Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

8130459498

COMBINED SCIENCE **0653/33**

Paper 3 (Extended) **May/June 2015**

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 an HB 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 20.

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 **20** printed pages.

DC (FD) 110067

1 (a) Fig. 1.1 shows an early type of airship filled with hydrogen gas.

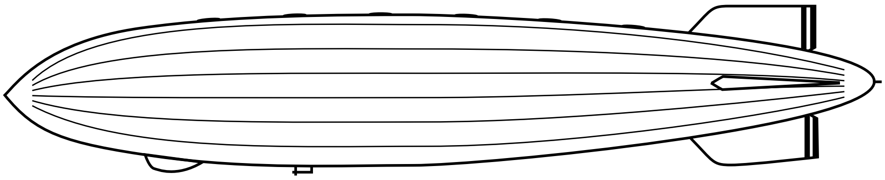


Fig. 1.1

A hydrogen molecule consists of two hydrogen atoms bonded together.

(i) Draw a diagram to show the electronic structure of a hydrogen molecule.

[2]

(ii) Suggest how the electronic structure causes the positively charged nuclei of the two atoms to be held together.

....

....

.... [1]

(iii) The use of hydrogen for airships declined following a disaster in which an airship caught fire.

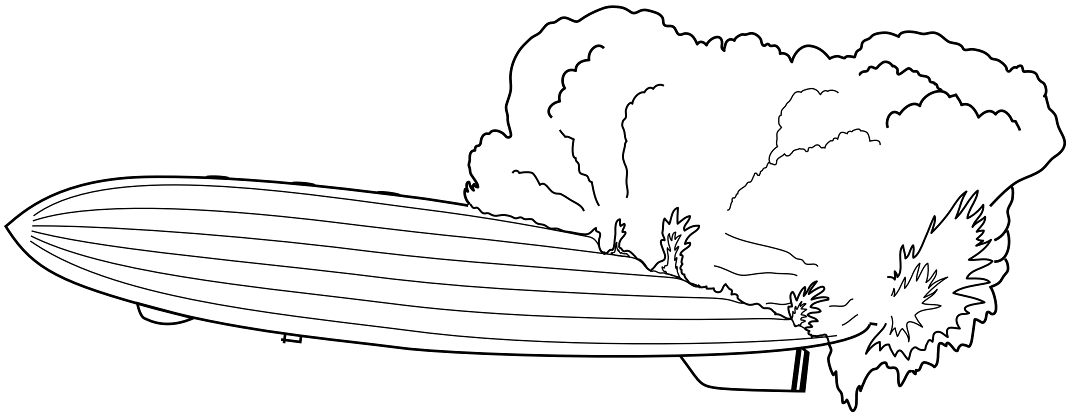


Fig. 1.2

Write a balanced symbol equation for the combustion of hydrogen.

.... [2]

(iv) Describe the energy transformation which occurs in this exothermic reaction.

....

.... [1]

(b) Fig. 1.3 shows a modern weather balloon containing hydrogen or helium gas.

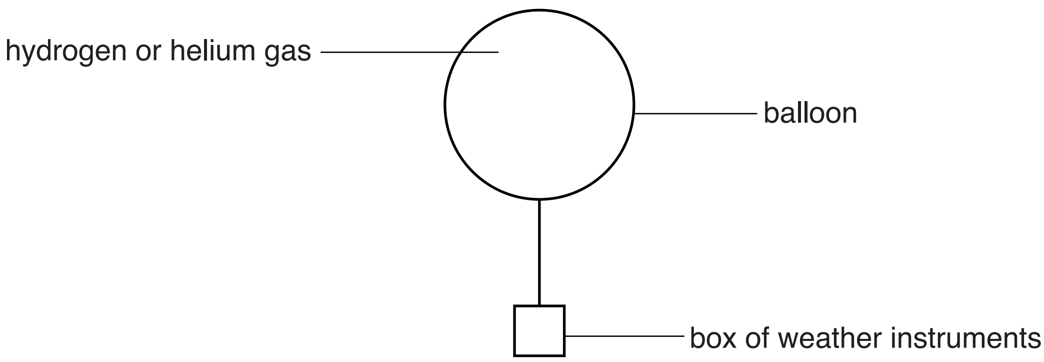


Fig. 1.3

Explain why the electronic structure of helium means that it is safer than hydrogen to use in a balloon.

....

....

