



Cambridge Assessment
International Education



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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.



1 (a) Fig. 1.1 shows the alimentary canal and associated organs in humans.

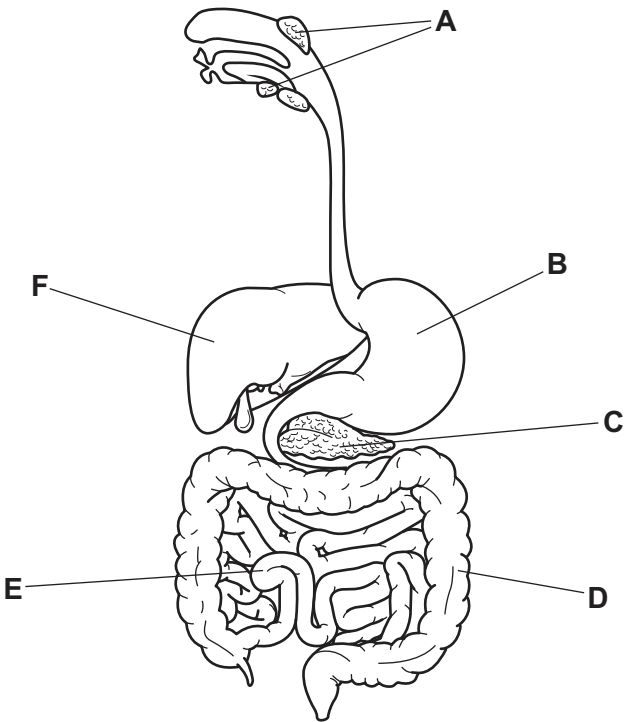


Fig. 1.1

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.

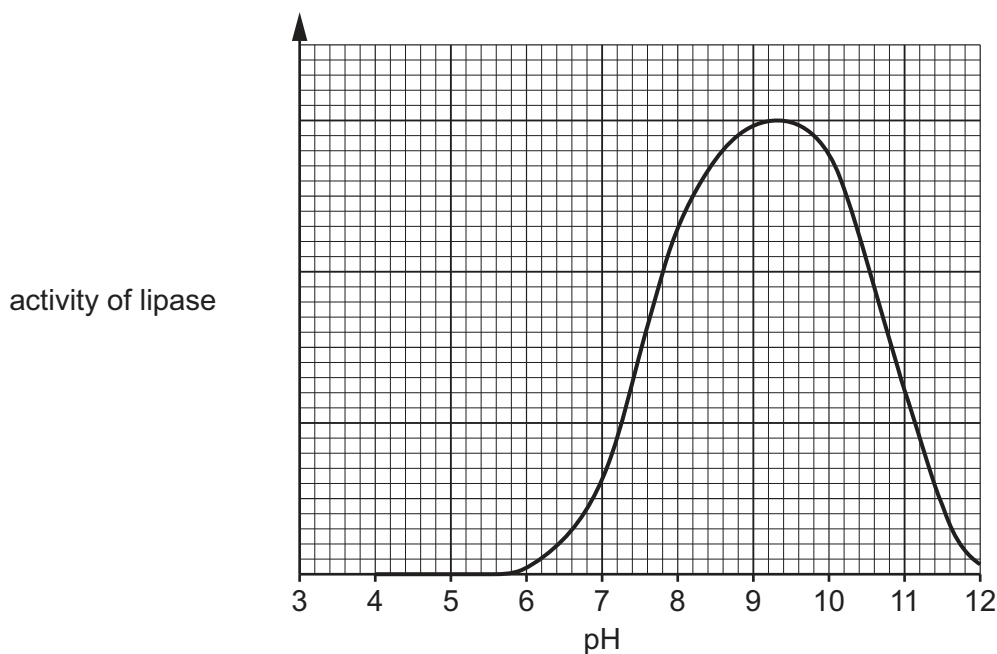


Fig. 1.2

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

Use data from Fig. 1.2 in your answer.

.....

.....

.....

.....

.....

[3]





- 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.

