* 0019656632601 *

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CANDIDATE NAME

CENTRE NUMBER

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* 3 1 5 4 3 2 1 7 8 2 *

COMBINED SCIENCE **0653/42**

Paper 4 Theory (Extended) **May/June 2024**

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 shows the alimentary canal and associated organs in humans.

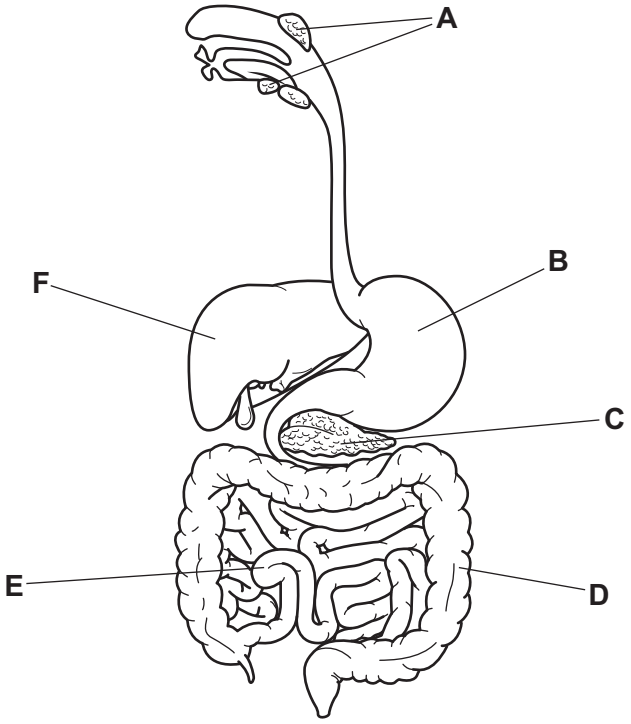


Fig. 1.1

Table 1.1 shows the name and function of some of the parts labelled in Fig. 1.1.

Complete Table 1.1.

Table 1.1

label	name of part	function
…….	stomach	digestion of protein
E	…….....	digestion of insoluble molecules and …… of soluble molecules
C	……	secretion of lipase

[3]

(b) **Two** types of digestion occur in the stomach of humans.

Complete these sentences about digestion in the stomach.

Muscles in the stomach wall contract to break down the food into …….. pieces.

This process is called …… digestion.

The insoluble protein molecules are then converted into soluble molecules by the process of …….. digestion.

The soluble molecules produced from the digestion of protein are called …….. .

[4]

(c) A lipase enzyme is found in the alimentary canal.

Fig. 1.2 shows the activity of this lipase enzyme at different pH values.

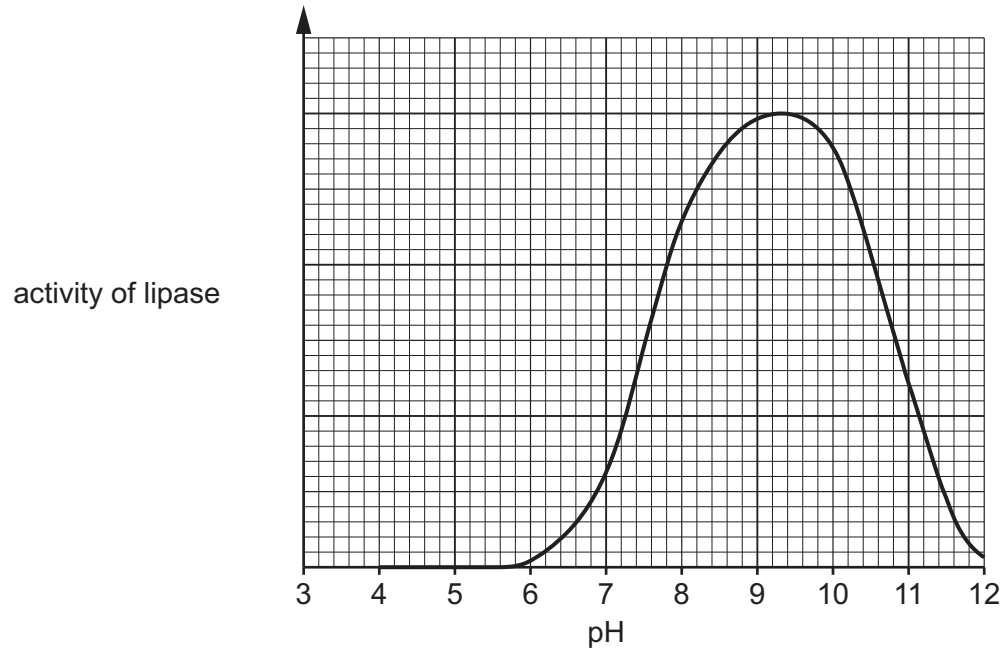


Fig. 1.2

Explain why this lipase enzyme is **not** active in the stomach.