.... [2]

2 **(a)** Fig 2.1 shows an animal cell.

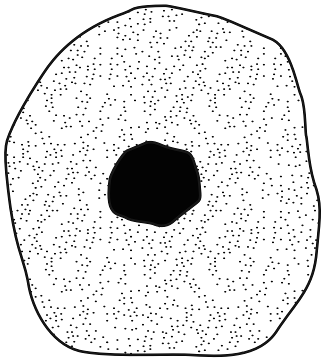


Fig. 2.1

(i) Identify the functions of the cell parts on Fig. 2.1 using label lines and the letters shown.

Use **C** to show the part which controls the cell.

Use **R** to show where chemical reactions, such as respiration, take place. [2]

(ii) One of the chemical reactions that takes place in the cell is aerobic respiration.

Complete the balanced symbol equation for aerobic respiration.

$C_6H_{12}O_6$ + ... → $6CO_2$ + ... [2]

(b) During exercise food stores are broken down in the body by respiration to release energy for muscles to contract. Some people exercise when they are trying to lose weight.

Anna is trying to lose weight by exercising.

Table 2.1 shows the approximate energy needed for 30 minutes each of four different types of exercise for Anna.

Table 2.1

type of exercise	energy needed for 30 minutes of exercise / kJ
cycling	850
golf	670
swimming	830
walking	580

(i) Anna went swimming for 30 minutes and then spent 30 minutes playing golf.
Calculate the **total** amount of energy she needs for these activities.

amount of energy needed = ... kJ [1]

(ii) From Table 2.1, suggest which two 30-minute activities cause Anna to break down the most of her food stores.

Explain your answer.

activities .... and ....

explanation ....

.... [2]

(iii) The exercise made Anna's pulse rate increase. This meant that her heart was beating more quickly.

Explain fully how this change in heart rate helps Anna to carry out the exercise.

....

....

....

.... [2]

(iv) Suggest a reason why the energy values given in Table 2.1 cannot be exactly the same for everyone doing the exercise.

....

.... [1]

3 Fig. 3.1 shows a man on a snowboard moving down a hill.

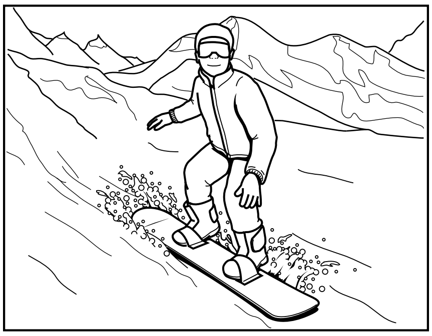


Fig. 3.1

Fig. 3.2 shows a graph of the man's speed as he goes down the hill.

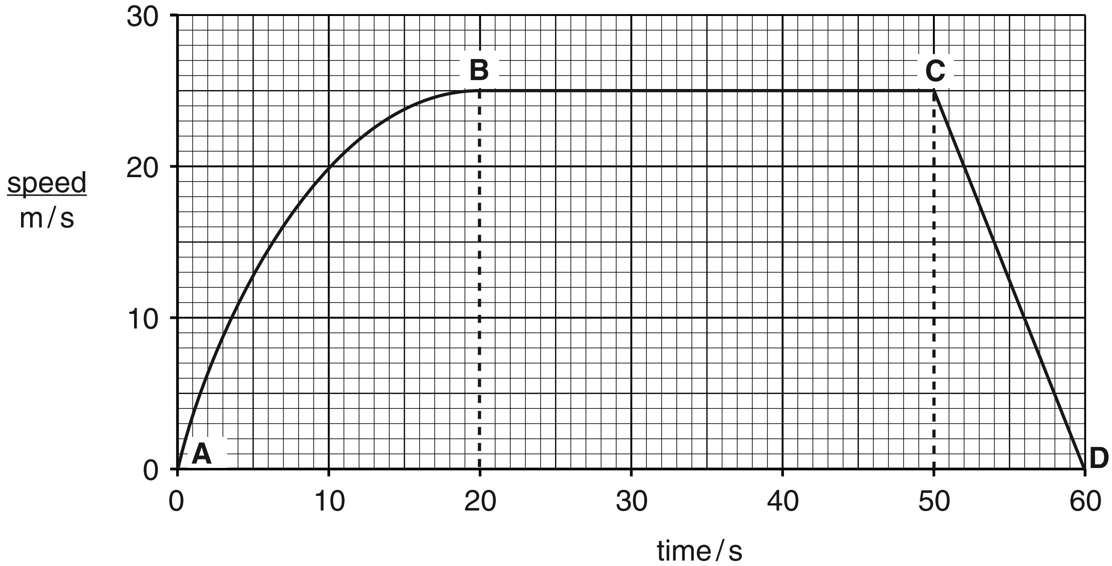


Fig. 3.2

(a) Describe the motion of the man between points

A and **B**, ...

