

CANDIDATE
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COMBINED SCIENCE

0653/31

Paper 3 (Extended)

October/November 2014

1 hour 15 minutes

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 soft pencil for any diagrams, graphs, tables or rough working.

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.

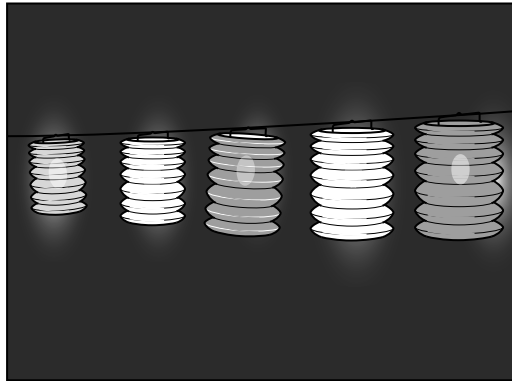
A copy of the Periodic Table is printed on page 24.

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 **21** printed pages and **3** blank pages.

- 1 Party lights add light and colour to festive occasions.

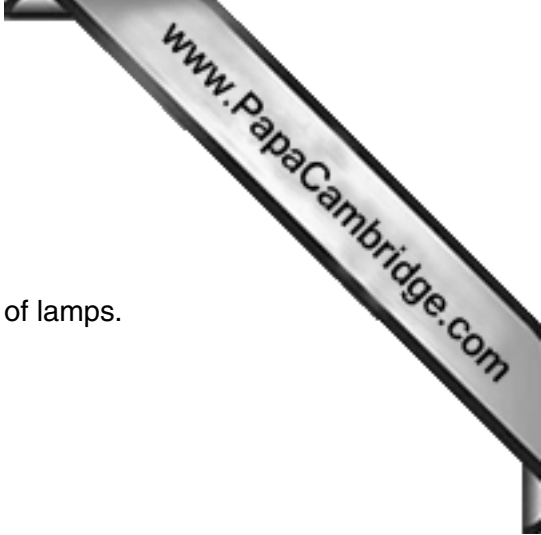


A set of party lights has a switch and a battery connected to five lamps in parallel.

The battery consists of four cells in series.

- (a) Draw the circuit diagram using standard circuit symbols for this set of party lights.

[2]



(b) The p.d. across the battery of four cells is 6V.

(i) Each lamp in the set is labelled 6V, 0.5A.

Find the current from the source required to light this set of lamps.

current from source = A [1]

(ii) Use your answer to (i) to calculate the total resistance of the set of lights.

State the formula that you use and show your working.

formula

working

total resistance = Ω [2]

(c) Most sets of party lights have lamps that are connected in parallel but some sets are connected in series.

State what happens to the set of lights if one lamp breaks when the lamps are connected in series,

.....

parallel.

.....[1]

2 Gasoline and petroleum jelly are products obtained from petroleum (crude oil) following distillation at an oil refinery.

(a) Statements **A** to **D** below describe the processes which occur during fractional distillation to produce gasoline.

The processes have been written in the wrong order.

A	gasoline vapour condenses into a liquid at its boiling point
B	petroleum mixture is heated in a furnace
C	vapour mixture enters the fractionating column
D	vapour mixture rises and cools

In the boxes in Fig. 2.1 write the letters **A** to **D** to show the correct order of the processes.

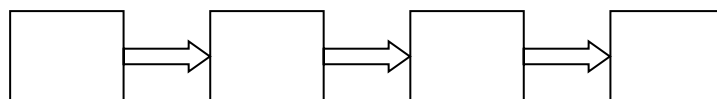


Fig. 2.1

[2]

(b) A process called *cracking* is also carried out at an oil refinery.

Fig. 2.2 shows the apparatus used to demonstrate the cracking of petroleum jelly.

