Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6104483026

COMBINED SCIENCE **0653/43**

Paper 4 Theory (Extended) **October/November 2021**

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 **24** pages. Any blank pages are indicated.

1 **(a)** Fig. 1.1 is a diagram of a fetus inside the uterus.

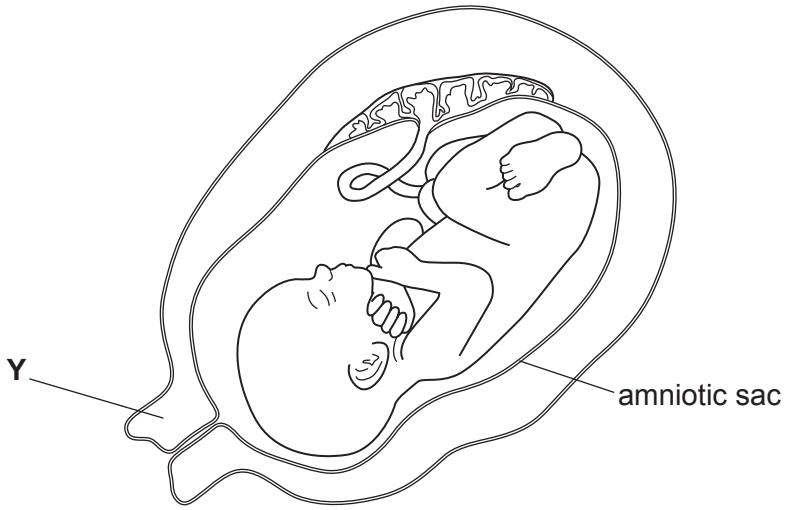

Fig. 1.1

(i) Identify the part labelled **Y** in Fig. 1.1.

..... [1]

(ii) State the function of the amniotic sac.

.....

..... [1]

(iii) Describe how carbon dioxide is removed from the blood of the fetus.

.....

.....

.....

..... [3]

(b) Describe how the human heart works to pump blood around the body.

.....

.....

..... [2]

(c) Table 1.1 shows information about human male and female gametes.

Complete Table 1.1.

Table 1.1

	male gametes	female gametes
name	.....	eggs
where they are produced	.....	ovaries
number released at any one time	over 40 million	.....
adaptive feature	.....	jelly coating

[4]

[Total: 11]