....

B and **C**. ....

.... [2]

(b) Use the area under the graph to calculate the distance travelled by the man between points **C** and **D**.

Show your working.

distance = ... m [2]

(c) Calculate the acceleration of the man between points **C** and **D**.

State the formula you use, show your working and state the unit of your answer.

formula

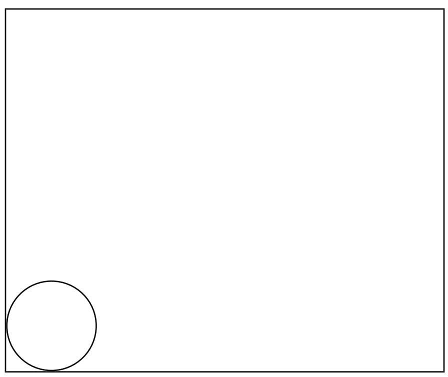
working

acceleration = ... unit .... [3]

(d) Snow is made of solid ice crystals.

In the box below, draw a diagram to show the arrangement of particles in a solid.

One particle has been drawn for you. You need to draw at least 11 more.



[2]

4 **(a)** A sample of soil is mixed with water and filtered.

(i) Describe a test that would show that the soil is acidic.

....

....

.... [2]

(ii) In order to reduce soil acidity, limestone is sometimes added.
Limestone consists mainly of calcium carbonate.

Complete the word equation for the reaction occurring between calcium carbonate and dilute hydrochloric acid.

calcium carbonate + hydrochloric acid $\rightarrow$ carbon dioxide + ... + ...

[2]

(b) Fig 4.1 shows apparatus some students use to investigate the effect of temperature on the rate of reaction between calcium carbonate and dilute hydrochloric acid.

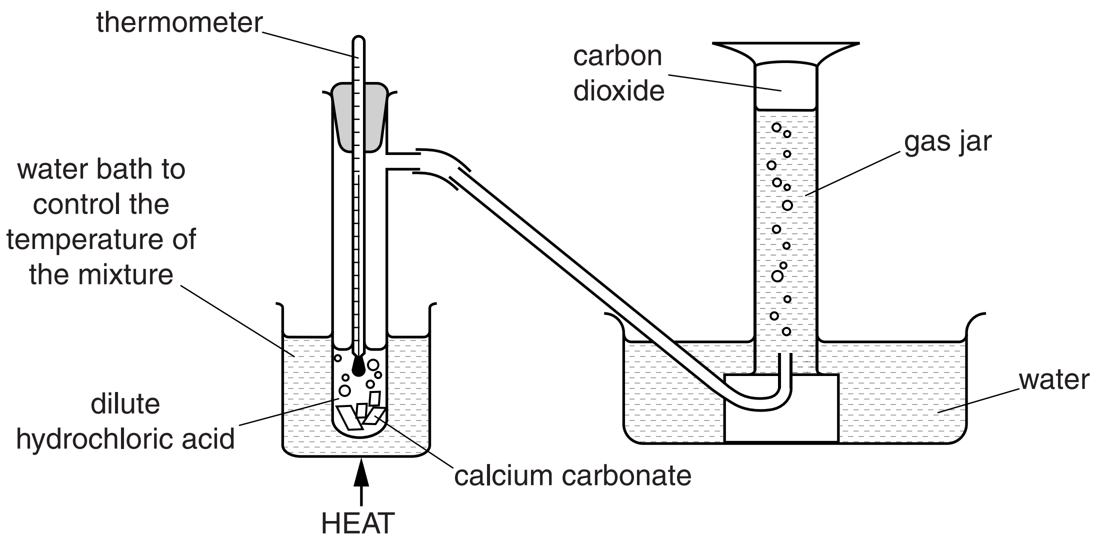


Fig. 4.1

They add pieces of calcium carbonate to the dilute hydrochloric acid and time how long it takes for carbon dioxide to fill the inverted gas jar.

