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COMBINED SCIENCE**0653/41**

Paper 4 Theory (Extended)

October/November 2024**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.



- 1 (a) Fig. 1.1 shows the female human reproductive system.

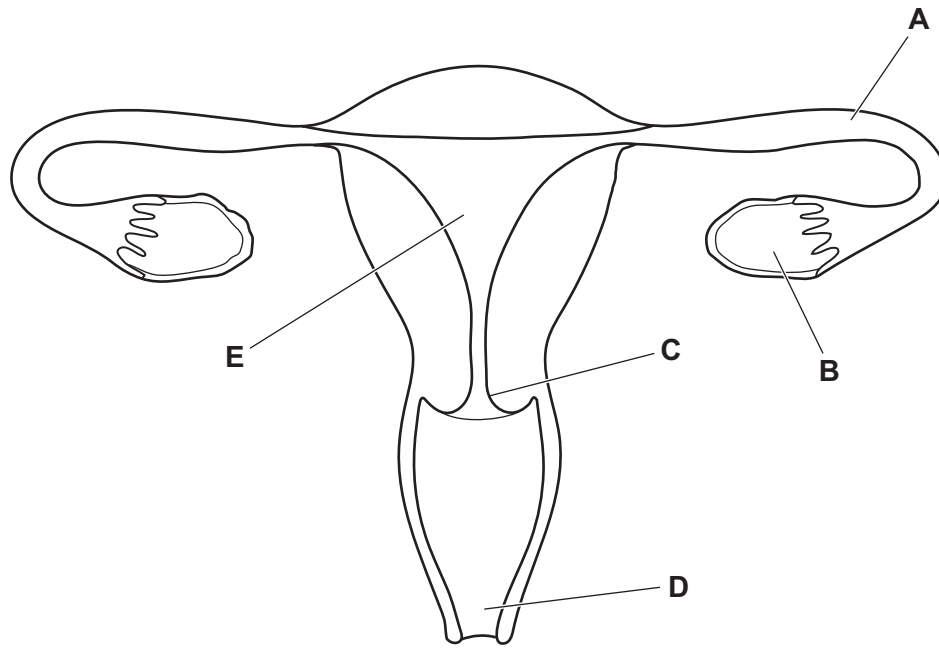


Fig. 1.1

- (i) State the letter in Fig. 1.1 that identifies the part of the female reproductive system:
- where female gametes are made [2]
- that receives the penis during sexual intercourse.

- (ii) During pregnancy, a placenta forms inside the female reproductive system.
- Describe **two** functions of the placenta.

- 1
- 2 [2]

- (b) In the **male** human reproductive system, the penis releases male gametes.

State **two** adaptive features of male human gametes.

- 1
- 2 [2]



(c) Describe **two** differences between fertilisation in humans and fertilisation in plants.

1

.....

2

.....

[2]

(d) Fig. 1.2 shows pollen grains from one plant species.

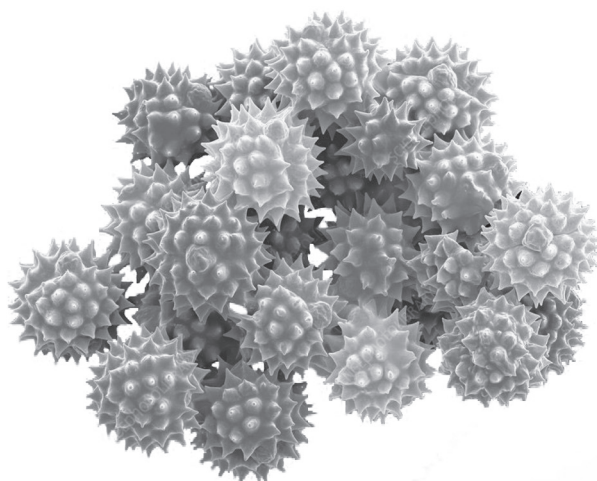


Fig. 1.2

The pollen grains have structural adaptations for pollination by one type of agent.

Identify the type of pollination agent.

Explain your answer using evidence from Fig. 1.2.

pollination agent

explanation

.....

[2]

[Total:10]





2 The position of an element in the Periodic Table is related to its atomic structure.

(a) (i) Explain the positions of sodium, Na, and potassium, K, in the Periodic Table.

Use ideas about atomic structure in your answer.

.....

.....

.....

..... [2]

(ii) State the nucleon number of sodium.

..... [1]

(b) Table 2.1 shows some information about an atom of lithium, Li, and an ion of copper, Cu²⁺.

Complete Table 2.1.

Table 2.1

	proton number	nucleon number	number of protons	number of neutrons	number of electrons
Li atom	3	7			
Cu ²⁺ ion	29	64			

[4]

(c) Copper is a transition element.

(i) Transition elements are shiny, hard metals with high melting points and high boiling points.

State **one** other physical property of transition elements.

..... [1]

(ii) State **two** chemical properties of transition elements that are different to the chemical properties of lithium.

1

2 [2]

[Total: 10]





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- 3 A block of wood has a weight of 24.1 N.

Fig. 3.1 shows the block of wood on a shelf.

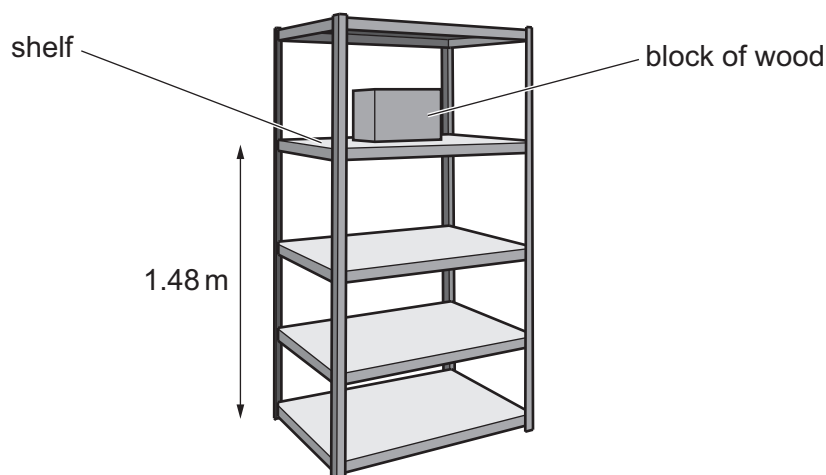


Fig. 3.1

- (a) The mass of the block of wood is 2.45 kg.

Calculate the Earth's gravitational field strength.

Show your working.

Give the units of your answer.

gravitational field strength = ... units [3]

- (b) The block of wood is at a vertical height of 1.48 m above the ground.

Calculate the gravitational potential energy (GPE) of the block of wood.

GPE = ... J [2]





(c) The block of wood has a length of 0.64 m and a width of 0.25 m, as shown in Fig. 3.2.

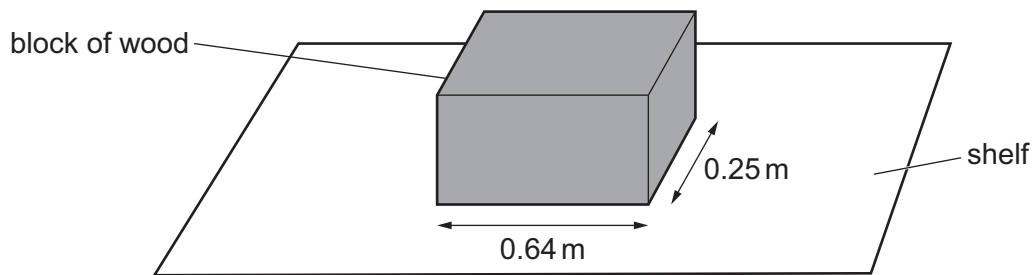


Fig. 3.2

Calculate the pressure exerted by the block of wood on the shelf.

pressure = ... Pa [3]

[Total: 8]





- 4 (a) Fig. 4.1 is a graph showing the effect of humidity on the rate of transpiration in a plant.

