



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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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	
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9	
Total	

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



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

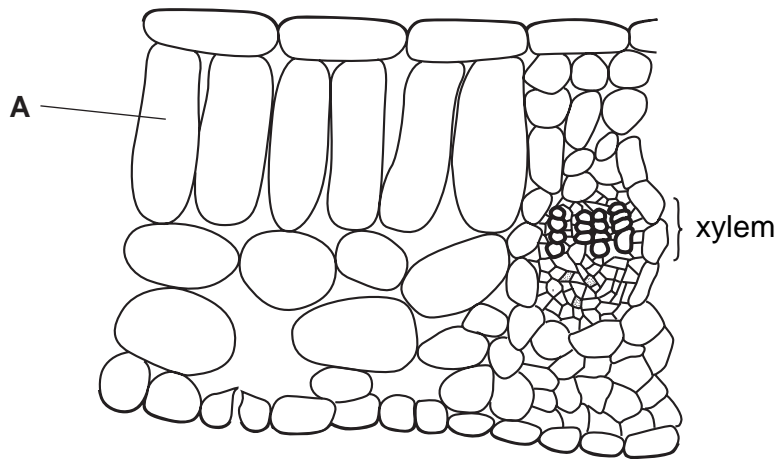


Fig. 1.1

(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]

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.

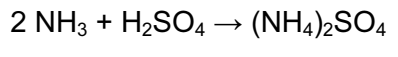
..... [1]

(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.



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

- 1 50.0 cm³ of a solution containing 2.0 mol / dm³ of ammonia were placed into a glass beaker.
- 2 50.0 cm³ of a solution containing 2.0 mol / dm³ of sulphuric acid were added to the ammonia solution.

(i) Calculate the number of moles of ammonia which the student used.
(There are 1000 cm³ in 1 dm³.)

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]

5

(iii) The formula of the sulphate ion is SO_4^{2-} . Explain why the formula of ammonium sulphate is $(\text{NH}_4)_2\text{SO}_4$.

.....

.....

..... [2]

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 .

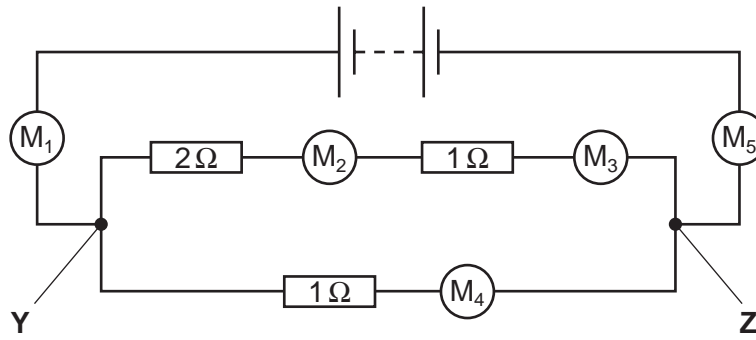


Fig. 3.1

(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 2Ω and 1Ω 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]

(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.

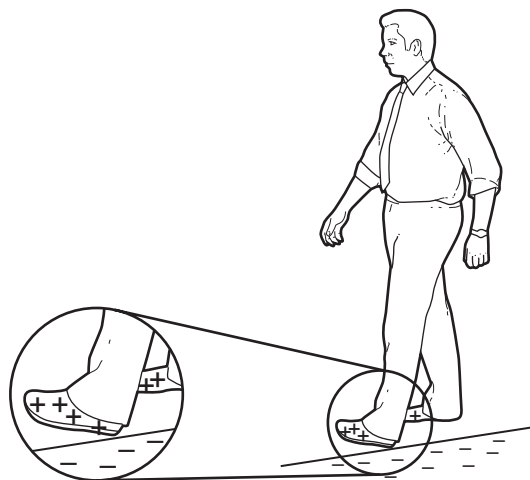


Fig. 3.2

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

.....

.....

.....

..... [3]

- 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.

