



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/41

May/June 2020

1 hour 15 minutes

No additional materials are needed.

- 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.

- 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. Blank pages are indicated.

- 1 (a) Table 1.1 shows the percentage composition of the gases in inspired air and in expired air.

Table 1.1

gas	percentage composition of inspired air	percentage composition of expired air
carbon dioxide	0.04	4
nitrogen	78	78
oxygen	21	16

Explain why the percentage of carbon dioxide is greater in expired air than in inspired air.

.....

 [2]

- (b) State **two** features of alveoli that make them efficient gas exchange surfaces.

1.
 2. [2]

- (c) Fig. 1.1 shows some cells which line the trachea.

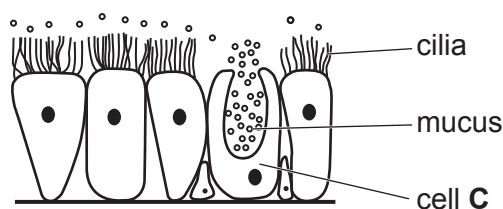


Fig. 1.1

- (i) State the name of cell **C** as shown in Fig. 1.1.

..... [1]

- (ii) Describe the roles of cilia and mucus in the protection of the gas exchange system.

cilia

 mucus
 [2]

- (iii) Describe **one** effect of tar in tobacco smoke on the gas exchange system.

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

[Total: 8]

2 The formula of methanol is CH_3OH .

(a) Explain why methanol is **not** a hydrocarbon.

.....
 [1]

(b) (i) Complete the dot-and-cross diagram for a molecule of methanol.

C O

[2]

(ii) Explain why a molecule of methanol contains only covalent bonds.

.....
 [1]

(c) Methanol is used as a fuel because it burns in oxygen.

Complete the equation for the complete combustion of methanol.

$2\text{CH}_3\text{OH} + \dots \rightarrow \dots + \dots$ [2]

(d) Fig. 2.1 shows the energy level diagram for the complete combustion of methanol.

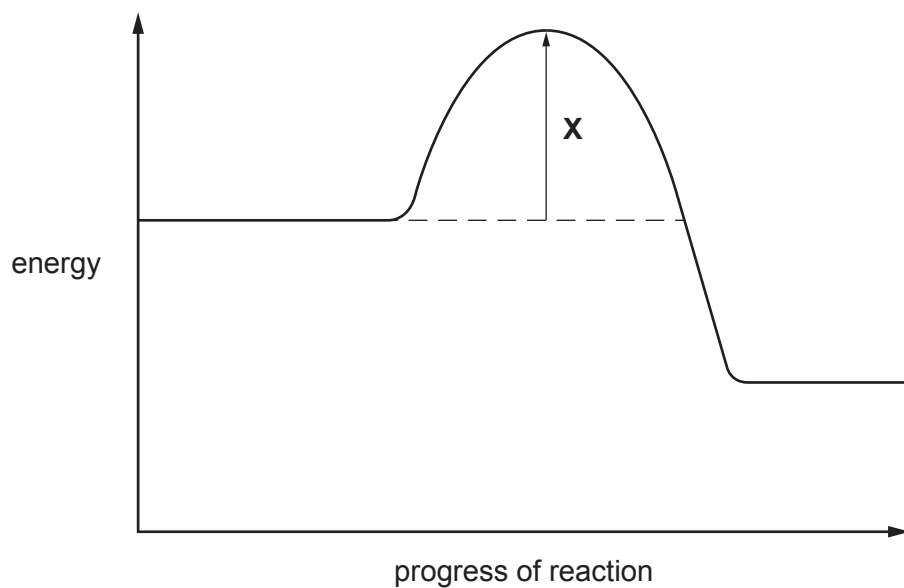


Fig. 2.1

(i) On Fig. 2.1, write the words *reactants* and *products* in suitable places. [1]

(ii) State what the energy value **X** on Fig. 2.1 represents.