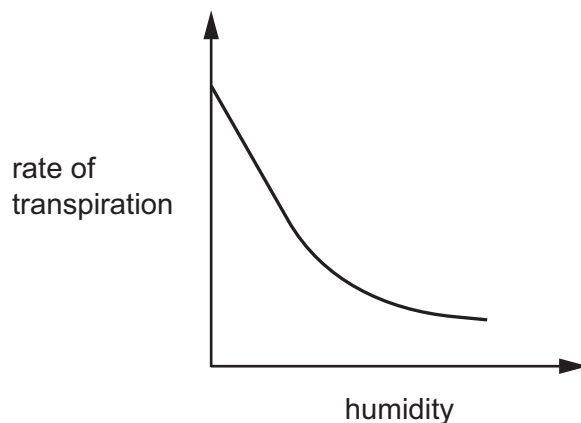


Fig. 4.1

Explain the shape of the graph shown in Fig. 4.1.

.....

.....

.....

.....

..... [3]

- (b) Plants require light for photosynthesis.

Complete the balanced symbol equation for photosynthesis.



[2]



(c) A scientist investigates phototropism in two plant shoots, **A** and **B**.

The scientist covers the tip of shoot **A** with material that allows light to pass through.
The scientist covers the tip of shoot **B** with material that blocks light.

The shoots are left to grow in light coming from one direction only.

Fig. 4.2 shows the results.

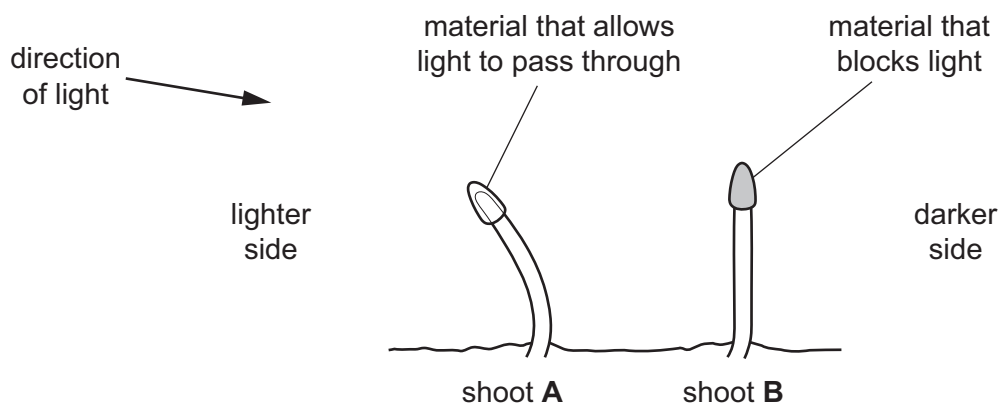


Fig. 4.2

Complete these sentences to explain the results.

More light passes through the material on shoot **A** on the lighter side than on the darker side.

This causes an distribution of auxin in shoot **A**.

Auxin stimulates more growth by cell on the darker side of shoot **A**.

Shoot **B** does not respond to the light because auxin is only made in the

..... of the shoot.

[3]

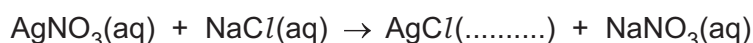
[Total: 8]





5 Silver chloride, magnesium chloride and sodium chloride are salts.

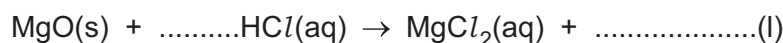
(a) The equation shows a reaction used to prepare silver chloride, AgCl .



Complete the equation by adding the missing state symbol.

[1]

(b) The equation shows a reaction used to prepare magnesium chloride, MgCl_2 .



(i) Complete and balance the equation.

[2]

(ii) Suggest the change in the pH of the reaction mixture during this reaction.

Explain your answer.

pH changes from to

explanation

[2]

(c) Aqueous chlorine reacts with aqueous sodium bromide to form sodium chloride.

(i) State the name of the other product of this reaction.

..... [1]

(ii) Explain why aqueous bromine does **not** react with aqueous sodium chloride.

.....

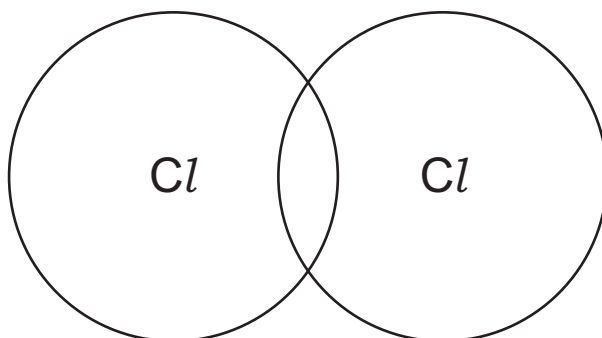
..... [1]





(iii) Chlorine, Cl_2 , is a covalently bonded molecule.

Complete the dot-and-cross diagram to show the outer shell electrons in Cl_2 .



[2]

[Total: 9]





6 Fig. 6.1 shows a musical instrument called a glockenspiel.

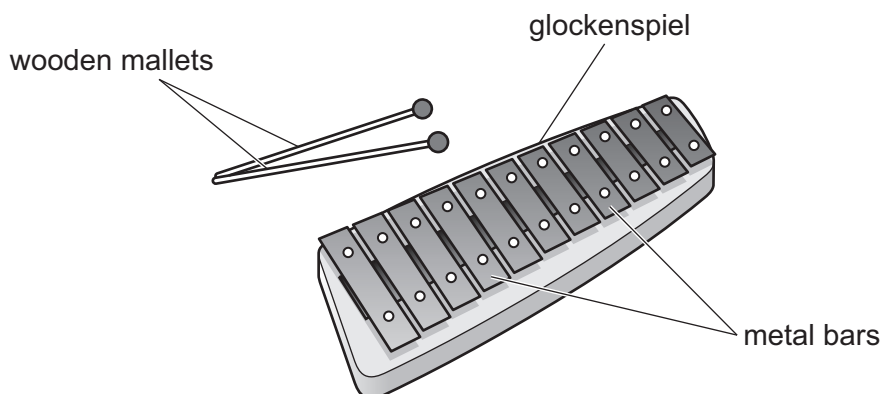


Fig. 6.1

The wooden mallets are used to hit the metal bars of the glockenspiel to produce sounds.

- (a) The metal used for the bars of the glockenspiel has a melting point of 660°C .

State what is meant by melting point.

.....
 [1]

- (b) The sounds produced by the glockenspiel have a frequency range of $784\text{--}4186\text{ Hz}$.

- (i) The speed of sound in air is 340 m/s .

Calculate the wavelength of the sound with the highest pitch produced by the glockenspiel.

wavelength = ... m [3]

- (ii) Describe the longitudinal nature of sound waves.

.....

 [2]





(c) Fig. 6.2 shows a sound wave moving from air into water.

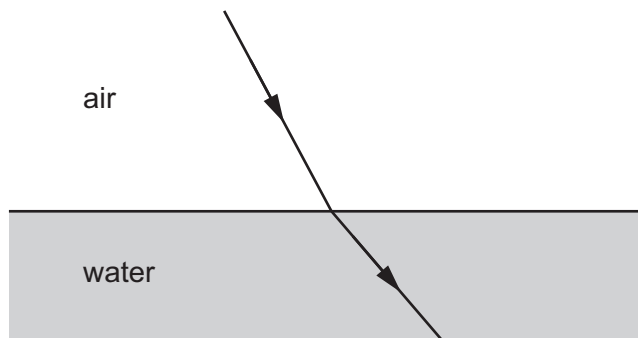


Fig. 6.2

State the name of the effect seen in Fig. 6.2 and explain why it occurs.

name of effect

explanation

.....

.....

[3]

(d) Complete Table 6.1 to show the properties of solids, liquids and gases.

Place **one** tick (✓) or cross (✗) in each box. Three have been done for you.

Table 6.1

property	solids	liquids	gases
fixed volume		✓	
fixed shape			✗
ability to flow		✓	

[2]

[Total: 11]





7 (a) Fig. 7.1 shows a food chain.