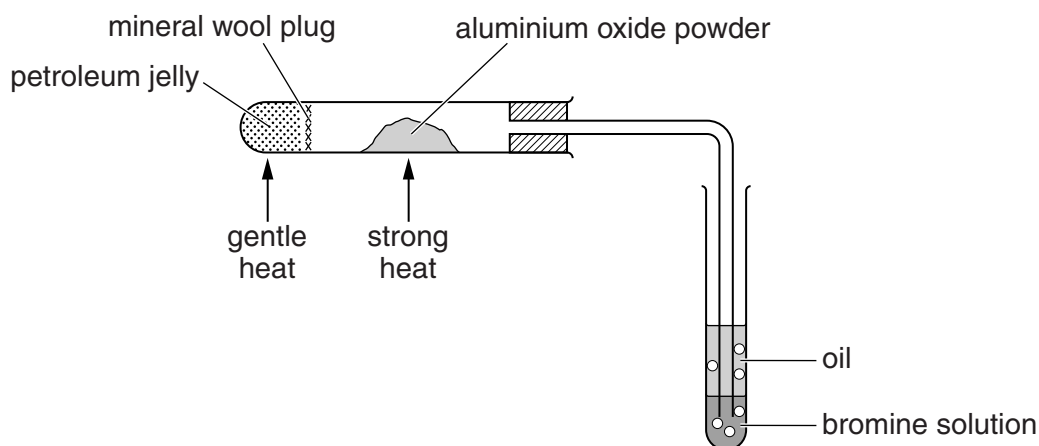


Fig. 2.2

Petroleum jelly is gently heated until it melts and then boils.

The vapour passes over aluminium oxide powder, which is strongly heated.

The gas formed reacts with bromine solution.

An oil forms on top of the bromine solution.

- (i) State the function of the aluminium oxide.

.....

- (ii) Explain, in terms of collisions of reacting particles, why the aluminium oxide is powdered.

.....

.....

.....[2]

- (iii) List petroleum jelly, diesel oil and refinery gas in order of their boiling points.

highest boiling point

.....

lowest boiling point

[1]

- (iv) List petroleum jelly, diesel oil and refinery gas in order of the average length of their molecules.

longest molecules

.....

shortest molecules

[1]

- (v) State the relationship between boiling point and length of molecules.

Explain your answer.

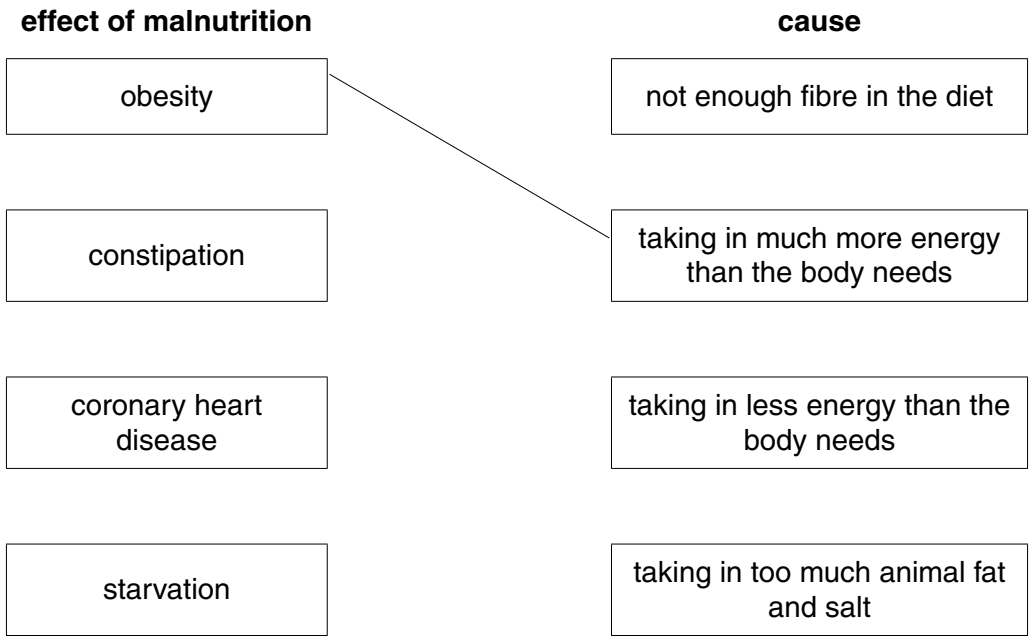
.....

.....

.....[2]

3 (a) If a person does not eat a balanced diet, they can suffer from malnutrition.

(i) Use straight lines to match the effects of malnutrition to their causes. One line is for you.



[2]

(ii) A person has constipation.

Suggest **one** food that may be missing from their diet and explain how this food prevents constipation.

food

explanation

.....[2]

(iii) Obese people are extremely overweight because they are taking in more energy than they need.

Suggest **one** food an obese person should avoid eating regularly and explain your answer.

food

explanation

.....[1]

(b) Taking exercise is recommended for people who are overweight.

A survey was carried out to compare the amounts of exercise taken by two groups of people. The first group was made up from people of normal weight and the second group was made up from overweight people. Each group contained 100 men and women.

The survey determined how many people took exercise at least twice a week. To count as exercise, an activity had to raise a person's heart rate for at least 20 minutes.

