Cambridge IGCSE

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **May/June 2018**

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 an HB 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.

CAMBRIDGE
International Examinations

[Turn over

1   Fig. 1.1 shows a diagram of the alimentary canal and associated organs.
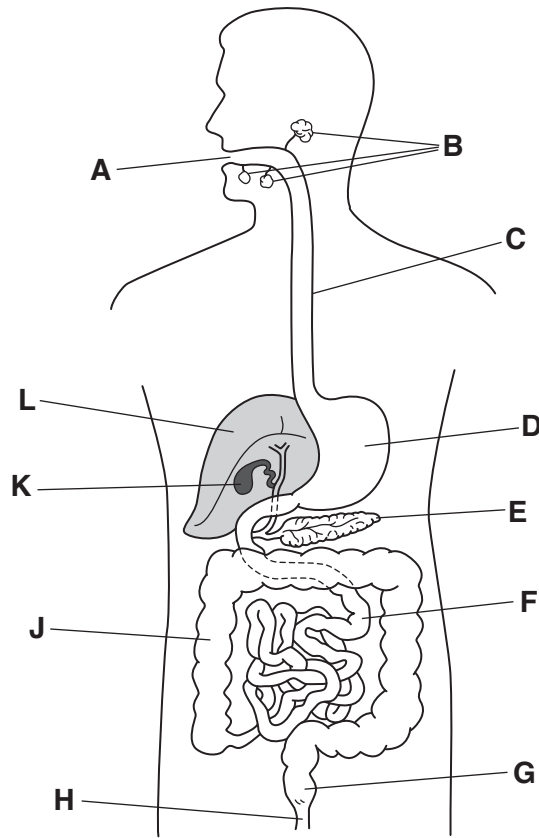
Fig. 1.1

(a) (i) Using Fig. 1.1, state the letter which represents the site of

bile production, ...

fat digestion, ...

lipase production.   ....

[3]

(ii) Describe the effect of bile on fats.

....

....

....[2]

(b) Fats are broken down by lipase into fatty acids and glycerol.

Describe in detail where in the alimentary canal fatty acids and glycerol are absorbed.

....

....

....

....

....[3]

(c) The environment inside the stomach is very acidic.

Explain why fat digestion **does not** occur in the stomach.

....

....

....[2]

2 A student investigates what happens when she adds magnesium to dilute hydrochloric acid.
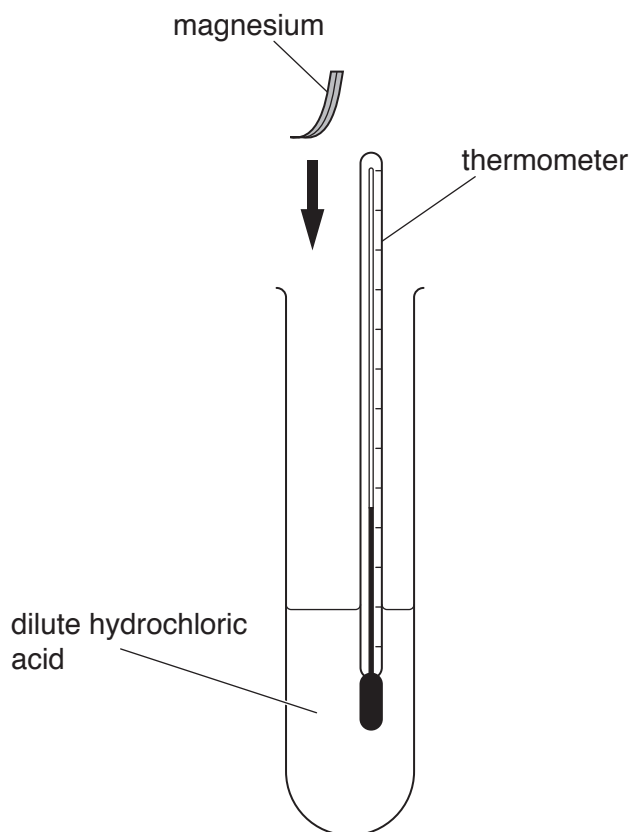
Fig. 2.1 shows the apparatus she uses.

Fig. 2.1

(a) (i) The reaction is exothermic.

Describe **two** observations that show a chemical reaction occurs in her investigation.

1 ....

2 ....
[2]

(ii) Name the magnesium compound that forms.

....[1]

(iii) Explain, in terms of electrons, why magnesium atoms are oxidised in the reaction.