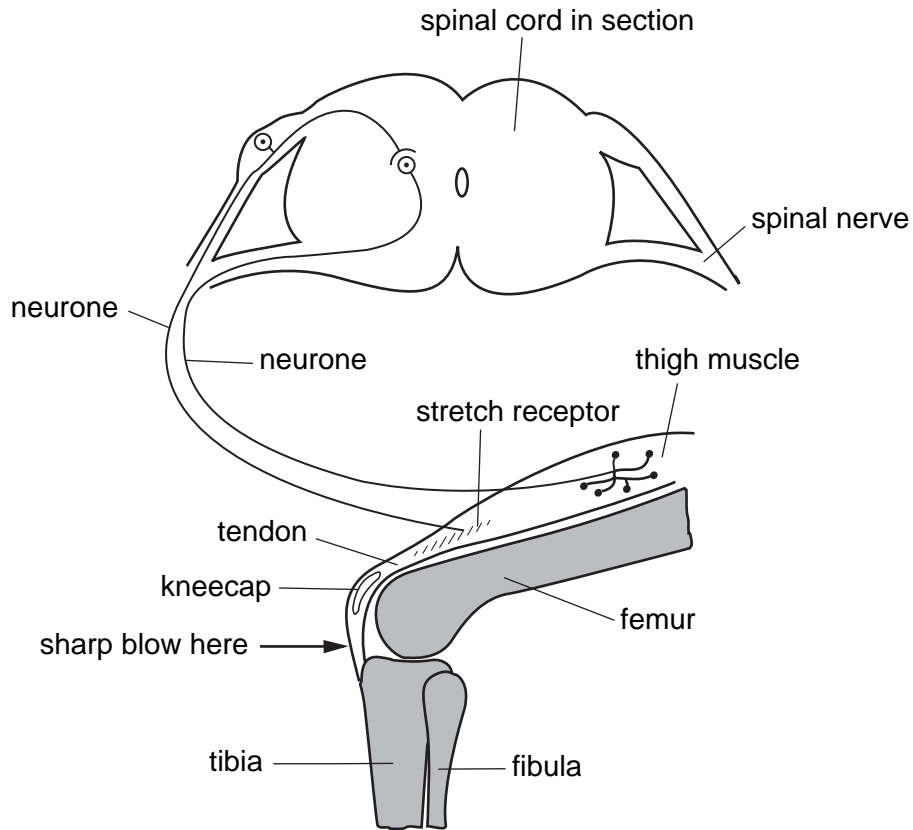


Fig. 4.1

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

.....

 [2]

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

.....

 [2]

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

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.

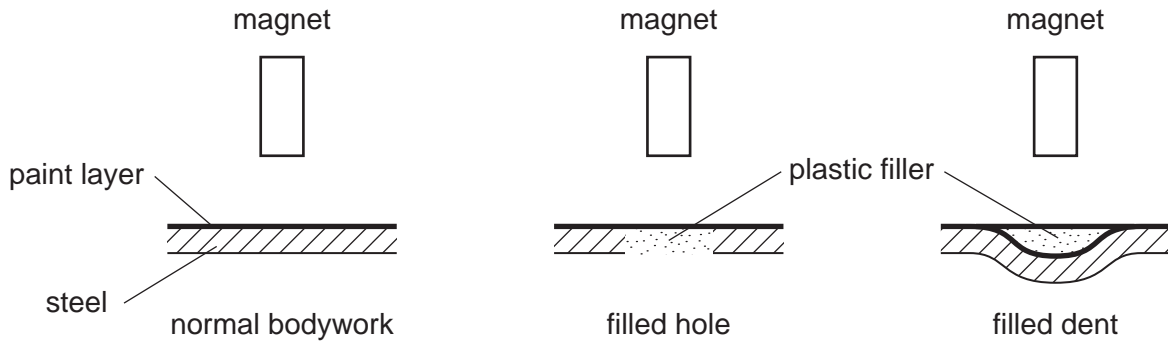


Fig. 5.1

(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]

(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/m².

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 crash.

.....

.....

