UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

CO-ORDINATED SCIENCES **0654/03**

Paper 3 (Extended) **May/June 2008**

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 a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
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.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

This document consists of **24** printed pages.

For Examiner's Use

1 Fig. 1.1 shows a transverse section through a leaf. The contents of the cells are not shown.

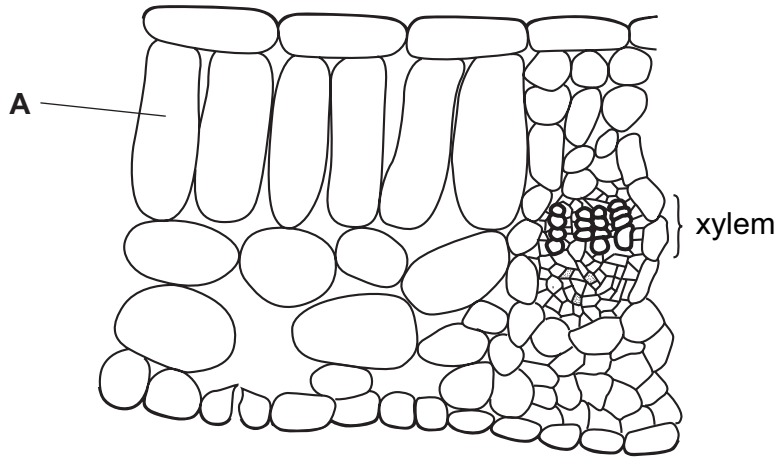


Fig. 1.1

(a) In the space below, make a large, labelled diagram of cell **A**, to show its structure and contents.

[3]

(b) State two functions of xylem tissue in a leaf.

1. .....

2. ..... [2]

(c) A farmer grows spinach in a glasshouse.

He decided to use artificial lighting to increase the yield of the crop. He tried out four different wavelengths of light.

He measured the volume of carbon dioxide taken up per square metre of leaves per second. He also measured the mass of the spinach leaves that were produced.

Table 1.1 shows his results.

Table 1.1

wavelength of light / nm	units of carbon dioxide taken up per m^2 of leaf per second	mass of leaves produced / kg per m^2
660	6.5	7.8
670	8.3	8.2
680	10.1	8.8
690	9.1	8.3

(i) State **two** variables that should have been kept constant during this experiment.

.....

.....

[2]

(ii) Which wavelength of light gave the highest yield?

.....

[1]

(iii) Explain why the pattern for the units of carbon dioxide taken up is similar to the pattern for the mass of leaves produced.

.....

.....

.....

[2]

(iv) Explain why plants are able to use some wavelengths of light more than other wavelengths.

.....

.....

.....

[2]

For Examiner's Use

2 Starch, cellulose and proteins are compounds found in plants.

(a) (i) State the **chemical symbols** of the three elements which are combined together in starch.

..... [1]

(ii) Plants contain proteins which are compounds containing nitrogen atoms. These atoms have been obtained from gaseous nitrogen in the air by nitrogen fixation.

Explain the meaning of the term *nitrogen fixation*.

.....

.....

..... [2]

(b) Ammonium sulphate is a fertiliser which is produced in a reaction between sulphuric acid and ammonia solution. The balanced equation for this reaction is shown below.

$$2\,NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

In an attempt to produce a solution containing only ammonium sulphate, a student used the following method.

1 50.0 cm^3 of a solution containing 2.0 mol / dm^3 of ammonia were placed into a glass beaker.

2 50.0 cm^3 of a solution containing 2.0 mol / dm^3 of sulphuric acid were added to the ammonia solution.

(i) Calculate the number of moles of ammonia which the student used.
(There are 1000 cm^3 in 1 dm^3.)

Show your working.

..... [2]

(ii) Explain whether or not the student had calculated the correct amount of sulphuric acid to use.

Show your working.

..... [3]

(iii) The formula of the sulphate ion is SO_4^{2-}. Explain why the formula of ammonium sulphate is $(NH_4)_2SO_4$.

