Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

2232084033

COMBINED SCIENCE **0653/32**

Paper 3 (Extended) **May/June 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 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 28

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 **28** printed pages.

IB14 06_0653_32/4RP

1 **(a)** In many countries, vehicle speeds are measured by speed cameras to see if they are exceeding the speed limit. The camera takes two photographs of a vehicle after it passes the camera.

Fig. 1.1 shows a moving van about to pass a speed camera.

The van drives over lines painted on the road at 1 metre intervals.

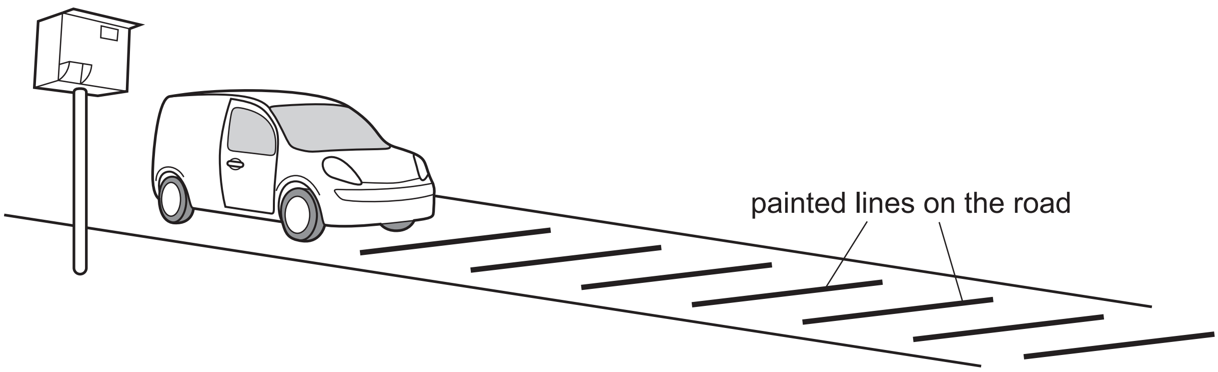


Fig. 1.1

Fig. 1.2 shows the position of the van as the camera takes the first photograph. Fig. 1.3 shows the position of the van 0.2 seconds later, as the camera takes the second photograph.

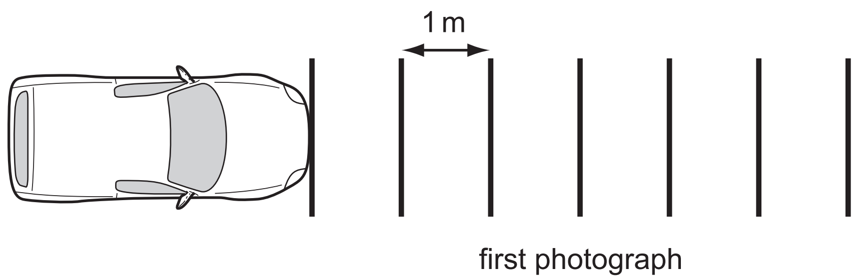


Fig. 1.2

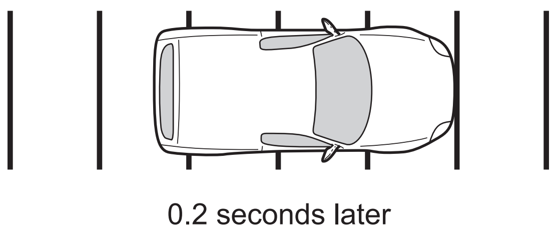


Fig. 1.3

(i) Calculate the speed of the van in m / s.

State the formula that you use and show your working.

formula

working

.... m / s [2]

(ii) The speed limit on this road is 80 km / h.

Show, by calculation, that the van was breaking the speed limit.

speed of the van = ... km / h [2]

(b) **(i)** The mass of the van is 1600 kg.

Calculate the kinetic energy of the van when it travels at a steady speed of 10 m / s.

State the formula that you use and show your working.

formula

working

kinetic energy of van = ... J [2]

(ii) The van stops.

Explain what happens to the kinetic energy.

....

.... [2]

(c) The driver sounds the van's horn when he needs to warn of his approach. The horn emits a note of frequency 200 Hz.

The wavelength of the sound wave is 1.6 m.

Calculate the speed of sound in air.