Use data from Fig. 1.2 in your answer.

.....

.....

.....

.....

..... [3]

[Total: 10]

2 Different types of mixtures need different separation processes to isolate the pure substances from the mixture.

(a) For each separation process, draw **one** straight line to the correct description.

separation process	description
crystallisation	separating an insoluble solid from a mixture of a solid in water
filtration	separating dyes from a mixture of dyes in a coloured ink
chromatography	separating a salt from an aqueous solution

[2]

(b) Pure water is separated from a mixture of soluble salt and water by distillation. Fig. 2.1 shows the apparatus used.

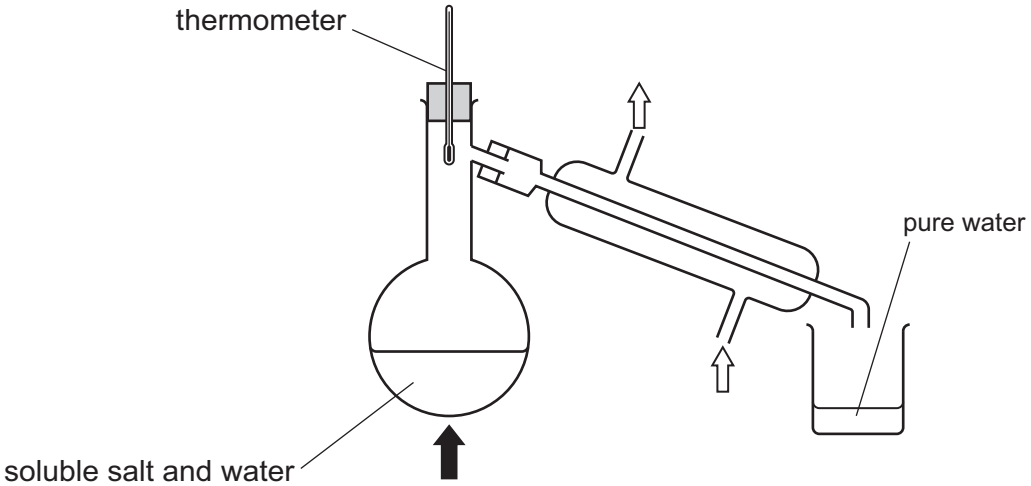


Fig. 2.1

Explain how pure water is separated from this mixture by distillation.

.....

.....

.....

.....

.....

..... [3]

(c) Sodium chloride is a salt.

Table 2.1 shows the melting points and boiling points of sodium chloride and of water.

Table 2.1

	melting point / °C	boiling point / °C
sodium chloride	801	1413
water	0	100

(i) Explain why sodium chloride has a high melting point.

.....

.....

.....

..... [2]

(ii) Explain why the boiling point of water is higher than its melting point.

Use ideas about energy and particles in your answer.

.....

.....

.....

..... [2]

(iii) Fig. 2.2 shows the arrangement of particles in water at +10 °C.

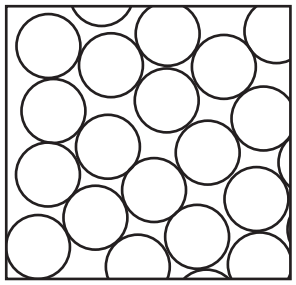
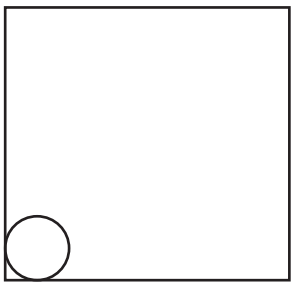


Fig. 2.2

Complete the diagrams in Fig. 2.3 to show the arrangement of particles in water at –10 °C and at +110 °C.

water particles at –10 °C



water particles at +110 °C

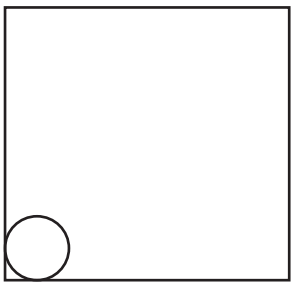


Fig. 2.3

[2]