The results are shown in Fig. 3.1.

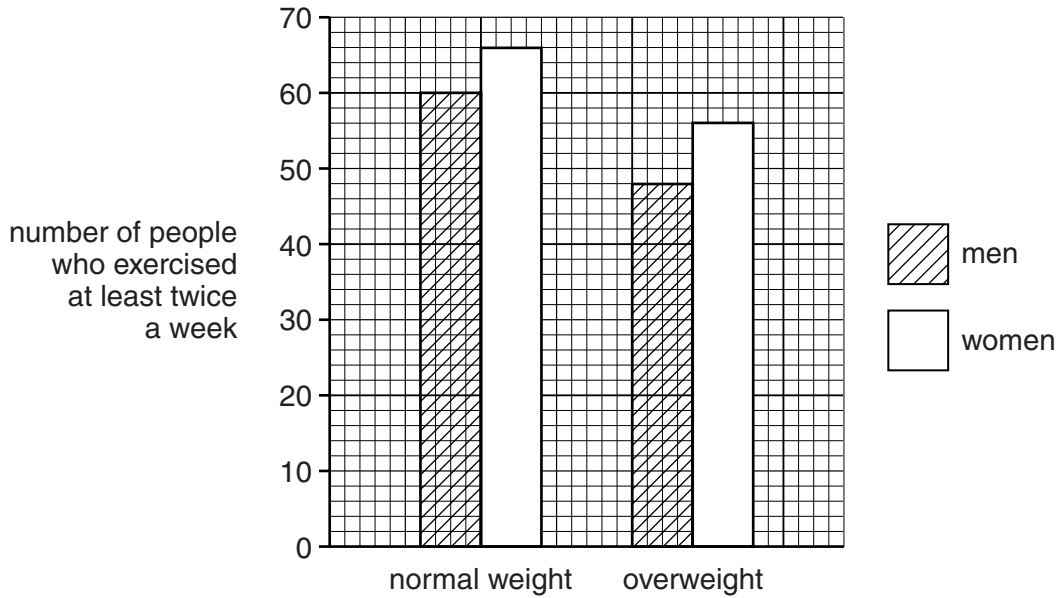


Fig. 3.1

(i) Use the information in Fig. 3.1 to compare the level of exercise people did in terms of their sex,

.....

their weight.

.....
 [2]

(ii) Suggest why there is not enough evidence in the survey to conclude that exercise prevents people from being overweight.

.....

 [2]

- 4 (a) A student investigates the neutralisation reaction between hydrochloric acid and potassium hydroxide.

Fig. 4.1 shows the apparatus she uses.

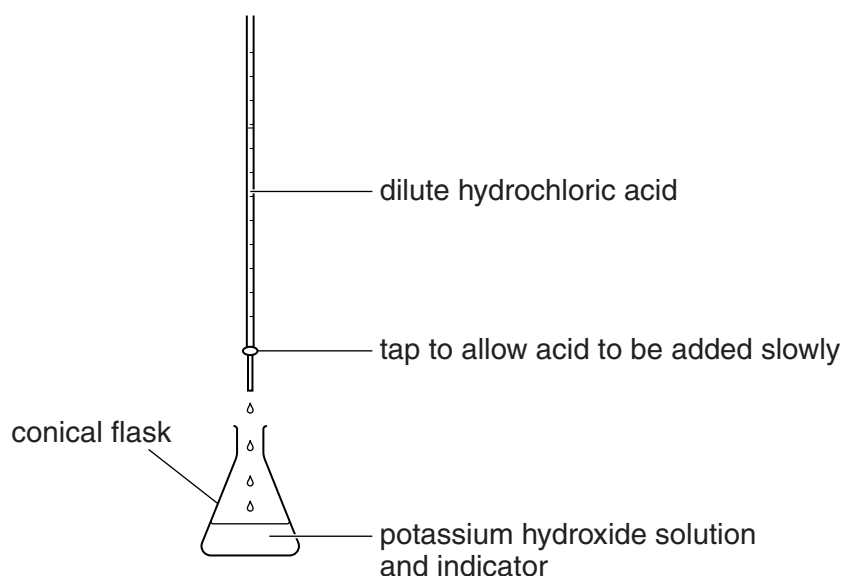


Fig. 4.1

She adds full range indicator (Universal Indicator) solution to the potassium hydroxide solution. Potassium hydroxide solution is alkaline.

She slowly adds some dilute hydrochloric acid to the potassium hydroxide solution until the solution in the flask is neutral.

The colour of the indicator changes as she adds the acid.