State the formula that you use and show your working.

formula

working

speed of sound = ... m / s [2]

2 Fig. 2.1 shows a water lily. The leaves of the water lily float on the surface of water.

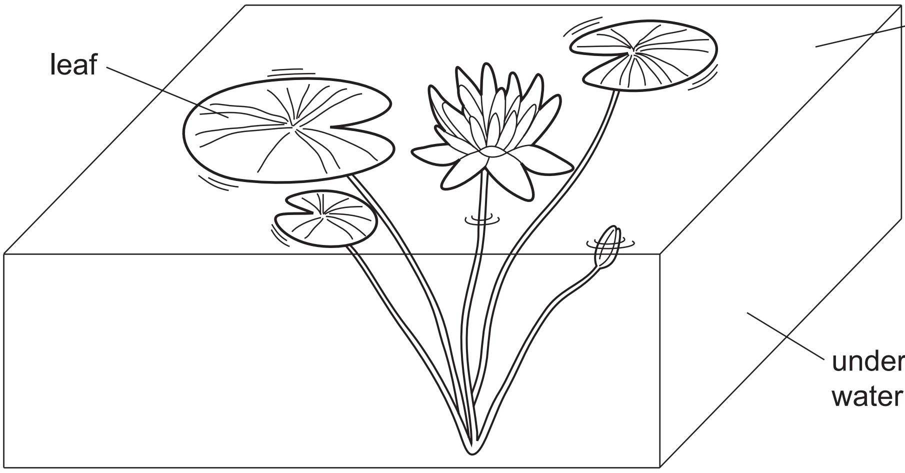


Fig. 2.1

The water lily produces carbohydrates by photosynthesis.

(a) Complete and balance the symbol equation for photosynthesis.

.... CO_2 + 6 H_2O $\xrightarrow[\text{chlorophyll}]{\text{light}}$ $C_6H_{12}0_6$ + ... [2]

(b) Fig. 2.2 shows a cross-section of a small part of a water lily leaf as seen under the light microscope.

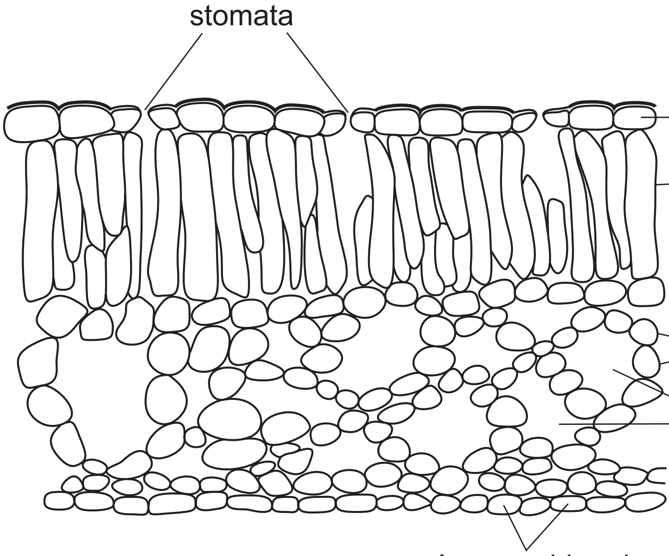


Fig. 2.2

(i) Suggest how the large size of the air pockets in the leaf adapts the water lily to its habitat.

....

.... [1]

(ii) The roots of most plants have root hair cells but water lilies do not.

Suggest why the roots of water lily plants do **not** need root hair cells.

....

....

.... [2]

(c) Some fertiliser is washed into a deep pond where a water lily is growing. The fertiliser causes the water lily to grow very quickly, and the leaves soon cover the surface of the pond.

Predict and explain how this growth of the water lily affects

(i) small submerged aquatic plants,

....

.... [1]

(ii) the amount of dissolved oxygen in the water at the bottom of the pond,

....

....

.... [2]

(iii) fish and snails in the pond.

....

.... [1]

3 **(a)** Fig. 3.1 shows the arrangement of copper atoms and zinc atoms in the alloy brass.

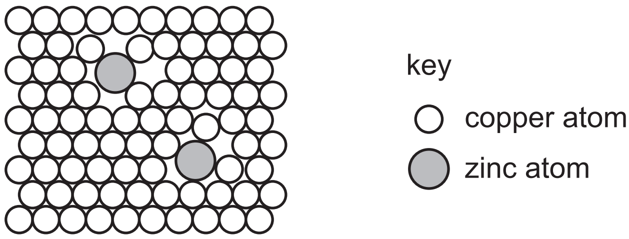


Fig. 3.1

Use Fig. 3.1 to explain the difference in malleability between brass and pure copper.