....

....[1]

(b) Fig. 2.2 shows magnesium reacting with carbon dioxide.

The reaction produces magnesium oxide, MgO, and carbon.

carbon dioxide
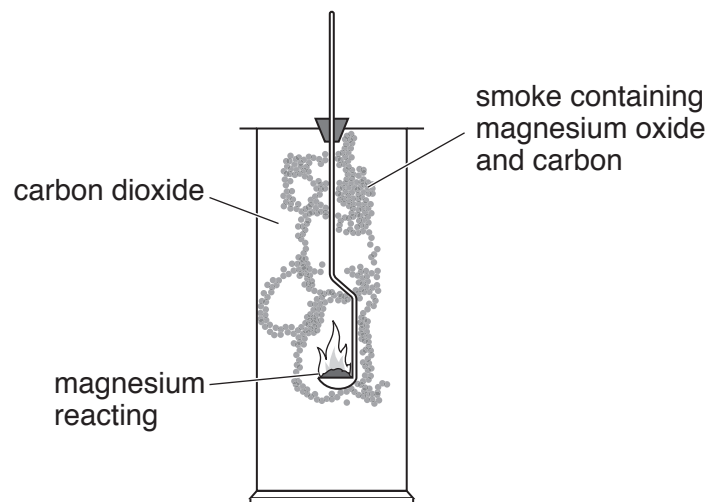
smoke containing magnesium oxide and carbon

magnesium reacting

Fig. 2.2

Construct the **balanced symbolic** equation for this reaction.

....[2]

(c) Table 2.1 shows information about the composition of a magnesium alloy.

The table is incomplete.

Table 2.1

element	% by mass
aluminium	6.0
calcium	2.0
magnesium	
manganese	0.4
zinc	0.1

(i) Calculate the mass of magnesium in 200 g of the alloy.

mass = ... g [1]

(ii) Calculate the number of moles of magnesium in 200 g of the alloy.

[A_r: Mg, 24]

Show your working.

....[1]

(iii) Suggest **one** reason why an alloy of magnesium, rather than pure magnesium, is used to make parts for car engines.

....

....[1]

3 **(a)** Four athletes at an athletics competition are trying to qualify for the Olympic Games in 2020.

To qualify for the 200 m race the athletes have to complete the race in less than 20.5 s.

Table 3.1 shows some information about the four athletes during their race.

Table 3.1

athlete	average speed (m/s)
P	9.80
Q	10.20
R	9.71
S	10.42

(i) Identify, by calculation, the athletes who qualify for the Olympic Games.

Explain your answer.

athletes ....

explanation ....

....

....

....
[3]

(ii) The mass of athlete **P** is 80 kg. Calculate the kinetic energy of the athlete when he is moving at his average speed.

State the formula you use and show your working.

formula

working

kinetic energy = ... J [2]

(b) Fig. 3.1 shows an athlete standing in front of a mirror fixed on a wall.
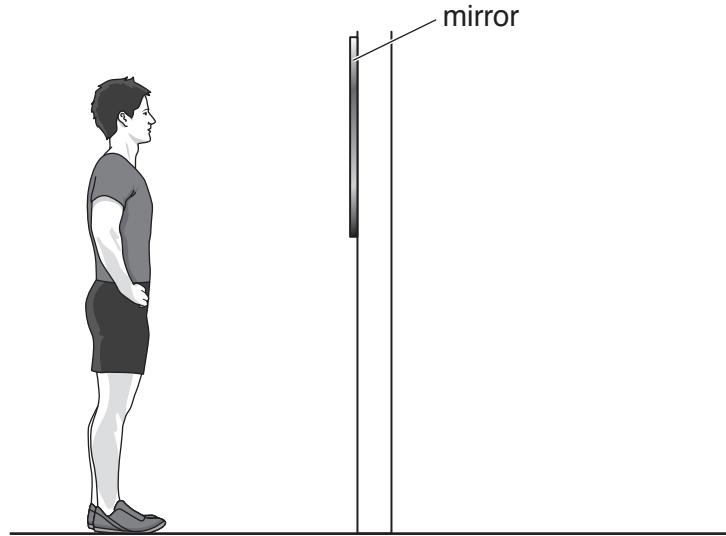

Fig. 3.1

On Fig. 3.1, draw the letter **X** to show the position of the image of the athlete's nose.　　　[2]

(c) After running, the athlete is sweating and some of the sweat evaporates.