Fig. 4.2 shows how the colour of the indicator changes with pH.

pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
colour	RED		ORANGE			GREEN			BLUE			PURPLE			

Fig. 4.2

- (i) State the initial and final values of the pH of the solution in the flask.

initial

final

[1]

- (ii) State the initial and final colour of the indicator in the solution in the flask.

initial

final

[1]

(b) The reaction between hydrochloric acid and potassium hydroxide forms potassium chloride.

(i) Complete the balanced chemical equation for the reaction.



(ii) The student repeats part (a) in order to prepare a colourless sample of crystals of potassium chloride.

She changes the method described in part (a) slightly, using information obtained from the first time she carried out the experiment.

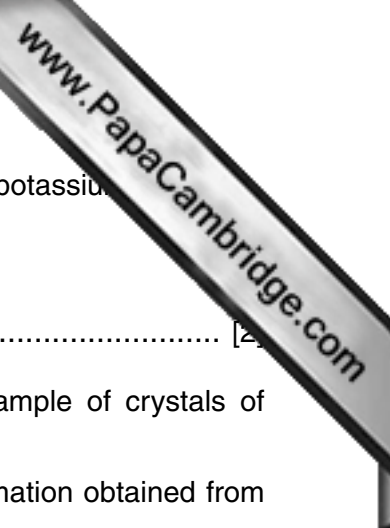
Describe the change in method and explain how she uses the results of her first experiment.

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

(c) The melting point of crystals of potassium chloride is 770°C .

Explain, in terms of the forces between particles, why potassium chloride forms crystals with a high melting point.

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



5 (a) Fig. 5.1 shows cells X and Y which were taken from different areas of the same leaf.

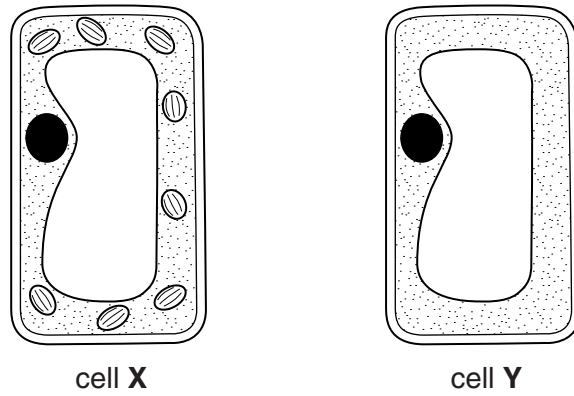


Fig. 5.1

Fig. 5.2 shows a leaf similar to the one from which these cells were taken.



Fig. 5.2

On Fig. 5.2, use label lines and the letters X and Y to show where these leaf cells came from.

Explain your answer below.

.....

.....

.....[2]

- (b) The leaf in Fig. 5.2 was then tested with iodine solution for the presence of starch.
 - (i) On Fig. 5.3 draw the result of the starch test on this leaf.
Label the leaf with the colours that are observed in different areas.

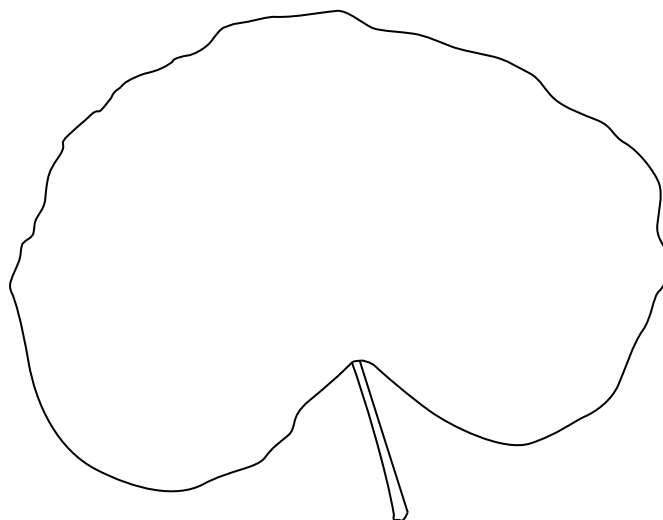


Fig. 5.3

- (ii) Explain why only parts of the leaf show the presence of starch.

.....

.....

.....

.....[3]

- (c) In humans, starch is digested by the enzyme amylase which starts its action while food is in the mouth cavity.

Explain in detail why amylase stops working after the food is swallowed and reaches the acidic conditions in the stomach.

.....

.....

.....

.....[3]

- 6 (a) Fig. 6.1 shows an aircraft accelerating along the airport runway.