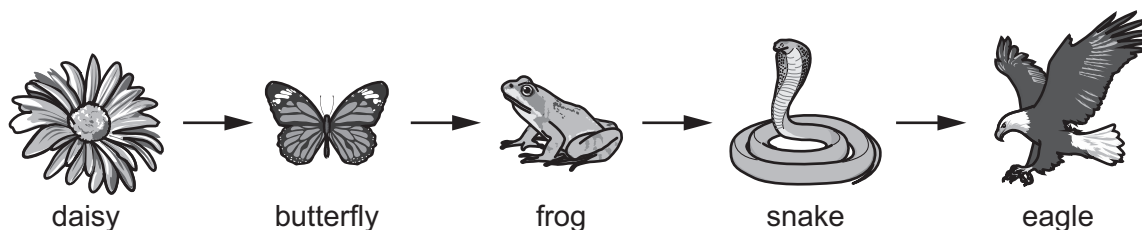


Fig. 7.1

(i) State the name of an organism in Fig. 7.1 that:

is a quaternary consumer

occupies trophic level 1.

[2]

(ii) State **two** processes that transfer energy out of a food chain.

1

2

[2]

(b) Humans digest food in the alimentary canal using enzymes.

(i) Table 7.1 shows the names of some enzymes and the substrates and products for these enzymes.

Complete Table 7.1.

Table 7.1

enzyme	substrate	product
amylase		simpler sugars
.....	protein	amino acid
lipase	fats	 and

[3]





(ii) State **two** functions of hydrochloric acid in the alimentary canal.

1

2

[2]

[Total: 9]





8 Carbon dioxide is a greenhouse gas.

(a) Complete the sentence about greenhouse gases in the Earth's atmosphere.

Increased concentrations of greenhouse gases cause an
greenhouse effect.

[1]

(b) Table 8.1 shows some reactions that make carbon dioxide.

Complete Table 8.1 by stating the formula and name of **one** compound that can be used in each type of reaction.

Choose from the formulae shown.



You may use each formula once, more than once or not at all.

Table 8.1

reaction that makes carbon dioxide	compound	
	formula	name
complete combustion of a gaseous compound		
reaction of a solid with a dilute acid		
thermal decomposition		

[3]

(c) Carbon dioxide is produced when gasoline (petrol) is burned in vehicle engines.

(i) Gasoline is a fraction of petroleum that contains saturated hydrocarbon molecules.

State **one** other way that the structures of molecules within the gasoline fraction are similar.

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





(ii) The cracking of larger alkanes makes smaller alkanes and alkenes.

State **two** conditions required for cracking.

1

2

[2]

[Total: 7]





- 9 Fig. 9.1 shows an electrical circuit that includes three identical lamps and a fixed resistor.

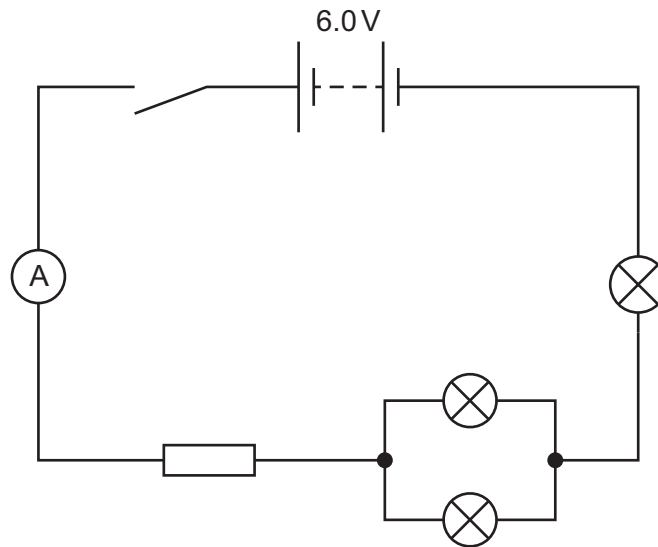


Fig. 9.1

- (a) State the name of the component that is the energy source for the circuit.

..... [1]

- (b) Draw on Fig. 9.1 to show how a voltmeter is connected to measure the potential difference (p.d.) across the fixed resistor. [2]

- (c) The switch is closed.

The reading on the ammeter is 0.25A.

The resistance of the fixed resistor is 15Ω .

- (i) Calculate the **total** resistance of the circuit.

total resistance of circuit = ... Ω [2]





(ii) Use your answer to (c)(i) to calculate the resistance of **one** lamp.

Show your working.

resistance of one lamp = ... Ω [3]

[Total: 8]

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The Periodic Table of Elements

Group																		
I	II	Key										III	IV	V	VI	VII	VIII	
		atomic number atomic symbol name relative atomic mass																
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20	
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40	
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	
55 Cs caesium 133	56 Ba barium 137	lanthanoids 57–71		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —
87 Fr francium —	88 Ra radium —	actinoids 89–103		104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganeson —

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
	89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

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



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COMBINED SCIENCE

0653/42

Paper 4 Theory (Extended)

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1 hour 15 minutes

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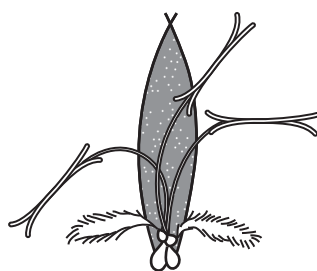
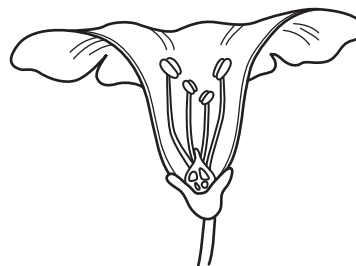
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- 1 (a) Fig. 1.1 shows sections through two different flowers, **X** and **Y**.

flower **X**flower **Y****Fig. 1.1**

- (i) Draw a label line with the letter **A** to identify the anther on flower **X** in Fig. 1.1. [1]
- (ii) The flowers have structural adaptations for pollination by different types of agent.

Identify the type of pollination agent for flower **Y**.

Give **one** reason for your answer using evidence from Fig. 1.1.

pollination agent

reason
 [2]

- (b) The leaves of plants have different types of cell with different functions.

Complete the sentences about leaves.

- Between the upper epidermis and the spongy mesophyll layers, there is a layer of cells called the mesophyll.
- The mesophyll cells in this layer are adapted for photosynthesis because they contain large numbers of
- Sugars produced in the leaf are transported to other parts of the plant in vessels.

[3]





(c) Plants are producers in food chains.

(i) Circle **two** of the words in **bold** to give the correct definition of producers.

Producers are organisms that make their own **organic** / **trophic** nutrients,
usually using **energy** / **food** from sunlight, through the process of photosynthesis.

[1]

(ii) Circle the type of consumer that feeds on a producer in a food chain.

primary

quaternary

secondary

tertiary

[1]

(d) Plants growing in lakes and ponds are sometimes affected by eutrophication.

Tick (✓) **two** boxes to identify correct descriptions of two parts of the process of eutrophication.

increased aerobic respiration by decomposers in the water

☐

decreased availability of nitrates in the water

☐

increased decomposition of dead producers in the water

☐

increased aerobic respiration by plants

☐

increased concentration of dissolved oxygen in the water

☐

[2]

[Total: 10]





2 Lithium, sodium, potassium and rubidium are elements in Group I of the Periodic Table.

(a) Group I elements react with water.

(i) State the names of the **two** products formed when rubidium reacts with water.

1

2

[2]

(ii) Describe how the reaction of rubidium with water is different from the reaction of lithium with water.

.....

..... [1]

(iii) State the flame test colour for lithium.

..... [1]

(b) A sodium ion, Na^+ , has a proton number of 11 and a nucleon number of 23.

Complete Table 2.1 to show the number of protons, neutrons and electrons in this ion.

Table 2.1

	number of protons	number of neutrons	number of electrons
Na^+ ion			

[3]



(c) The melting points and densities of lithium and potassium are shown in Table 2.2.

Table 2.2

element	melting point/°C	density in g/cm ³
lithium	181	0.53
potassium	63	0.86

Predict whether the statements are true or false.

Tick (✓) **one** box for each statement.

	true	false
Sodium is a liquid at room temperature.	☐	☐
Rubidium is more dense than potassium.	☐	☐
The density of sodium is less than 0.50 g/cm ³ .	☐	☐
The melting point of rubidium is 70 °C.	☐	☐

[2]

(d) Sodium chloride is an ionic compound.

Describe the lattice structure of sodium chloride.

.....

.....

..... [2]

[Total: 11]





3 Fig. 3.1 shows an electric car with solar cells on its roof.

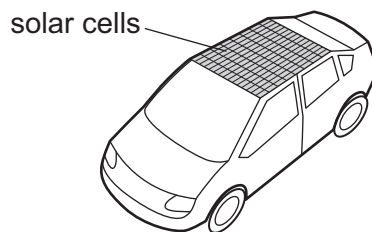


Fig. 3.1

(a) Complete the sentences about energy transfer.

