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COMBINED SCIENCE

0653/43

Paper 4 Theory (Extended)

October/November 2020

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. Blank pages are indicated.

1 (a) Fig. 1.1 shows red blood cells and white blood cells.

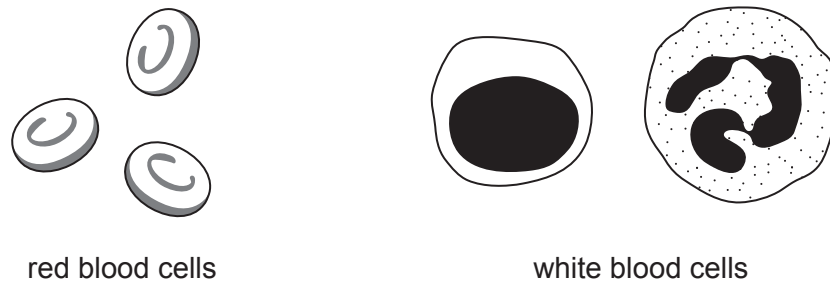


Fig. 1.1

(i) Describe how the structure of a red blood cell is adapted for transporting oxygen.

.....
 [1]

(ii) State **two** functions of white blood cells.

1
 2 [2]

(b) Fig. 1.2 is a flowchart to show the circulation of blood in humans.

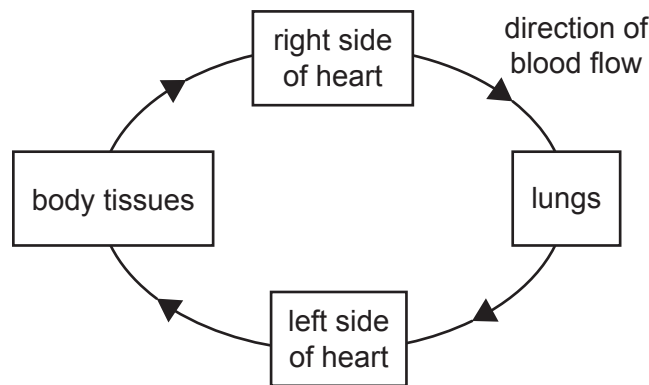


Fig. 1.2

(i) Explain why the circulation in Fig. 1.2 is described as a *double circulation*.

.....
 [1]

(ii) Describe **two** advantages of a double circulation.

1

 2
 [2]

(c) During exercise, the breathing rate and heart rate increase.

Describe how these two increases cause an increase in the amount of oxygen reaching the exercising muscles.

increase in breathing rate

.....

.....

increase in heart rate

.....

.....

[2]

(d) Smoking tobacco can cause cancer.

Name **two** other diseases caused by smoking tobacco.

1

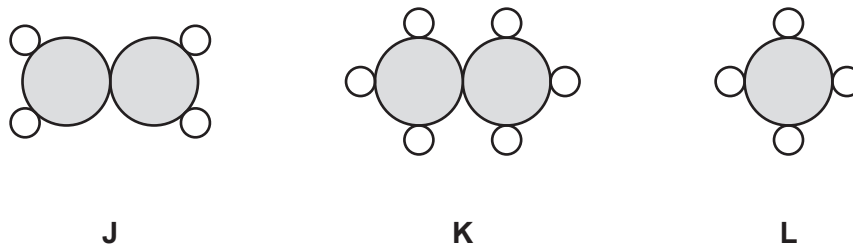
2

[2]

[Total: 10]

2 Compounds **J**, **K** and **L** are hydrocarbons.

The structures of one molecule of compounds **J**, **K** and **L** are shown in Fig. 2.1.



Key:

○ hydrogen

● carbon

Fig. 2.1

(a) State which compound, **J**, **K** or **L**, is ethene.

Explain your answer.

compound

explanation

.....

..... [1]

(b) Ethene is made by cracking gas oil.

(i) Describe what is meant by *cracking*.

.....

..... [1]

(ii) State **one** condition required for cracking.

..... [1]

(c) Draw a dot-and-cross diagram of the molecule of compound **K**.

Show the outer shell electrons only.