2 Fig. 2.1 shows the energy level diagrams for four different compounds dissolving in water.

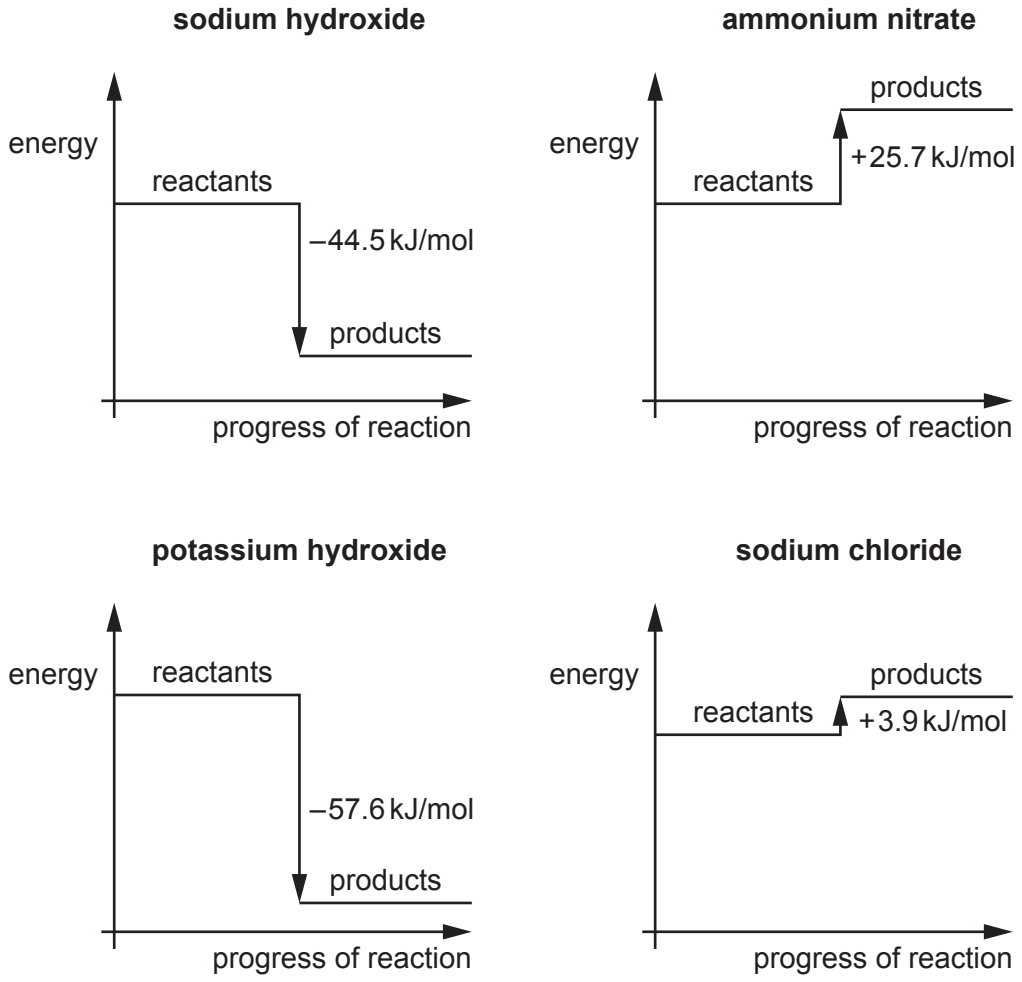

Fig. 2.1

(a) Dissolving in water is an endothermic reaction for **two** of these four compounds.

State the names of these two compounds.

Use the energy level diagrams to explain your answer.

compound 1 .....

compound 2 .....

explanation .....

.....

.....

[2]

(b) A teacher dissolves some solid sodium hydroxide in water to make a solution.

The teacher records the initial temperature of the water before adding the sodium hydroxide.

The teacher records the temperature of the solution every 10 s after adding the sodium hydroxide.

Table 2.1 shows the results.

Table 2.1

initial temperature of water / °C	temperature of solution / °C					
	10 s	20 s	30 s	40 s	50 s	60 s
22.0	28.0	34.5	33.0	31.5	30.5	29.0

(i) Name **two** pieces of equipment the teacher uses to collect the data in Table 2.1.

1 .....

2 .....
[2]

(ii) Describe the changes in the temperature of the solution over the 60 s.

Explain why these changes occur.

changes in temperature .....

.....

explanation .....

.....

.....
[3]

(iii) Calculate the maximum temperature change shown by the data in Table 2.1.

maximum temperature change = ... °C [1]

[Total: 8]

3 A laser is a device that emits a beam of electromagnetic radiation.

Some lasers emit visible light. Some lasers emit infrared radiation.

(a) (i) Fig. 3.1 shows an incomplete electromagnetic spectrum.

On Fig. 3.1, write *visible light* and *infrared* in their correct places.

increasing frequency ←

gamma radiation					microwaves	

Fig. 3.1

[2]

(ii) The speed of visible light in a vacuum is 3×10^8 m/s.

State the speed of infrared radiation in a vacuum.

Explain your answer.

speed of infrared radiation ..... m/s

explanation .....

.....

[1]

(b) A laser emits a beam of red visible light of wavelength 635×10^{-9} m.

Calculate the frequency of the red visible light emitted by the laser.

State the unit of your answer.

frequency = ... unit ..... [3]

(c) Lasers can be used in hospitals to treat some types of cancer.

The cancer cells absorb radiation from the laser beam and increase in temperature.

The cancer cells are destroyed by high temperature.

(i) Absorption of radiation transfers energy to the cancer cells.

Identify the type of energy transferred to the cancer cells.

..... [1]

(ii) Laser treatment is more effective when the cancer cells are covered with a dull black carbon coating.