[Total: 11]

3 Fig. 3.1 shows an old-fashioned room heater made of iron. The heater burns oil as a fuel.

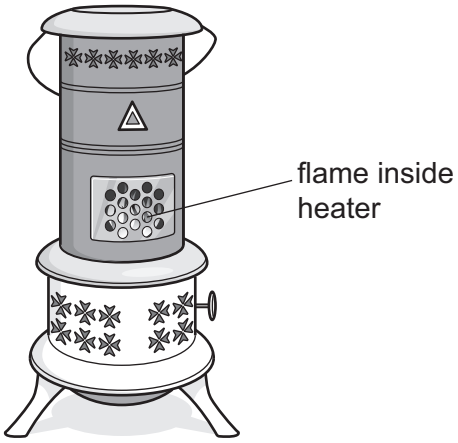


Fig. 3.1

(a) Complete the sentence to state the energy transfers that occur when the oil burns with a visible flame.

Energy is transferred from ..... potential energy to ..... energy and light.

[2]

(b) Describe how the process of convection enables the transfer of energy from the flame to the top of the heater.

.....

.....

..... [2]

(c) Fig. 3.2 shows a person warming their hand with radiation from the side of the heater.

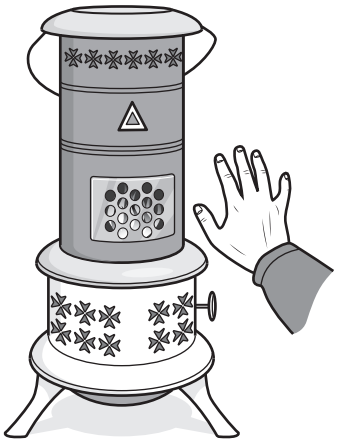


Fig. 3.2

Radiation from the heater is mainly in the infrared region of the electromagnetic spectrum.

The flame emits infrared radiation from the heater with a frequency of 0.95×10^{14} Hz.

(i) State what is meant by frequency.

.....

..... [1]

(ii) State **one** region of the electromagnetic spectrum that has a lower frequency than infrared.

..... [1]

(iii) Calculate the wavelength of radiation with a frequency of 0.95×10^{14} Hz.

The speed of electromagnetic waves = 3.0×10^{8} m/s.

wavelength = ... m [2]

[Total: 8]

4 **(a)** A student labels a diagram of a plant cell.

Fig. 4.1 shows the student's diagram.

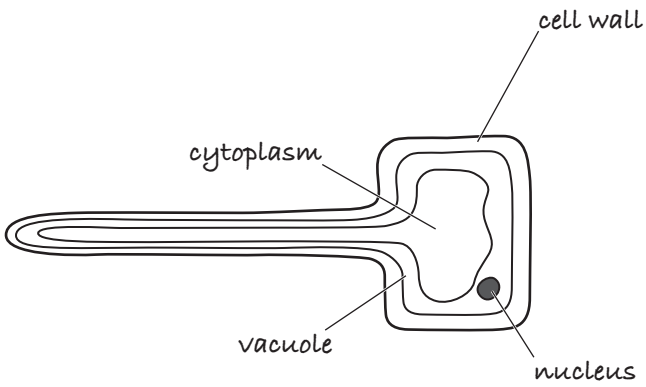


Fig. 4.1

(i) The student has **not** labelled the diagram correctly.

(Circle) **all** the labels on Fig. 4.1 that are **not** correct. [1]

(ii) Explain how the cell in Fig. 4.1 is adapted to its function.

.....

.....

..... [2]

(b) Fig. 4.2 shows the effect of carbon dioxide concentration and light intensity on the rate of photosynthesis.