[2]

(d) In the presence of a catalyst, one molecule of compound **L** reacts with one molecule of steam to produce carbon monoxide and hydrogen.

Construct the balanced symbol equation for this reaction.

..... [2]

(e) State **two** compounds that are produced during the complete combustion of compound **K**.

1

2

[2]

[Total: 9]

- 3 Fig. 3.1 shows a climber using a safety rope to climb a rock face.

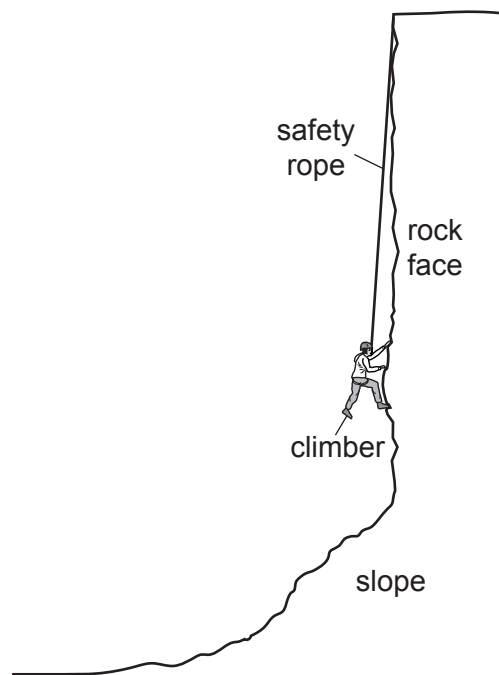


Fig. 3.1

- (a) The climber has a weight of 820 N.

The gravitational field strength g is 10 N/kg.

- (i) Calculate the mass of the climber.

mass = kg [1]

- (ii) The climber moves a vertical distance of 12 m up the rock face.

Calculate the change in gravitational potential energy (G.P.E.) of the climber.

change in G.P.E. = J [2]

- (b) A small piece of rock falls from the rock face, lands on the slope below and rolls to a stop.

Fig. 3.2 shows the speed–time graph for the piece of rock.

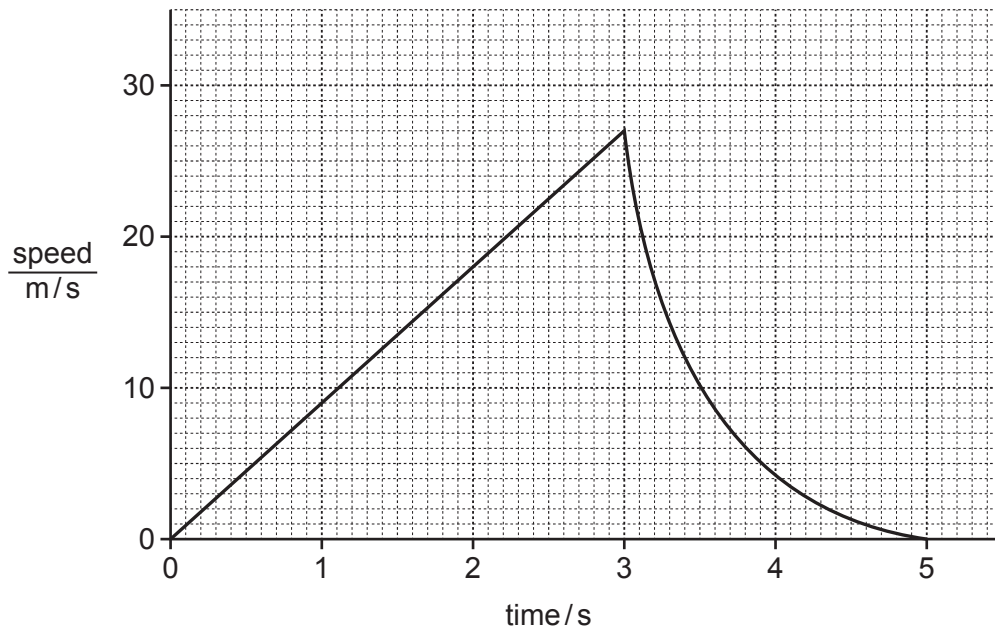


Fig. 3.2

- (i) Use Fig. 3.2 to calculate the initial acceleration of the piece of rock.