..... [1]

(e) During the combustion of methanol, the amount of carbon dioxide in the atmosphere increases.

Suggest one effect of this increase.

.....

..... [1]

[Total: 9]

- 3 Fig. 3.1 shows a spacecraft taking off from the Moon.

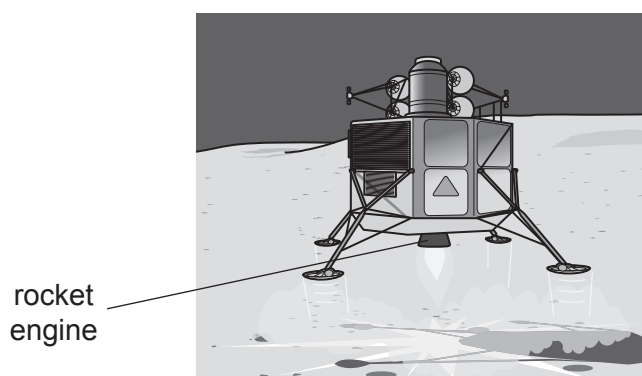


Fig. 3.1

- (a) The total mass of the spacecraft is 5000 kg.
- (i) The gravitational field strength on the Moon is 1.6 N/kg .

Calculate the weight of the spacecraft on the Moon.

weight = ... N [1]

- (ii) The rocket engine pushes the spacecraft vertically upwards with a constant force of 15000 N.

Calculate the work done by the rocket engine to move the spacecraft to a height of 500 m.

work done = ... J [2]

- (iii) Use your answer to (a)(i) to calculate the gravitational potential energy gained by the spacecraft at 500 m above the Moon's surface.

gravitational potential energy = ... J [2]

- (iv) Explain the difference between your answers to (a)(ii) and (a)(iii).

.....
 [1]

- (b) Fig. 3.2 shows two large mirrors left behind on the Moon's surface.

The two mirrors are arranged at 90° to each other.

A laser light beam from the Earth can be reflected back to the Earth by the mirrors. This enables the distance between the Earth and the Moon to be measured.

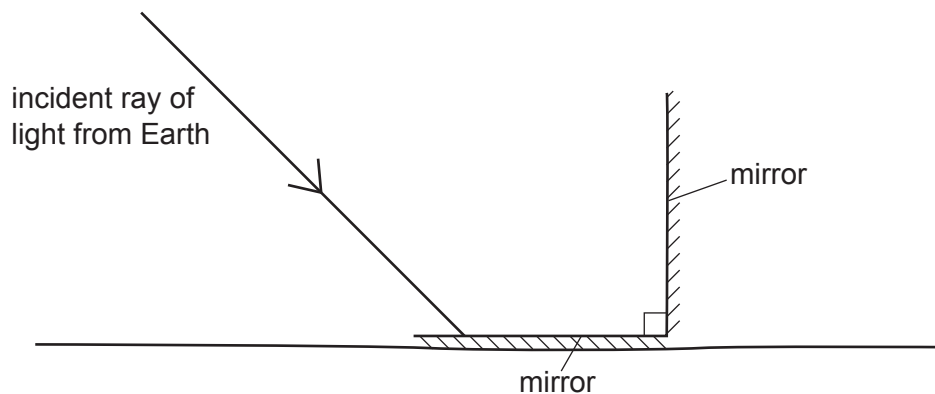


Fig. 3.2

- (i) On Fig. 3.2 complete the ray diagram to show how the ray of light is reflected back parallel to the incident ray. [2]
- (ii) Light takes 2.56 s to travel from the Earth to the Moon and back again.

The speed of electromagnetic waves in space is $3.00 \times 10^5 \text{ km/s}$.

Calculate the distance from the Earth to the Moon.

distance = ... km [2]

[Total: 10]

- 4 (a) If the light shining on a shoot tip is more intense on one side, the shoot shows a growth response.