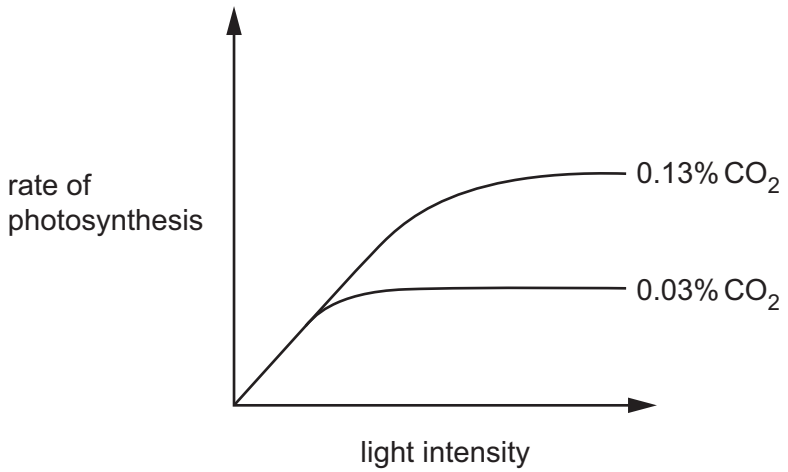


Fig. 4.2

(i) Describe the effect of increasing **light intensity** on the rate of photosynthesis as shown in Fig. 4.2.

.....

.....

..... [1]

(ii) Trees in a forest are cut down and burnt where they fall.

Use Fig. 4.2 to suggest why the rate of photosynthesis in the surrounding plants increases.

.....

.....

.....

..... [2]

(c) Explain why the leaves of plants deficient in magnesium change from green to yellow.

.....

.....

.....

..... [2]

[Total: 8]

5 Nitrogen and oxygen react together at high temperatures in car engines to form oxides of nitrogen.

(a) Nitrogen monoxide, NO, is one of the oxides of nitrogen.

Fig. 5.1 shows the energy level diagram for the reaction of nitrogen and oxygen to form nitrogen monoxide.

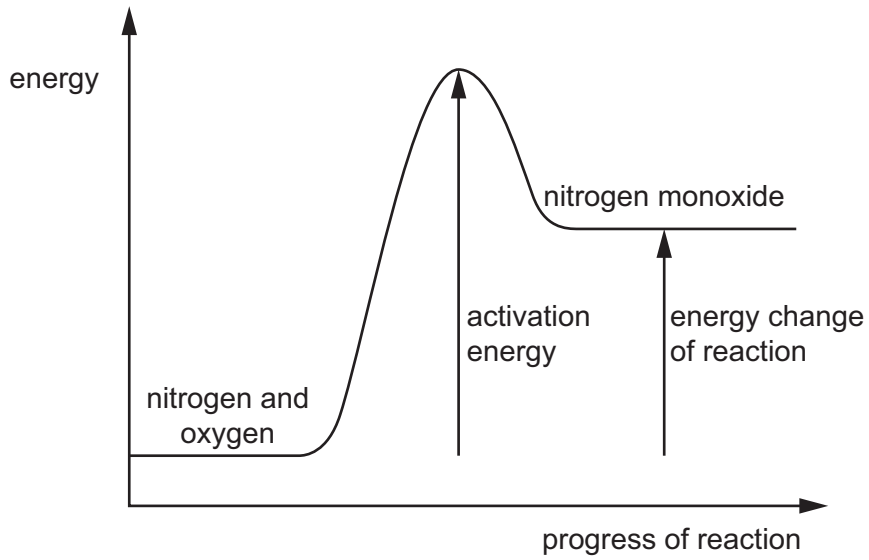


Fig. 5.1

Explain the energy changes shown in Fig. 5.1.

Use ideas about bond breaking and bond forming in your answer.

.....

.....

.....

..... [2]

(b) Nitrogen monoxide, NO, reacts with oxygen to form nitrogen dioxide, NO_2.

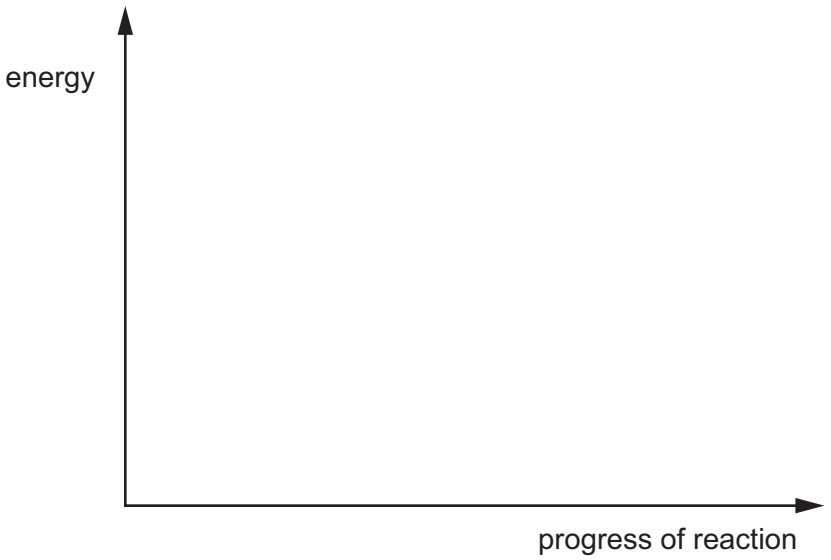
(i) Write a balanced symbol equation for the reaction between nitrogen monoxide and oxygen.

