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CANDIDATE NAME

CENTRE NUMBER | | | | | |

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5234400452

COMBINED SCIENCE **0653/43**

Paper 4 Theory (Extended) **October/November 2022**

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 **20** pages.

[Turn over

1 **(a)** Fig. 1.1 is a diagram of a wind-pollinated flower.

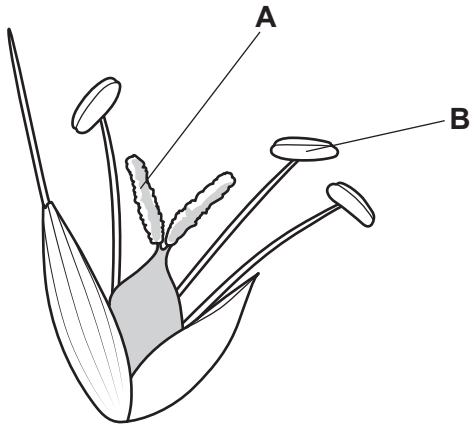

Fig. 1.1

(i) State the names of the parts labelled **A** and **B** on Fig. 1.1.

A .....

B .....
[2]

(ii) On Fig. 1.1, draw a label line and the letter **X** to identify the part that produces ovules. [1]

(iii) Describe **two** adaptations for wind pollination of the flower shown in Fig. 1.1.

1 .....

2 .....
[2]

(b) Fig. 1.2 shows a food web.

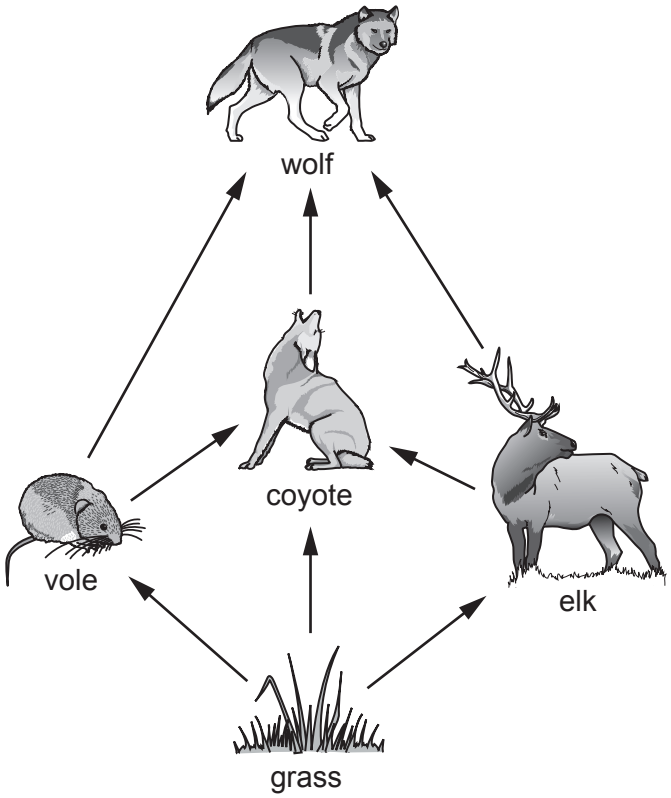

Fig. 1.2

(i) Use Fig. 1.2 to construct **one** food chain that contains the vole.

..... [2]

(ii) Identify **one** organism in Fig. 1.2 that is on the third trophic level.

..... [1]

(iii) Identify **one** organism in Fig. 1.2 that is a primary **and** a secondary consumer.

..... [1]

(c) Grass photosynthesises.

State the balanced chemical equation for photosynthesis.

..... [2]

[Total: 11]