For Examiner's Use

.....

.....

..... [2]

For Examiner's Use

3 The circuit in Fig. 3.1 was set up and the current measured by meters M_1, M_2, M_3, M_4 and M_5.

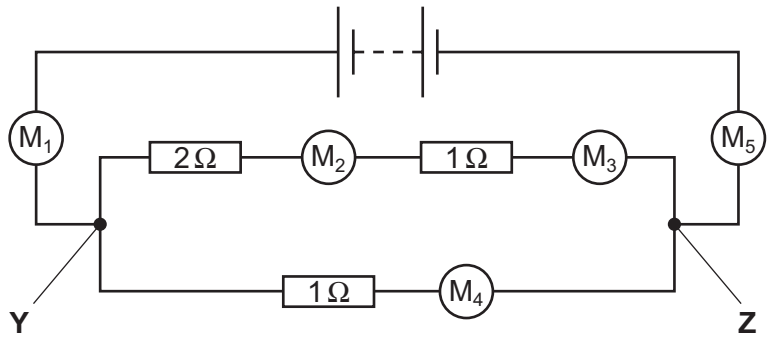


Fig. 3.1

(a) (i) The readings on M_1 and M_2 are shown in Table 3.1. Complete the table for M_3, M_4 and M_5.

Table 3.1

M_1 = 4A
M_2 = 1A
M_3 =
M_4 =
M_5 =

[1]

(ii) Calculate the total resistance of the 2 Ω and 1 Ω resistors in series.

..... [1]

(iii) Calculate the total resistance between **Y** and **Z**.

State the formula that you use and show your working.

formula

working

..... [3]

For Examiner's Use

(b) The current flows through M_1 for one minute.

Calculate the charge which has passed.

State the formula that you use and show your working.

formula

working

..... [2]

(c) A man walking on a non-conducting floor surface may become positively charged as shown in Fig. 3.2.

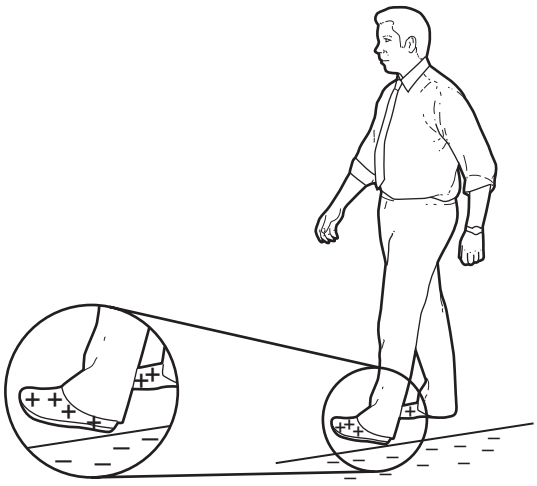


Fig. 3.2

Explain in terms of charged particles how he acquired this charge.

.....

.....

.....

..... [3]

For Examiner's Use

4 A doctor may test a person's knee-jerk reflex, to check that the nervous system is working properly. When a sharp tap is given just below the kneecap, one of the thigh muscles contracts so that the lower leg moves quickly upwards.

Fig. 4.1 shows some of the structures involved in the knee-jerk reflex.