　(i) Describe, in terms of particles, how evaporation occurs from the surface of a liquid.

　　...

　　...

　　...

　　...

　　...[3]

　(ii) State **two** ways in which the rate of evaporation can be increased from the surface of a liquid.

　　1 ....

　　2 ....
　　[2]

4 Table 4.1 shows the mass of some of the nutrients in $100\,cm^3$ of breast milk and $100\,cm^3$ of formula milk.

Table 4.1

nutrient	$100\,cm^3$ of breast milk	$100\,cm^3$ of formula milk
protein	1.6 g	1.3 g
fat	4.8 g	3.4 g
calcium	35.5 mg	55.0 mg

(a) Describe the differences between breast milk and formula milk as shown in Table 4.1.

Show your working to help explain your answer. Give units where appropriate.

....

....

....

....

....[3]

(b) (i) During pregnancy, nutrients are provided for the growing baby by the mother.

Describe in detail how nutrients are transferred from the mother to the growing baby.

....

....

....

....

....[3]

(ii) Circle **all** the waste materials that would pass from the growing baby to the mother.

amino acids   **carbon dioxide**   **faeces**

glucose   **iron**   **oxygen**   **urea**

[2]

5 (a) Table 5.1 shows the numbers of electrons in each shell in atoms of five elements **A** to **E**.

The letters are **not** the chemical symbols of the elements.

Table 5.1

element	1st shell	2nd shell	3rd shell	4th shell
A	2			
B	2	5		
C	2	8	2	
D	2	8	7	
E	2	8	8	2

(i) Deduce which elements are in the same period of the Periodic Table.

....[1]

(ii) Deduce which element is nitrogen.

....[1]

(iii) Deduce which elements are metals.

....[1]

(b) Fig. 5.1 shows the reaction vessel used in the Haber process.
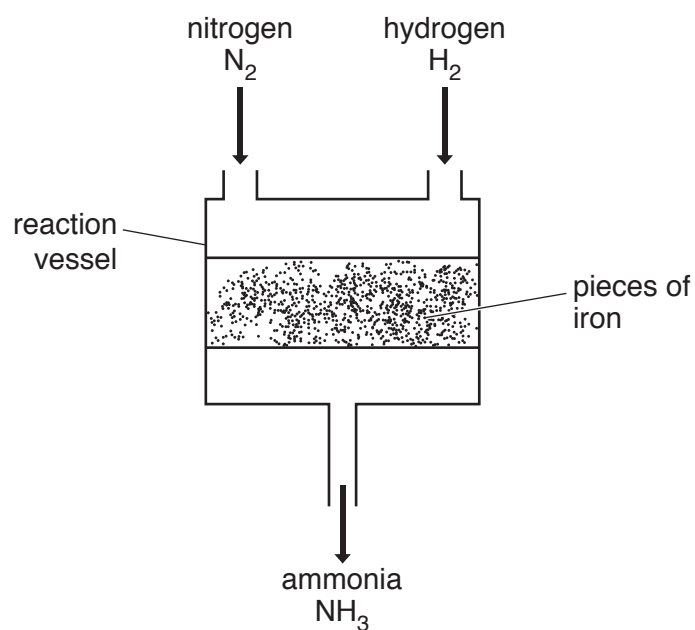
Fig. 5.1

(i) Describe how nitrogen is obtained from air.

....

....

....[2]

(ii) Describe the essential conditions in this reaction vessel.

....

....

....[2]

(c) Ammonia is used to make ammonium sulfate.

(i) Ammonium sulfate contains ammonium ions, NH_4^+, and sulfate ions, SO_4^{2-}.

Deduce the formula of ammonium sulfate.

Explain your answer.

formula ....

explanation ....

....
[2]

(ii) Describe how a solution of ammonium sulfate is tested to show that it contains ammonium ions.

test ....

....

result ....
[3]

6 (a) The cooling system of a truck uses water to remove thermal energy from the hot engine.

The heated water goes into the radiator.

Some of the thermal energy is lost from the radiator by radiation.