They repeat the experiment several times. Each time the experiment is repeated, the only difference is the temperature of the dilute hydrochloric acid.

Table 4.1 shows the results of the investigation.

Table 4.1

temperature / °C	time taken to fill the gas jar / s
20	156
30	75
40	37
50	20
60	10

(i) Use Table 4.1 to state how the rate of reaction changes when the experiment is repeated at higher temperatures.

....

.... [1]

(ii) Explain your answer to **(i)** in terms of the collisions between particles.

....

....

....

.... [2]

(c) The soil treatment described in **(a)(ii)** adds to the amount of carbon dioxide in the atmosphere.

(i) State another reason why the amount of carbon dioxide in the atmosphere is increasing.

....

.... [1]

(ii) Describe how this increase could be affecting the environment.

....

.... [1]

5 **(a)** Fig. 5.1 shows two small flowers of a wind-pollinated grass.

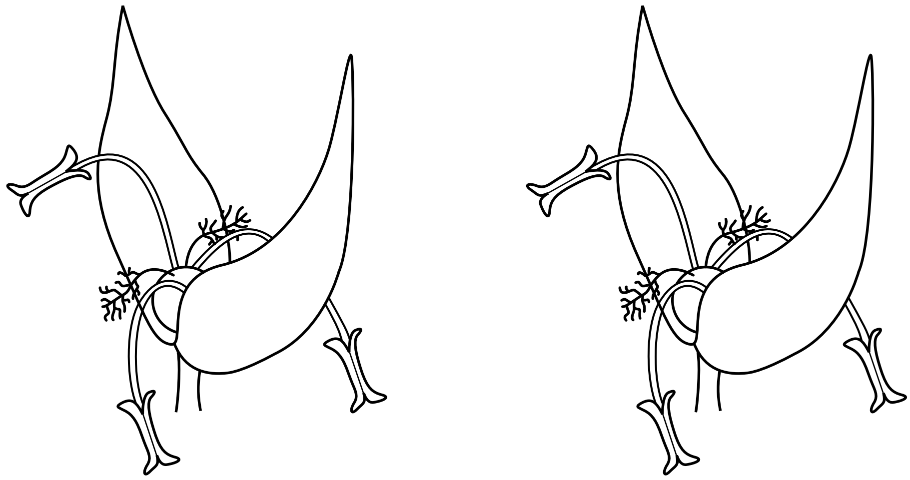


Fig. 5.1

(i) On Fig. 5.1 draw an arrow to show the transfer of pollen from flower **A** to flower **B** during pollination. [2]

(ii) Describe **two** adaptations of this grass flower for wind pollination. Use only features visible in Fig. 5.1.

1 ....

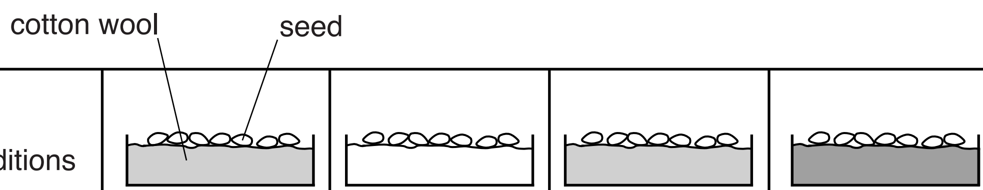
....

2 ....

.... [2]

(b) A student sets up an experiment to investigate the conditions needed for germination of seeds. She uses cotton wool and seeds as shown in Fig. 5.2.

Dish 3 is placed in a fridge with a glass door. The rest of the dishes are left by a window in the laboratory.



conditions	**dish 1**	**dish 2**	**dish 3**	**dish 4**
type of water use	tap water (pH7)	no water	tap water (pH7)	acid rain water (pH4)
temperature	20°C	20°C	4°C	20°C

Fig. 5.2

After a few days the dishes are examined.

Table 5.1 shows what the student observes.

Table 5.1

dish number	observations
1	all seeds germinated, seedlings 1 cm tall
2	no germination
3	no germination
4	no germination

Using the results in Table 5.1, describe evidence that the following conditions affect germination.

(i) temperature

....

.... [1]

(ii) pH

....

.... [1]

(iii) State **one** other condition, not investigated in this experiment, that is needed for germination of seeds.

.... [1]

(iv) For germination to take place the enzymes in the seeds must be active.

