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CANDIDATE NAME									
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8467321735

COMBINED SCIENCE **0653/33**

Paper 3 Theory (Core) **October/November 2023**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **24** pages. Any blank pages are indicated.

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[Turn over

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1 **(a)** Fig. 1.1 is a diagram of the human gas exchange system.

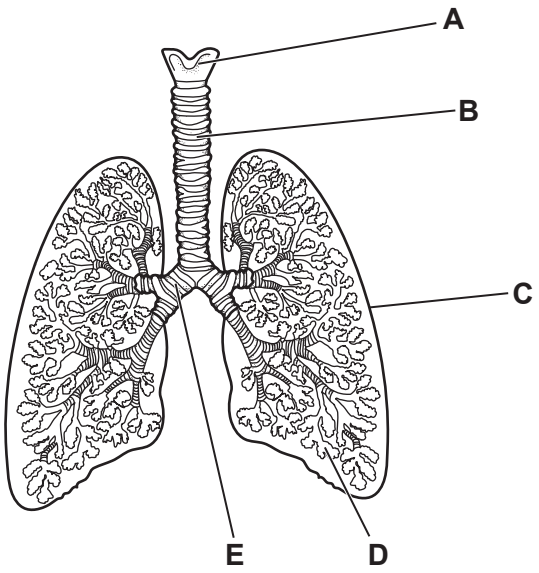

Fig. 1.1

(i) State the letter in Fig. 1.1 that identifies:

one of the bronchi .....

the trachea. .....

[2]

(ii) Circle the name of the blood vessel that takes blood from the lungs to the heart.

aorta **pulmonary artery** **pulmonary vein** **vena cava**

[1]

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(b) Table 1.1 shows the composition of inspired air and expired air.

Table 1.1

gas	percentage in inspired air	percentage in expired air
nitrogen	79	79
oxygen	21	16
gas **X**	0.04	4
water vapour	variable	saturated

(i) State the name of gas **X** in Table 1.1.

..... [1]

(ii) Calculate the difference between the percentage of oxygen in inspired and expired air.

..... % [1]

(iii) State the name of **one** process in the body that uses oxygen.

..... [1]

(c) Gas exchange takes place through stomata in the leaves of a plant.

Stomata are also involved in water loss.

(i) Complete the sentences to describe how water is lost from the leaves.

The water evaporates from the surfaces of the ..... cells.

The water vapour then exits the leaf by ..... through the stomata.

This process of water loss is called ..... .

[3]

(ii) Suggest why stomata may close on very hot dry days.

..... [1]

[Total: 10]

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2 A student investigates the reactions of four metals with dilute hydrochloric acid, HC*l*.

(a) In the first experiment, the student adds a piece of each metal to separate test-tubes of dilute hydrochloric acid.

The concentration and temperature of the acid are the same in each test-tube. The size of each piece of metal is the same, and the pieces of metal are added to the acid at the same time.

The student observes bubbles of gas being produced in three of the test-tubes, as shown in Fig. 2.1.

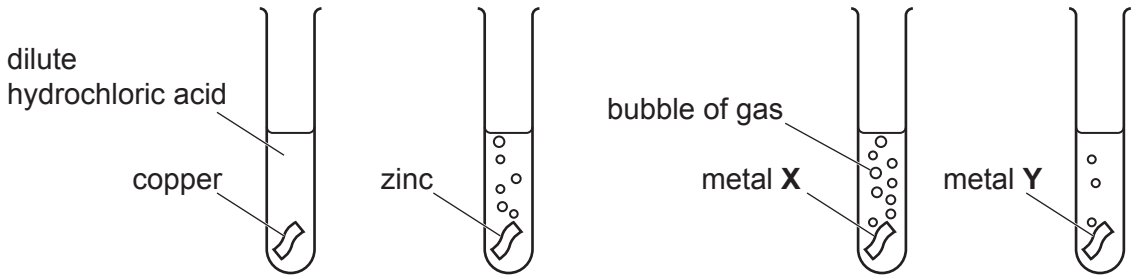

Fig. 2.1

(i) State the name of the gas produced in this investigation.

..... [1]

(ii) State the name of the salt made in the reaction between zinc and dilute hydrochloric acid.

..... [1]

(iii) Explain why bubbles of gas are produced in the test-tube containing zinc, but no bubbles of gas are produced in the test-tube containing copper.

.....

..... [1]

(iv) Suggest the identities of metal **X** and metal **Y**.