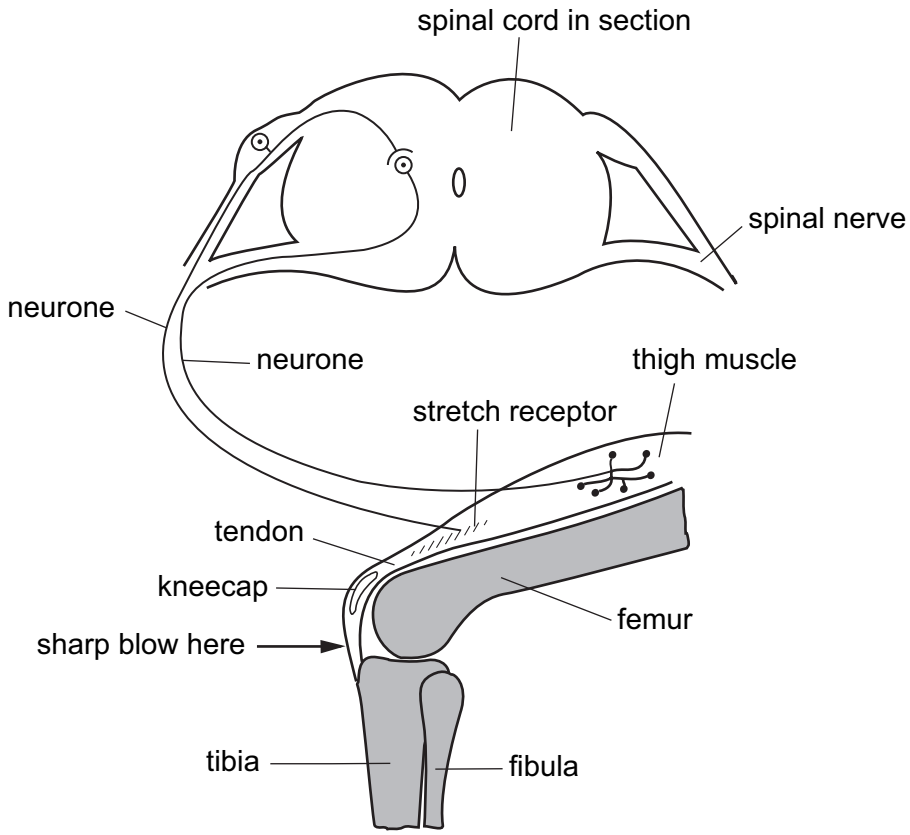


Fig. 4.1

(a) (i) Explain what is meant by a *reflex action*.

.....

.....

..... [2]

(ii) Explain the value of reflex actions to an organism.

.....

.....

..... [2]

For Examiner's Use

(b) (i) On Fig. 4.1, draw a label to **one** structure that is part of the central nervous system, and label it CNS. [1]

(ii) On Fig. 4.1, draw arrows on the two neurones to show the direction of the nerve impulses as they travel from the receptor to the effector. [1]

(c) The human skeleton is made of bone and cartilage. Cartilage covers the surfaces of the tibia and femur at the knee joint.

(i) Describe the function of cartilage at the knee joint.

.....

.....

..... [2]

(ii) State **one** difference in the properties of bone and cartilage, and explain how this difference helps them to carry out their different functions.

.....

.....

..... [2]

For Examiner's Use

5 The bodywork of a car is usually made from steel.

(a) If part of the bodywork goes very rusty it is usually removed and replaced with plastic filler, before being painted.

A car mechanic can use a magnet to find out if parts of the bodywork of a car have been filled with plastic filler.

He tests three areas of a car by placing a magnet near the surface as shown in Fig. 5.1.

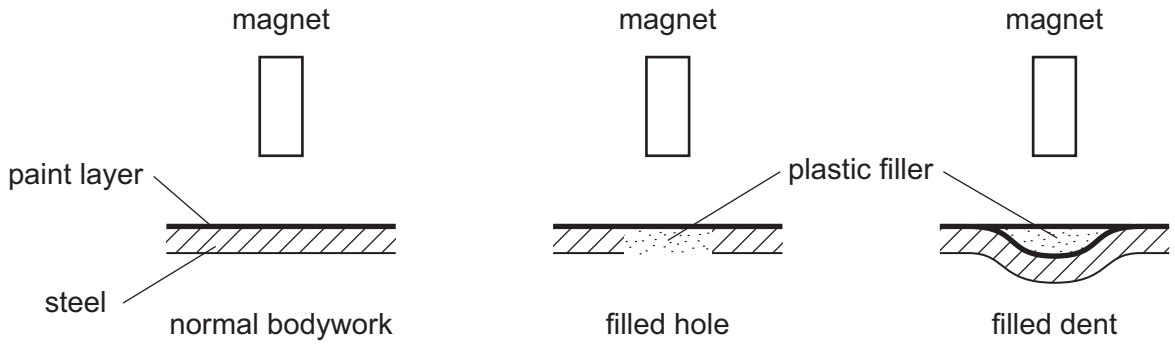


Fig. 5.1

(i) Complete the table.