Name the response of the shoot to light.

..... [1]

- (b) Fig. 4.1 shows a shoot which is evenly illuminated.
Fig. 4.2 shows how the same shoot grows when light shines from one side.

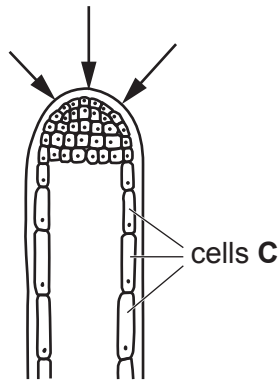


Fig. 4.1

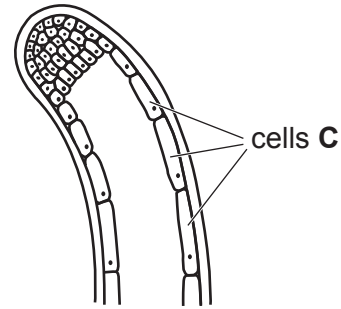


Fig. 4.2

- (i) On Fig. 4.2, draw an arrow to show the direction of the light shining on the shoot. [1]

- (ii) The response by the shoot in Fig. 4.2 is shown by most plants.

Describe the advantage of this response.

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

- (iii) Describe how cells C are different in Fig. 4.1 compared with Fig. 4.2.

..... [1]

- (iv) Describe the role of the hormone auxin in the response of the shoot shown in Fig. 4.2.

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

- (c) The hormone adrenaline is secreted in humans. Table 4.1 shows some statements about adrenaline.

In Table 4.1 place a tick (✓) to show **two** correct statements about adrenaline.

Table 4.1

statement about adrenaline	tick (✓) if correct
causes pupils of the eye to get smaller	
increases the blood glucose concentration	
increases the pulse rate	
less is secreted when a person is scared	
slows the rate of breathing	

[2]

[Total: 9]

- 5 (a) Iron is a transition element.

State **one** property of iron that is common to all transition elements but not to other metals.

..... [1]

- (b) Fig. 5.1 shows the arrangement of particles in pure solid iron.

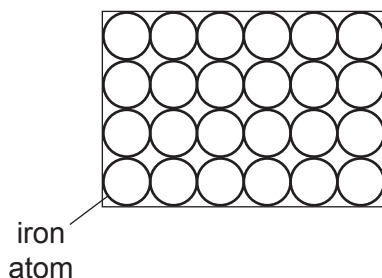


Fig. 5.1

- (i) Explain why a high temperature is needed to melt solid iron.

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

- (ii) Steel is an alloy of iron. It contains iron atoms and smaller carbon atoms.

Complete Fig. 5.2 to show the arrangement of atoms in solid steel.

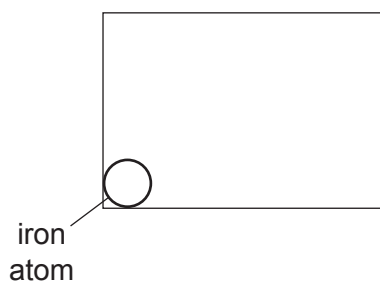


Fig. 5.2

[1]

(c) Iron is extracted from iron oxide in the blast furnace.

(i) The word equation for one of the reactions in the blast furnace is shown.



State why this is a redox reaction.

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

(ii) Iron(III) oxide contains iron(III) ions, Fe^{3+} , and oxide ions, O^{2-} .

Deduce the formula of iron(III) oxide.

..... [1]

(iii) Magnesium can be extracted from magnesium oxide by electrolysis.

Explain why magnesium **cannot** be extracted from magnesium oxide in a blast furnace.

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

[Total: 9]

6 Naphthalene is a solid that melts at 80°C to form a liquid.

- (a) Some solid naphthalene is heated until it has all melted. The liquid is then allowed to cool slowly.