Choose from the list of metals.

aluminium **calcium** **iron** **magnesium**

metal **X** .....

metal **Y** .....
[1]

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(b) In the second experiment, the student uses the apparatus shown in Fig. 2.2 to investigate the rate of reaction of zinc with dilute hydrochloric acid.

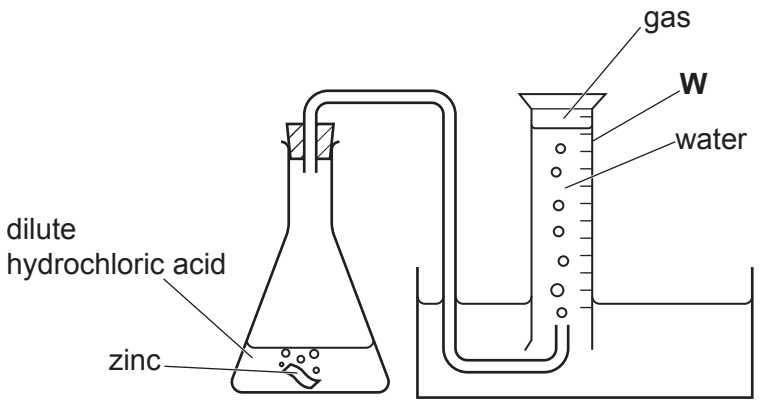

Fig. 2.2

(i) State the name of the piece of apparatus labelled **W**.

..... [1]

(ii) State **one** other piece of apparatus, not shown in Fig. 2.2, that the student uses to investigate the rate of this reaction.

..... [1]

(iii) Suggest **one** way the student can increase the rate of this reaction.

.....

..... [1]

(iv) When zinc reacts with dilute hydrochloric acid, an aqueous zinc salt is formed.

This salt contains zinc ions, Zn^{2+}.

State a chemical test for zinc ions, Zn^{2+}, and give the observation for a positive result.

test .....

.....

observation .....

.....

[2]

[Total: 9]

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3 Fig. 3.1 shows a truck carrying a load moving horizontally along a flat level road.

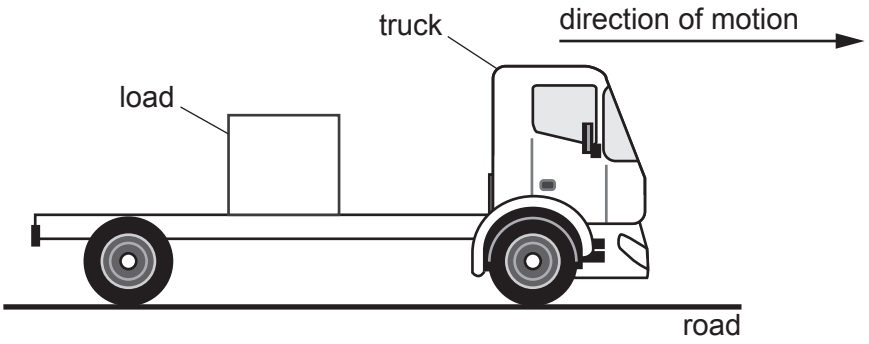

Fig. 3.1

(a) The load has a mass of 2500 kg.

(i) Calculate the weight of the load.

The gravitational force on unit mass *g* is 10 N / kg.

weight = ... N [2]

(ii) Draw an arrow on Fig. 3.1 to show the weight of the load. [1]

(iii) The load on the truck is made of solid gold.

The volume of the load is 1.3×10^5 cm^3.

Calculate the density of gold in kg / m^3.

density = ... kg / m^3 [3]

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(b) Fig. 3.2 shows the speed–time graph for the motion of the truck on a journey.