Fig. 6.1 shows the truck radiator.

cooling fins made of
folded copper foils
painted black

many thin copper
pipes, painted black,
containing hot water
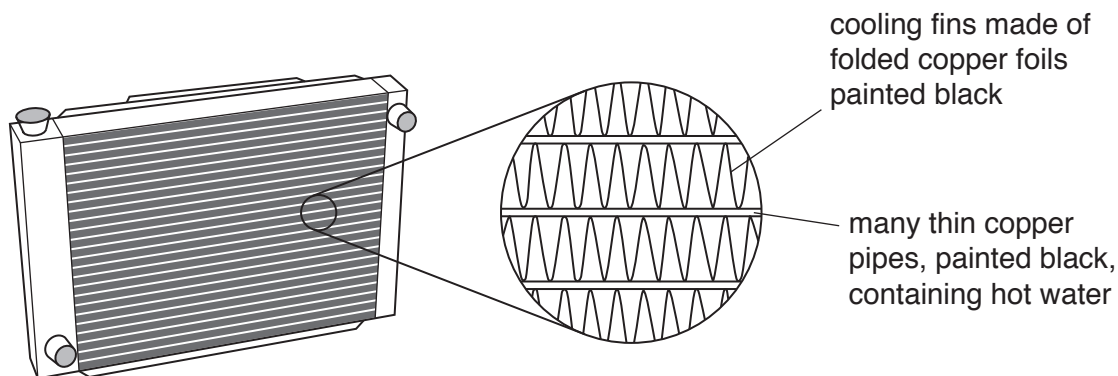
Fig. 6.1

Describe how the features of the radiator shown in Fig. 6.1 increase the rate of thermal energy loss by radiation.

....

....

....

....[2]

(b) The mass of water in the radiator is 7.5 kg.

The specific heat capacity of water is 4200 J/kg °C.

The thermal energy released when the water in the radiator cools is 475 kJ.

Calculate the temperature change of the water.

State the formula you use and show your working.

formula

working

temperature change = ... °C [2]

(c) If the water in the radiator gets too hot, a fan is used to cool the radiator.

The fan is turned by a small motor.

Fig. 6.2 shows a small electric motor.
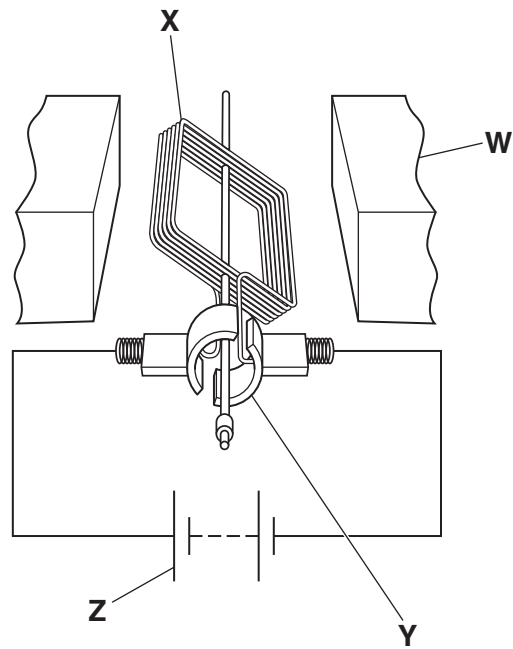
Fig. 6.2

(i) Identify the four labelled parts **W**, **X**, **Y** and **Z** in Fig. 6.2 by drawing one straight line from each letter to its correct label.

letter		label
W		axle
		battery
X		coil
		commutator
Y		magnet
Z		rotor

[2]

(ii) Describe the effect on the motor of increasing the current passing through the motor.

....[1]

(d) The driver of the truck experiences an electric shock when getting out of the truck.

This is caused by the creation of an electric field between the driver and the truck.

State the meaning of the term *electric field*.

....

....[1]

(e) The starter motor of the truck uses a very large current.

Explain why a relay is used to switch on the starter motor circuit.

....

....

....[1]

(f) The truck has two headlamps and two rear lamps all connected in parallel with the battery as shown in Fig. 6.3.
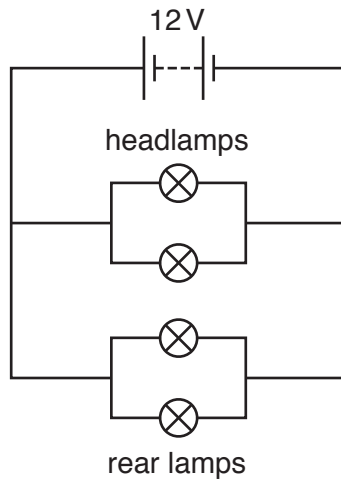
Fig. 6.3

Each headlamp has a resistance of $3\,\Omega$.

Each rear lamp has a resistance of $6\,\Omega$.