Suggest why the dull black carbon coating makes the treatment more effective.

.....

..... [1]

(d) Metal solids are good thermal conductors.

Describe **two** ways that thermal energy is conducted by a metal solid.

1 .....

.....

2 .....

.....

[2]

[Total: 10]

4 **(a)** Fig. 4.1 shows part of a food web.

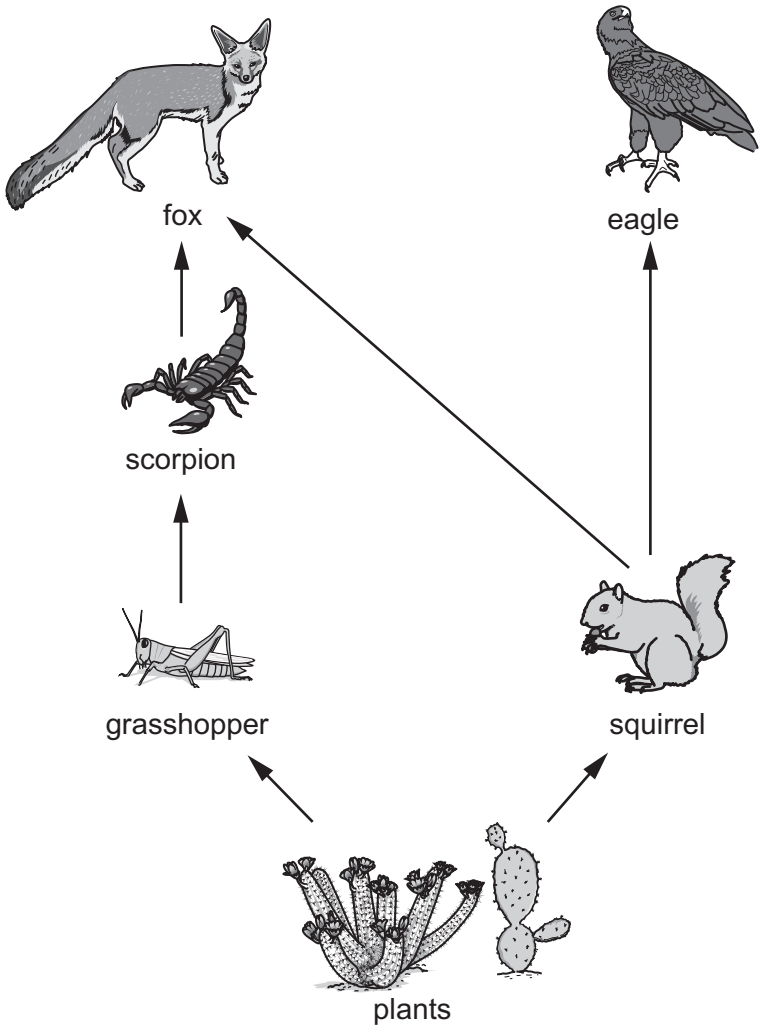

Fig. 4.1

(i) The food web is **not** complete.

Eagles also eat grasshoppers.

On Fig. 4.1, draw **one** arrow to show this relationship between eagles and grasshoppers. [1]

(ii) Identify **one** primary consumer in the food web shown in Fig. 4.1.

..... [1]

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

.....

.....

..... [2]

(b) The roots of plants take in water.

Explain how water moves from the soil into the root hair cells of a plant.

Use ideas about water potential in your answer.

.....

.....

.....

..... [3]

[Total: 7]

5 Fig. 5.1 shows how molten iron is used to join railway tracks together.

The molten iron is poured into the gap between the tracks.