....

....

.... [2]

(b) Copper slowly corrodes in air, forming a thin black coating of copper oxide, CuO. Copper oxide is an insoluble base which can be removed by reacting it with acid to form a blue solution.

(i) Name the type of compound, other than water, formed when an acid reacts with a base.

.... [1]

(ii) Hydrochloric acid, HC*l*, is used to produce copper chloride, $CuCl_2$, from copper oxide.

Write a balanced, symbolic equation for the reaction.

.... [2]

(c) A different compound of copper and oxygen exists. It is coloured red and contains the ions Cu^{+} and O^{2-}.

Deduce the chemical formula of this red copper oxide. Show how you obtained your answer.

....

.... [2]

Please turn over for Question 4.

4 A student does some exercise to find out if there is a relationship between type of exercise and pulse rate.

She measures and records her pulse rate when resting. She performs one type of exercise and then immediately measures her pulse rate again. She repeats this procedure for two more types of exercise. Each exercise is performed for the same length of time.

She allows her pulse to return to the resting measurement between each exercise.

Her results are shown in Table 4.1.

Table 4.1

type of exercise	pulse rate / beats per minute
resting	74
walking slowly	87
walking quickly	116
running	163

(a) **(i)** State which exercise produced the greatest increase in pulse rate and calculate this increase.

type of exercise ....

increase in pulse rate = ... beats / minute [2]

(ii) Describe the trend shown by the results in Table 4.1

....

.... [1]

(b) Complete the paragraph, using words from the list, to explain the changes in the student's body as she exercises.

You may use the words once, more than once, or not at all.

carbon dioxide **deeper** **faster** **glucose**

glycogen **respiration** **running** **shallower** **slower**

The student needs more energy for her leg muscles to contract, so the rate of

.... increases in her muscle cells. Her blood supplies more

oxygen and .... to her muscle cells, and removes more

.... To do this the student's heart beats at a

.... rate. [4]

5 **(a)** Table 5.1 shows the elements of the third period of the Periodic Table with their electronic structures.

Table 5.1

Group								
I	II		III	IV	V	VI	VII	0
Na 2,8,1	Mg 2,8,2		Al 2,8,3	Si 2,8,4	P 2,8,5	S 2,8,6	Cl 2,8,7	Ar 2,8,8

(i) Describe how the metallic character of these elements changes across the period.

.... [1]

(ii) State the relationship between the metallic character of an element and its electronic structure.

....

.... [1]

(b) Table 5.2 shows the properties of some elements in Group I of the Periodic Table.

Table 5.2

name of element	melting point / °C	reaction with water
lithium	181	metal remains solid and a gas is given off
sodium	98	metal melts and a gas is given off quickly
potassium	64	metal melts and the gas given off catches fire
rubidium		

(i) Use the information in Table 5.2 to predict the melting point and reaction with water of the element rubidium.

Write your predictions in the spaces provided in the table. [2]

(ii) State how you used the information in Table 5.2 to make your predictions.

....

....

.... [2]

(c) When hot sodium is held in a gas jar of chlorine, it burns. Sodium chloride forms on the walls of the jar.

The apparatus used is shown in Fig. 5.1.

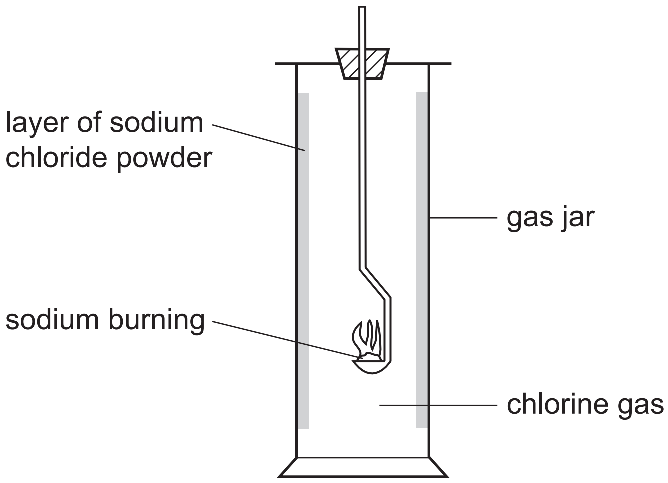


Fig. 5.1

Fig. 5.2 shows the structures of an atom of sodium and an atom of chlorine.