[Turn over

2 The electronic structures of a chlorine atom and a chloride ion are shown in Fig. 2.1.

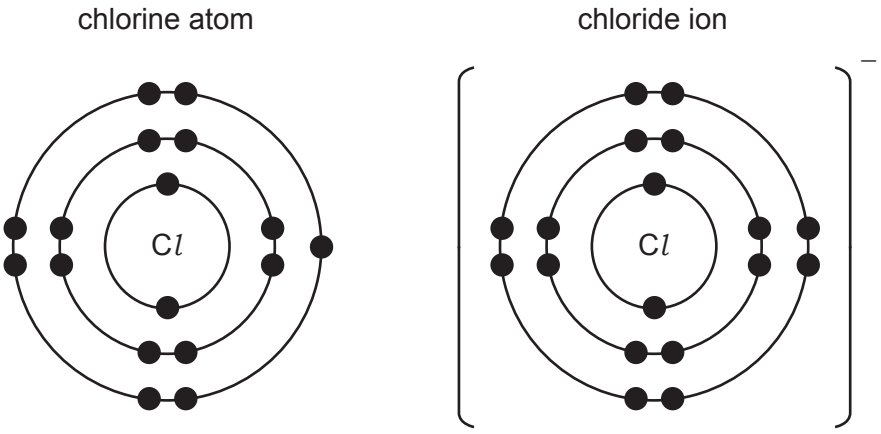

Fig. 2.1

(a) State **two** differences between the chlorine atom and the chloride ion shown in Fig. 2.1.

1 .....

2 .....

[2]

(b) **(i)** Explain how Fig. 2.1 can be used to deduce the proton number of chlorine.

.....

..... [1]

(ii) Explain how Fig. 2.1 can be used to deduce the period number of chlorine in the Periodic Table.

.....

..... [1]

(iii) Element **X** and chlorine are in the same group of the Periodic Table.

Element **X** is less reactive than chlorine.

Suggest the identity of element **X**.

Give a reason for your answer.

element **X** .....

reason .....

.....

[2]

(c) Table 2.1 shows the melting points of chlorine and sodium chloride.

Table 2.1

	melting point / °C
chlorine	–101
sodium chloride	801

Explain the difference in the melting points of chlorine and sodium chloride.

Use ideas about structure and attractive forces in your answer.

.....

.....

.....

..... [3]

[Total: 9]

3 A new world water speed record was set in 1978 by a specially designed speed boat.

Fig. 3.1 shows forces **K**, **L**, **M** and **N** acting on the moving boat.

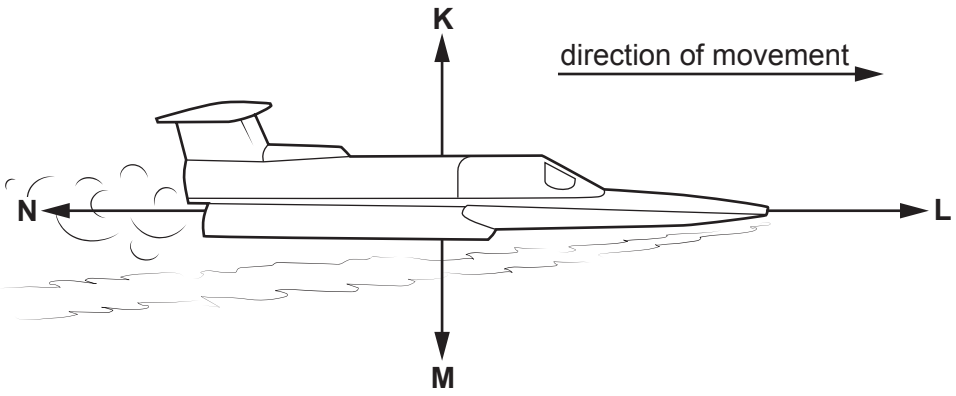

Fig. 3.1

(a) **(i)** State the letter that represents the friction acting on the boat. ..... [1]

(ii) Force **L** is 10 000 N. Force **N** is 8000 N.

Describe the effect of these forces on the motion of the boat.

.....

..... [1]

(b) The world record speed of the boat is 142 m / s.

(i) Calculate the world record speed of the boat in kilometres per hour (km / h).

speed = ... km / h [1]

(ii) The engine of the boat exerts a force of 15 000 N to accelerate the boat from rest to its world record speed.

The boat moves a distance of 504 m.

Calculate the work done by the engine on the boat.

Give the unit of your answer.

work done = ... unit ..... [3]

(c) Fig. 3.2 shows the speed–time graph for the boat doing a practice run.