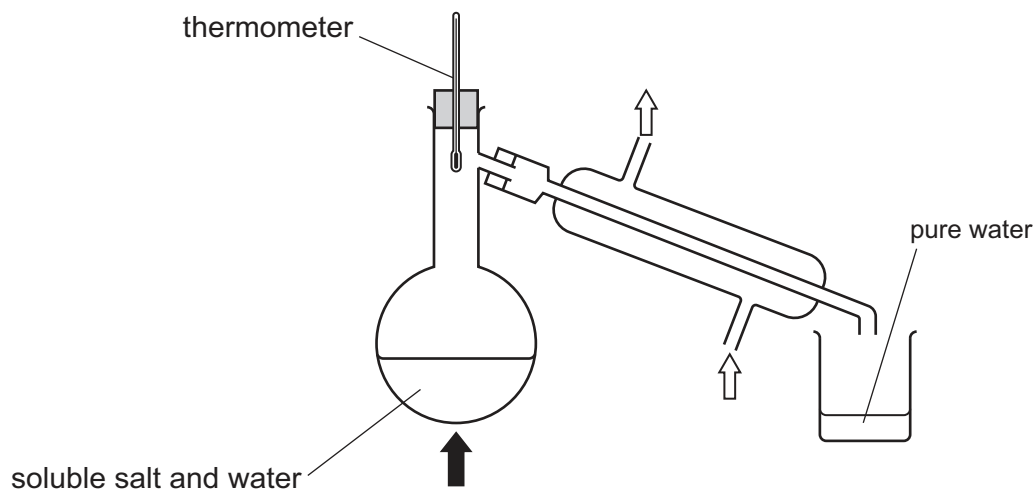


Fig. 2.1

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

.....

.....

.....

.....

.....

..... [3]



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(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]

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7



(iii) Fig. 2.2 shows the arrangement of particles in water at $+10^{\circ}\text{C}$.

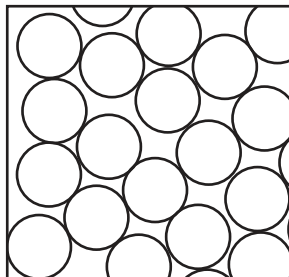
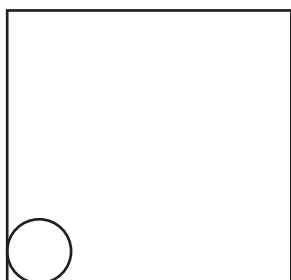


Fig. 2.2

Complete the diagrams in Fig. 2.3 to show the arrangement of particles in water at -10°C and at $+110^{\circ}\text{C}$.

water particles at -10°C



water particles at $+110^{\circ}\text{C}$

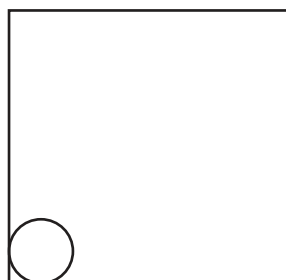


Fig. 2.3

[2]

[Total: 11]





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

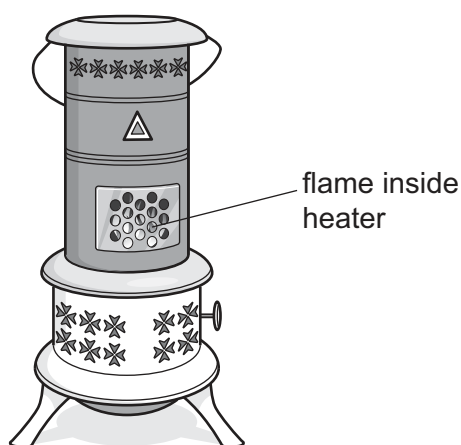


Fig. 3.1

- (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.

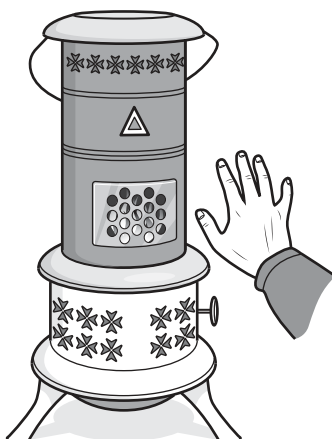


Fig. 3.2





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.