Give the units of your answer.

acceleration = units [3]

- (ii) On Fig. 3.2, draw an **X** on the graph to show when the piece of rock lands on the slope. [1]

- (iii) Describe the motion of the piece of rock between 3.0 s and 5.0 s.

.....
 [1]

(c) A scientist investigates the extension of the safety rope.

The scientist tests the safety rope with a load of 820 N (Test 1) and with a load of 898 N (Test 2).

Fig. 3.3 shows the test results.

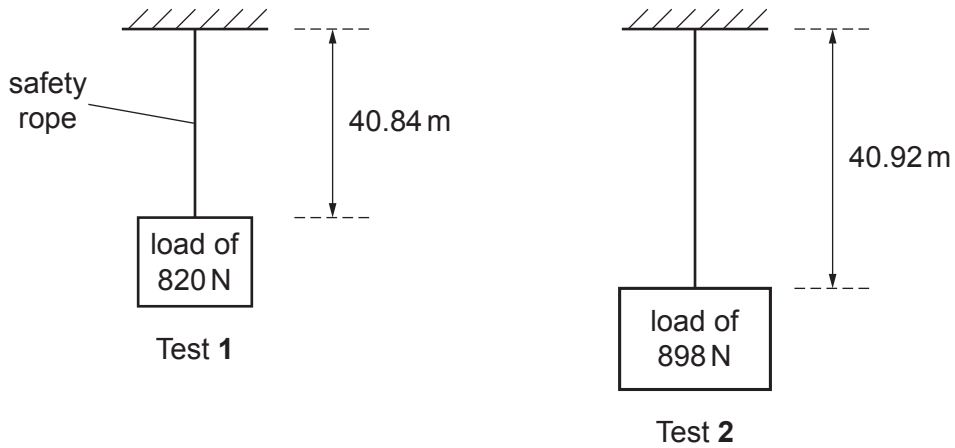


Fig. 3.3 (not to scale)

The scientist uses a safety rope with an original length of 40.00 m.

(i) Determine the extension of the safety rope in Test 1.

extension = m [1]

(ii) Use Fig. 3.3 to show that the safety rope obeys Hooke's Law in Test 1 and Test 2.

.....

.....

.....

.....

..... [2]

[Total: 11]

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4 A balanced diet contains all the nutrients in the correct proportions to meet a person's need.

(a) Explain why a pregnant woman should increase her intake of vitamin D.

.....

.....

.....

..... [2]

(b) (i) State **one** symptom of a person who suffers from a deficiency of iron in the diet.

..... [1]

(ii) State **one** food that is a good source of iron.

..... [1]

(c) Fig. 4.1 shows the percentage of the adult population with obesity in different countries in 2000 and in 2016.