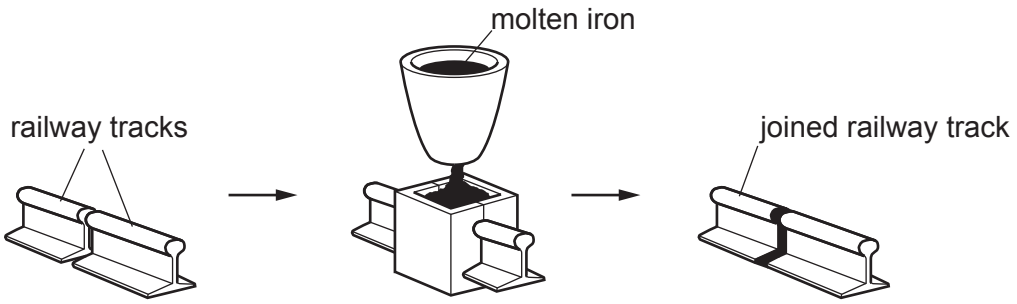

Fig. 5.1

The molten iron is produced in a reaction between aluminium and iron(III) oxide.

The reaction is exothermic and the temperature rises to about 2500 °C.

The equation for this reaction is shown.

$$2\,Al(s) + Fe_2O_3(s) \longrightarrow 2\,Fe(l) + Al_2O_3(s)$$

(a) Use the state symbols in the equation to suggest the melting point of iron and the melting point of aluminium oxide.

Explain your answers.

melting point of iron .....°C

melting point of aluminium oxide .....°C

explanation .....

.....

[2]

(b) Explain why iron is made in this reaction.

Use ideas about reactivity in your answer.

.....

.....

..... [2]

(c) The reaction between aluminium and iron(III) oxide is a redox reaction.

Name the oxidising agent in this reaction.

Explain your answer.

oxidising agent .....

explanation .....

.....

[2]

(d) The names and formulae of two different oxides of iron are listed in Table 5.1.

Table 5.1

name of iron oxide	formula
iron(II) oxide	FeO
iron(III) oxide	Fe_2O_3

Explain why the two different oxides of iron have these formulae.

Use ideas about the charges on the ions in your answer.

.....

.....

..... [2]

[Total: 8]

6 Fig. 6.1 shows a dinosaur called Tyrannosaurus Rex (T-Rex).

T-Rex lived about 66 million years ago.

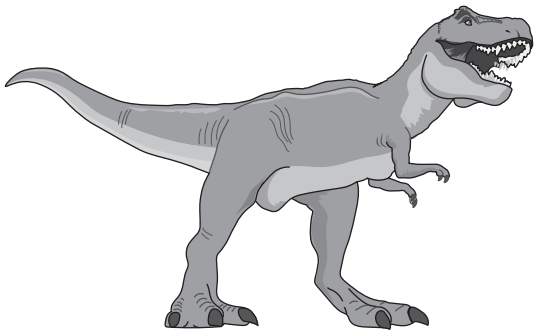

Fig. 6.1

(a) The T-Rex in Fig. 6.1 has a mass of 8000 kg.

Each foot has an area of 0.28 m^2 in contact with the ground.

Earth's gravitational field strength is 10 N / kg.

Calculate the pressure exerted by T-Rex standing on **two** feet.

pressure = ... Pa [3]

(b) The T-Rex moves for 14 s.

Fig. 6.2 shows a speed-time graph of the motion of the T-Rex.