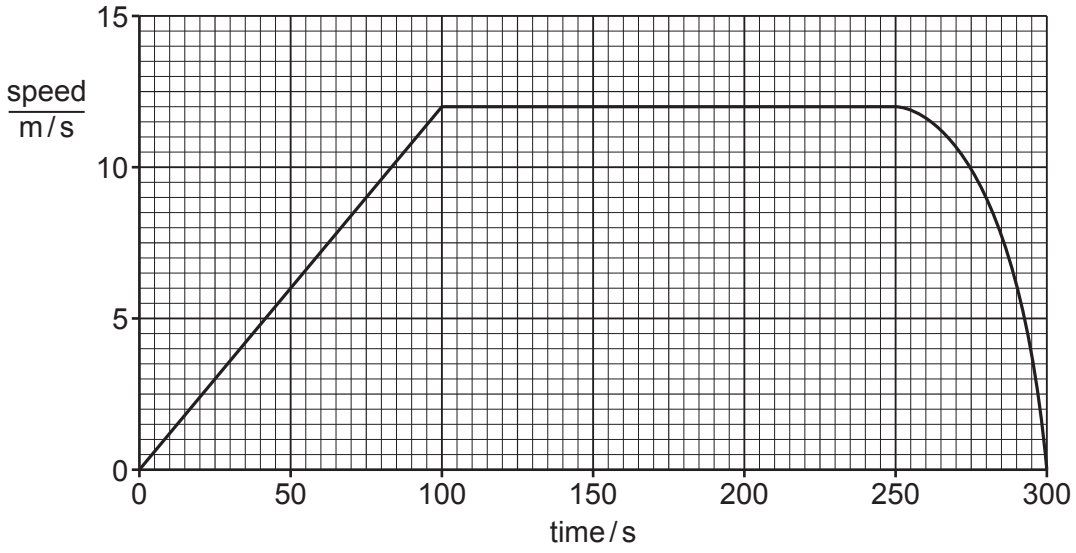

Fig. 3.2

(i) State the maximum speed of the truck on this journey.

maximum speed = ... m / s [1]

(ii) State the time taken by the truck to reach the maximum speed.

time = ... s [1]

(iii) Describe the motion of the truck between 250 s and 300 s.

.....

..... [1]

(c) On a different journey, the truck is moving along a flat level road at a constant speed of 5 m / s.

The engine of the truck provides a constant driving force.

Explain why this constant driving force does **not** change the speed of the truck.

.....

.....

..... [2]

[Total: 11]

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4 **(a)** Fig. 4.1 shows a food web for one ecosystem.

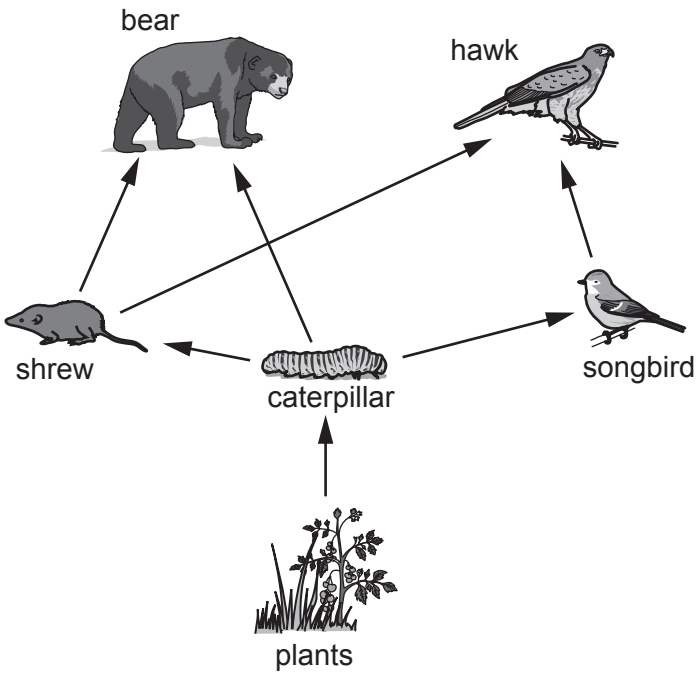

Fig. 4.1

(i) Identify the herbivore in Fig. 4.1.

..... [1]

(ii) Complete the sentences to explain why the hawk is a tertiary consumer.

Use **one** word in each gap.

The hawk eats an organism called a ..... .

This organism is a ..... consumer.

[2]

(iii) Rabbits are also found in the ecosystem.

Rabbits feed on plants.

Bears eat rabbits.

Construct a food chain to show this feeding relationship.

..... [2]

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(b) Some plants are pollinated by insects.

(i) Define the term pollination.

.....

.....

..... [2]

(ii) State the function of petals in pollination.

..... [1]

(c) Complete the sentences about fertilisation in humans.

Choose words from the list.

gamete **ovary** **oviduct**

ovum **uterus** **zygote**

Fertilisation in humans takes place in the ..... of the female.

After fertilisation, the fertilised egg is called the ..... .