Key

■ 2000 □ 2016

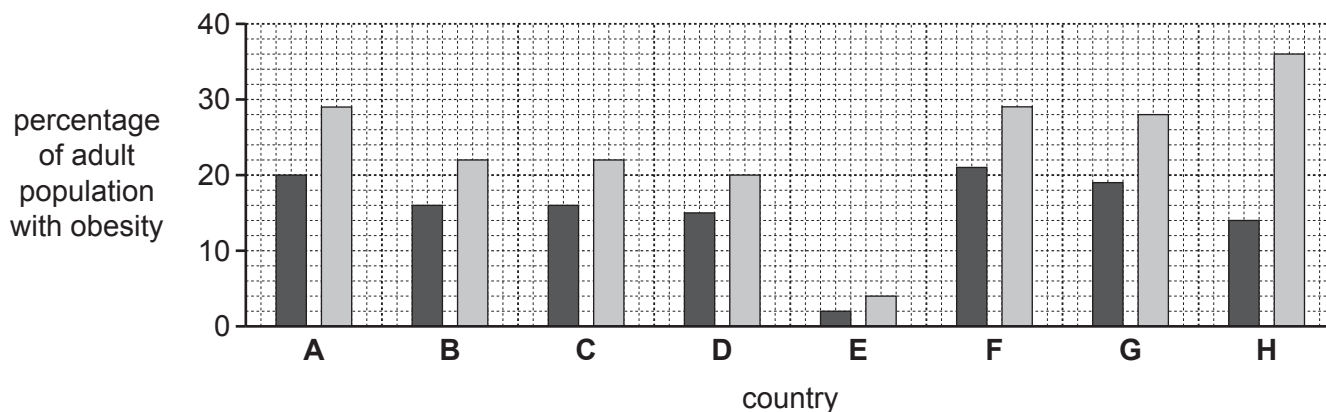


Fig. 4.1

(i) State how obesity is an example of **not** eating a balanced diet.

.....

..... [1]

(ii) State the letter of the country with the greatest increase in the percentage of adults with obesity from 2010 to 2016.

country = [1]

(d) Fig. 4.2 is a diagram of part of the alimentary canal.

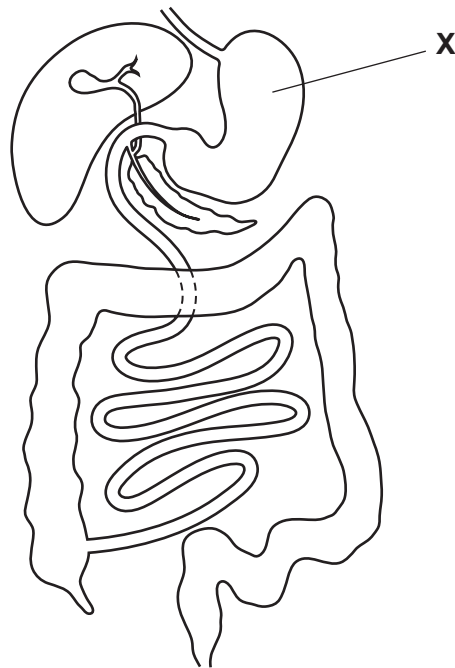


Fig. 4.2

(i) State the pH conditions inside organ X.

..... [1]

(ii) Describe how these conditions aid digestion.

.....
..... [1]

[Total: 8]

- 5 (a) Magnesium is an element in Group II and Period 3 of the Periodic Table.

The Periodic Table is shown on p24.

The nucleon number of an atom of magnesium is 24.

- (i) Deduce the number of neutrons and the number of protons in the nucleus of a magnesium atom.

number of neutrons =

number of protons =

[2]

- (ii) Describe the relationship between the number of outer shell electrons and the metallic character of elements across a period.

.....

..... [1]

- (b) Magnesium chloride contains magnesium ions, Mg^{2+} , and chloride ions, Cl^{-} .

Deduce the formula of magnesium chloride.

formula = [1]

- (c) Magnesium is produced by the electrolysis of molten magnesium chloride.

- (i) Explain why magnesium chloride must be molten and not solid for electrolysis.

.....

.....

..... [2]

- (ii) Describe what happens to a magnesium ion, Mg^{2+} , at the cathode during electrolysis.

Use ideas about electrons in your answer.

.....

.....

..... [2]

(d) Magnesium chloride is made in the reaction between magnesium and dilute hydrochloric acid. The temperature of the reaction mixture increases.

This reaction is exothermic because it releases thermal energy.

Explain why this reaction releases thermal energy.

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

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

[Total: 10]

- 6 Fig. 6.1 shows a space telescope for detecting gamma radiation from distant stars.