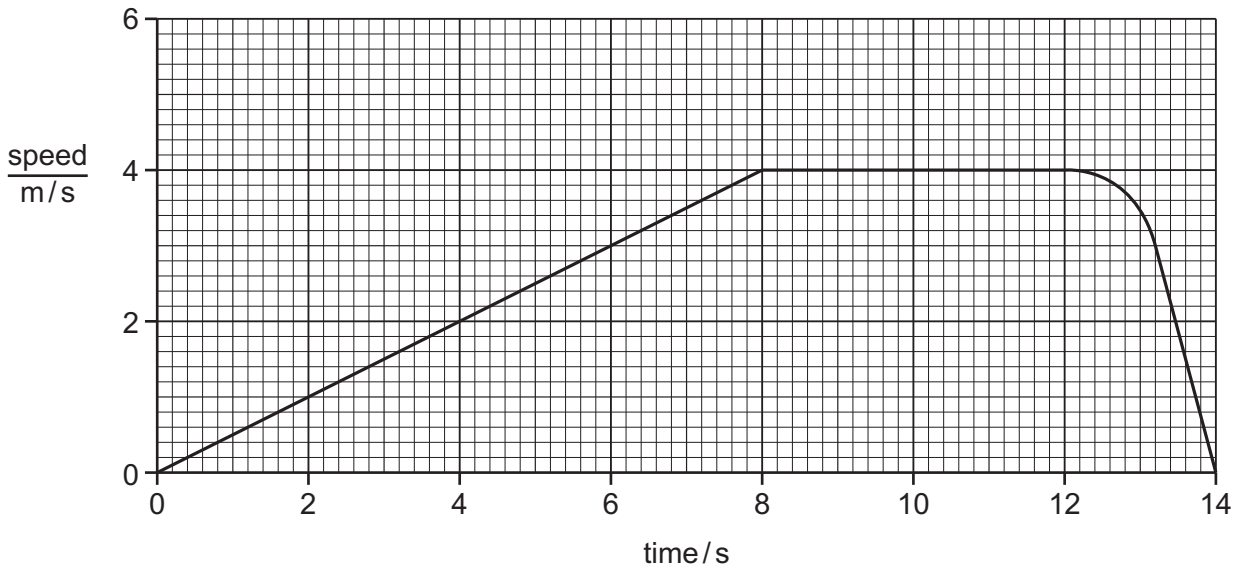

Fig. 6.2

(i) Calculate the acceleration of the T-Rex between 0 s and 8 s.

acceleration = ... m/s^2 [2]

(ii) Describe the motion of the T-Rex between 12 s and 14 s.

.....

..... [2]

(iii) Calculate the kinetic energy of the T-Rex when moving at its maximum speed.

kinetic energy = ... J [3]

[Total: 10]

7 **(a)** A student uses the apparatus in Fig. 7.1 to investigate the effect of temperature on the rate of photosynthesis of an aquatic plant.

During photosynthesis, the aquatic plant produces bubbles of gas.

The rate of bubbles produced shows the rate of photosynthesis.

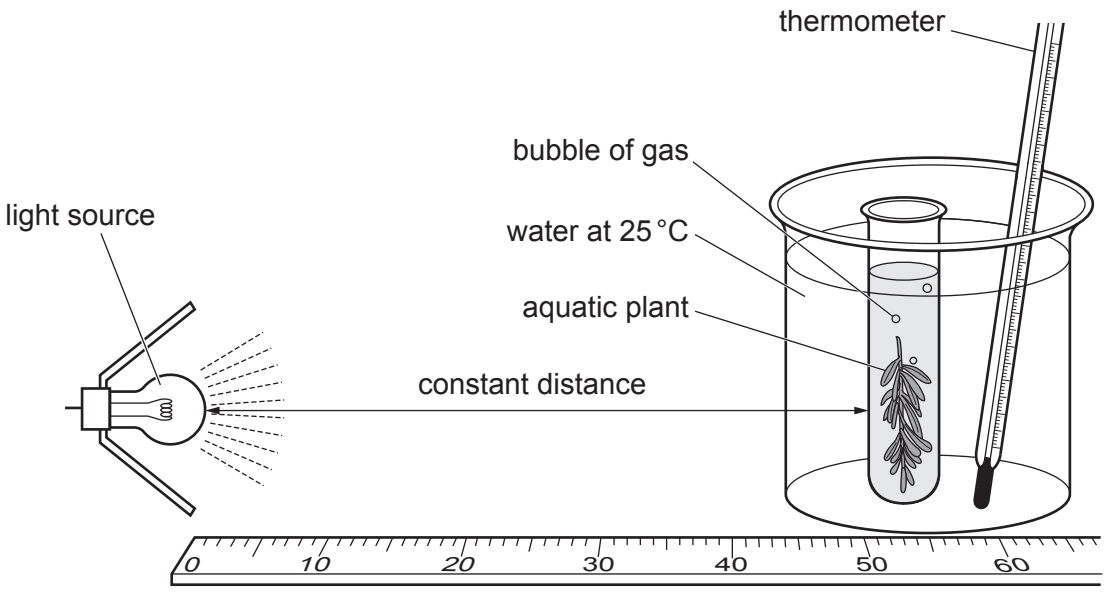

Fig. 7.1

The student counts the number of bubbles produced by the aquatic plant in 3 minutes.