(i) Calculate the combined resistance of:

the two headlamps

resistance = ... Ω

the two rear lamps

resistance = ... Ω

[2]

(ii) Use your answers from **(f)(i)** to find the total resistance in the truck lighting circuit.

resistance = ... Ω [1]

7 Fig. 7.1 shows a diagram of a section through the eye.
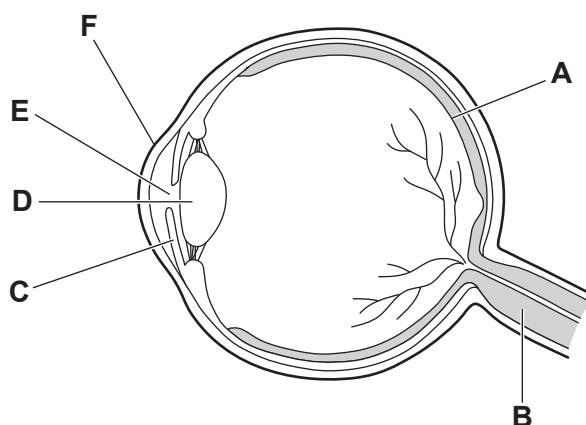
Fig. 7.1

(a) Table 7.1 shows the names, letters and functions of some of the parts of the eye shown in Fig. 7.1.

Use the information in Fig. 7.1 to complete Table 7.1.

Table 7.1

name of part	letter on Fig. 7.1	function
		refracts light as it enters the eye
iris		
	D	
	A	contains light sensitive cells

[4]

(b) Describe the changes which occur to the ciliary muscle, the suspensory ligaments and the lens when the eye focuses on a distant object.

ciliary muscle ....

suspensory ligaments ....

lens ....

[3]

(c) If dust enters the eye, the eye automatically blinks. This is a reflex action.

Suggest **and** explain why the response is coordinated by the unconscious part of the brain rather than the spinal cord.

....

....[1]

8 (a) Chlorine is a very reactive element in Group VII of the Periodic Table.

(i) Describe **and** explain what is observed, if anything, when chlorine is mixed with colourless sodium iodide solution.

observation ....

explanation ....

....
[2]

(ii) Explain, in terms of the electronic structure of atoms, why argon does not react with chlorine.

....

....[1]

(b) Chlorine combines with sodium to form sodium chloride.

Complete Fig. 8.1 to show the arrangement of some ions in a crystal of sodium chloride.

Write the chemical symbols and electrical charges of the ions in each circle.
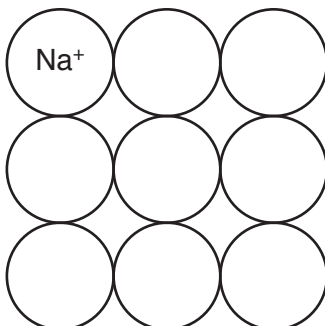
Fig. 8.1

[2]

(c) Fig. 8.2 shows apparatus producing chlorine by electrolysis.
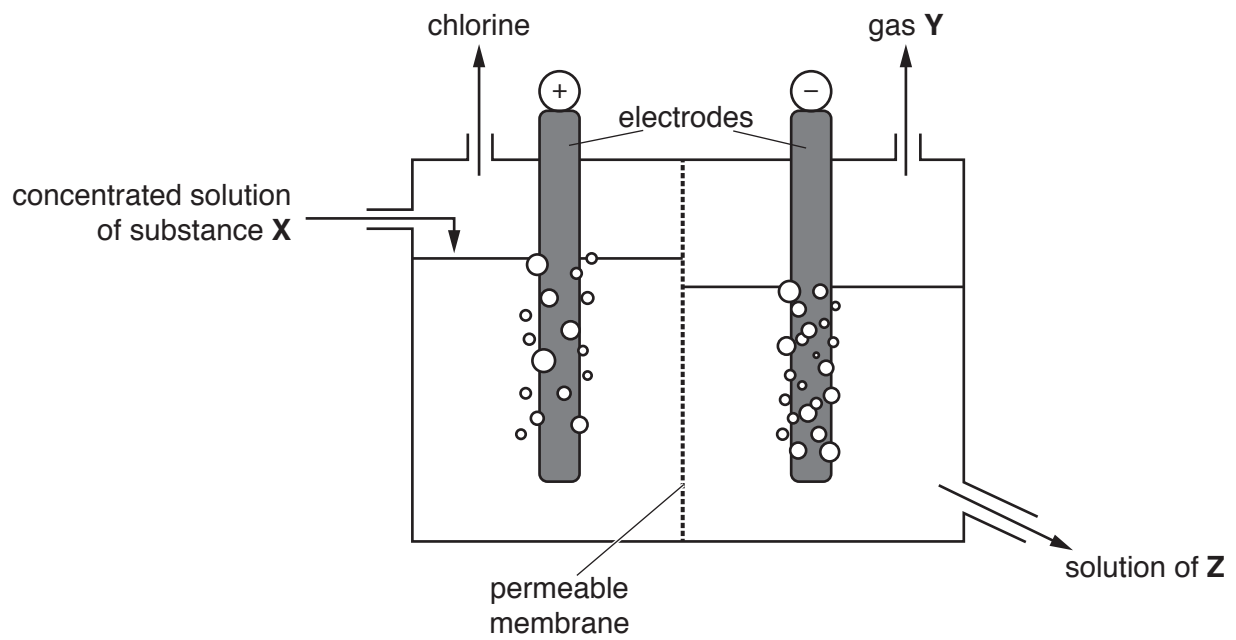
Fig. 8.2