The solar cells absorb light from the Sun. The solar cells charge the car battery.

Energy is stored in the car battery as energy.

[1]

(b) Fig. 3.2 shows a speed–time graph for the motion of the car on a journey.

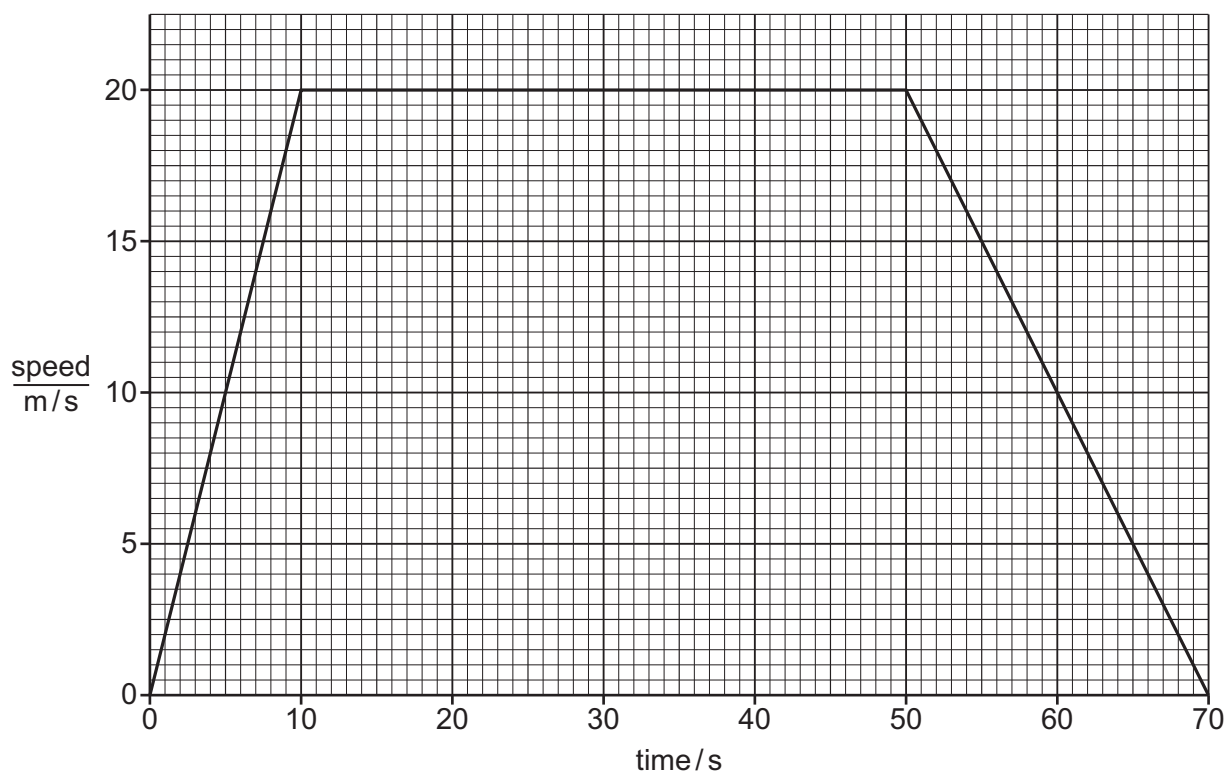


Fig. 3.2

(i) Use Fig. 3.2 to calculate the acceleration of the car during the first 10 s.

acceleration = ... m/s² [2]





(ii) Calculate the total distance, in kilometres, travelled by the car on the journey.

distance = ... km [3]

(iii) The mass of the car is 1200 kg.

Calculate the kinetic energy of the car at maximum speed.

kinetic energy = ... J [3]

[Total: 9]





4 (a) Fig. 4.1 shows drawings of three different blood vessels, **W**, **X** and **Y**.

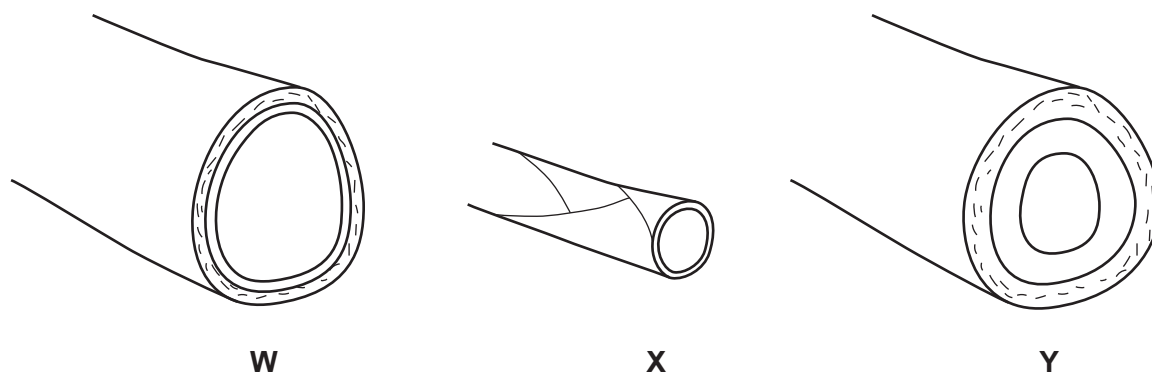


Fig. 4.1

Each blood vessel in Fig. 4.1 has an adaptation for a particular function.

Draw **one** straight line from each blood vessel to its adaptation and **one** straight line from each adaptation to its function.

blood vessel	adaptation	function
W	thick elastic walls	for diffusion of materials
X	permeable walls	to withstand high blood pressure
Y	large lumen	to reduce resistance to blood flow

[3]





(b) (i) Describe coronary heart disease.

.....

.....

..... [2]

(ii) A scientist records the number of people that die from coronary heart disease in one country in one year.

Table 4.1 shows the results.

Table 4.1

population of country	number of people that die from coronary heart disease
329 million	659 000

Calculate the percentage of the population that die from coronary heart disease.

percentage of population = ... % [2]

(iii) Smoking is a risk factor for coronary heart disease.

State **two** types of disease of the **gas exchange system** caused by smoking.

1

2 [2]

[Total: 9]





- 5 (a) State the names of **two** elements that are used to make inert electrodes for electrolysis.

1

2 [2]

- (b) Concentrated aqueous sodium chloride is electrolysed using inert electrodes, as shown in Fig. 5.1.

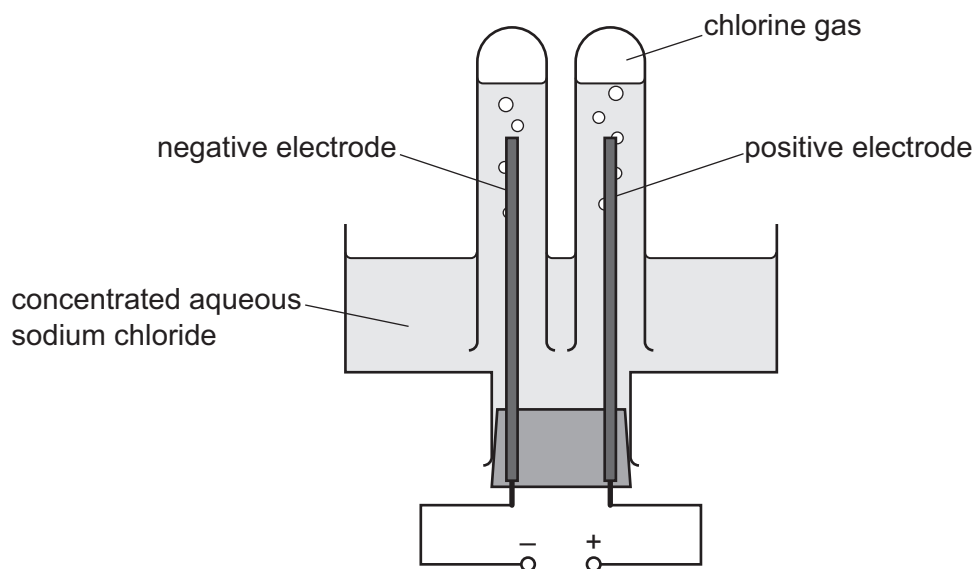
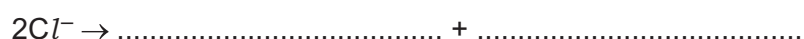


Fig. 5.1

- (i) State the name of the gas that forms at the negative electrode.