The aircraft, fully loaded, has a total mass of 205 000 kg.

The diagram shows four forces, labelled **P**, **Q**, **R** and **S**, acting on the aircraft as it moves along the runway before taking off.

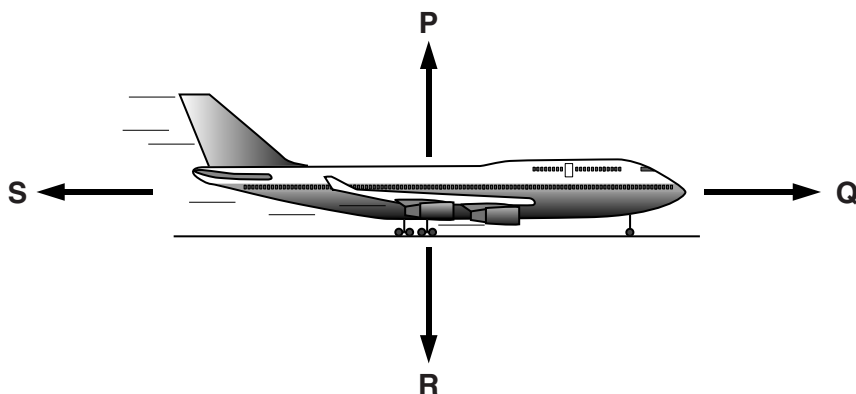


Fig. 6.1

- (i) State **two** forces from **P**, **Q**, **R** and **S** that are equal and opposite while the aircraft accelerates along the airport runway.

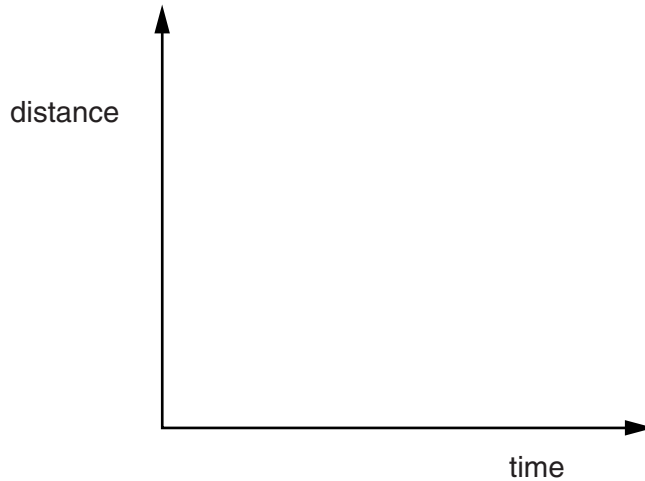
..... and [1]

- (ii) State which force from **P**, **Q**, **R** and **S** is the result of a gravitational field acting on the mass of the aircraft and give the name of this force.

.....
[2]



- (iii) On the axes below, sketch a distance/time graph for the aircraft as it moves along the runway from rest to take-off.



[1]

- (b) The aircraft takes off and climbs to a height of 5000 m.

The chemical energy in the aircraft's fuel is transferred to the aircraft as it takes off and climbs.

- (i) State **two** useful forms of energy gained by the aircraft as a result of this transfer.

..... and [1]

- (ii) The forms of energy in (b)(i) add up to less energy than the energy transferred from the fuel.

The principle of energy conservation applies to the energy transferred from the fuel.

State what happens to the remainder of the energy from the fuel.

.....[1]

- (c) When the aircraft levels out at a height of 5000m, it has burned some fuel and has a reduced total mass of 200 000 kg.

The aircraft flies at constant speed of 720 km/hr.

- (i) Calculate the speed of the aircraft in metres per second.

speed = m/s [1]

- (ii) Use your answer from (c)(i) to calculate the kinetic energy of the aircraft.

State the formula you use and show your working.

formula

working

kinetic energy = J [2]

7 (a) Fig. 7.1 shows the carbon cycle.