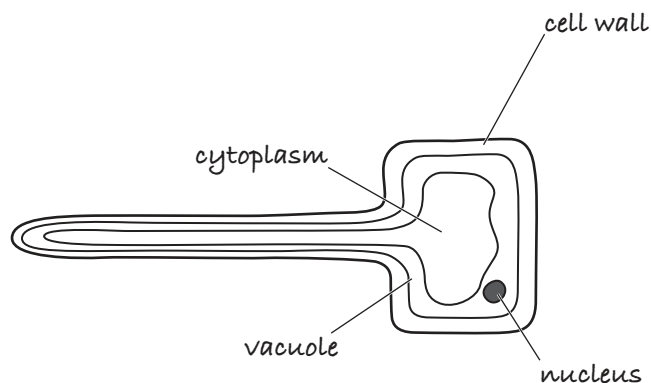


Fig. 4.1

- (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.

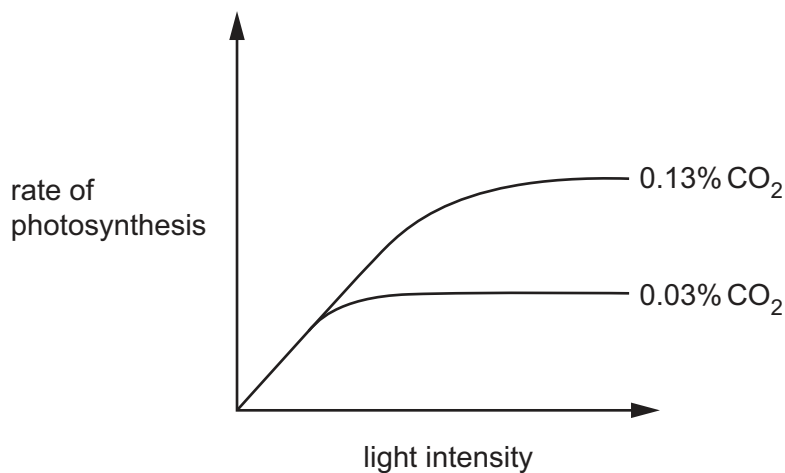


Fig. 4.2





- (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.

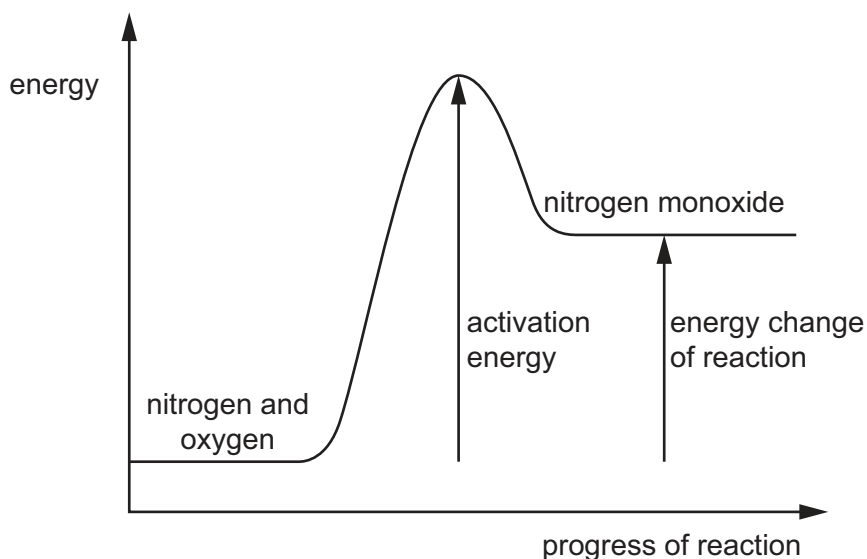


Fig. 5.1

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, NO₂.