Include the state symbols.

..... [2]

(ii) The reaction between nitrogen monoxide and oxygen is exothermic.

Draw a labelled energy level diagram for this reaction. Include labels for the activation energy and the energy change of reaction.



[2]

[Total: 6]

6 Fig. 6.1 shows a rover vehicle on the planet Mars.

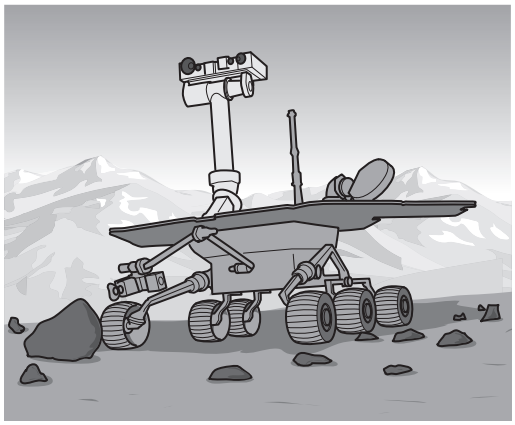


Fig. 6.1

(a) Fig. 6.2 shows a speed–time graph for the vehicle on one of its journeys.

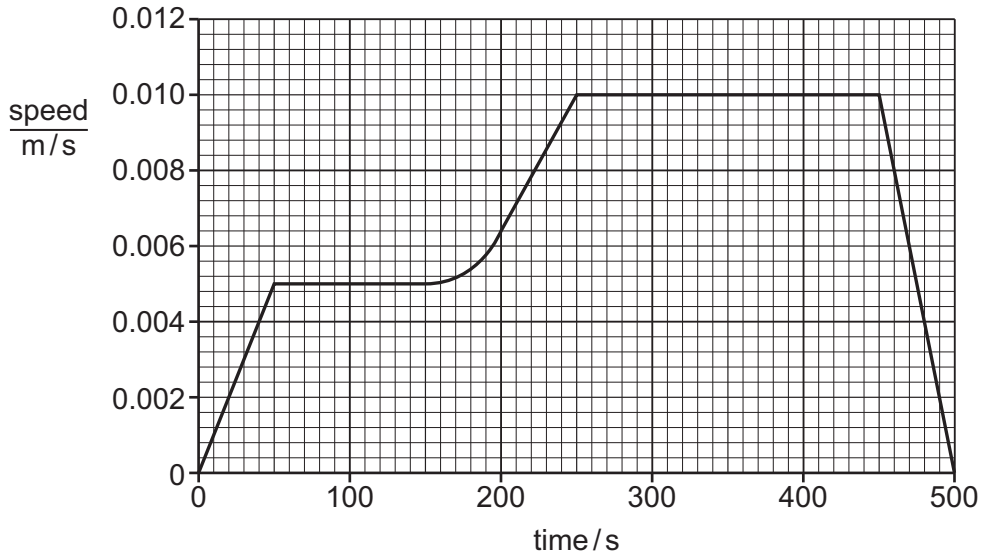


Fig. 6.2

(i) Use Fig. 6.2 to show that the maximum speed of the vehicle on this journey is 0.036 km / h.

[2]

(ii) Use Fig. 6.2 to calculate the acceleration of the vehicle as it starts its journey.

Give the units of your answer.

acceleration = ... units …… [3]

(iii) Describe the motion of the vehicle between 150 s and 200 s.

.....

..... [2]

(b) The mass of the vehicle is 890 kg.

On another journey, the vehicle travels across a rocky terrain at a speed of 0.050 m / s.

(i) Show that the kinetic energy of the vehicle is approximately 1.1 J.

[2]

(ii) While travelling at 0.050 m / s, the vehicle's motors switch off.

Assume **no** energy is lost due to friction and that the gravitational field strength on Mars is 3.8 N / kg.

Calculate the height that the vehicle must climb to allow it to stop.