Identify **X**, **Y** and **Z**.

X ....

Y ....

Z ....

[3]

9 **(a)** Elephants can carry heavy loads.

An elephant of mass 3000 kg is carrying a box of mass 100 kg.

(i) Calculate the combined weight of the elephant and the box. (g = 10 N/kg).

combined weight = ... N [1]

(ii) The elephant carries the box up a hill and finishes 50 m higher up.

Use your answer to **(a)(i)** to calculate the work done in gaining this height.

State the formula you use and show your working.

formula

working

work done = ... J [2]

(iii) State the potential energy gained by the elephant and box in gaining this height.

potential energy = ... J [1]

(iv) The elephant stands with all four feet on the ground. The area of each foot is 600 cm^2.

Calculate the pressure, in N/cm^2, exerted by the elephant and the box on the ground.

State the formula you use and show your working.

formula

working

pressure = ... N/cm^2 [2]

(b) An elephant communicates with other elephants using infrasound.

Infrasound is a very low frequency sound wave, which is usually impossible for a human to hear.

(i) Suggest a possible frequency for infrasound and explain your answer.

frequency .... Hz

explanation ....

....

....
[2]

(ii) Infrasound waves travel through the air as a series of compressions and rarefactions.

Describe **two** differences between a region of compression and a region of rarefaction.

1 ....

....

2 ....

....
[2]

(iii) Explain, in terms of compressions, what is meant by the wavelength of a sound wave.

....

....[1]

10 (a) Different aquatic species are tested to find the range of pH values they are able to tolerate.

Fig. 10.1 shows a summary of the results.

The shading indicates the pH values that the species are able to tolerate.

	pH 6.5	pH 6.0	pH 5.5	pH 5.0	pH 4.5	pH 4.0
trout fish	▨	▨	▨	▨		
bass fish	▨	▨	▨			
perch fish	▨	▨	▨	▨	▨	
frogs	▨	▨	▨	▨	▨	▨
snails	▨	▨				

Fig. 10.1

(i) Using Fig. 10.1, state the name of the organism that can survive over the smallest pH range.

....[1]

(ii) Using Fig. 10.1, state the name of the organism that can survive in the most acidic conditions.

....[1]

(b) Burning fossil fuels releases carbon dioxide and gases which can cause acid rain. Acid rain affects the pH of rivers and lakes.

(i) State a gas that causes the formation of acid rain.

....[1]

(ii) Describe **and** explain the effects of the release of carbon dioxide on the environment.

....

....

....

....

....[3]

11 Gasoline and refinery gas are mixtures of hydrocarbons.

(a) Name the raw material from which gasoline and refinery gas are extracted.

....[1]

(b) (i) Refinery gas contains butane.

Complete Fig. 11.1 to show the molecular structure of one butane molecule.

$$\begin{array}{c} | \\ -\,C\,- \\ | \end{array}$$
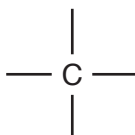
Fig. 11.1

[2]

(ii) Describe **one** difference and **one** similarity in the structure of the molecules of butane and of butene.

difference ....

....

similarity ....

....

[2]

(c) Gasoline is oxidised in a car engine, producing exhaust gas.

Exhaust gas is a mixture of gases.