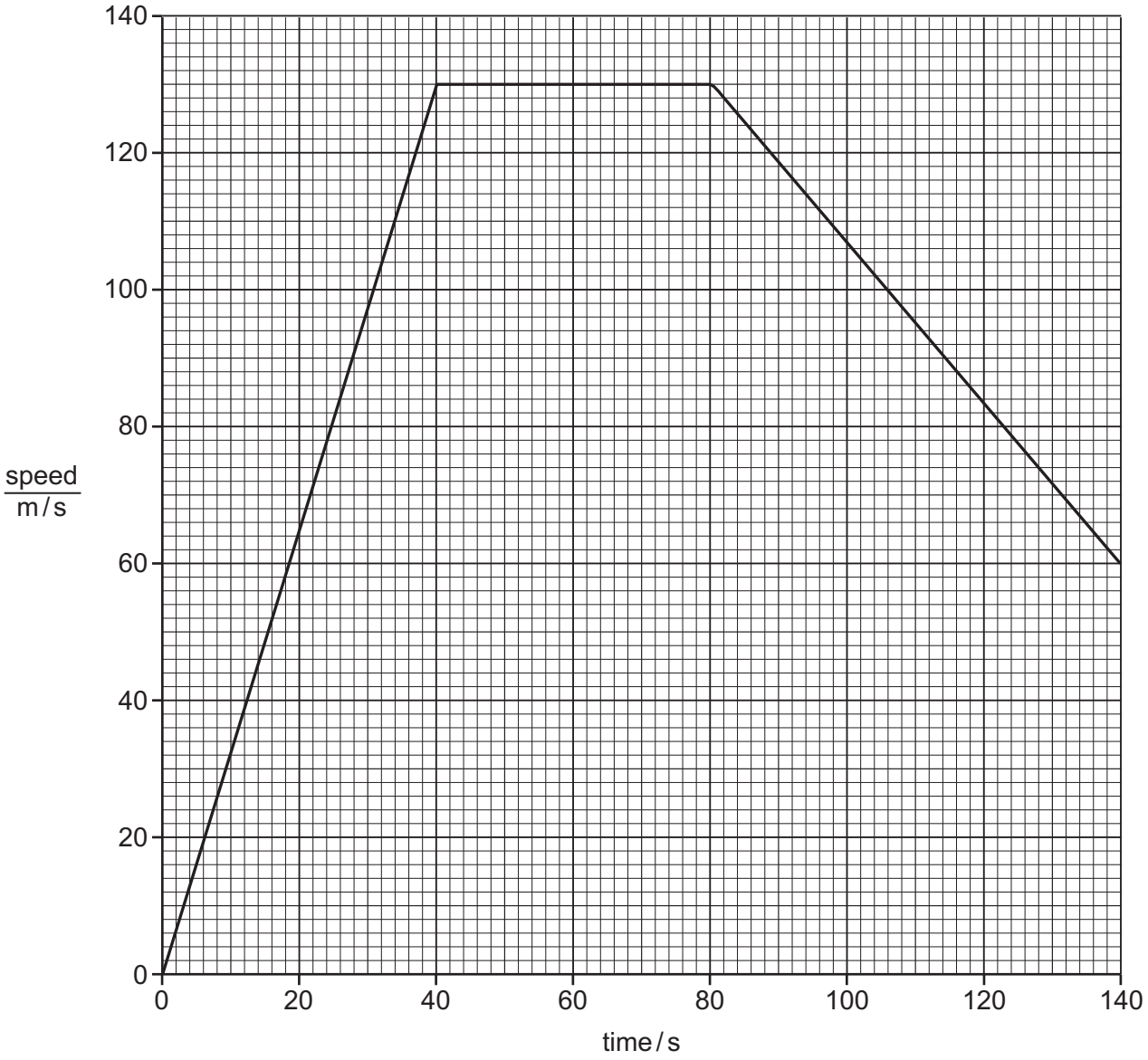

Fig. 3.2

(i) State the maximum speed of the boat shown in Fig. 3.2.

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

(ii) Use Fig. 3.2 to determine the distance the boat moves between 0 and 80 s.

distance = ... m [3]

[Total: 10]

4 **(a)** Fig. 4.1 is a diagram of a human heart.

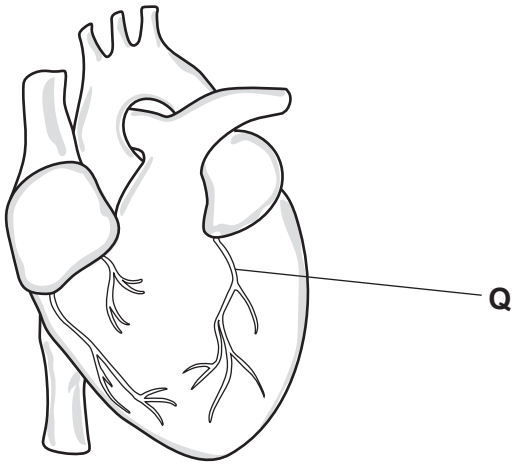

Fig. 4.1

(i) State the name of part **Q** and explain how it is linked to coronary heart disease.