..... [2]

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

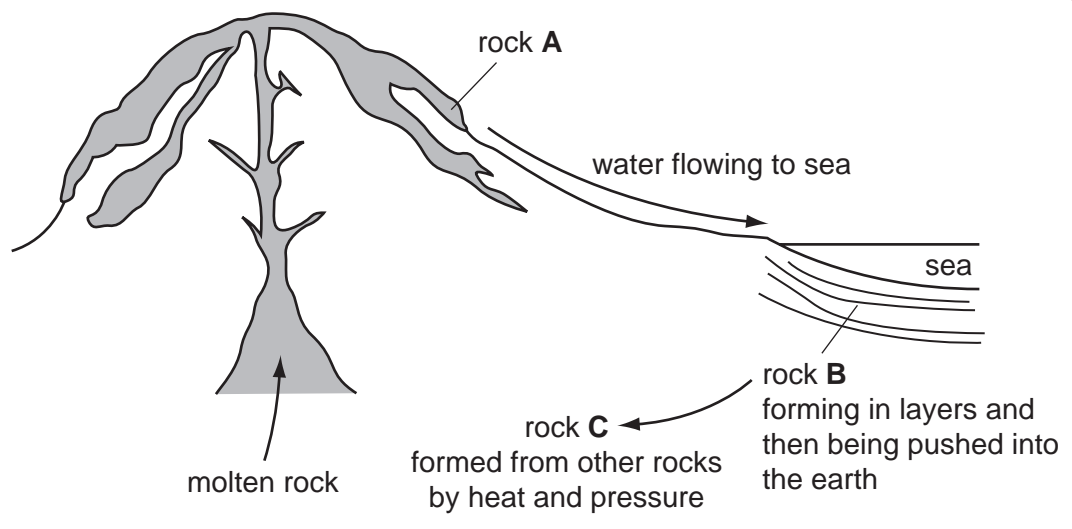


Fig. 6.1

(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.

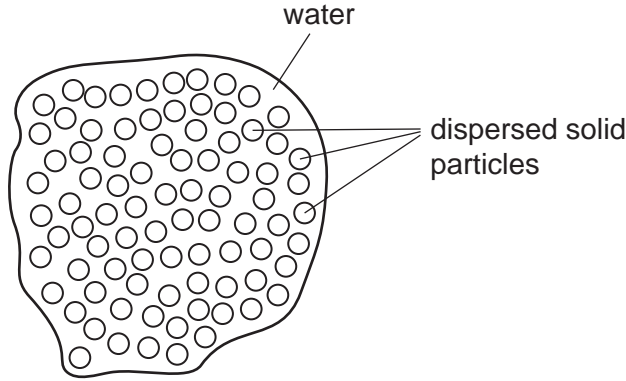


Fig. 6.2

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.

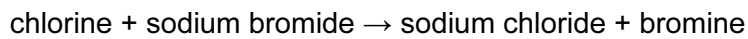
.....

.....

..... [2]

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

The reaction between chlorine and sodium bromide solution produces bromine.

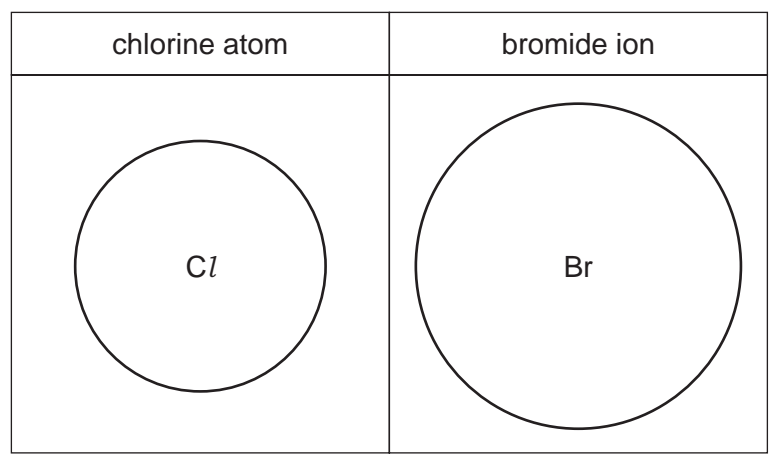


(i) Explain why chlorine but **not** iodine reacts with sodium bromide.

.....