..... [1]

- (ii) Complete the ionic equation for the reaction at the positive electrode.



[2]

- (c) Molten sodium chloride is also electrolysed using inert electrodes.

State the names of the **two** products formed when **molten** sodium chloride is electrolysed.

1

2 [2]

[Total: 7]





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- 6 (a) Fig. 6.1 shows a circuit with two resistors, **X** and **Y**, connected in series.

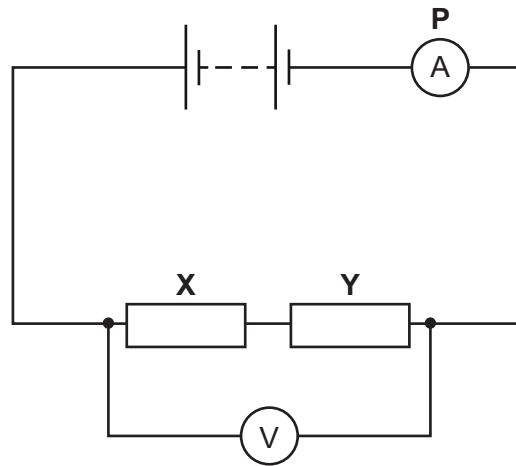


Fig. 6.1

Resistor **X** has a resistance of $18\ \Omega$.

Resistor **Y** has a resistance of $15\ \Omega$.

The reading on ammeter **P** is 0.20 A .

- (i) Determine the reading on the voltmeter.

reading = ... V [3]

- (ii) Determine the time taken for the battery to supply 330 J of energy.

time = ... s [2]



(b) Fig. 6.2 shows a circuit with two different resistors, **F** and **G**, connected in parallel.

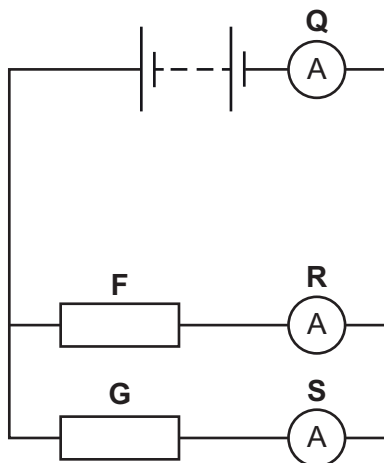


Fig. 6.2

(i) The reading on ammeter **Q** is 1.05 A.

The reading on ammeter **R** is 0.41 A.

Determine the reading on ammeter **S**.

reading = ... A [1]

(ii) Resistor **F** has a resistance of $51\ \Omega$.

Resistor **G** has a resistance of $33\ \Omega$.

Calculate the combined resistance of resistors **F** and **G** in parallel.

resistance = ... Ω [2]

[Total: 8]





7 (a) Fig. 7.1a shows a model of an enzyme.

Fig. 7.1b shows four possible substrates, **A–D**, for this enzyme.

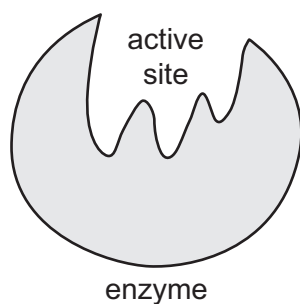


Fig. 7.1a

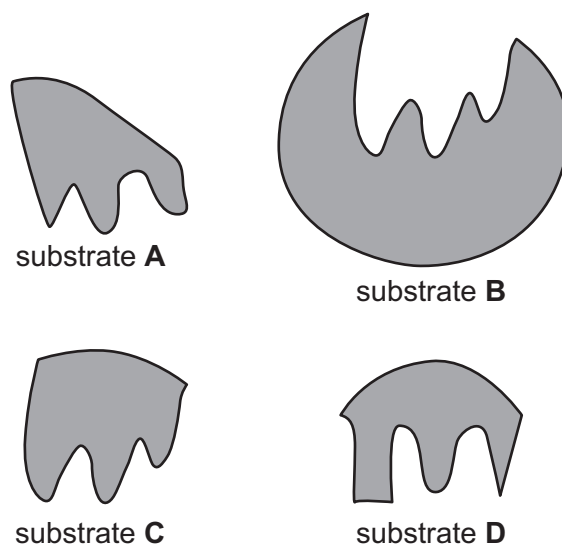


Fig. 7.1b

Identify which substrate, **A–D**, is the substrate for the enzyme shown in Fig. 7.1a.

Give a reason for your answer.

substrate

reason

..... [2]

(b) A protease is an enzyme that breaks down proteins.

(i) State the name of the solution used to test for the presence of protein.

..... [1]

(ii) Explain how the protein requirement of a woman changes during pregnancy.

.....

.....

..... [2]





(iii) The small intestine has a pH range of 6.0 to 7.4.

Explain why the protease in gastric juice stops working when it reaches the small intestine.

.....

.....

.....

..... [3]

[Total: 8]





8 Carbon dioxide is a gas in air.

(a) Dilute hydrochloric acid reacts with calcium carbonate to form carbon dioxide.

State the names of the **two** other products formed when dilute hydrochloric acid reacts with calcium carbonate.

1

2 [2]

(b) Carbon dioxide is made from calcium carbonate by thermal decomposition.

Describe the thermal decomposition of calcium carbonate.

.....

.....

..... [2]

(c) Carbon dioxide is also formed in the blast furnace by the combustion of carbon.

Complete the balanced equation for one **other** reaction in the blast furnace that produces carbon dioxide.

..... + ... → + 3CO₂ [2]

(d) Carbon dioxide is a greenhouse gas.

(i) State the name of **one** other greenhouse gas.

..... [1]

(ii) Suggest why scientists are concerned about the **enhanced** greenhouse effect.

.....

..... [1]

[Total: 8]





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9 Fig. 9.1 shows a candle made of wax.

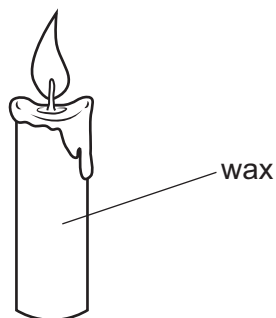


Fig. 9.1

(a) A thin converging lens is used to focus light from the candle.

Fig. 9.2 shows three rays of light incident on the lens.

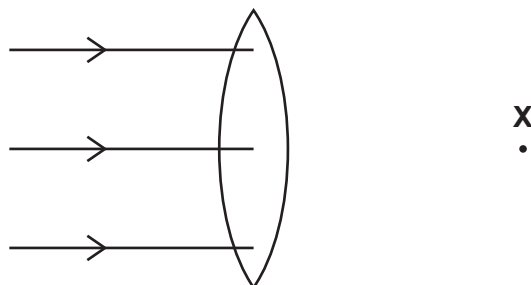


Fig. 9.2

(i) Complete the ray diagram to show how the rays are focused at point X. [1]

(ii) State the name of point X.

..... [1]

(b) The candle is made of solid wax of density 920 kg/m^3 .

The wax has a mass of 0.23 kg .

Calculate the volume of the wax.

volume = ... m^3 [2]



- (c) Some of the candle wax melts.

Describe the differences between solid wax and liquid wax in terms of:

- the forces between the wax molecules
- the motion of the wax molecules.

.....

.....

.....

.....

..... [3]

- (d) Fig. 9.3 shows liquid wax being heated in a beaker.

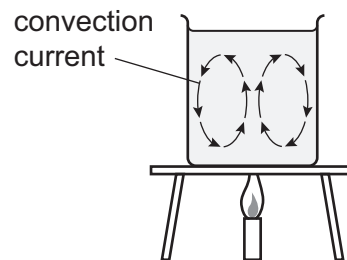


Fig. 9.3

Fig. 9.3 shows convection currents in the liquid wax.

Explain why density changes in the liquid wax cause the convection currents shown.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

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The Periodic Table of Elements

Group																		
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII	
		Key atomic number atomic symbol name relative atomic mass																
3 Li lithium 7	4 Be beryllium 9																	
11 Na sodium 23	12 Mg magnesium 24																	
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —	
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —	

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
	89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

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





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COMBINED SCIENCE**0653/43**

Paper 4 Theory (Extended)

October/November 2024**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.