Fig. 11.2 shows the exhaust gas from a car being released into the air.
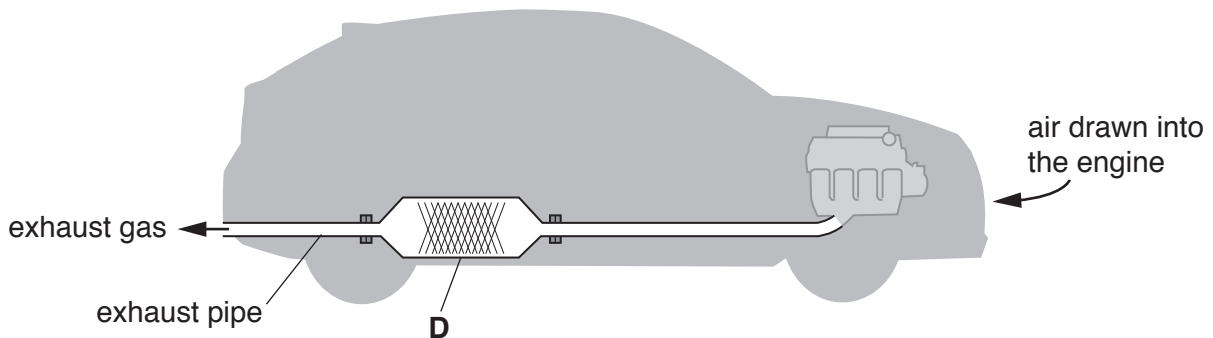
Fig. 11.2

(i) State and explain the difference between the amounts of carbon dioxide and water vapour in the exhaust gas and the air drawn into the engine.

....

....

....[2]

(ii) Suggest why the exhaust gas contains some gaseous oxygen.

....

....[1]

(d) Before the exhaust gas passes through the part of the exhaust pipe labelled **D** in Fig. 11.2, it also contains nitrogen dioxide, NO_2.

Nitrogen dioxide is chemically reduced when the exhaust gas passes through the part labelled **D**.

(i) Suggest how nitrogen dioxide is formed in the car's engine.

....

....[1]

(ii) State what type of substance is contained in **D** that increases the rate of reduction of nitrogen dioxide.

....[1]

(iii) Suggest the name of the unreactive gas produced when nitrogen dioxide is reduced.

Explain your answer.

gas ....

explanation ....

....

[1]

12 (a) A metal saucepan containing water is placed onto the hot-plate of an electric cooker.

Fig. 12.1 shows some water being heated in the saucepan.
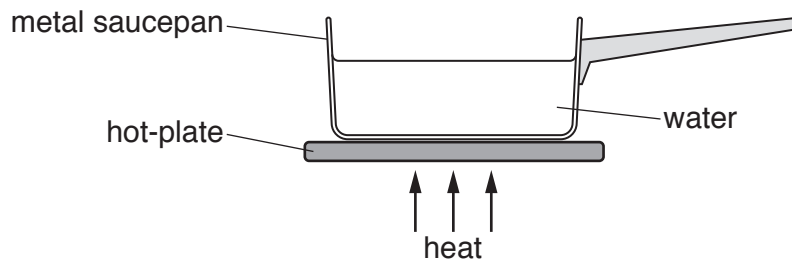
Fig. 12.1

When the base of the metal saucepan is heated, the metal expands.

Fig. 12.2 represents the metal atoms present in the metal saucepan before heating.

cold metal
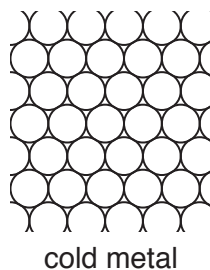
Fig. 12.2

Use the words or phrases in the list to complete the sentences to describe the arrangement of the particles after heating.

Each word or phrase may be used once, more than once or not at all.

decrease   increase   stay the same

The size of the particles will ....

The vibration of the particles will ....

The distance between the particles will ....

[2]

(b) Water can also be heated in a solar cooker.

Mirrors are used to reflect rays of light from the Sun onto a metal can containing water.

Fig. 12.3 shows a simplified view of a solar cooker. The paths of three rays of light from the Sun have been started.