The temperature is measured every minute as the liquid cools and becomes solid again.

Fig. 6.1 shows a graph of the results.

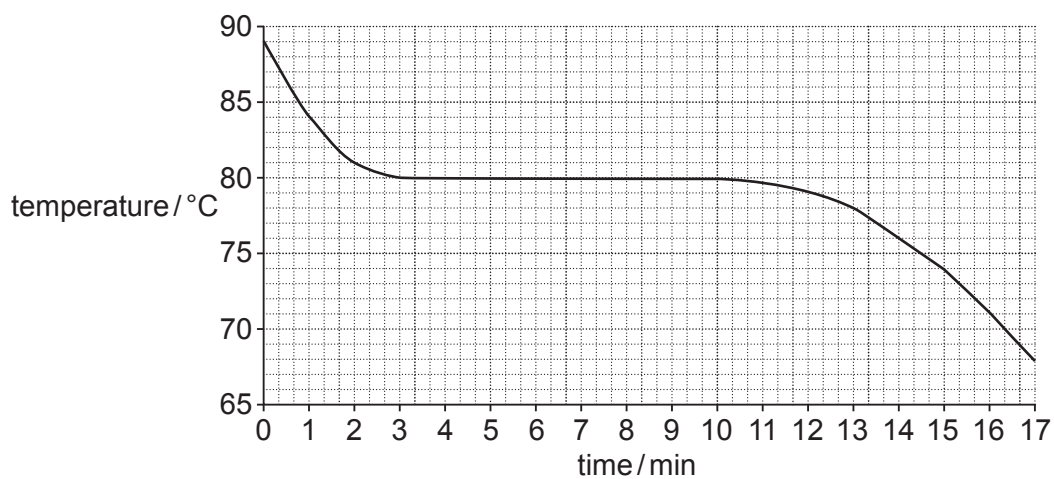


Fig. 6.1

On Fig. 6.1, draw an **X** to show a part of the graph at which all of the naphthalene is liquid. [1]

- (b) Fig. 6.2 shows a test-tube with liquid naphthalene at its melting point.

Fig. 6.3 shows the same test-tube with the same mass of naphthalene when it has all turned solid.

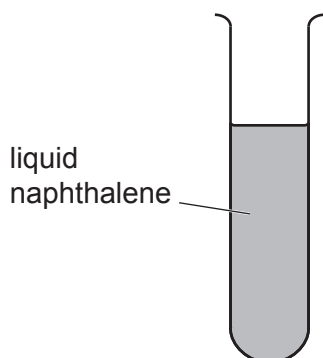


Fig. 6.2

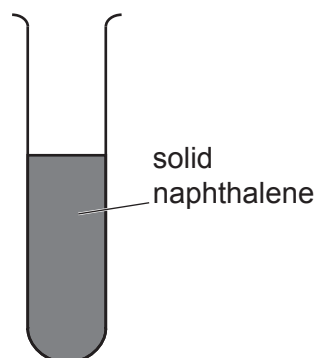


Fig. 6.3

- (i) Suggest how the distances between the molecules in liquid naphthalene and in solid naphthalene compare.

Give a reason for your answer.

.....

 [2]

- (ii) Suggest how the motions of the molecules in liquid naphthalene and in solid naphthalene compare.

Give a reason for your answer.

.....

 [2]

- (c) The solid naphthalene cools very slowly, as the vibrations of the large molecules do not conduct thermal energy well and there are no mobile electrons.

Predict whether solid naphthalene will be a good or poor conductor of electricity.

Give a reason for your answer.

.....
 [1]

[Total: 6]

- 7 (a) The substrates and products of three digestive enzymes are shown in Table 7.1.

Complete Table 7.1.

Table 7.1

substrate	digestive enzyme	product
.....	amylase	sugars
fat		 and fatty acids
protein	protease	

[3]

- (b) State **two** functions of the hydrochloric acid in gastric juice in the stomach.