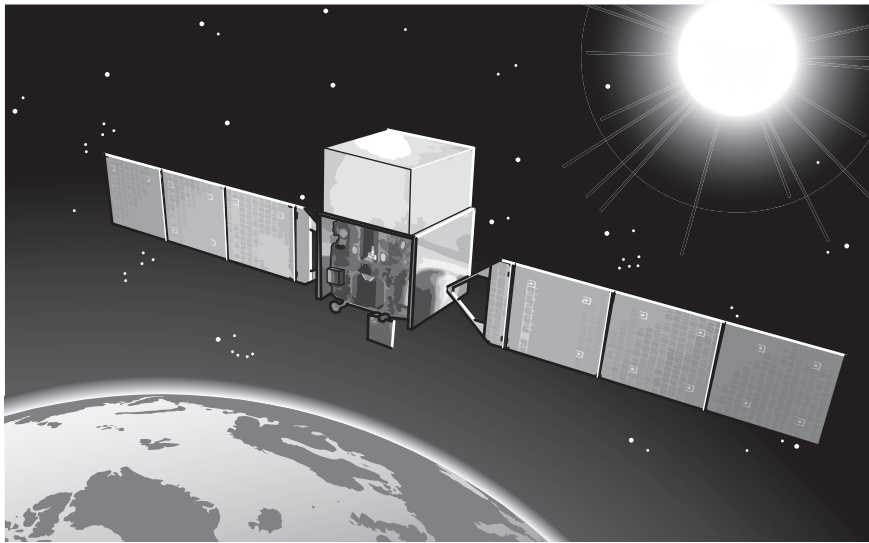


Fig. 6.1

- (a) Fig 6.2 shows the position of gamma radiation in the electromagnetic spectrum.

On Fig 6.2, write

- a tick (✓) underneath the radiation with the lowest frequency
- a cross (X) underneath the radiation that causes sunburn.

gamma radiation	X-rays	ultraviolet	visible light	infra-red	microwaves	radio waves

Fig. 6.2

[2]

- (b) A star that emits gamma radiation is billions of kilometres away from Earth.

- (i) The gamma radiation received by the space telescope today gives astronomers information about the star as it was in the past.

Explain why it does **not** give astronomers information about the star as it is today.

.....
 [1]

- (ii) The astronomer measures the wavelength of the gamma radiation received.

The wavelength of the gamma radiation is 2.0×10^{-14} m.

The speed of the gamma radiation is 3.0×10^8 m/s.

Calculate the frequency of the gamma radiation.

frequency = Hz [2]

- (c) Fig. 6.3 shows three penguins on a clear, sunny day.

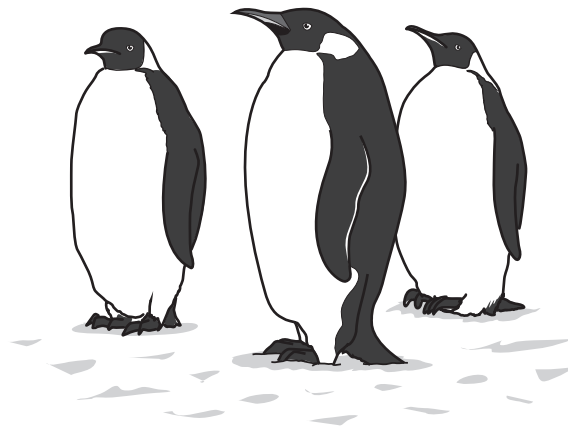


Fig. 6.3

Radiation from the Sun heats some parts of the penguins' bodies more than other parts.

- (i) Name the electromagnetic radiation from the Sun that is mainly responsible for this heating effect.

..... [1]

- (ii) Suggest which parts of the penguins' bodies are heated more than other parts.

Give a reason for your answer.

.....

.....

..... [1]

[Total: 7]

- 7 Fig. 7.1 shows a mistletoe plant growing on a tree branch. The mistletoe plant is attached to the branch by structures that grow deep into the wood.