Use this information to explain fully why the seeds did not germinate in dish **4**.

....

....

.... [2]

6 Many different musical instruments are played in an orchestra.

Table 6.1 shows the lowest and highest frequencies for the sounds of the musical notes produced by some instruments in an orchestra.

Table 6.1

instrument	lowest frequency / Hz	highest frequency / Hz
bassoon	58	932
cello	65	659
clarinet	147	1865
flute	262	2093
harp	31	3322
trumpet	165	1000
violin	196	2637

(a) Identify which instrument in Table 6.1

(i) has the largest difference between highest and lowest pitch, ... [1]

(ii) produces a sound with the longest wavelength. .... [1]

(b) A large drum emits sound of frequency 30 Hz.

Explain why a drum that emits a frequency of 15 Hz would not be used in an orchestra.

....

.... [1]

(c) Calculate the wavelength for the highest frequency sound made by a trumpet. The speed of sound in air is 330 m/s.

State the formula you use and show your working.

formula

working

wavelength = ... m [2]

(d) Fig. 6.1 shows a violin string before the violinist plays.

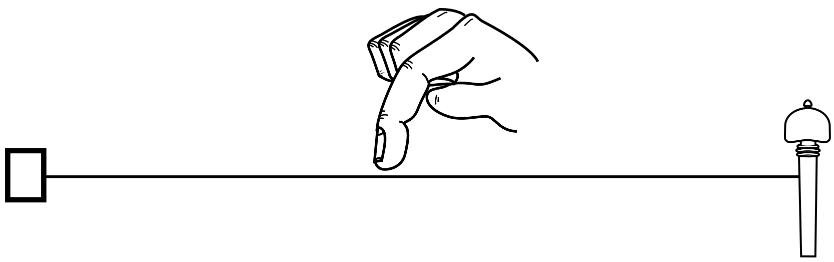


Fig. 6.1

On Fig. 6.2 draw a diagram to show how the violin string vibrates when the violinist plucks the string and use your diagram to explain why this produces sound waves

Fig. 6.2

....

....

....

.... [3]

7 **(a)** When a hydrocarbon **D** undergoes cracking, two new compounds, **X** and **Y**, are obtained.

X and **Y** are tested using bromine solution.

These processes are shown in Fig. 7.1.

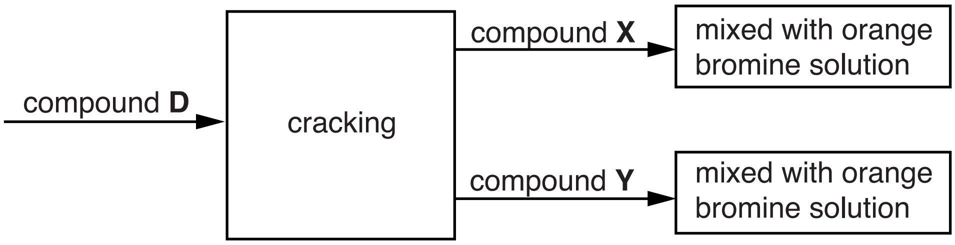


Fig. 7.1

X is an alkane. **Y** is an alkene.

(i) State **two** conditions needed for cracking.

1 ....

2 .... [2]

(ii) Compare the size of the molecules of compounds **X** and **Y** with the size of the molecules of compound **D**.

....

.... [1]

(iii) Describe the effects on the bromine solution caused by **X** and **Y**.

X ....

....

Y ....

.... [1]

(b) Draw the molecular structures of ethane and ethene.

ethane **ethene**

[3]

(c) Fig. 7.2 shows how bromine is produced from molten lead bromide in a laboratory experiment, $PbBr_2$.