[2]

[Total: 10]

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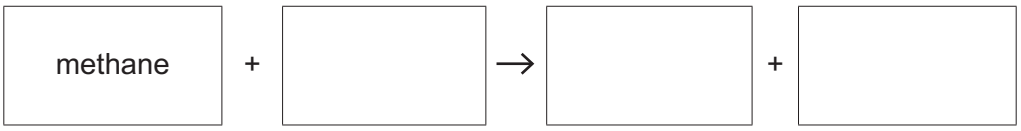
5 Natural gas and petroleum are fossil fuels.

(a) Methane is the main constituent of natural gas.

Complete the word equation for the complete combustion of methane.



[1]

(b) Petroleum is a mixture of saturated hydrocarbon molecules.

It is separated by the process shown in Fig. 5.1.

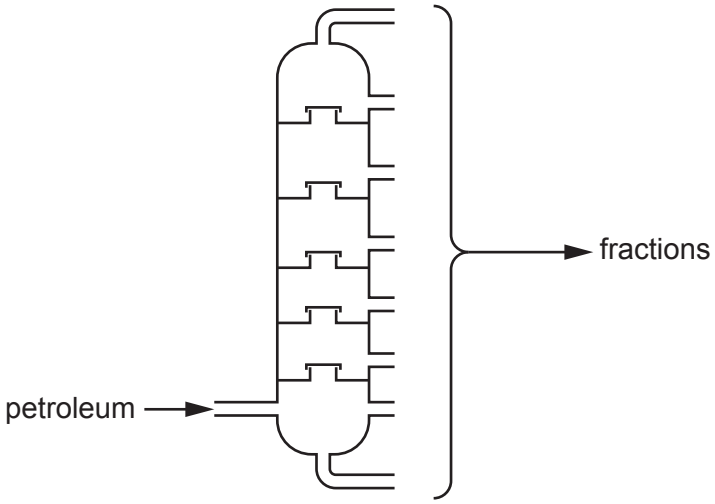


Fig. 5.1

(i) State the name of this process.

..... [1]

(ii) State the name of the fraction used for bottled gas for heating and cooking.

..... [1]

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(c) Naphtha from petroleum is used to produce alkenes.

(i) State the name of the process that is used to produce alkenes.

..... [1]

(ii) Describe the colour change when aqueous bromine is added to an alkene.

from ..... to ..... [1]

(iii) Alkenes form addition polymers.

Name **one** alkene and the addition polymer that it forms.

alkene .....

addition polymer .....
[1]

[Total: 6]

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6 Fig. 6.1 shows a wind turbine used to generate electricity for the electrical system of a house.

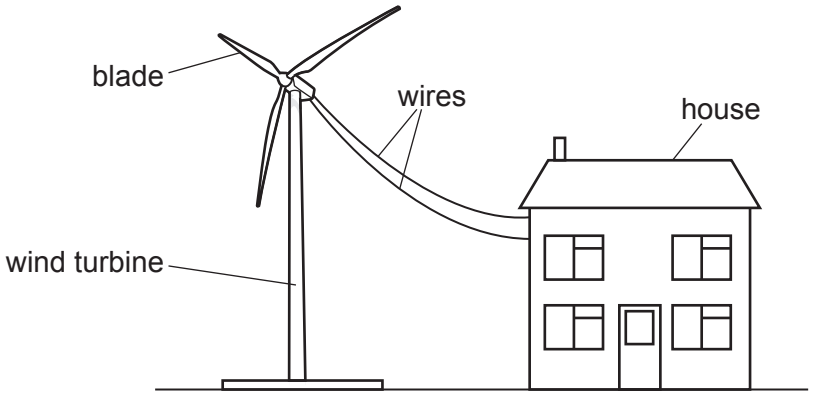

Fig. 6.1

(a) Complete the sentences to describe the energy transfers for the wind turbine.

The ..... energy of the wind rotates the blades of the turbine.

The generator in the wind turbine uses the ..... energy of the rotating blades to generate ..... energy.

[3]

(b) The electromotive force (e.m.f.) produced by the wind turbine is 230 V.

There is a current of 9.2 A in each wire connected to the house.

(i) State the name of a suitable metal for the wires.

..... [1]

(ii) Complete the sentence:

The current in the metal wires is due to a flow of ..... . [1]

(iii) Calculate the resistance of the electrical system of the house.

Give the unit of your answer.

resistance = ... unit ..... [3]

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(c) Fig. 6.2 shows electricity wires hanging between poles on a cold day.