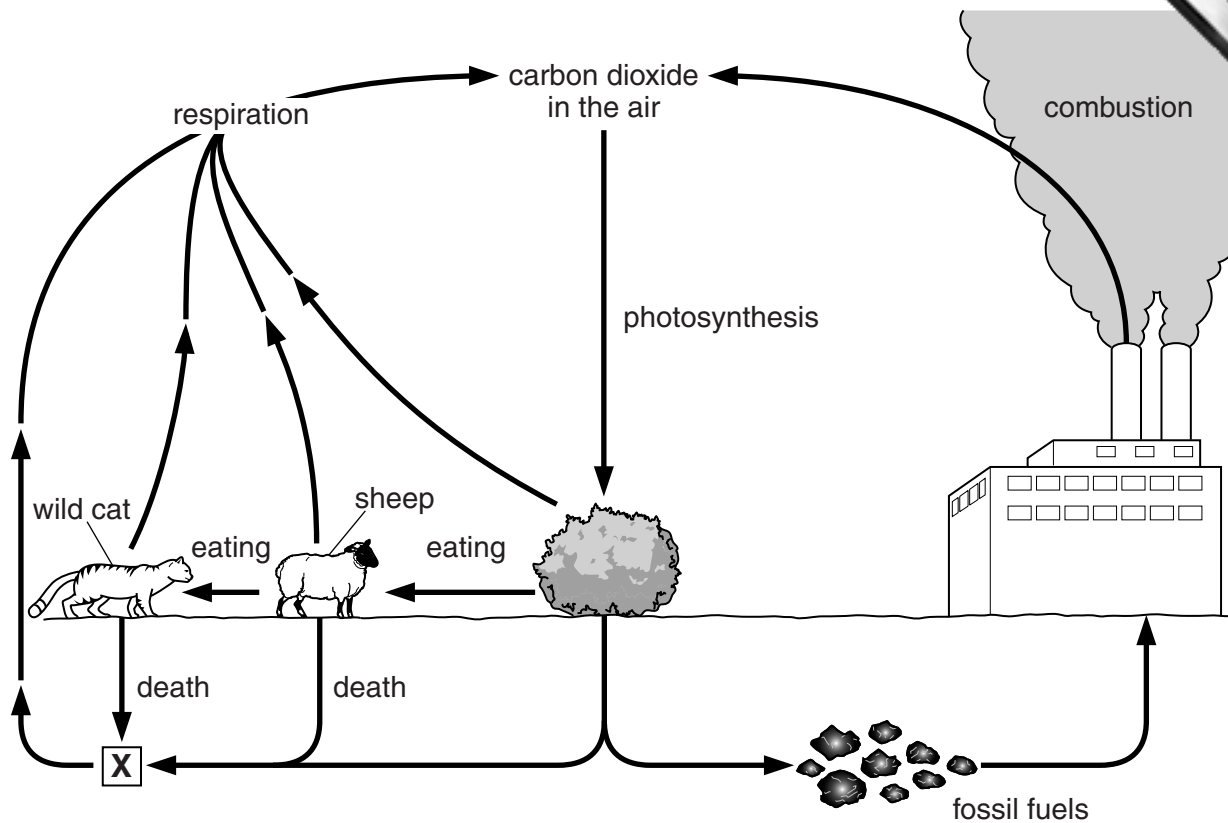


Fig. 7.1

(i) The sheep eats a plant leaf. A carbon atom from the starch in this leaf enters the air shortly after the leaf is eaten.

Describe a possible pathway taken by the carbon atom. Explain your answer fully.

.....

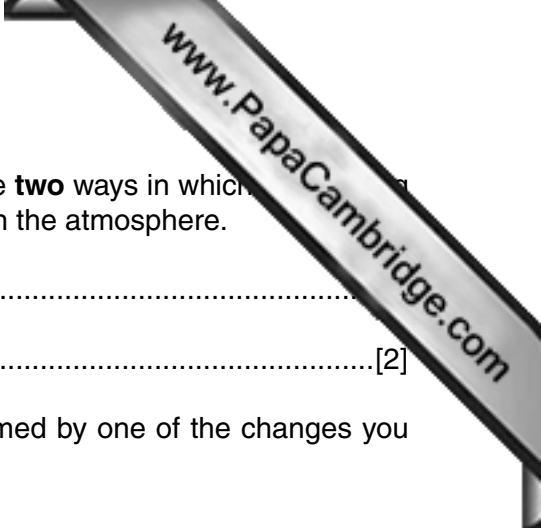
[3]

(ii) The organisms labelled X are found in the soil.

Describe in detail the role these organisms play in the carbon cycle.

.....

[3]



(b) (i) With reference to Fig. 7.1 and your own knowledge, state **two** ways in which the use of fossil fuels can change the composition of the gases in the atmosphere.