The student does this two more times and calculates the average number of bubbles.

The student then repeats the investigation at different temperatures of water.

Table 7.1 shows the results.

Table 7.1

temperature of water / °C	number of bubbles produced in 3 minutes			
	experiment 1	experiment 2	experiment 3	average
25	56	64	59	60
30	75	78	83	79
35	98	93	97	96
40	78	81	76	78
45	20	21	19	20

(i) Describe the effect of temperature on the rate of photosynthesis shown by the results in Table 7.1.

.....

.....

..... [2]

(ii) The process of photosynthesis is controlled by enzymes.

Explain the result at 45 °C in Table 7.1.

Use ideas about enzymes in your answer.

.....

.....

..... [2]

(b) Fig. 7.2 shows a cross-section of a leaf of a plant.

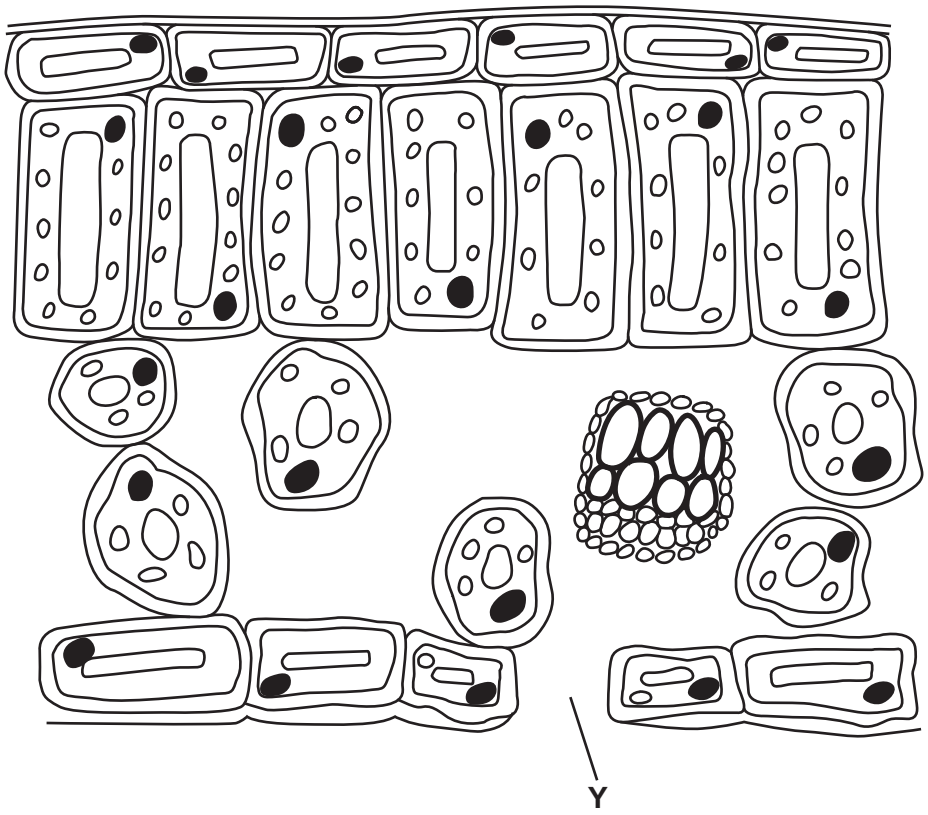

Fig. 7.2

(i) On Fig. 7.2, draw a label line and the letter **X** to identify cells adapted to synthesise **most** of the carbohydrates made by the leaf. [1]

(ii) State the function of the part labelled **Y** in Fig. 7.2.

..... [1]

(iii) Explain why a deficiency in magnesium ions results in a reduction in the synthesis of carbohydrates.

.....

.....

.....

.....