1 Fig. 1.1 shows a food web.

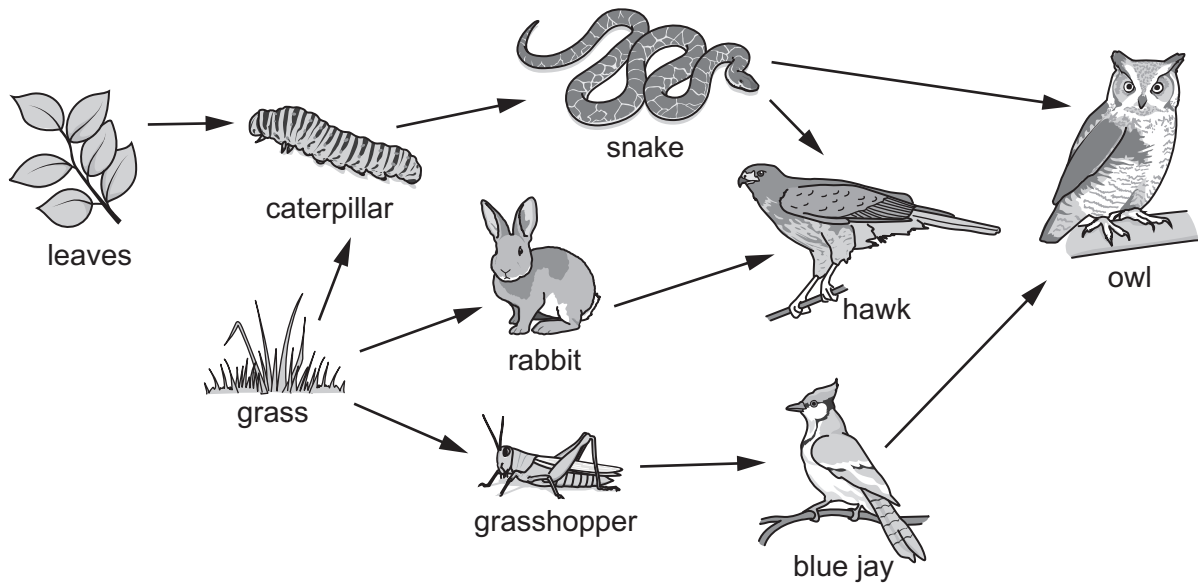


Fig. 1.1

(a) (i) Identify **one** herbivore shown in Fig. 1.1.

..... [1]

(ii) Identify **all** the animals that eat the snake.

..... [1]

(iii) Identify **all** the animals that occupy trophic level 3.

..... [1]

(b) The food web in Fig. 1.1 contains food chains with fewer than five trophic levels.

Explain why food chains usually have fewer than five trophic levels.

.....

.....

.....

.....

..... [3]

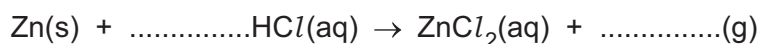
[Total: 6]





2 (a) Excess solid zinc is added to dilute hydrochloric acid in a conical flask.

(i) Complete the equation for the reaction.



[2]

(ii) Describe what is observed during this reaction.

.....

 [2]

(iii) The mixture in the flask at the end of the reaction contains unreacted solid zinc and aqueous zinc chloride.

State how unreacted solid zinc is removed from this mixture.

.....
 [1]

(iv) Describe how crystals of zinc chloride are obtained from aqueous zinc chloride.

.....

 [2]

(b) The formula for sodium chloride is NaCl .

The formula for zinc chloride is ZnCl_2 .

Explain why sodium chloride and zinc chloride contain different numbers of chloride ions.

Use ideas about the charges on ions in your answer.

.....

 [2]

[Total: 9]





- 3 (a) Complete the sentences about sound. Use **one** word or a number in each gap.

Sound is produced by sources.

The healthy human ear can hear frequencies of sound between Hz and 20 000 Hz.

Sound travels faster in liquids than in

[3]

- (b) State why a wave is refracted as it moves from one medium to another.

.....

..... [1]

- (c) Table 3.1 shows some of the properties of solids, liquids and gases and how the kinetic model of matter explains these properties.

In Table 3.1, circle **one** statement in each column that relates to **gases**.

One column has been completed for you.

Table 3.1

volume and shape	fluidity	molecular motion	molecular separation	intermolecular forces
fixed volume and fixed shape	can flow	molecules move only by vibrating about fixed positions	molecules are close together	no forces between molecules
fixed volume and no fixed shape	cannot flow	molecules move around while still touching each other	molecules are far apart	moderate forces between molecules
no fixed volume and no fixed shape		molecules move quickly in all directions		strong forces between molecules

[2]





(d) A radio signal of frequency 1.2×10^7 Hz is sent from a satellite in space to the Moon.

Calculate the wavelength of the radio signal.

The speed of electromagnetic waves in a vacuum is 3.0×10^8 m/s.

wavelength = ... m [2]

[Total: 8]





4 (a) The photosynthesis reaction in plants is controlled by enzymes.

- (i) The rate of photosynthesis in a submerged aquatic plant is measured by counting the number of gas bubbles released by the plant in 5 minutes.

Table 4.1 shows the effect of temperature on the rate of photosynthesis in an aquatic plant.

Table 4.1

temperature of water / °C	number of gas bubbles released in 5 minutes
10	30
20	72
30	96
40	42
50	28
60	2

Explain the result for 60 °C in Table 4.1.

Use ideas about enzymes in your answer.

.....

.....

.....

.....

.....

..... [3]

- (ii) Describe the importance of stomata in the process of photosynthesis.

.....

.....

..... [2]





(iii) Carbohydrates produced in photosynthesis are stored as starch in plants.

State the solution used to test for the presence of starch and the observation for a positive result.

solution

observation

[2]

(b) Starch is part of a balanced diet for humans.

Complete the sentences about starch digestion in the human alimentary canal.

Starch is digested by an enzyme called

The enzyme breaks down starch molecules into smaller carbohydrate molecules called

The enzyme is secreted into the mouth from the glands and into the small intestine from the

[4]

[Total: 11]





- 5 Dilute sulfuric acid is electrolysed using inert electrodes as shown in Fig. 5.1.

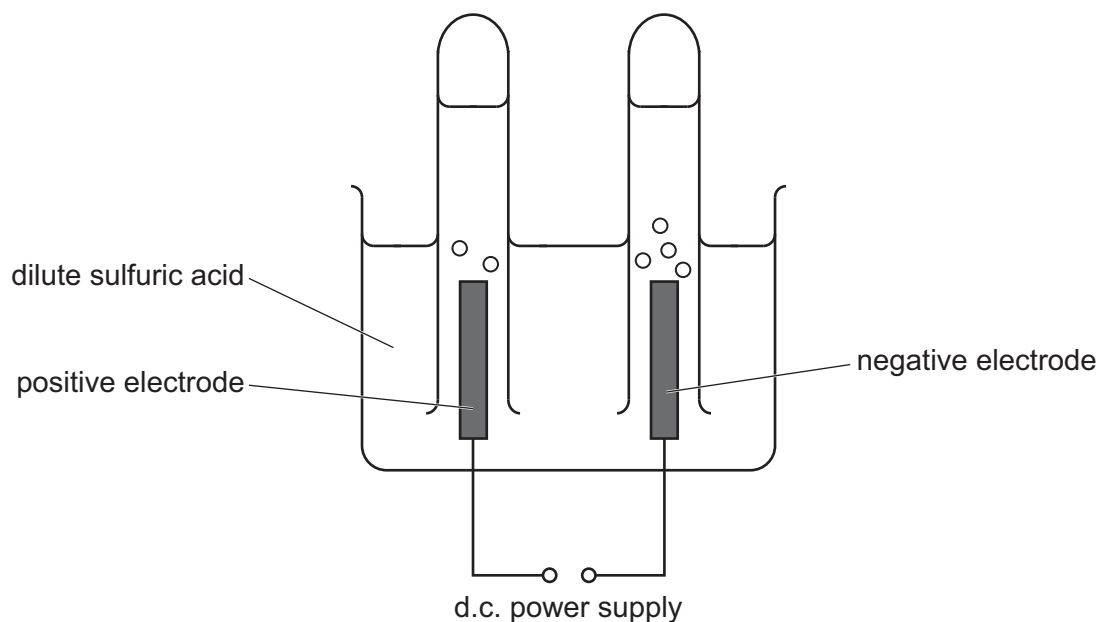


Fig. 5.1

- (a) Use **one** word in each gap to complete the definition of electrolysis.