1.

.....

2.

.....

[2]

- (c) Fig. 7.1 shows a graph of activity against temperature for two enzymes, **A** and **B**.

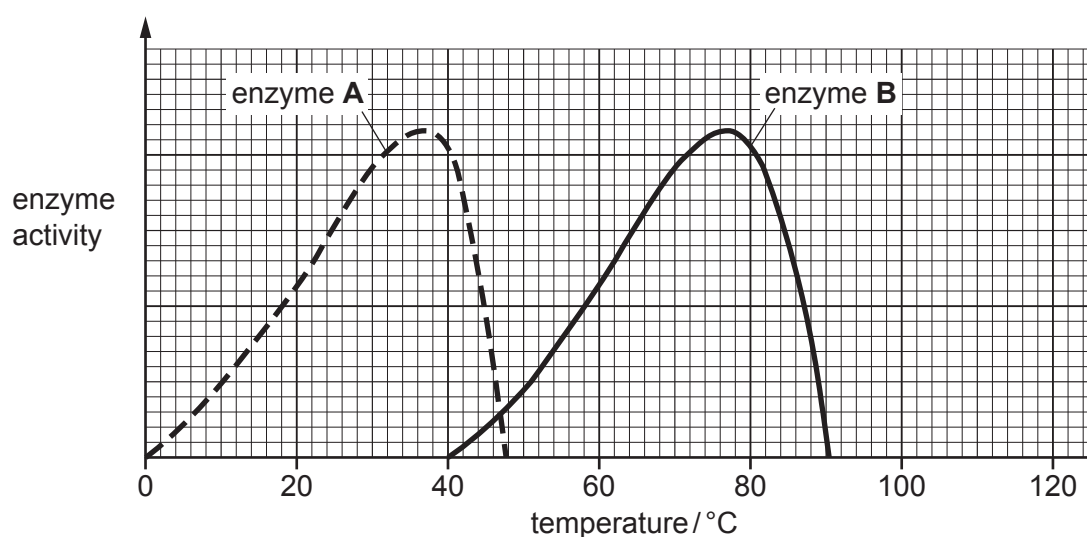


Fig. 7.1

- (i) Identify the temperature of maximum activity of enzyme **B**.

temperature = ... °C [1]

- (ii) The enzyme activity of both enzymes is the same at 47 °C.

The temperature is increased to 50 °C.

State and explain the effects of this temperature increase on the activity of enzyme **A**.

.....

.....

.....

.....

..... [3]

- (iii) Amylase is a digestive enzyme secreted in parts of the alimentary canal.

Suggest which enzyme, **A** or **B**, is amylase. Give a reason for your answer.

enzyme

reason

..... [1]

[Total: 10]

8 (a) When dilute sulfuric acid is electrolysed, hydrogen forms at the cathode.

(i) Describe, in terms of electrons, what happens to one hydrogen ion at the cathode.

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

(ii) State the test for hydrogen gas and give the positive result.

test
result [2]

(iii) Name the product at the anode.

..... [1]

(b) Magnesium reacts with dilute sulfuric acid to produce magnesium sulfate.

Explain why the rate of this reaction increases when the temperature of the acid is higher.

Use ideas about particles in your answer.

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

(c) Name **one** other substance that reacts with dilute sulfuric acid to produce magnesium sulfate.

..... [1]

[Total: 8]

- 9 Fig. 9.1 shows a microwave oven connected to a mains electricity supply.