..... [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]

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

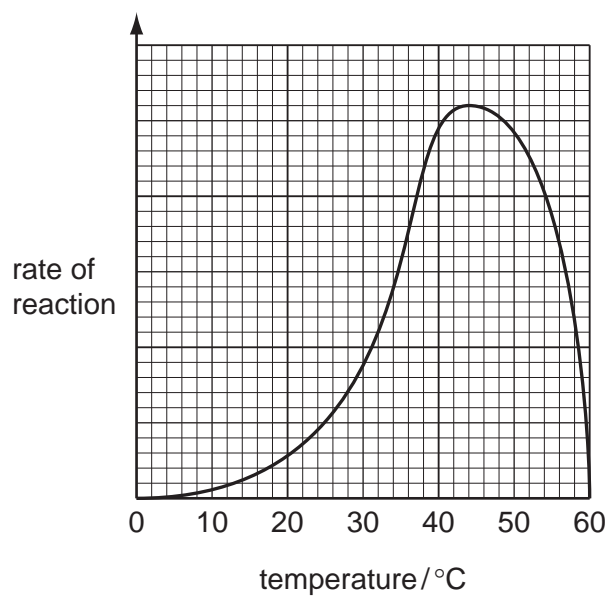


Fig. 7.1

(i) State the optimum temperature for this enzyme.

..... [1]

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

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

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

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

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

.....
..... [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]

8 Heat energy is obtained when hydrocarbon fuels are burned. Natural gas, methane and coal are 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.

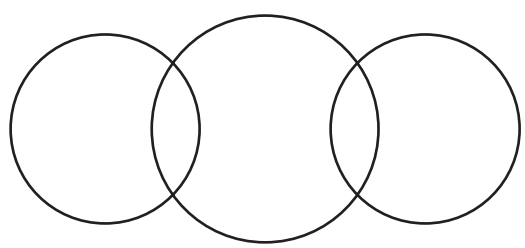
Table 8.1

	% 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.

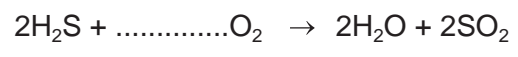


[2]

(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.



number of oxygen molecules

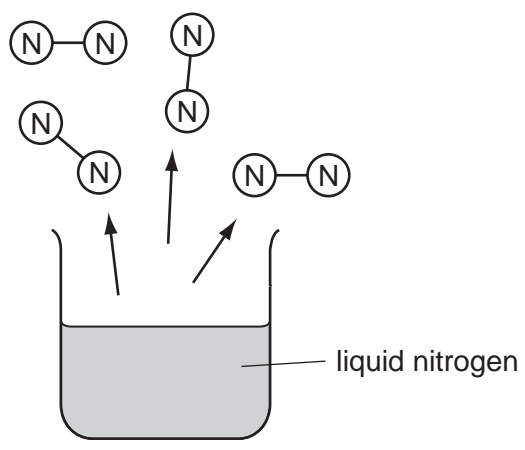
explanation
.....
..... [2]

(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.



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]

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]