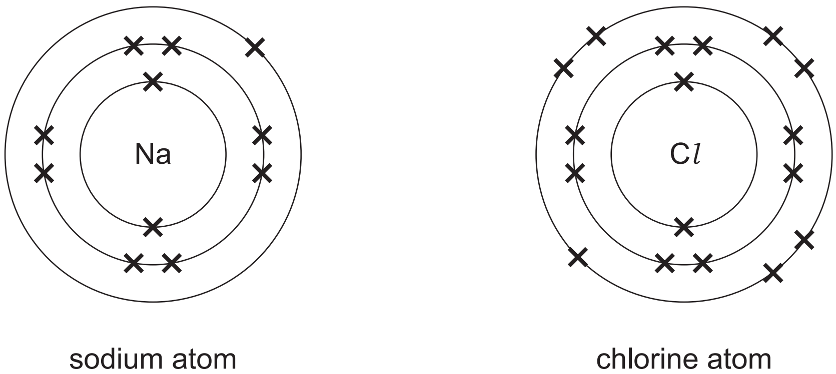
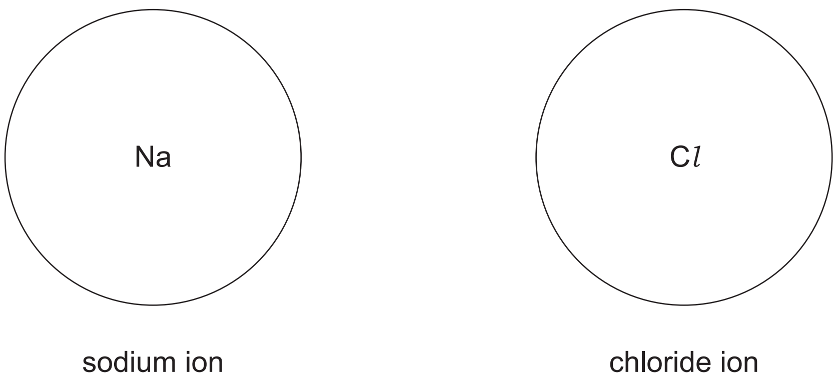


Fig. 5.2

(i) Draw diagrams showing the arrangement of the **outer** electrons of a sodium ion and a chloride ion that are formed during the reaction.



[2]

(ii) Describe how the ions are formed during the reaction.

....

....

.... [2]

(iii) Explain why the sodium ions and chloride ions stay strongly bonded once they have formed.

....

.... [1]

Please turn over for Question 6.

6 Fig. 6.1 shows part of a flower that reproduces by wind pollination.

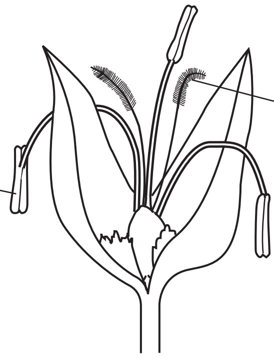


Fig. 6.1

(a) Define *pollination*.

....

.... [1]

(b) Use Fig. 6.1 to explain how the following are adaptations for wind pollination.

(i) the shape of the stigmas

....

.... [1]

(ii) the position of the anthers

....

.... [1]

(c) Fig. 6.2 shows diagrams of two pollen grains. One pollen grain is from a wind-pollinated flower, the other is from an insect-pollinated flower. The diagrams are not drawn to scale.

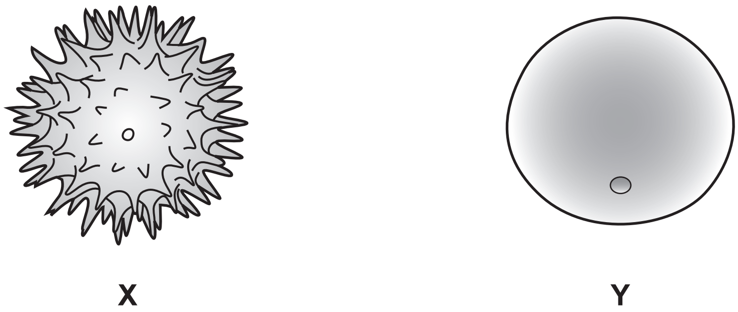


Fig. 6.2

Suggest which pollen grain, **X** or **Y**, comes from an insect-pollinated flower.