Q .....

explanation .....

.....

[2]

(ii) Risk factors for coronary heart disease include diet and smoking.

State **two** other risk factors for coronary heart disease.

1 .....

2 .....

[2]

(b) Fig. 4.2 shows how physical activity affects heart rate.

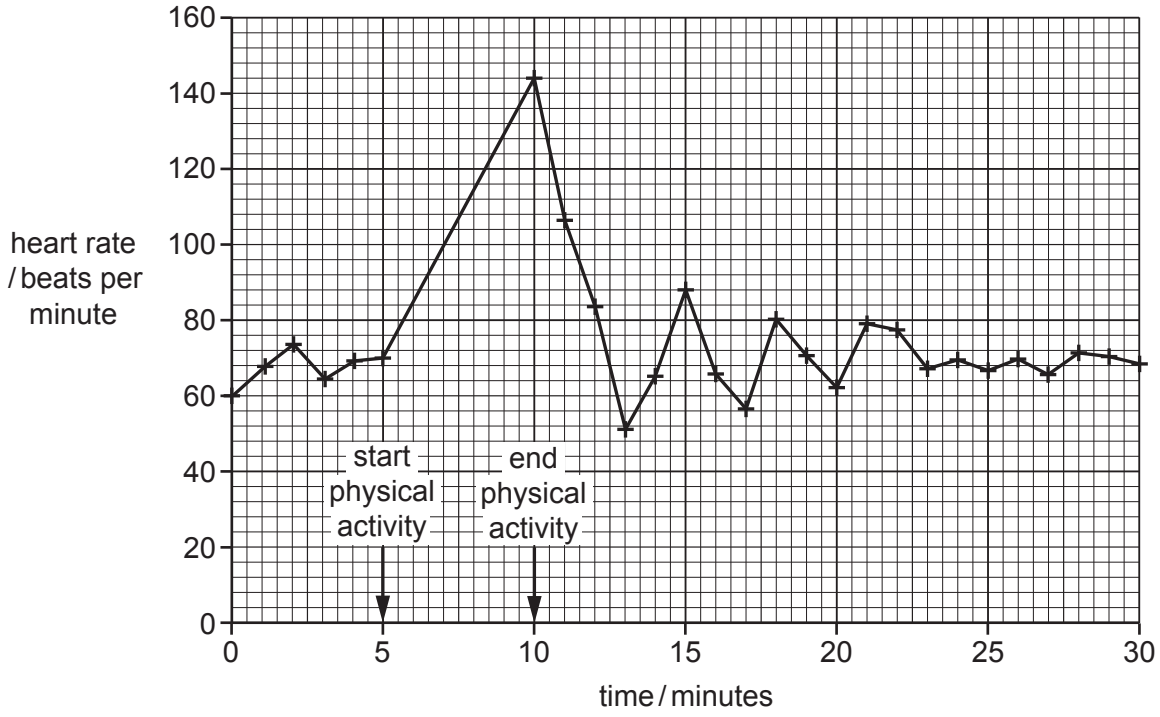

Fig. 4.2

(i) Use Fig. 4.2 to calculate the percentage increase in heart rate between 0 and 10 minutes.

percentage increase in heart rate = ... % [2]

(ii) Explain the shape of the graph in Fig. 4.2 between 5 and 10 minutes.

.....

.....

.....

.....

..... [3]

[Total: 9]

5 **(a)** Iron is extracted from hematite in the blast furnace.

One chemical equation for the extraction of iron in the blast furnace is shown.

$$Fe_2O_3 + 3CO \rightarrow .....Fe + ...$$

(i) Complete the balanced chemical equation. [2]

(ii) Identify the reducing agent in this extraction.

Explain your answer.

reducing agent .....

explanation .....

.....

[1]

(b) Iron rusts when it reacts with oxygen and water to make hydrated iron(III) oxide.

(i) A word equation for the rusting of iron is shown.

iron + oxygen + water → hydrated iron(III) oxide

Explain why rusting is described as an oxidation reaction.