area	effect on a magnet
normal bodywork	
filled hole	
filled dent	weakly attracted

[1]

(ii) What assumption have you made about the properties of plastic filler?

.....

[1]

(iii) Would this method work if the bodywork was made of aluminium?

Explain your answer.

.....

[1]

(iv) Suggest why the bodywork of some cars is made from aluminium rather than steel.

.....

[1]

For Examiner's Use

(b) After a car has been driven, the tyres are hot. The air in each tyre has a temperature of 45 °C and the pressure of the air in the tyres is 2.5 N / m^2.

After a while the temperature of the air in the tyres falls to 25 °C.

(i) What is the temperature of the air in the tyres in kelvins when the tyres are at 25 °C?

..... K [1]

(ii) Calculate the pressure of the air in the tyres at 25 °C, assuming that the volume of the tyre does not change.

State the formula that you use and show your working.

formula

working

[3]

(iii) Explain in terms of particles why the pressure of the air in the tyres increases when the temperature increases.

.....

.....

..... [2]

(c) (i) The car has a mass of 1000 kg. It is travelling at 12 m / s when it collides with a wall.

Calculate the kinetic energy of the car before the collision.

State the formula that you use and show your working.

formula

working

..... [2]

(ii) Explain why wearing seat belts can help to lessen the injuries produced in a head-on crash.

For Examiner's Use

.....

.....

..... [2]

6 Fig. 6.1 shows some natural processes which occur on and under the Earth's surface.

For Examiner's Use

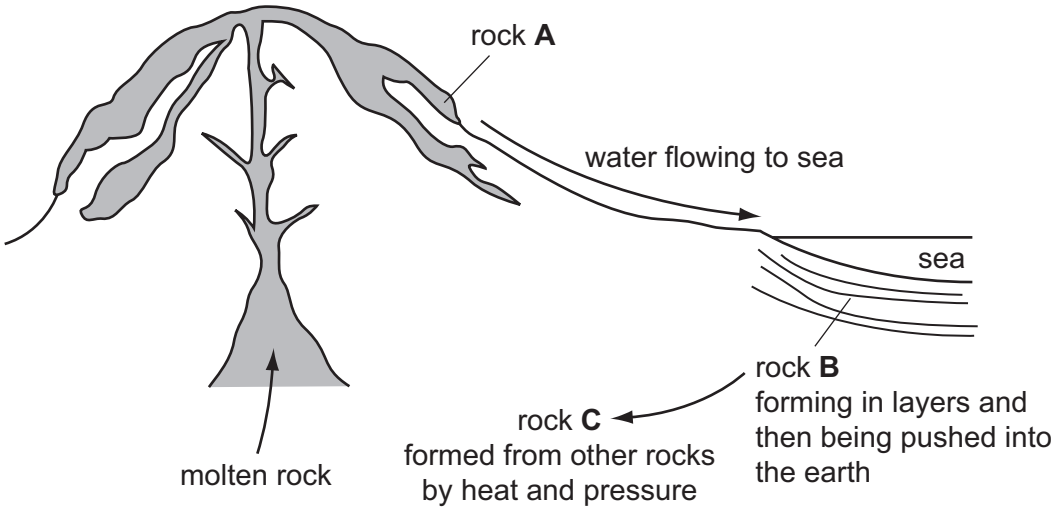


Fig. 6.1

(a) (i) State which rock, **A**, **B** or **C**, was formed when a hot liquid cooled and changed into a solid.