Give your answer in mm.

height = ... mm [3]

[Total: 12]

7 **(a)** Fig. 7.1 shows the double circulatory system in humans.

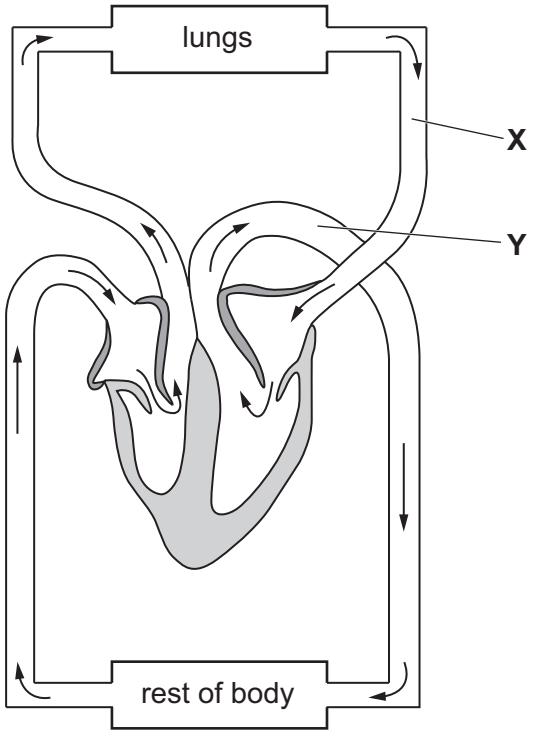


Fig. 7.1

(i) The arrows show the direction of blood flow.

Identify the blood vessels labelled **X** and **Y** in Fig. 7.1.

X .....

Y .....

[2]

(ii) On Fig. 7.1, draw a label line and the letter **S** to identify the septum.

[1]

(iii) Explain the advantages of a double circulatory system.

.....

.....

..... [2]

(b) The lungs contain the gas exchange surface in humans.

(i) List **two** features of gas exchange surfaces.

1 .....

2 .....

[2]

(ii) The composition of inspired air is different to expired air.

Tick (✓) **all** the boxes that explain this statement.

Carbon dioxide is a product of respiration.	
Nitrogen is taken into the blood and used in respiration.	
Oxygen is a product of respiration.	
Water is a reactant of respiration.	
Water evaporates from the lining of the alveoli.	

[2]

[Total: 9]

8 Solid magnesium and some magnesium compounds react with dilute acids to make salts.

Some of the reactants and products of these reactions are shown in Table 8.1.

Table 8.1

reactants		products	
solid	dilute acid	salt	other product(s)
magnesium	sulfuric acid	magnesium sulfate	……
……	sulfuric acid	magnesium sulfate	water
magnesium carbonate	……	magnesium chloride	…… …… and ……

(a) Complete Table 8.1. [4]

(b) **(i)** Identify **one** substance in Table 8.1 that has a pH less than 3.

..... [1]

(ii) Identify **one** covalent substance in Table 8.1 that has a pH greater than 5.

..... [1]

(c) Explain how the position of magnesium in the Periodic Table and the electronic structure of magnesium relate to its metallic character.

.....

.....

.....

.....

..... [3]

[Total: 9]

9 Fig. 9.1 shows a circuit diagram for part of an electric dishwashing machine.

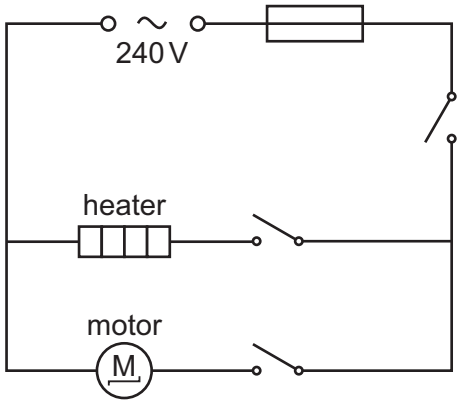


Fig. 9.1

(a) State the circuit component represented by the symbol –o ~ o–.

..... [1]

(b) The resistance of the heater is 25 Ω.

(i) Calculate the current in the heater.

current = ... A [2]

(ii) Use your answer to **(b)(i)** to calculate the power required by the heater.

power = ... W [2]

(c) On Fig. 9.1, draw a lamp connected in the circuit that will **only** be on when the heater is switched on but will **not** reduce the current in the heater. [2]

[Total: 7]

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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).