.....

..... [1]

(ii) State **one** method of rust prevention and describe how this method works.

method .....

description .....

.....

.....

[2]

(c) Iron reacts with dilute hydrochloric acid in an exothermic reaction.

(i) The reaction produces iron(II) chloride.

State the formula of iron(II) chloride.

..... [1]

(ii) Explain how a reaction is exothermic.

Use ideas about bonds in your answer.

.....

.....

.....

.....

..... [3]

[Total: 10]

6 Fig. 6.1 shows an electric toaster used to toast one slice of bread.

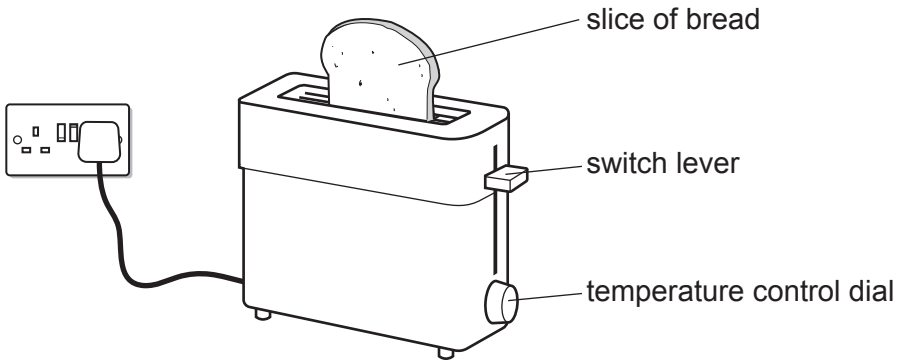

Fig. 6.1

Fig. 6.2 shows the circuit diagram for the toaster.

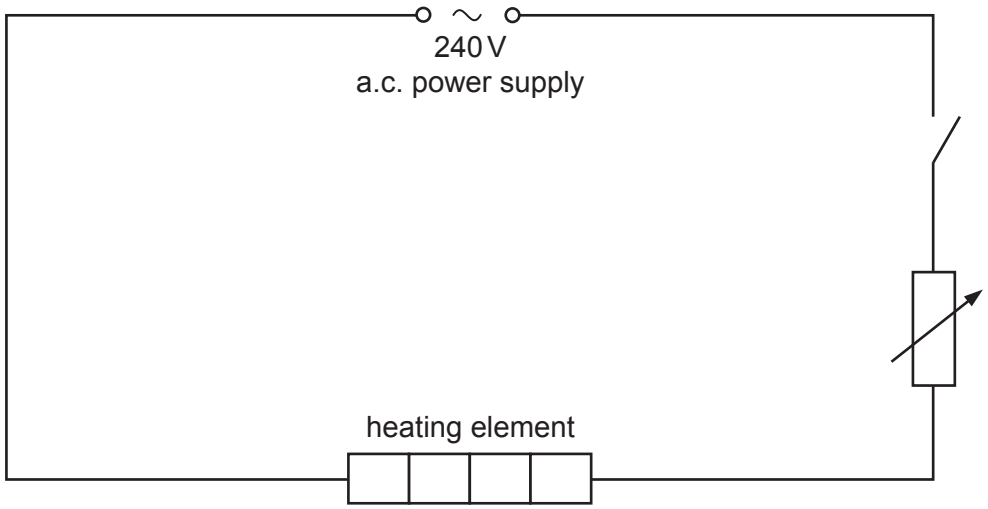

Fig. 6.2

(a) Add a voltmeter to the circuit diagram in Fig. 6.2 to measure the potential difference (p.d.) across the heating element.

Use the correct circuit symbol. [1]

(b) The switch lever is pushed down to switch the toaster on.

The temperature control dial adjusts the variable resistor.

(i) The resistance of the variable resistor is adjusted to 36 Ω.

The resistance of the heating element is 54 Ω.

Calculate the total resistance in the circuit.

resistance = ... Ω [1]

(ii) The resistance of the variable resistor is decreased.

Explain why the thermal energy output from the heating element increases.

.....

.....

.....

..... [2]

(c) Fig. 6.3 shows the circuit diagram for a different toaster that has two heating elements connected in parallel.