Explain your answer.

....

.... [1]

7 Fig. 7.1 shows a solar-powered lantern. It uses photovoltaic (solar) cells which charge a battery during the day.

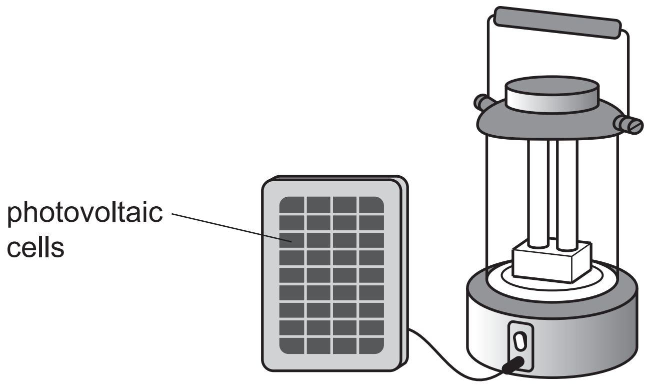
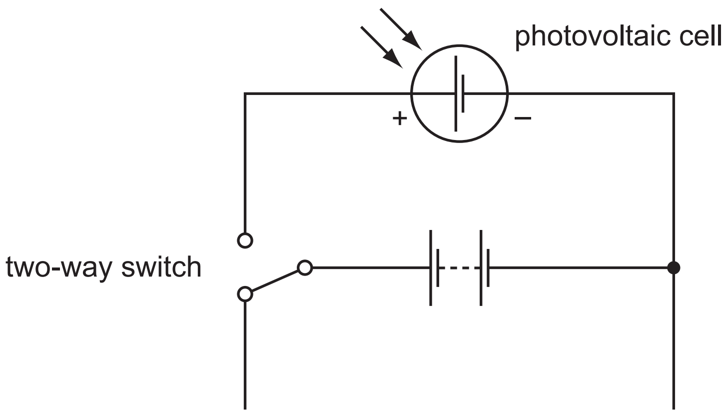


Fig. 7.1

(a) When the lantern is switched on so that the lamp lights, the battery supplies a current to two lamps connected in parallel.

Complete the circuit diagram for the circuit within the lantern.



[2]

(b) Complete the sequence of the energy transformations from the light falling on the solar cell to the output from the lamps.

light energy

↓

....

↓

chemical energy

↓

electrical energy

↓

....

[1]

(c) (i) The battery has a voltage of 3 V when fully charged, and supplies a current of 0.6 A to the lamps.

Calculate the power output from the battery.

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

formula

working

power = ... unit .... [3]

(ii) Another version of the solar lantern has the same battery and lamps but the lamps are connected in series instead of in parallel.

Describe and explain the effect this difference will have on the operation of the lantern.

....

....

.... [2]

8 (a) Excess hydrochloric acid in the stomach can cause discomfort. Medicine containing magnesium carbonate can be used to ease this discomfort.

Describe and explain the effect that magnesium carbonate has on the pH of the contents of the stomach.

....

....

.... [2]

(b) Fig. 8.1 shows that the medicine can be supplied as a tablet in different sizes.

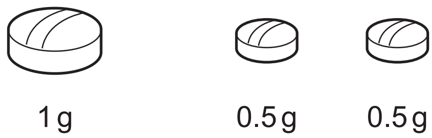


Fig. 8.1

Two students investigate the effect of tablet size on the rate of the chemical reaction between magnesium carbonate and dilute hydrochloric acid. This reaction produces carbon dioxide gas.

The total volume of gas produced is measured at one minute intervals from the start of the reaction. Readings were taken for 10 minutes.

One student uses one 1 g tablet. The other student uses two 0.5 g tablets. They use the same volume and concentration of acid at the same initial temperature.

Fig. 8.2 shows some of the apparatus they use.