Electrolysis is the breakdown of an ionic when molten or in aqueous solution by the passage of

[2]

- (b) Hydrogen gas forms at the negative electrode.

Complete the ionic equation for the reaction.



[2]

- (c) Dilute sulfuric acid contains water.

Hydroxide ions from the water react at the positive electrode to form oxygen gas.

Describe what happens to the hydroxide ions in this reaction.

.....

 [2]





- (d) Universal indicator is added to the dilute sulfuric acid at the beginning of the electrolysis.
The universal indicator turns red.

Explain why the universal indicator does **not** change colour when the dilute sulfuric acid is electrolysed.

.....

..... [1]

[Total: 7]





6 Fig. 6.1 shows an ox pulling a plough along horizontal ground.

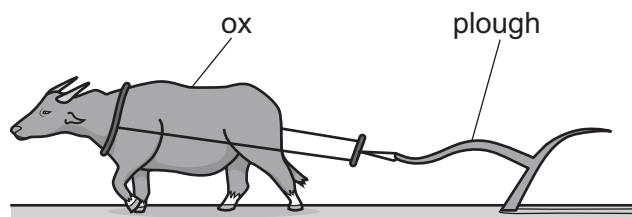


Fig. 6.1

(a) Fig. 6.2 shows a speed–time graph for the motion of the ox and plough on one journey.

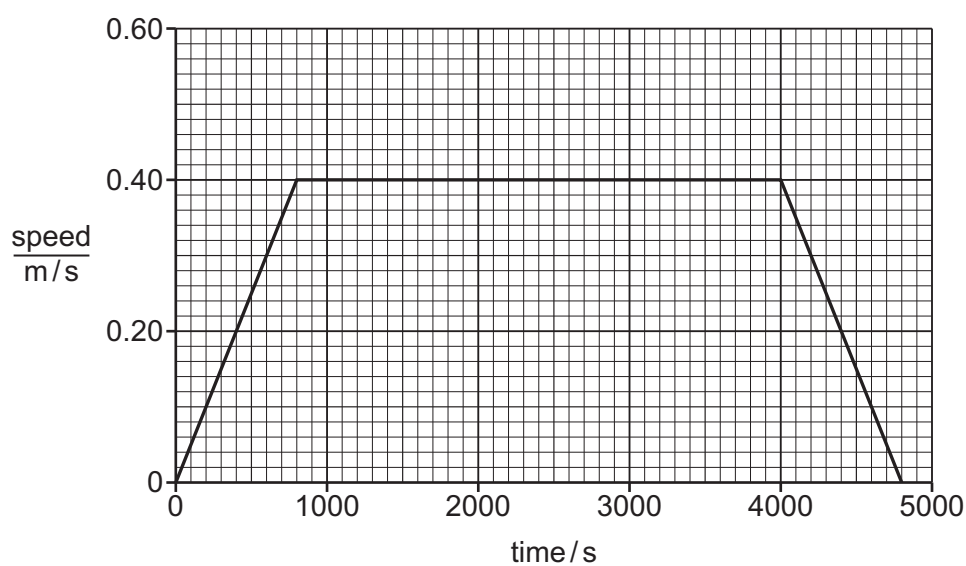


Fig. 6.2

(i) Use Fig. 6.2 to state the maximum speed of the ox and plough on this journey.

maximum speed = ... m/s [1]

(ii) Use Fig. 6.2 to calculate the total distance, **in kilometres**, travelled by the ox and plough.

distance = ... km [3]





- (b) On a different journey, the ox pulls the plough along horizontal ground with a constant force of 1100 N for 330 s.

The work done on the plough is 462 000 J.

The total energy output of the ox is 792 000 J.

- (i) Calculate the distance, **in metres**, moved by the plough.

distance = ... m [2]

- (ii) Suggest why the total energy output of the ox is greater than the work done on the plough.

.....

..... [2]

- (iii) Calculate the total power output of the ox.

Give the unit of your answer.

power = ... unit [3]

[Total: 11]





- 7 (a) Fig. 7.1 shows a diagram of the double circulatory system in humans.

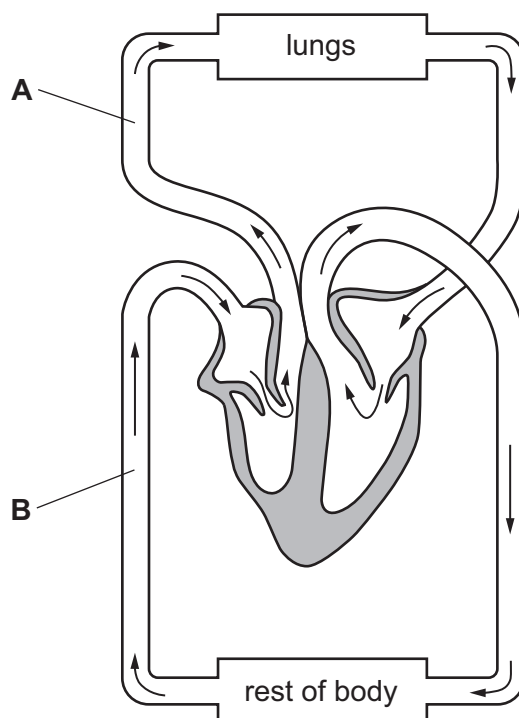


Fig. 7.1

The arrows show the direction of blood flow.

- (i) State the names of the blood vessels labelled **A** and **B** on Fig. 7.1.

A

B

[2]

- (ii) Use a label line with the letter **X** to label the **left** atrium in Fig. 7.1.

[1]

- (iii) Describe how the heart pumps blood to the body.

.....

.....

..... [2]

- (b) Coronary heart disease (CHD) has many risk factors.

One risk factor is gender.

- (i) State **two** other risk factors for coronary heart disease.

1

2

[2]





- (ii) A medical study records the number of male and female people with coronary heart disease in one country over a period of 32 years.

Fig. 7.2 shows a graph of the results.