.....

[1]

(ii) Rock **B** formed in layers from tiny pieces of solid (sediment) which were washed down to the sea by rivers and compressed. The sediment was produced from rock **A** whose surface had been damaged by weathering.

Describe **one** way in which the surface of rock **A** could have been weathered.

.....

.....

.....

.....

[2]

(b) A sample of the water flowing into the sea, as shown in Fig. 6.1, was taken to a laboratory for testing.

A student observed a drop of water under a microscope.

Fig. 6.2 shows a labelled diagram of what he saw.

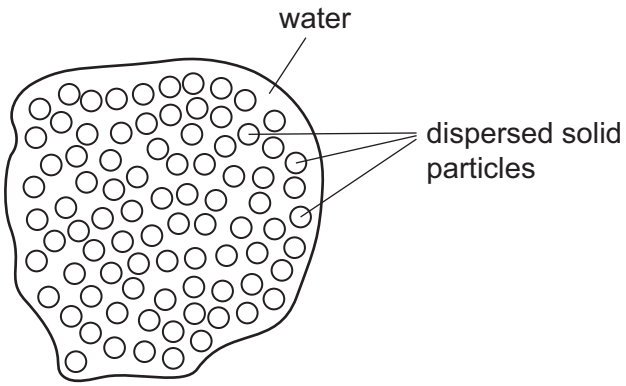


Fig. 6.2

Explain why the water sample looked cloudy and not transparent. You may wish to add some light rays to Fig. 6.2 to help you answer this question.

.....

.....

..... [2]

(c) The element bromine is extracted from concentrated solutions of bromine compounds.

The reaction between chlorine and sodium bromide solution produces bromine.

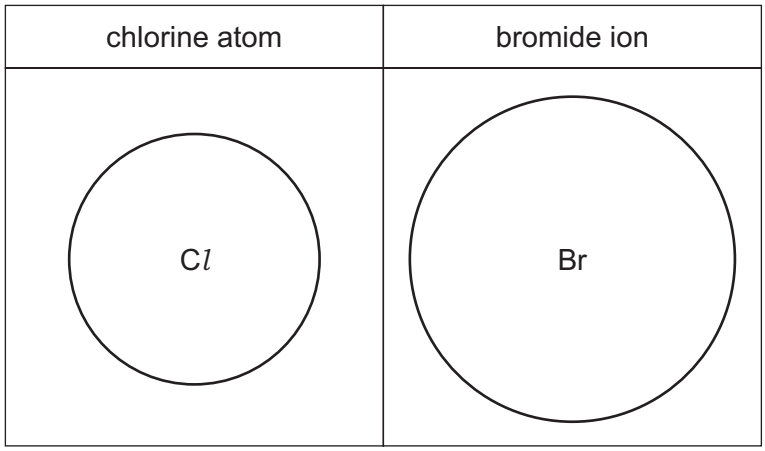
chlorine + sodium bromide → sodium chloride + bromine

(i) Explain why chlorine but **not** iodine reacts with sodium bromide.

.....

..... [1]

(ii) In the boxes below, draw diagrams of a chlorine atom and a bromide ion, showing only the electrons in the outer shells.



[2]

(iii) Describe how the numbers of outer electrons of the particles you have drawn in **(ii)** change during the reaction of chlorine with sodium bromide.

.....

.....

..... [2]

(d) A solution of bromine is used to discover whether a compound is a saturated or unsaturated hydrocarbon.

Explain the meanings of the words *saturated* and *unsaturated* hydrocarbon.

.....

.....

.....

..... [2]

For Examiner's Use

7 **(a)** Fig. 7.1 shows how the action of the enzyme lipase is affected by temperature.