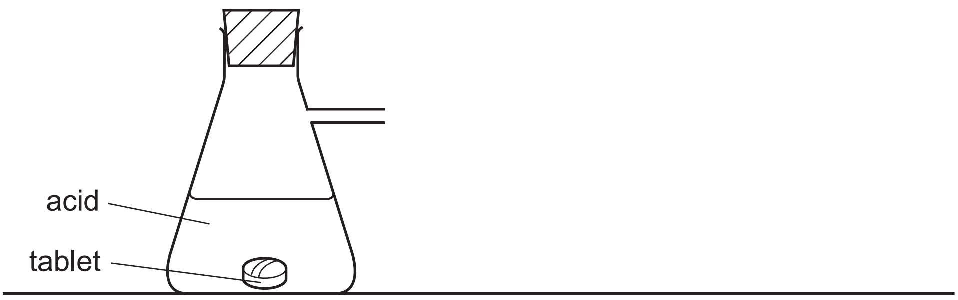


Fig. 8.2

(i) Complete Fig. 8.2 to show how the volume of gas is measured. Label the apparatus. [2]

The graph in Fig. 8.3 is drawn using the results obtained by the student who uses the one 1 g tablet of magnesium carbonate.

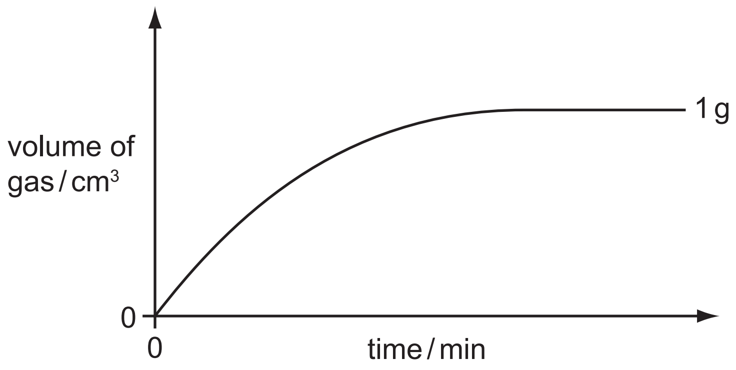


Fig. 8.3

(ii) State and explain what the graph in Fig. 8.3 shows about changes to the rate of reaction over time.

....

....

.... [2]

(iii) Using the axes in Fig. 8.3, sketch the graph of the results obtained by the student who used two 0.5 g tablets. [2]

9 Many modern houses in colder countries are designed to conserve energy.

(a) Fig. 9.1 shows how the outside walls of the house are constructed. The 5 cm air gap between bricks and concrete building blocks has been filled with insulating sheets of expanded polystyrene.

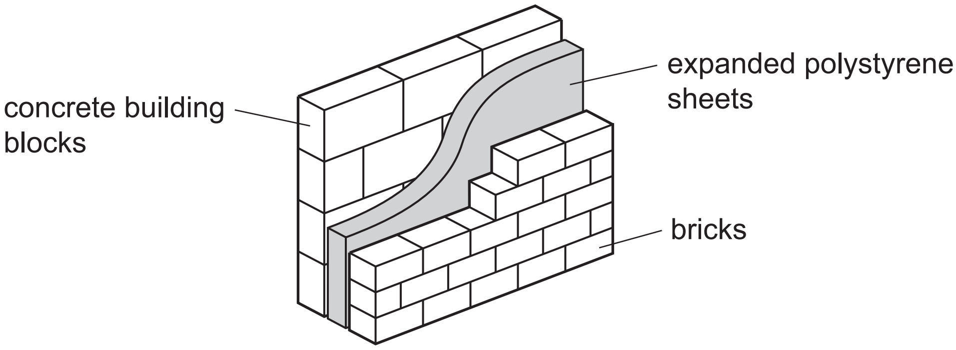


Fig. 9.1

(i) Expanded polystyrene is made of a plastic filled with many tiny gas bubbles. This material is a very poor conductor of heat.

Suggest, by referring to the arrangement and movement of gas molecules, why expanded polystyrene is a much worse conductor than bricks and concrete building blocks.

....

.... [1]

(ii) Describe another way in which expanded polystyrene sheets, placed in the air gap between bricks and blocks, prevent heat loss from the house.

....

.... [1]

(b) Fig. 9.2 shows graphs of the temperatures inside and outside the house over a 24 hour period.

