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

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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