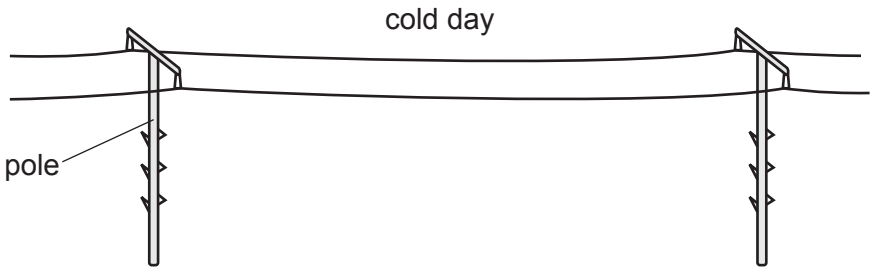

Fig. 6.2

Fig. 6.3 shows the same electricity wires on a hot day.

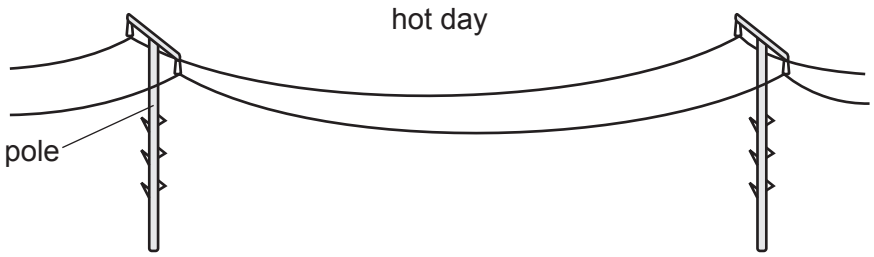

Fig. 6.3

Explain why the wires hang differently on the hot day.

.....

..... [1]

[Total: 9]

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7 **(a)** Carbohydrates are part of a balanced diet for humans.

Large carbohydrates are digested by enzymes in the alimentary canal.

The graph in Fig. 7.1 shows the effect of pH on the activity of one enzyme.

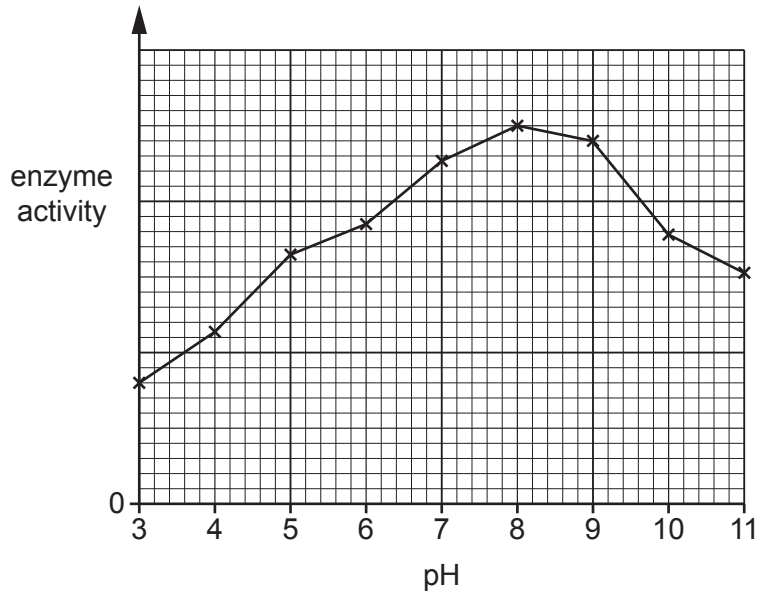

Fig. 7.1

(i) Describe the effect of pH on the enzyme activity.

Include data from Fig. 7.1 in your answer.

.....

.....

..... [2]

(ii) State the **three** chemical elements that make up carbohydrates.

1 .....

2 .....

3 .....

[1]

(iii) State the dietary importance of carbohydrates.

..... [1]

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(b) Digested food is transported in the blood.

State the name of the component of blood that transports digested food.

..... [1]

(c) Blood can be tested for the presence of human immunodeficiency virus (HIV) in the body.

State **two** ways that the spread of HIV is controlled.

1 .....

2 .....
[2]

[Total: 7]

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8 **(a)** Chlorine exists as diatomic molecules.

(i) State what is meant by the term molecule.

.....

..... [1]

(ii) State what is meant by the term diatomic.

.....

..... [1]

(iii) Chlorine is dissolved in a solvent to form aqueous chlorine.