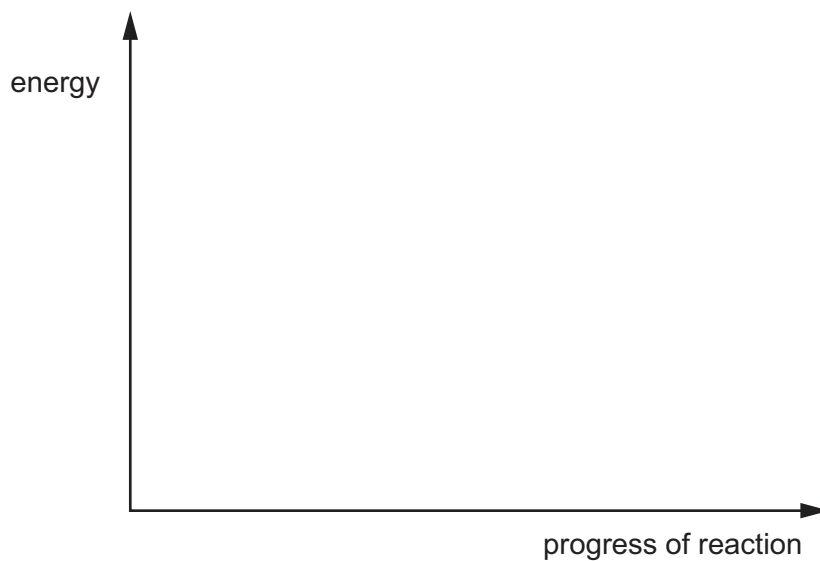
- (i) Write a balanced symbol equation for the reaction between nitrogen monoxide and oxygen.

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.

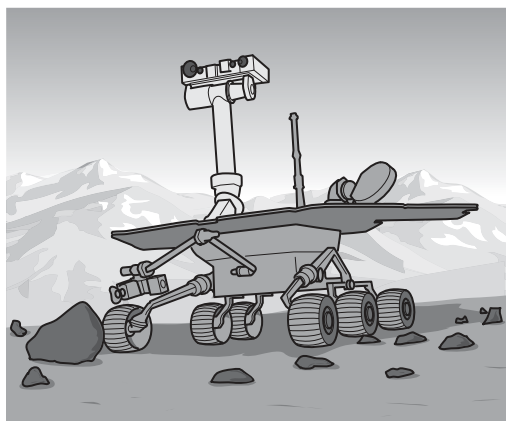


Fig. 6.1

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

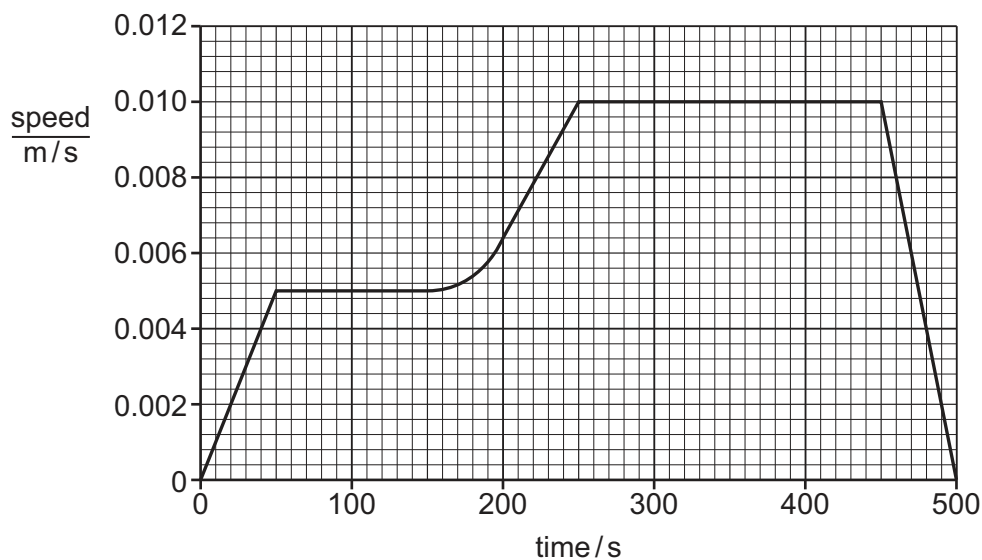


Fig. 6.2

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

[2]



* 0019656632715 *



15



- (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.