Continue the rays of light to show that only two rays strike the metal can.
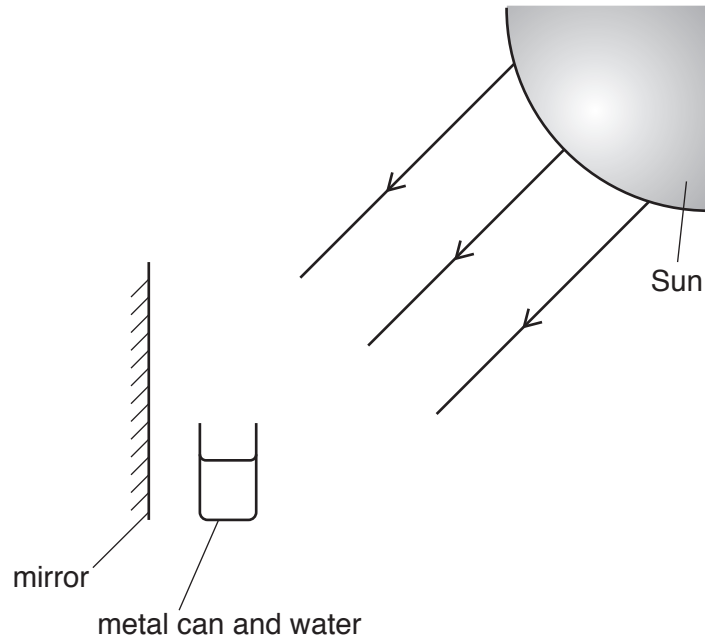
Fig. 12.3

[2]

(c) Energy is required to heat up the saucepan. The thermal capacity of the saucepan is 500 J/°C.

State what is meant by the term *thermal capacity*.

....

....[1]

13 Fig. 13.1 is a photograph of a cross-section through a leaf as viewed through a light microscope.
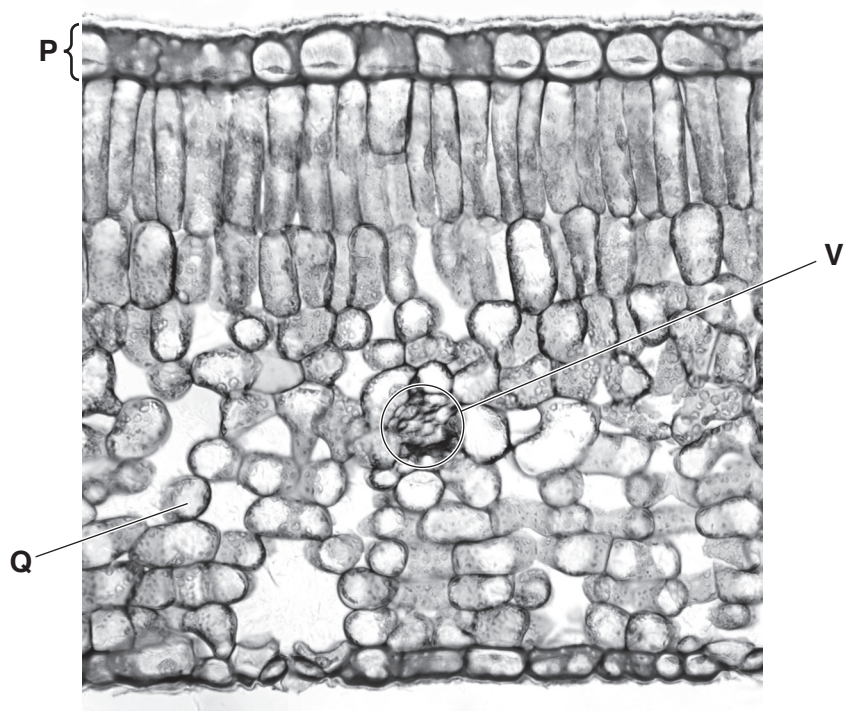
Fig. 13.1

(a) Using Fig. 13.1, identify the parts labelled **P** and **Q**.

P ....

Q ....

[2]

(b) The part labelled **V** in Fig. 13.1 contains two tissues. One of these tissues is responsible for translocation.

(i) Name **one** substance transported by translocation.

....[1]

(ii) Name the **two** tissues contained in part **V** in Fig. 13.1.

1 ....

2 ....

[2]

(c) The leaf contains many palisade cells.

The boxes on the left show some parts of a palisade cell.

The boxes on the right show the function of parts of a palisade cell.

Draw **four** lines to link each part of a palisade cell with its function.

part of palisade cell	**function**
cell membrane	strengthens the cell
cell wall	controls substances entering and leaving the cell
chloroplast	contains water and supports the cell
vacuole	site of photosynthesis

[3]

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31

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
						1 H hydrogen 1											2 He helium 4
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	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 –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

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
actinoids	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 $24\,dm^3$ at room temperature and pressure (r.t.p.).