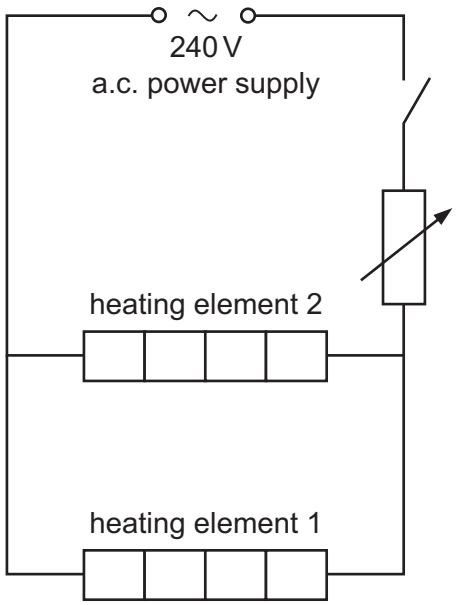

Fig. 6.3

(i) Heating element 1 has a resistance of 41.0 Ω.

Heating element 2 has a resistance of 53.0 Ω.

Show that the combined resistance of the two heating elements in parallel is 23.1 Ω.

[2]

(ii) The variable resistor is adjusted so that the total resistance in the circuit is 60.0 Ω.

The toaster is switched on.

The current in heating element 1 is 2.3 A.

Calculate the current in heating element 2.

current = ... A [3]

[Total: 9]

7 **(a)** Fig. 7.1 shows cells that line the gas exchange system of humans.

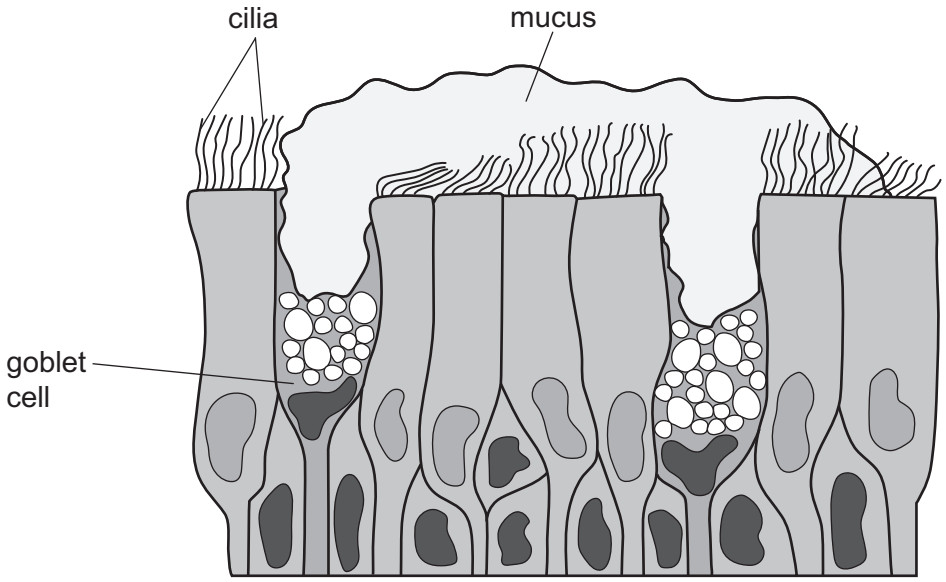

Fig. 7.1

(i) Use Fig. 7.1 to explain how tar in tobacco smoke prevents the cells from protecting the gas exchange system.

.....

.....

.....

.....

..... [3]

(ii) Explain how the carbon monoxide in tobacco smoke affects the function of red blood cells.

.....

.....

..... [2]

(b) The lungs contain a gas exchange surface. This surface is large and thin.

State **two** other features of gas exchange surfaces.

1 .....

2 .....

[2]

[Total: 7]

8 Car engines take in air.

Unreacted air and other gases leave the car in the exhaust gases, as shown in Fig. 8.1.

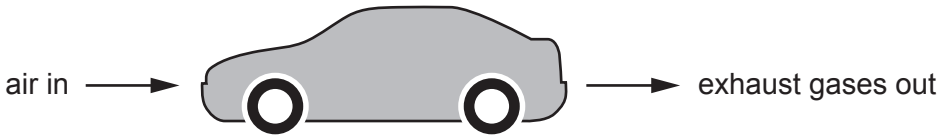

Fig. 8.1

(a) The air entering a car engine is a mixture of gases which includes nitrogen, oxygen, argon and carbon dioxide.