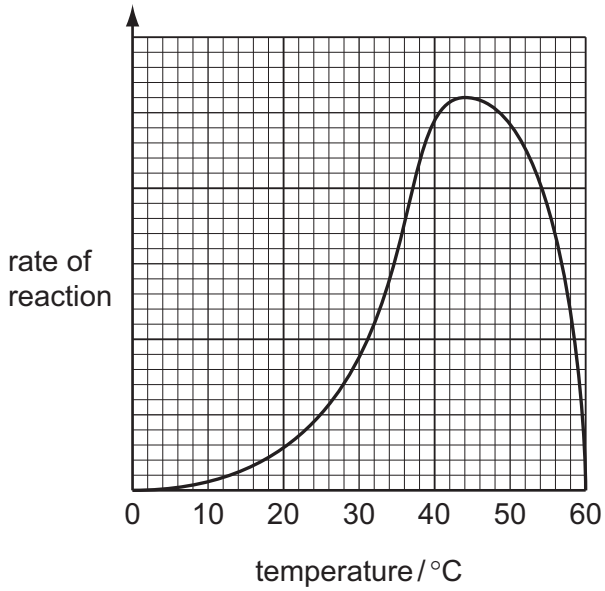


Fig. 7.1

(i) State the optimum temperature for this enzyme.

..... [1]

(ii) Explain the shape of the curve between 0 ºC and 40 ºC.

.....

.....

.....

..... [3]

(iii) Explain the shape of the curve between 45 ºC and 60 ºC.

.....

.....

..... [2]

(b) (i) Describe the sites of production and action of lipase in the human alimentary canal.

For Examiner's Use

.....

..... [2]

(ii) Outline the function of lipase.

.....

..... [1]

(c) Enzymes are proteins. Name **two** kinds of proteins that are found in the human body, other than enzymes, and describe their roles.

.....

.....

.....

..... [3]

For Examiner's Use

8 Heat energy is obtained when hydrocarbon fuels are burned. Natural gas, methane, is an important hydrocarbon fuel. Natural gas is extracted from the Earth's crust.

(a) Methane is a fossil fuel formed from the remains of organisms.

Describe briefly what has happened to the remains of these organisms that has resulted in the formation of methane.

.....

.....

..... [2]

(b) Biogas is an alternative source of methane made from biodegradable materials. Biogas may be obtained from waste materials stored in landfill sites and from controlled reactions in vessels called digesters. Some information about two sources of biogas is shown in Table 8.1.

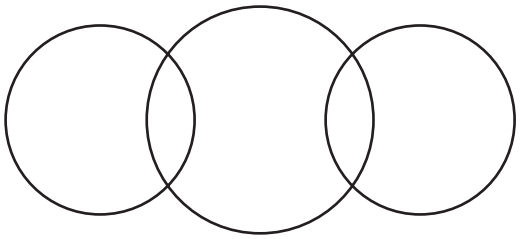
Table 8.1

	% of substances in the biogas mixture	
	biogas from a digester	biogas from landfill
methane	60 – 70	45 – 55
carbon dioxide	30 – 40	30 – 40
nitrogen	less than 1	5 – 15
hydrogen sulphide	0.2	0.03

(i) Hydrogen sulphide is made of molecules in which two hydrogen atoms are bonded to one sulphur atom.

Complete the bonding diagram below to show

- the chemical symbols of the elements in a molecule of hydrogen sulphide,
- the arrangement of the outer electrons of each atom.



[2]

For Examiner's Use

(ii) When biogas is burned, any hydrogen sulphide present is oxidised.

The symbolic equation below for this reaction is incomplete.

State how many molecules of oxygen are required to oxidise two molecules of hydrogen sulphide and explain your answer.

$$2H_2S + ...O_2 \rightarrow 2H_2O + 2SO_2$$

number of oxygen molecules .....

explanation .....

.....

..... [2]

(iii) Use the data in Table 8.1 and information in **(ii)** to suggest and explain **one** advantage and **one** disadvantage of burning biogas from a digester rather than from landfill.

advantage

.....

.....