State the formula of the solvent and the formula of the solute in aqueous chlorine.

solvent .....

solute .....
[2]

(iv) State why chlorine is used in the treatment of the water supply.

.....

..... [1]

(b) Chlorine is in Group VII of the Periodic Table.

One atom of chlorine is represented as shown.

$$^{37}_{17}Cl$$

(i) Deduce the number of protons and neutrons in the nucleus of this atom.

protons .....

neutrons .....
[2]

(ii) State the number of electrons in the outer shell of a chlorine atom and in the outer shell of a chloride ion, Cl^-.

Cl atom .....

Cl^- ion .....
[2]

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(c) State why chlorine does **not** react with neon, a Group VIII element.

Use ideas about electronic structure in your answer.

.....

.....

..... [2]

[Total: 11]

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9 Fig. 9.1 shows a lighthouse used at night to warn ships of dangerous rocks in the water.

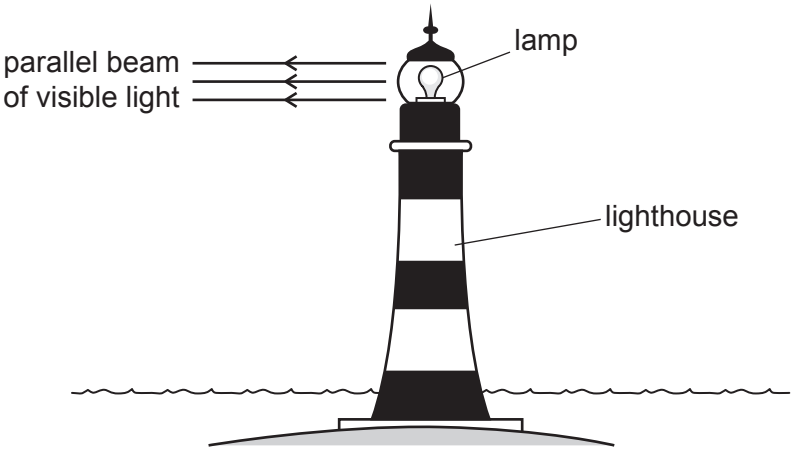

Fig. 9.1

(a) A thin converging lens is used to form a parallel beam of visible light.

Fig. 9.2 shows the lens placed in front of the lamp.

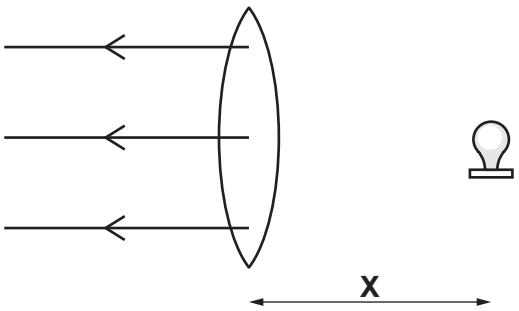

Fig. 9.2

(i) Complete Fig. 9.2 to show how three rays from the lamp form the beam from the lens. [1]

(ii) State the name of the distance labelled **X** in Fig. 9.2.

..... [1]

(iii) Fig. 9.3 shows an incomplete electromagnetic spectrum.

Write visible light on Fig. 9.3 in the correct position.

← increasing frequency						
	X-rays					radio waves

Fig. 9.3

[1]

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(b) In fog, the beam from the lighthouse cannot be seen easily.

Therefore, the lighthouse also uses a foghorn to make a loud sound.

Fig. 9.4 shows a foghorn.

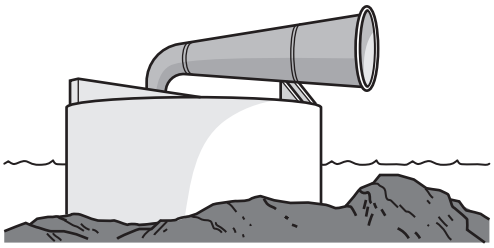

Fig. 9.4

(i) The foghorn emits a loud sound.

Describe the amplitude of a loud sound.

..... [1]

(ii) The sound from the foghorn has a low pitch.

Suggest a suitable frequency for the foghorn that can be heard by humans with healthy ears.

Give a reason for your answer.

frequency ..... Hz

reason .....

.....

[1]

(iii) The foghorn is heard on a ship at a distance of 2100 m from the lighthouse.

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

Calculate the time taken for sound from the foghorn to travel to the ship.

time = ... s [2]

[Total: 7]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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

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