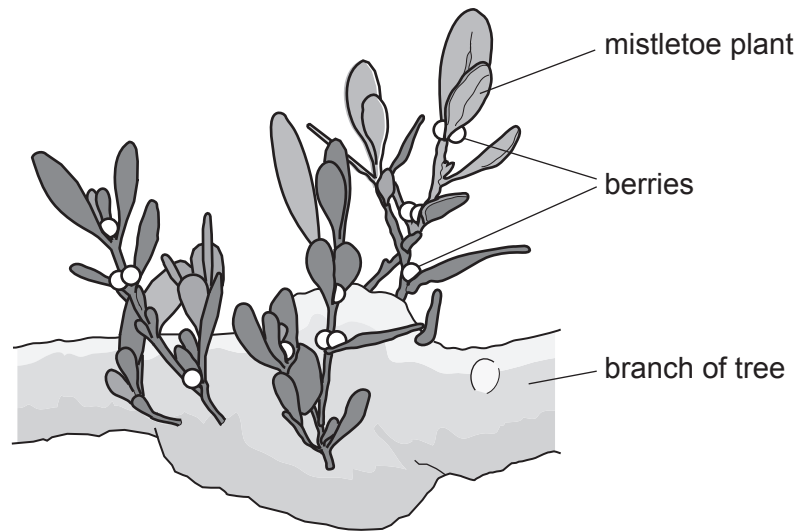


Fig. 7.1

- (a) (i) The mistletoe obtains water and mineral ions from inside the branch.

State the part of a flowering plant that has this function.

..... [1]

- (ii) Name the mineral ion that the mistletoe must absorb to make chlorophyll.

..... [1]

- (iii) Explain how a deficiency of the mineral needed to make chlorophyll affects the mistletoe plant.

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

(b) Small birds such as thrushes feed on the berries of the mistletoe plant.

Cats feed on thrushes. Hawks feed on cats and thrushes.

(i) Construct **one** complete food chain using this information.

..... [2]

(ii) Explain why the hawks can be described as secondary consumers **and** tertiary consumers.

.....

.....

.....

..... [2]

[Total: 9]

- 8 (a) Copper chloride is made when copper oxide reacts with dilute hydrochloric acid.

The equation for the reaction is shown.



Explain why warm hydrochloric acid reacts faster than cold hydrochloric acid.

Use ideas about particles and collisions in your answer.

.....

.....

.....

..... [2]

- (b) Copper is a transition element.

Describe **one** property of copper that is **not** a property of Group I metals.

.....

..... [1]

- (c) Chlorine gas is made by the electrolysis of aqueous copper chloride.

- (i) Damp litmus paper is used to test for chlorine.

State the positive result.

..... [1]

- (ii) Explain why chlorine is used in the treatment of water supplies.

.....

..... [1]

(d) Copper ions, Cu^{2+} , can be detected using chromatography.

Fig. 8.1 shows a chromatogram of a solution containing copper ions.

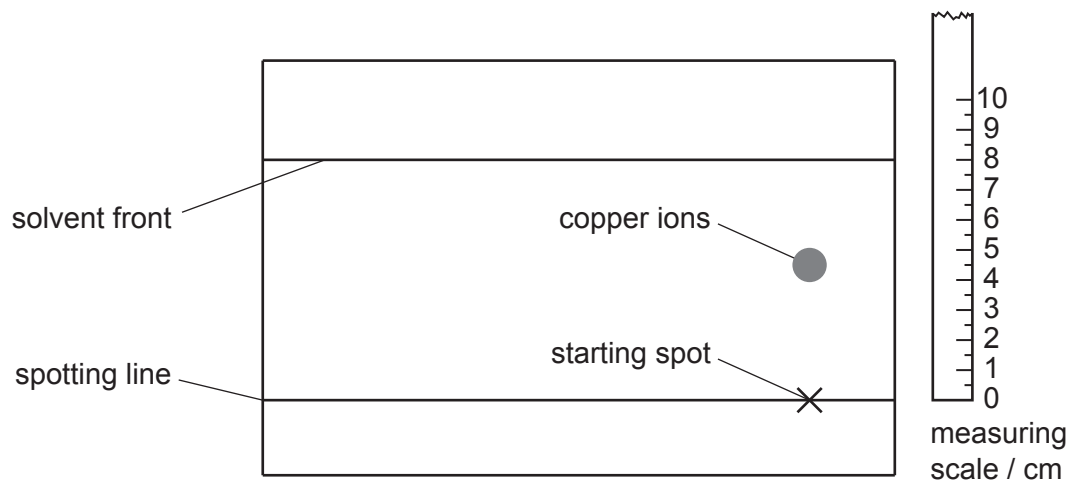


Fig. 8.1

Use the measuring scale in Fig. 8.1 to calculate the R_f value for the copper ions.