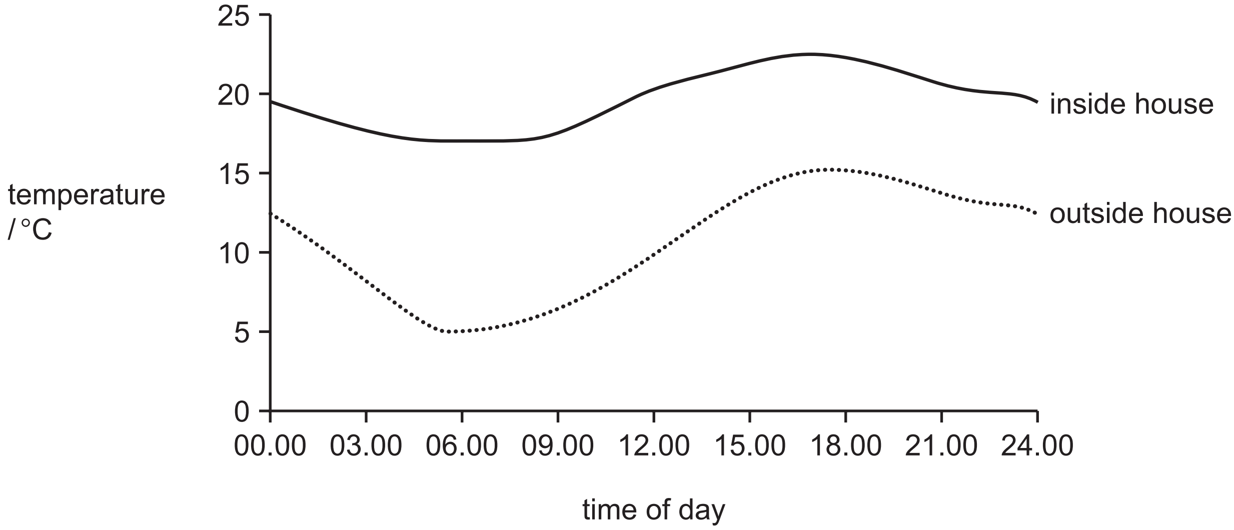


Fig. 9.2

More heat is lost when the difference in temperature between inside and outside the house is greater.

State the time of day at which heat loss from the house is greatest.

.... [1]

(c) State the colour that the outside of the house should be painted to reduce heat loss. Give a reason for your answer.

....

.... [2]

(d) Electricity for the house is partly supplied by a row of solar panels.

Fig. 9.3 shows the solar panels facing the Sun. In front of the solar panels is a metal mirror.

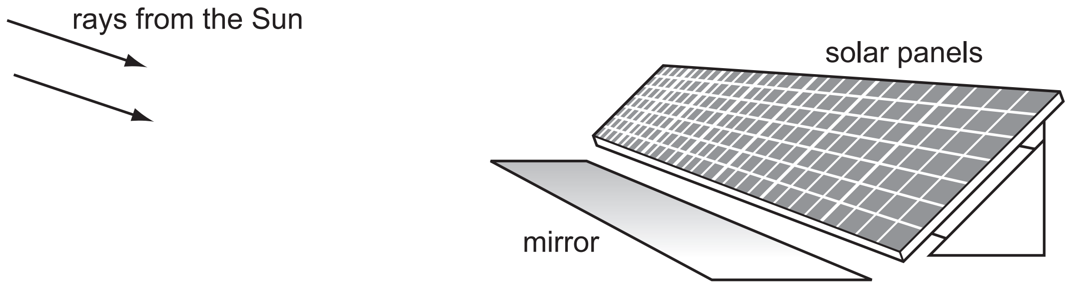


Fig. 9.3

(i) On Fig. 9.4 continue the rays to show how the mirror increases the amount of the Sun's rays reaching the solar panels.

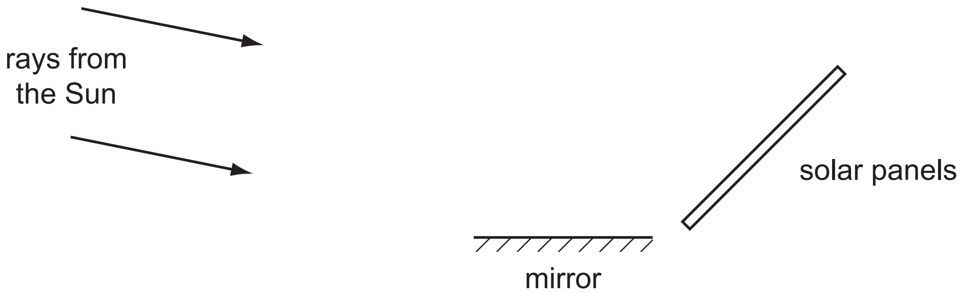


Fig. 9.4

[2]

The solar panels transfer the Sun's visible light and infra-red radiation energy into electrical energy.