.....

disadvantage

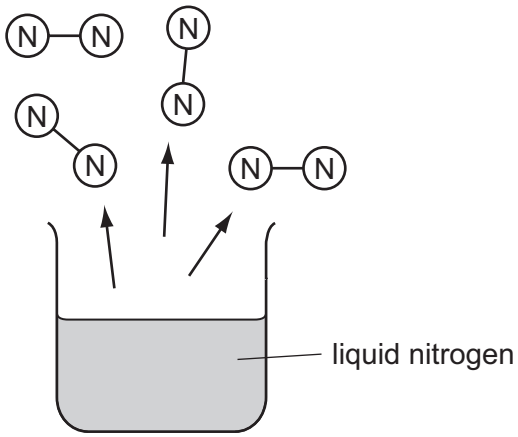
.....

.....

..... [3]

(c) When liquid nitrogen evaporates, nitrogen molecules, N_2, separate and form nitrogen gas.

For Examiner's Use



Explain, in terms of forces of attraction, why **molecules** of nitrogen rather than individual **atoms** of nitrogen separate from each other when liquid nitrogen evaporates.

.....

.....

..... [2]

For Examiner's Use

9 **(a)** Dolphins can communicate underwater by emitting pulses of sound waves which have a frequency of 40 000 Hz.

(i) The speed of sound waves in water is 1500 m / s.

Calculate the wavelength of these waves.

State the formula that you use and show your working.

formula

working

..... [2]

(ii) The speed of sound in air is 330 m / s.

Suggest in terms of particles why the speed of sound waves in water is so much greater than the speed of sound waves in air.

.....

..... [2]

For Examiner's Use

(b) The graph in Fig. 9.1 shows the motion of a dolphin travelling through water.