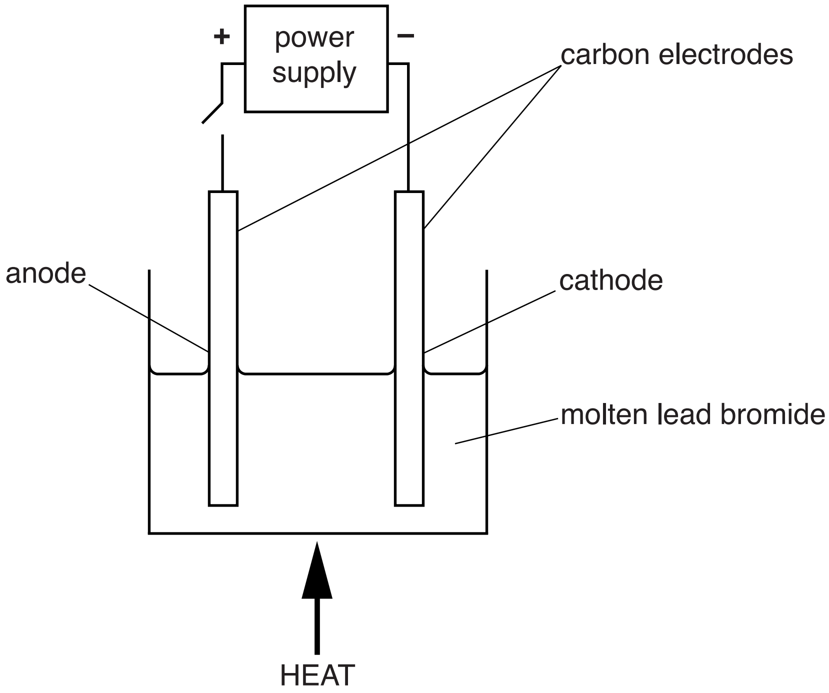


Fig. 7.2

(i) Explain why bromide ions move to the anode when the switch is closed.

....

.... [1]

(ii) Describe how bromine atoms are formed at the anode.

....

.... [1]

8 **(a)** Fig. 8.1 shows the flow of chemical energy through the food chains in a habitat. The numbers represent the amount of chemical energy per square metre per year.

producers	$\longrightarrow$	primary consumers (herbivores)	$\longrightarrow$	secondary consumers (carnivores)
21 000 kJ		3000 kJ		400 kJ

Fig. 8.1

(i) Calculate the percentage of the chemical energy in the producers that is **not** transferred to the carnivores.

Show your working.

answer = ...% [2]

(ii) The source of energy for the producers is sunlight which is needed for photosynthesis.

Describe the role of chlorophyll in energy transformation during photosynthesis.

....

....

.... [2]

(b) Fig. 8.2 shows a food chain in Africa. The information inside the box includes details about the flow of energy into and out of the zebra.

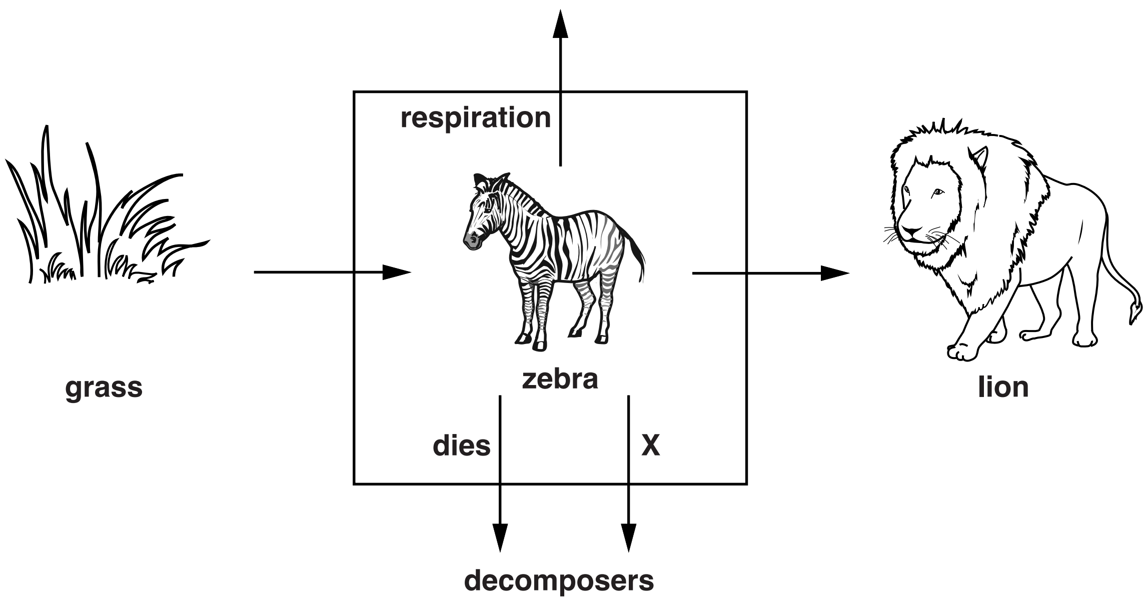


Fig 8.2

(i) Suggest ways in which energy could be lost at **X**.