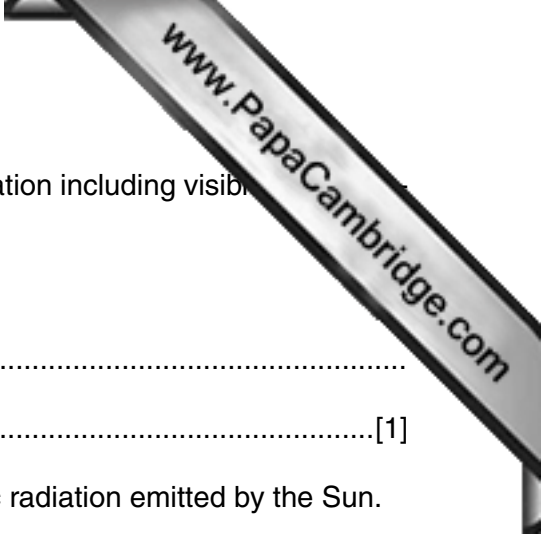
1

2[2]

(ii) Suggest **one** way in which the environment can be harmed by one of the changes you have stated in part (b)(i).

.....

.....[1]



8 The Sun emits many different frequencies of electromagnetic radiation including visible light, red, ultra-violet and X-rays.

(a) (i) State the meaning of the term *frequency*.

.....
[1]

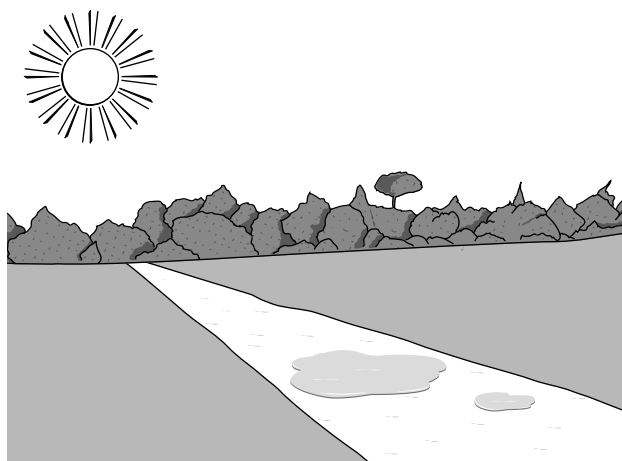
(ii) Complete Table 8.1 to show the types of electromagnetic radiation emitted by the Sun.

Table 8.1

highest frequency			lowest frequency			
gamma radiation			visible light		microwaves	radio waves

[2]

(b) After rain has fallen, puddles of water are left on the ground. When the Sun shines, it warms the air and the water in the puddles and dries the ground.



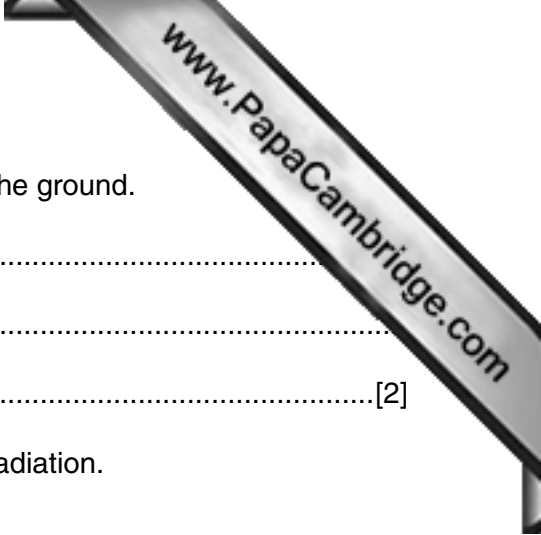
(i) Complete the following sentences about the forces and distances between molecules, using words or phrases.

When the Sun warms the water in a puddle on the ground, the water expands because the water molecules

When the water expands, the forces between the molecules

As the air above the puddle gets warmer, the molecules in the air move

[3]



(ii) Use your answers to (b)(i) to explain why the Sun dries the ground.

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

(c) The Sun produces sound waves as well as electromagnetic radiation.

(i) Explain why we cannot hear any sound from the Sun.

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

(ii) It takes eight minutes for the visible light emitted from the Sun to travel to the Earth.

Suggest how long it would take for a burst of X-rays emitted by the Sun to travel to the Earth. Give a reason for your answer.

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

9 (a) The Thermite reaction occurs between aluminium and iron oxide powders.

It is an example of a redox reaction.

Fig. 9.1 shows how a furnace in which the Thermite reaction is occurring can be used to repair a broken steel rail.