R_f value = [2]

[Total: 7]

- 9 Fig. 9.1 shows an extractor fan in the wall of a bathroom. The extractor fan is used to remove damp (wet) air from the bathroom.

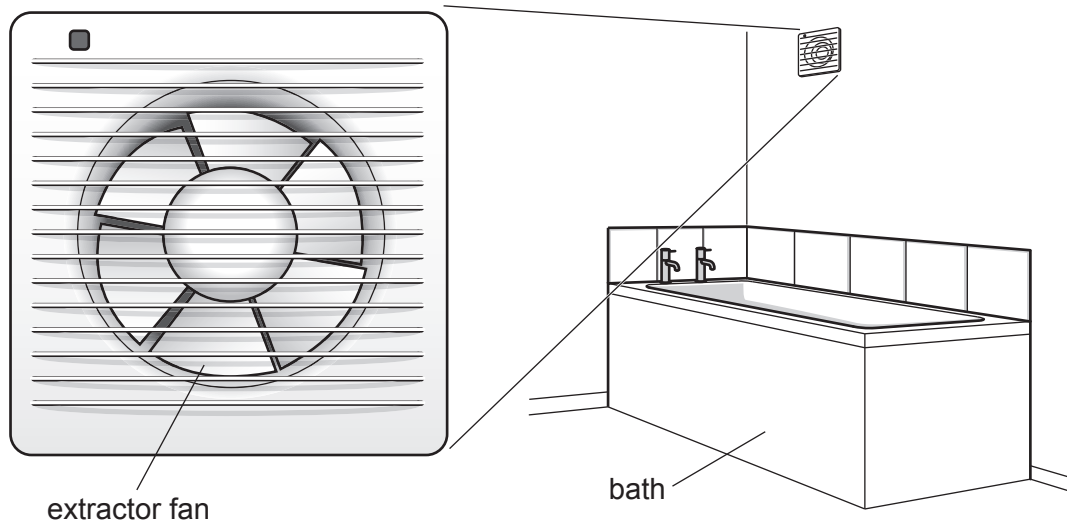


Fig. 9.1

(a) Compare a gas to a liquid in terms of:

- the distances between the molecules
- the forces between the molecules
- the motion of the molecules.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Hot water at the surface of the bath evaporates into water vapour. This makes the air in the bathroom damp.

Suggest how using the fan to extract damp air from the bathroom affects the evaporation of water from the bath.

Give a reason for your answer.

.....

.....

..... [2]

- (c) The bathroom light and the electric motor for the extractor fan are controlled by a single switch. A fuse protects the circuit.

Fig. 9.2 shows the circuit diagram.

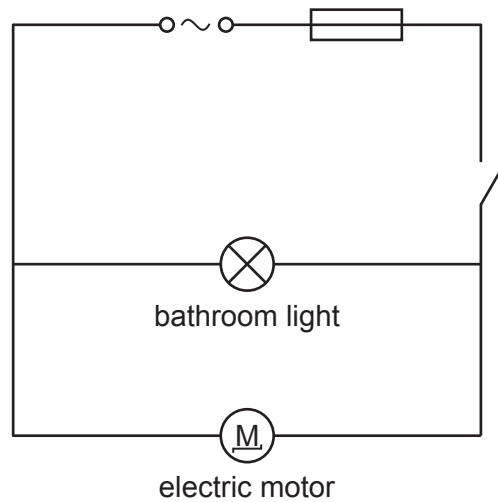


Fig. 9.2

The electric motor for the extractor fan has a power rating of 12 W. The current in the motor is 0.080 A.

- (i) Calculate the potential difference across the motor.

potential difference = V [2]

- (ii) The power rating of the bathroom light is 18 W.

The fuse in the circuit needs replacing.

Show that a fuse rated at 0.5 A is a suitable replacement.

.....
 [2]

[Total: 9]

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The Periodic Table of Elements

		Group																																	
I	II											III	IV	V	VI	VII	VIII																		
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										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											1 H hydrogen 1	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
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 —																		

lanthanoids

actinoids

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
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 dm³ at room temperature and pressure (r.t.p.).