..... [3]

[Total: 9]

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8 Table 8.1 shows some properties of three elements in Group VII of the Periodic Table.

(a) (i) Complete Table 8.1.

Table 8.1

element	state at room temperature and pressure	colour at room temperature and pressure	melting point / °C	boiling point / °C
chlorine	gas	pale green	–219	–188
bromine	liquid		–7	59
iodine		grey-black	114	184

[2]

(ii) Explain why chlorine, bromine and iodine are in the same group of the Periodic Table.

Use ideas about electrons in your answer.

.....

..... [1]

(b) Fluorine is another element in Group VII.

(i) Fluorine molecules have the formula F_2. The atoms are held together by a single covalent bond.

Draw a dot-and-cross diagram for a fluorine molecule.

Show the outer electrons only.

[2]

(ii) Fluorine is a diatomic element.

Explain what is meant by *diatomic element*.

.....

.....

..... [2]

(c) The names of some elements in Group I are listed.

lithium
sodium
potassium
rubidium

(i) State which Group I element in this list reacts most vigorously with chlorine.

Give a reason for your answer.

element .....

reason .....

.....

.....
[2]

(ii) State the formula of the compound formed when potassium reacts with chlorine.

Use the Periodic Table on page 24 to help you.

..... [1]

[Total: 10]

9 Fig. 9.1 shows some electrical components of a car.

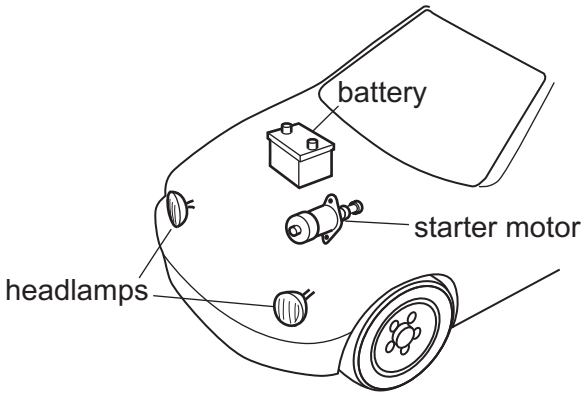

Fig. 9.1

Fig. 9.2 shows a circuit diagram for the components.

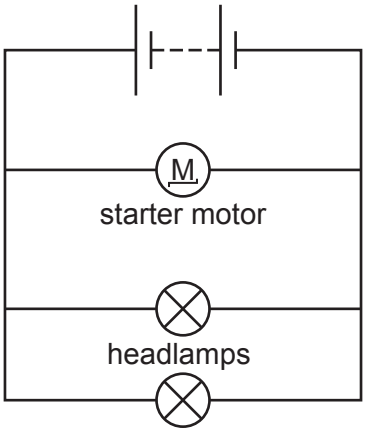

Fig. 9.2

(a) State **one** advantage of connecting the headlamps in parallel.

.....

..... [1]

(b) One headlamp requires a current of 5A.

The headlamp is switched on for five hours.

Calculate the total charge that flows through the headlamp in this time.

charge = ... C [3]

(c) The circuit is changed to include two switches, **S1** and **S2**.

- Switch **S1** controls the starter motor but does **not** control the headlamps.
- Switch **S2** controls **both** the headlamps but does **not** control the starter motor.

On Fig. 9.3, complete the circuit diagram to include switches **S1** and **S2**.

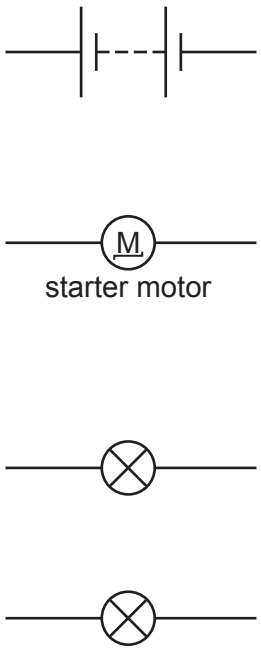

Fig. 9.3

[3]

[Total: 7]

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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.).