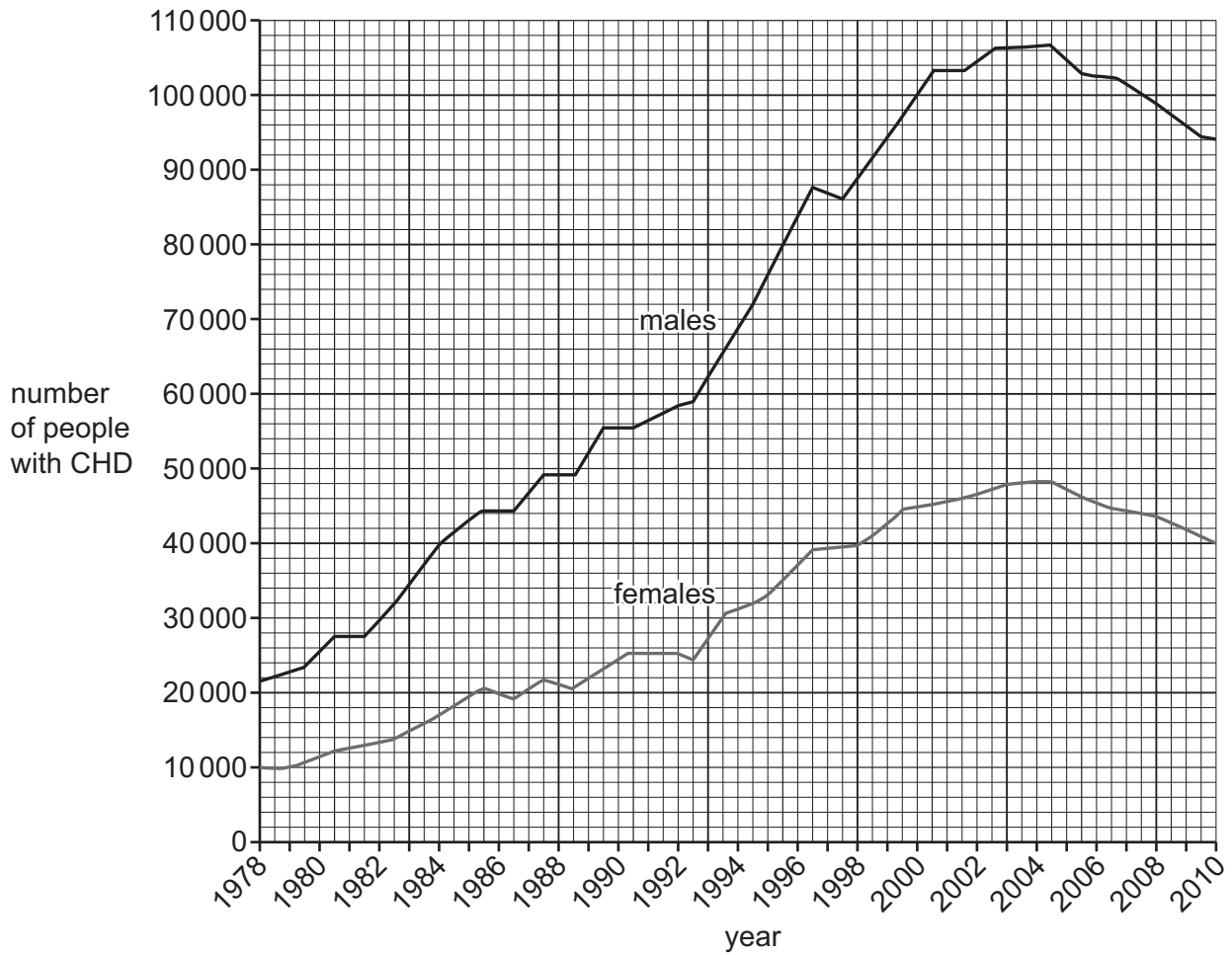


Fig. 7.2

Compare the trends for males and females shown in Fig. 7.2.

Use data from Fig. 7.2 in your answer.

.....

.....

.....

.....

..... [3]

[Total: 10]





- 8 (a) The formula for methanol is CH_3OH .

Complete the dot-and-cross diagram in Fig. 8.1 to show the bonding in methanol.

Show outer-shell electrons only.

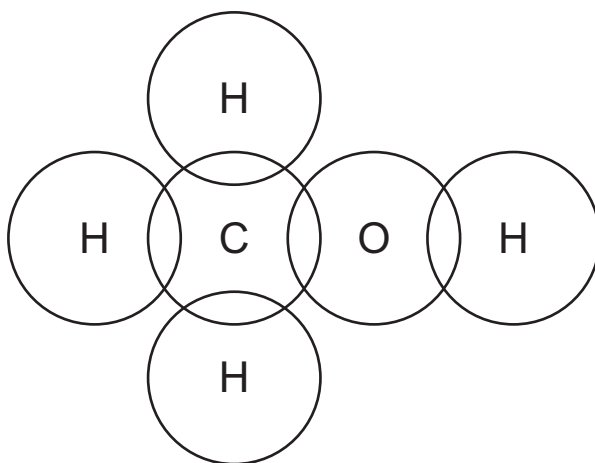


Fig. 8.1

[3]

- (b) Ethene, C_2H_4 , is an alkene.

Ethane, C_2H_6 , is an alkane.

- (i) State **one** difference in the bonding of ethene and of ethane.

.....
 [1]

- (ii) The complete combustion reactions of both ethene and ethane produce carbon dioxide and water.

Identify whether the statements are true or false.

Tick (✓) **one** box for each statement.

	true	false
One molecule of ethene produces the same number of molecules of carbon dioxide as one molecule of ethane.	☐	☐
One molecule of ethene produces the same number of molecules of water as one molecule of ethane.	☐	☐
The combustion reactions of ethene and ethane are both endothermic.	☐	☐

[2]



- (c) The general formulae for alkenes and alkanes are shown in Table 8.1.

Table 8.1

alkenes	alkanes
C_nH_{2n}	C_nH_{2n+2}

Write the formula for:

an alkene with 10 hydrogen atoms

an alkane with 10 hydrogen atoms.

[2]

- (d) Aqueous bromine is added to a sample of an alkene and to a separate sample of an alkane.

State the colour of each sample after the aqueous bromine is added.

alkene

alkane

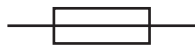
[2]

[Total: 10]





- 9 (a) State the name of the component with the electrical symbol shown.



[1]

- (b) Fig. 9.1 shows a circuit diagram for the two headlamps and two rear lamps of a car.

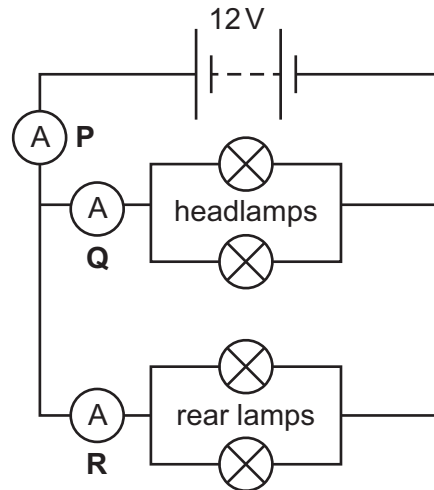


Fig. 9.1

Both headlamps are identical.

Both rear lamps are identical but different from the headlamps.

Ammeter **P** reads 11.0A.

Ammeter **R** reads 1.0A.

- (i) Determine the reading on ammeter **Q**.

reading = ... A [1]





(ii) Use your answer to (b)(i) to determine the resistance of **one** headlamp.

resistance = ... Ω [3]

(c) A motorcycle has **one** headlamp and **one** rear lamp.

Each lamp is made from a length of filament wire.

The wires in each lamp are made of the same metal.

The wire in the rear lamp:

- is three times the length of the wire in the headlamp
- has half the cross-sectional area of the wire in the headlamp.

The resistance of the headlamp of the motorcycle is 3.0Ω .

Determine the resistance of the rear lamp of the motorcycle.

resistance = ... Ω [3]

[Total: 8]





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The Periodic Table of Elements

Group																		
I	II											III	IV	V	VI	VII	VIII	
1Hhydrogen1 Key atomic number atomic symbol name relative atomic mass																		
3Li lithium 7	4Be beryllium 9											5B boron 11	6C carbon 12	7N nitrogen 14	8O oxygen 16	9F fluorine 19	10Ne neon 20	
11Na sodium 23	12Mg magnesium 24											13Al aluminium 27	14Si silicon 28	15P phosphorus 31	16S sulfur 32	17Cl chlorine 35.5	18Ar argon 40	
19K potassium 39	20Ca calcium 40	21Sc scandium 45	22Ti titanium 48	23V vanadium 51	24Cr chromium 52	25Mn manganese 55	26Fe iron 56	27Co cobalt 59	28Ni nickel 59	29Cu copper 64	30Zn zinc 65	31Ga gallium 70	32Ge germanium 73	33As arsenic 75	34Se selenium 79	35Br bromine 80	36Kr krypton 84	
37Rb rubidium 85	38Sr strontium 88	39Y yttrium 89	40Zr zirconium 91	41Nb niobium 93	42Mo molybdenum 96	43Tc technetium	44Ru ruthenium 101	45Rh rhodium 103	46Pd palladium 106	47Ag silver 108	48Cd cadmium 112	49In indium 115	50Sn tin 119	51Sb antimony 122	52Te tellurium 128	53I iodine 127	54Xe xenon 131	
55Cs caesium 133	56Ba barium 137	57–71 lanthanoids		72Hf hafnium 178	73Ta tantalum 181	74W tungsten 184	75Re rhenium 186	76Os osmium 190	77Ir iridium 192	78Pt platinum 195	79Au gold 197	80Hg mercury 201	81Tl thallium 204	82Pb lead 207	83Bi bismuth 209	84Po polonium	85At astatine	86Rn radon
87Fr francium	88Ra radium	89–103 actinoids		104Rf rutherfordium	105Db dubnium	106Sg seaborgium	107Bh bohrium	108Hs hassium	109Mt meitnerium	110Ds darmstadtium	111Rg roentgenium	112Cn copernicium	113Nh nihonium	114Fl flerovium	115Mc moscovium	116Lv livermorium	117Ts tennessine	118Og oganesson

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
	89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

actinoids

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