....

....

.... [2]

(ii) Explain the importance of the decomposers shown in Fig. 8.2.

....

....

.... [2]

9 Fig. 9.1 shows a caravan which uses an electric heater to supply warm air to heat the caravan and to heat water.

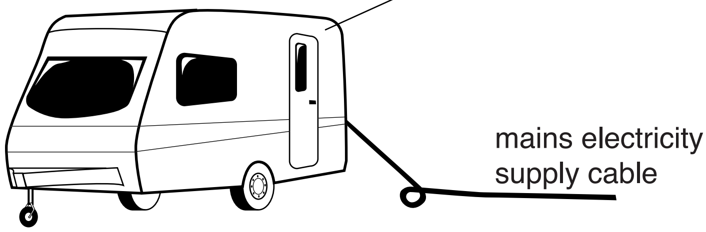


Fig. 9.1

Fig. 9.2 shows a circuit diagram for the electric heater. It contains two elements, one for heating the air and one for heating the water.

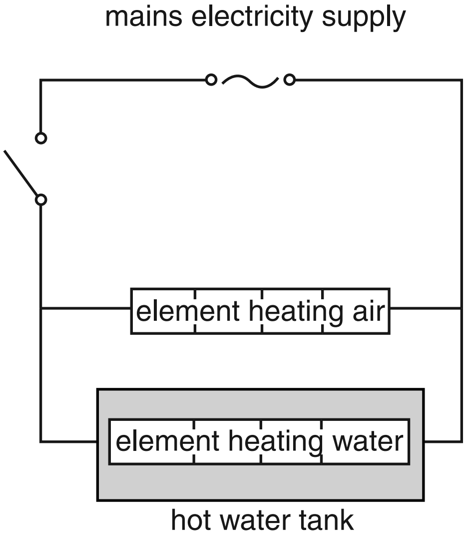


Fig. 9.2

(a) (i) The air around the electric heater is heated. The heated air then flows around the caravan and warms the people sitting inside.

Name the process by which the heated air warms up the caravan.

.... [1]

(ii) Explain why the heater causes the warm air to circulate inside the caravan.

....

.... [2]

(iii) The hot water must be kept hot in the hot water tank after the heater is switched off.

Suggest a method of keeping the water hot for a long time in the tank after heating.

....

.... [1]

(b) The circuit diagram in Fig. 9.2 only allows both heating elements to be switched on or both heating elements to be switched off.

Complete the circuit diagram in Fig. 9.3 to show a different circuit which allows the people in the caravan to have one element switched on and the other element switched off.

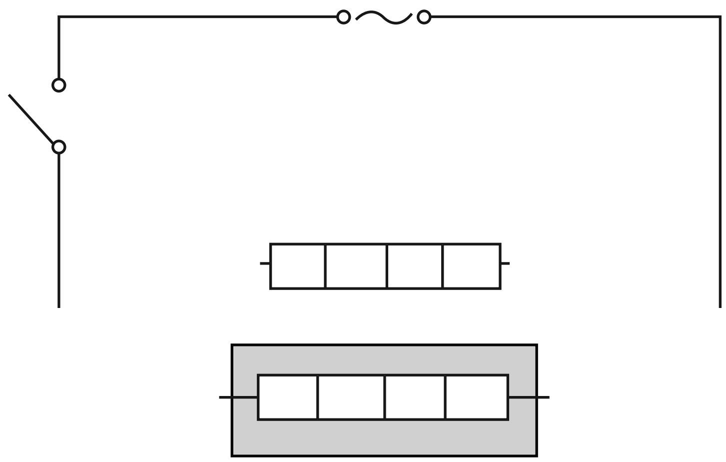


Fig. 9.3

[2]

(c) The resistance of the water heater is 30 Ω.

When both elements are switched on, the current in the water-heating element is 8 A and the current in the air-heating element is 4 A.

(i) Calculate the potential difference across the heating elements from the mains electricity supply.

State any formula that you use, show your working and state the unit of your answer.

formula

working

potential difference = ... unit .... [3]

(ii) Use the formula $P = IV$ to calculate the electrical power taken by the warm air heater.

Show your working.

power = ... W [1]

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
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	**Tc** Technetium 43	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** b	a = relative atomic mass **X** = atomic symbol b = atomic (proton) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).