(ii) Fig. 9.5 shows some parts of the electromagnetic spectrum. On Fig. 9.5, label the boxes representing the **visible** and **infra-red** parts of the spectrum with their names.

gamma rays		ultra-violet			microwaves	

Fig. 9.5

[2]

Please turn over for Question 10.

10 Fig. 10.1 shows how the activity of an enzyme is affected by temperature

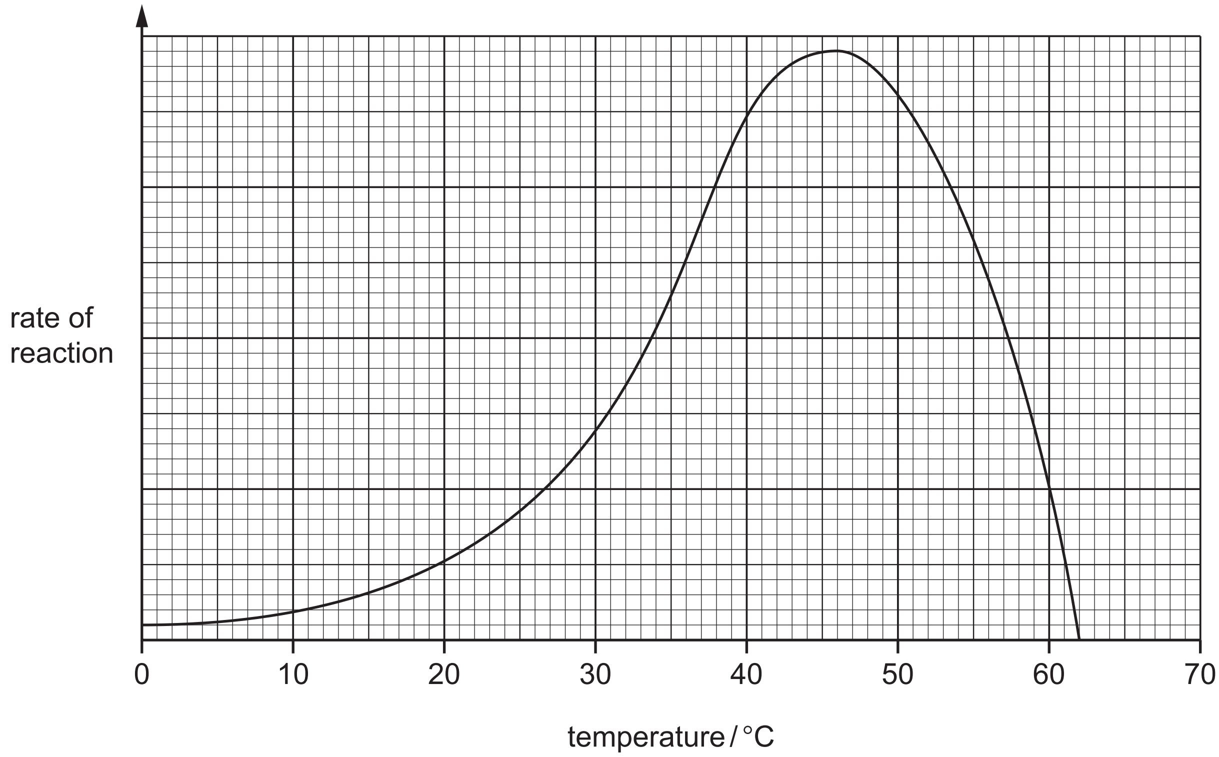


Fig. 10.1

(a) Define an *enzyme*.

....

.... [2]

(b) State the optimum temperature of the enzyme.

.... [1]

(c) Describe and explain, in terms of the movement and shape of molecules, why the rate of reaction changes

(i) between 10 °C and 30 °C,

....

....

.... [2]

(ii) between 50 °C and 60 °C.

....

....

.... [2]

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	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**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	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

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

Key: a **X** b

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

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