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

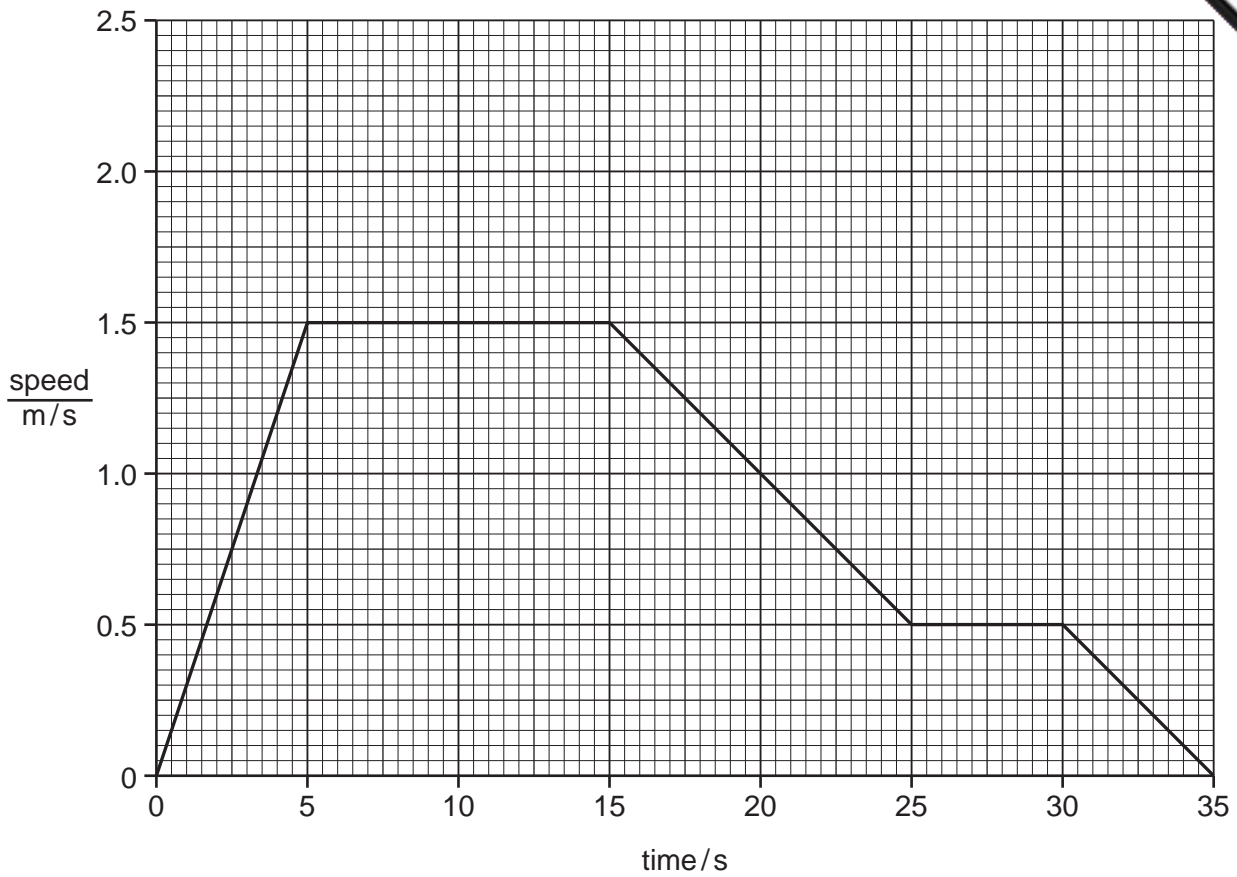


Fig. 9.1

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.

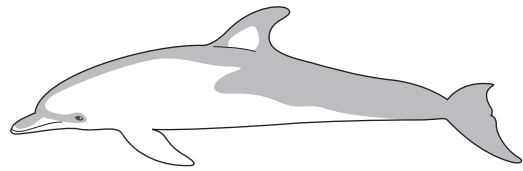


Fig. 9.2

[3]

DATA SHEET
The Periodic Table of the Elements

		Group																																		
I	II	III	IV	V	VI	VII	0																													
		1 H Hydrogen 1																																		
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											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											65 Zn Zinc 30	64 Cu Copper 29	59 Ni Nickel 28	59 Co Cobalt 27	56 Fe Iron 26	55 Mn Manganese 25	48 Ti Titanium 22	45 Sc Scandium 21	91 Zr Zirconium 40	91 Y Yttrium 39	89 Y Yttrium 39	137 Ba Barium 56	139 La Lanthanum 57	226 Ra Radium 88	227 Ac Actinium 89	†									
133 Cs Caesium 55	137 Ba Barium 56											115 In Indium 49	112 Cd Cadmium 48	106 Pd Palladium 46	108 Ag Silver 47	103 Rh Rhodium 45	101 Ru Ruthenium 44	101 Ru Ruthenium 44	96 Mo Molybdenum 42	93 Nb Niobium 41	93 Nb Niobium 41	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	212 Po Polonium 84	210 At Astatine 85	210 Rn Radon 86
												162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71																			
												98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium																			

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

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

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