(i) State which **one** of these gases is monoatomic.

..... [1]

(ii) Air is a mixture. Carbon dioxide is a compound.

Explain the difference between a mixture and a compound.

.....

.....

..... [2]

(b) The concentration of oxygen in the air entering a car engine is greater than the concentration of oxygen in the exhaust gases leaving the car.

Explain why.

.....

..... [2]

(c) Car exhaust gases cause an increase in the concentration of carbon dioxide in the atmosphere. This causes an enhanced greenhouse effect.

State **one** impact of an enhanced greenhouse effect.

..... [1]

(d) Carbon dioxide in the air dissolves in rainwater and causes damage to buildings.

State the name of **one** other gas that causes the same problem.

..... [1]

[Total: 7]

9 (a) (i) Fig. 9.1 shows an incomplete electromagnetic spectrum.

On Fig. 9.1, write infrared radiation in its correct place.

← increasing frequency						
gamma radiation			visible light			

Fig. 9.1

[1]

(ii) State the speed of infrared radiation in a vacuum.

..... m/s [1]

(iii) A toaster for toasting bread is one use of infrared radiation.

State **one** other use of infrared radiation.

..... [1]

[Turn over

(b) Fig. 9.2 shows a type of vacuum flask used for carrying a cold liquid at 5 °C.

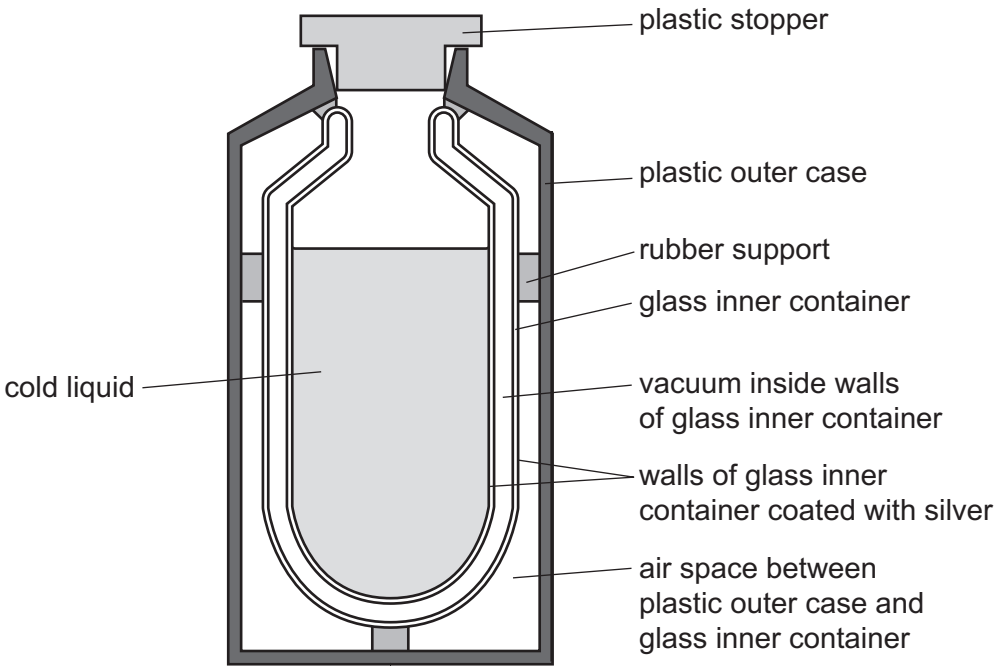

Fig. 9.2

The flask is placed in a room. The temperature of the room is 20 °C.

(i) Describe **one** way that the design of the flask reduces the transfer of thermal energy from the room to the liquid by:

convection .....

.....

radiation. .....

.....

[2]

(ii) Describe how a small amount of thermal energy is transferred from the room to the liquid by **conduction**.

Use ideas about vibrations in your answer.

.....

.....

..... [2]

(iii) A special type of vacuum flask is used to store liquid air at –196 °C.

Table 9.1 shows the boiling points of the main components of liquid air.

Table 9.1

component	boiling point / °C
argon	–186
nitrogen	–196
oxygen	–183

State which component is most likely to form bubbles of gas first.

Give a reason for your answer.

component .....

reason .....

.....

[1]

[Total: 8]

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).