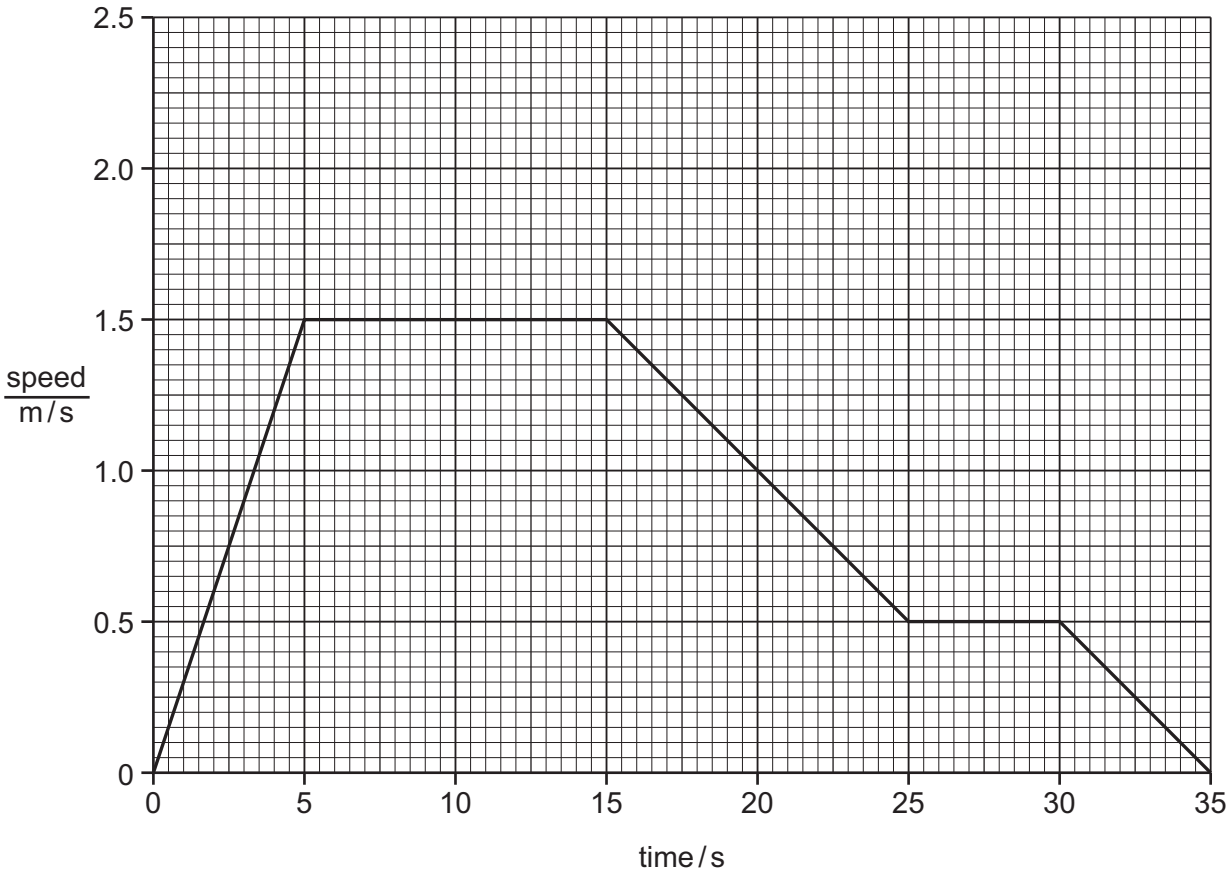


Fig. 9.1

Calculate the distance covered by the dolphin in the first 25 seconds.

Show your working.

..... [2]

(c) A man in a boat sees a dolphin under the water. Draw a ray of light on Fig. 9.2 to show how light travels from the dolphin's head to the man's eye.

For Examiner's Use

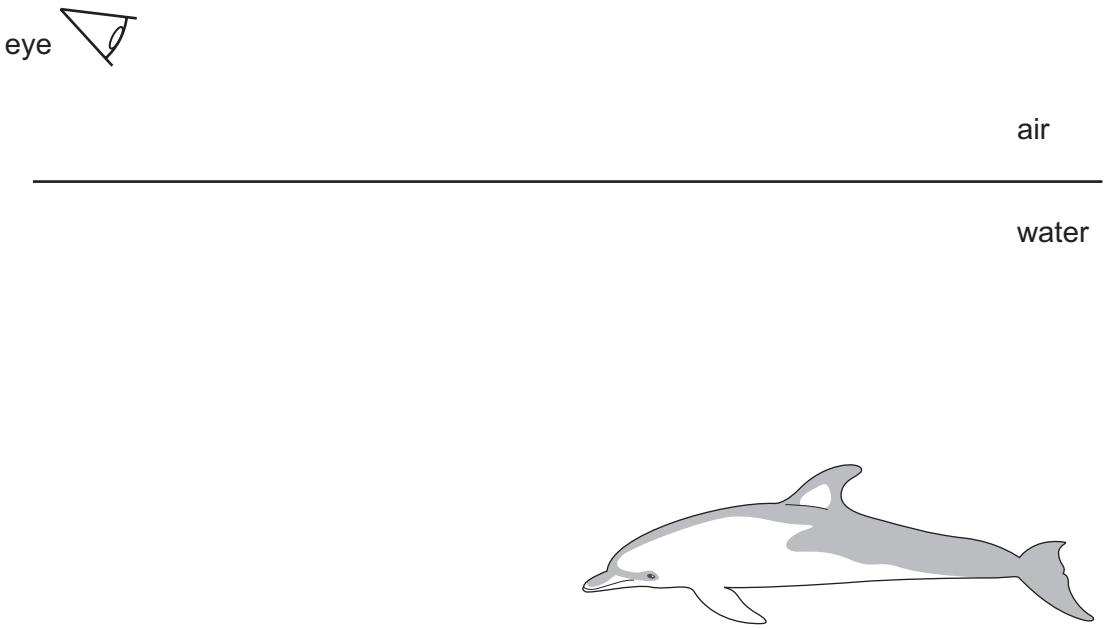


Fig. 9.2

[3]

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** Sulphur 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 above, **X** centre, b below

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.).