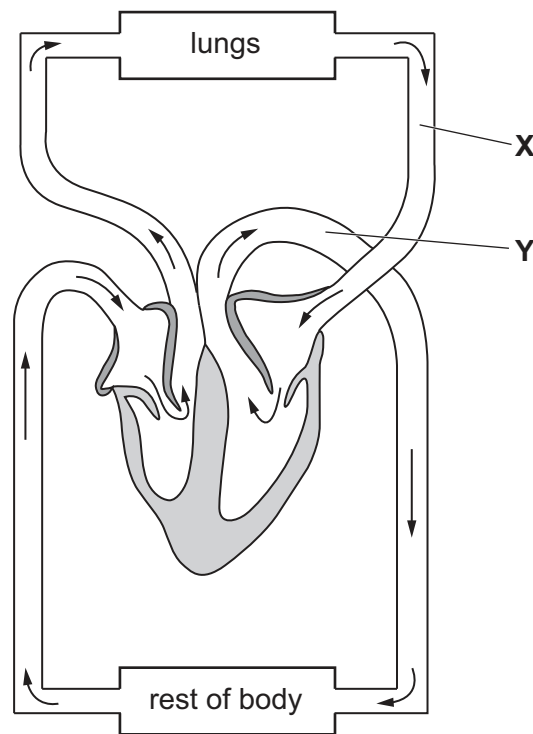


Fig. 7.1

- (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.

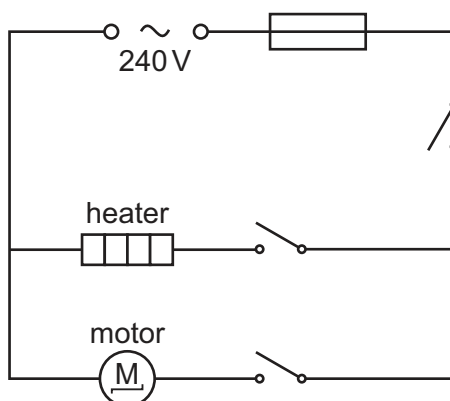


Fig. 9.1

- (a) State the circuit component represented by the symbol $\text{---} \bigcirc \sim \bigcirc \text{---}$.

..... [1]

- (b) The resistance of the heater is $25\ \Omega$.

- (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]

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Group

Group																		
I	II	Key										III	IV	V	VI	VII	VIII	
		1Hhydrogen1																
		atomic number atomic symbol name relative atomic mass																
3Li lithium 7	4Be beryllium 9											5B boron 11	6C carbon 12	7N nitrogen 14	8O oxygen 16	9F fluorine 19	10Ne neon 20	
11Na sodium 23	12Mg magnesium 24											13Al aluminium 27	14Si silicon 28	15P phosphorus 31	16S sulfur 32	17Cl chlorine 35.5	18Ar argon 40	
19K potassium 39	20Ca calcium 40	21Sc scandium 45	22Ti titanium 48	23V vanadium 51	24Cr chromium 52	25Mn manganese 55	26Fe iron 56	27Co cobalt 59	28Ni nickel 59	29Cu copper 64	30Zn zinc 65	31Ga gallium 70	32Ge germanium 73	33As arsenic 75	34Se selenium 79	35Br bromine 80	36Kr krypton 84	
37Rb rubidium 85	38Sr strontium 88	39Y yttrium 89	40Zr zirconium 91	41Nb niobium 93	42Mo molybdenum 96	43Tc technetium —	44Ru ruthenium 101	45Rh rhodium 103	46Pd palladium 106	47Ag silver 108	48Cd cadmium 112	49In indium 115	50Sn tin 119	51Sb antimony 122	52Te tellurium 128	53I iodine 127	54Xe xenon 131	
55Cs caesium 133	56Ba barium 137	57–71 lanthanoids		72Hf hafnium 178	73Ta tantalum 181	74W tungsten 184	75Re rhenium 186	76Os osmium 190	77Ir iridium 192	78Pt platinum 195	79Au gold 197	80Hg mercury 201	81Tl thallium 204	82Pb lead 207	83Bi bismuth 209	84Po polonium —	85At astatine —	86Rn radon —
87Fr francium —	88Ra radium —	89–103 actinoids		104Rf rutherfordium —	105Db dubnium —	106Sg seaborgium —	107Bh bohrium —	108Hs hassium —	109Mt meitnerium —	110Ds darmstadtium —	111Rg roentgenium —	112Cn copernicium —	113Nh nihonium —	114Fl flerovium —	115Mc moscovium —	116Lv livermorium —	117Ts tennessine —	118Og oganesson —

lanthanoids

actinoids

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