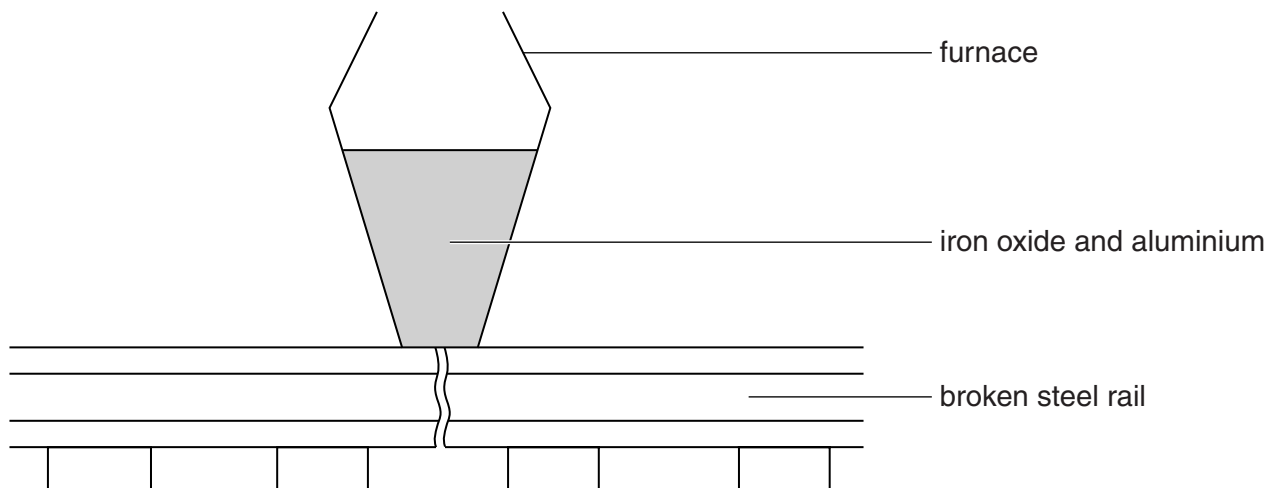


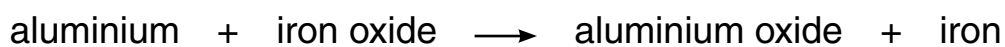
Fig. 9.1

The Thermite reaction produces molten iron that runs down into the broken rail and welds (joins) the ends together.

(i) State the type of chemical reaction that causes the temperature to increase.
[1]

(ii) State the energy transfer occurring during the reaction.
 → [1]

(iii) The word equation for the Thermite reaction is shown below.



Explain why the Thermite reaction is an example of a redox reaction.

.....

[2]

- (iv) Aluminium ore contains aluminium oxide.

A student suggests that metallic iron could be used to extract aluminium from its

State whether or not this would work.

Explain your answer by referring to the information contained in part (a)(iii).

.....

.....

.....[2]

- (b) In industry, aluminium is extracted from aluminium oxide by electrolysis.

Fig. 9.2 shows the apparatus used.

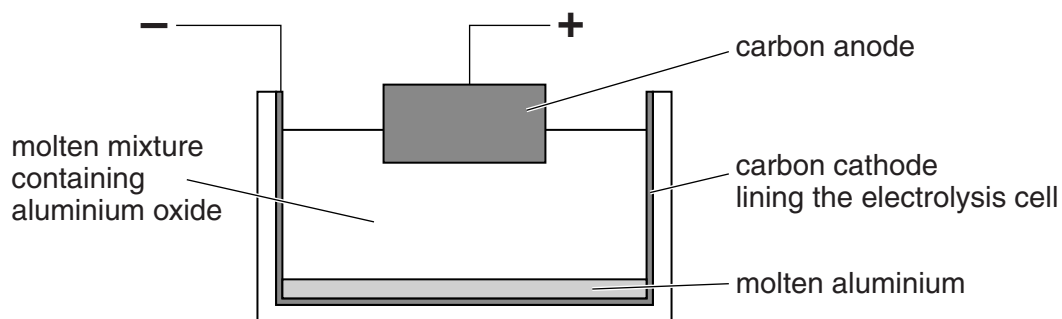


Fig. 9.2

- (i) Aluminium is deposited on the cathode.

Describe, by referring to the movement of ions and electrons, how these aluminium atoms are formed.

.....

.....

.....[2]

- (ii) Name the other substance formed by this electrolysis process.

.....[1]

DATA SHEET
The Periodic Table of the Elements

I		II		Group										VII	0											
				III	IV	V	VI																			
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10									
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18									
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36									
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	101 Ru Ruthenium 44	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54									
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86									
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89											140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
				232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103									

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

Key

a	X	a = relative atomic mass
X	X	X = atomic symbol
b	X	b = atomic (proton) number

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

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