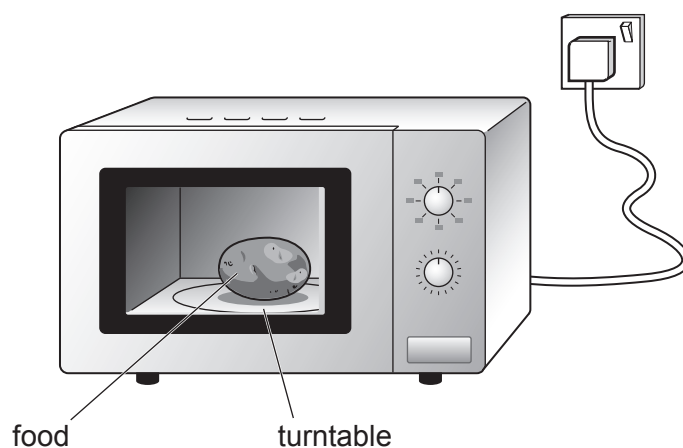


Fig. 9.1

When the door is closed, the oven can be switched on and the food gets hot.

- (a) State the main useful energy transfer that results in the food getting hot.

..... energy $\rightarrow$ energy [2]

- (b) Microwave radiation is generated inside the oven and absorbed by the food.

The microwave radiation has a frequency of $2.45 \times 10^9 \text{ Hz}$.

The speed of microwave radiation is $3.00 \times 10^8 \text{ m/s}$.

Calculate the wavelength of the microwaves.

wavelength = ... m [2]

- (c) When the oven is switched on, the food is rotated on a turntable turned by an electric motor. This ensures the food is heated completely.

All the circuit components of the microwave oven are connected in parallel. These components are the microwave generator, the turntable motor and a lamp.

- (i) The microwave oven has two switches.

- the main switch operates all the components,
- the other switch operates only the microwave generator and turntable motor.

On Fig. 9.2 complete the circuit diagram for the microwave oven, including the symbol for the mains electricity supply (a.c. power supply), the second switch and the lamp.

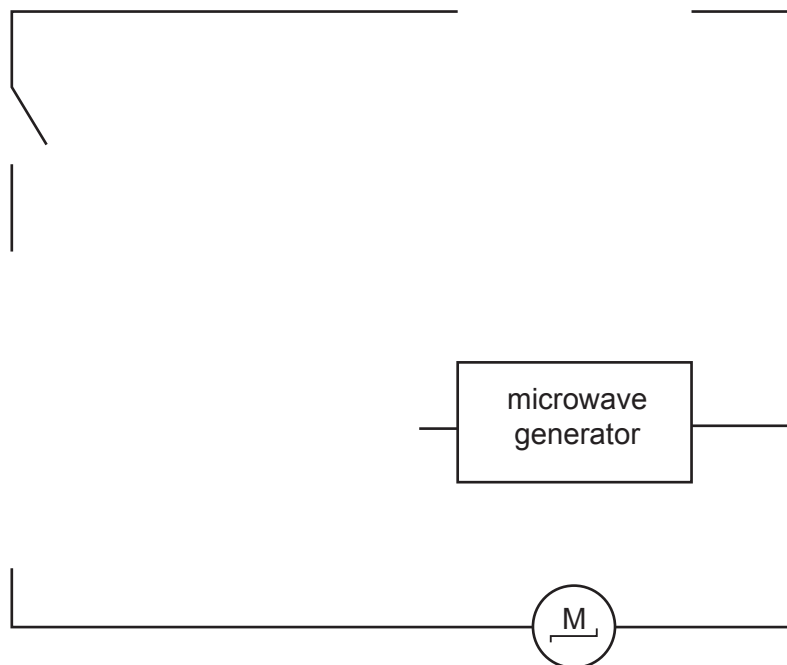


Fig. 9.2

[3]

- (ii) The current in each of the three components is shown.

lamp 0.1A

microwave generator 2.5A

turntable motor 0.2A

Calculate the current supplied from the mains supply.

current = ... A [1]

- (iii) The mains electricity supply is 230 V.

Calculate the power used by the microwave generator.

State the unit of your answer.

power = ... unit [3]

[Total: 11]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										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															
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 —		

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
	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.).

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COMBINED SCIENCE

0653/42

Paper 4 Theory (Extended)

May/June 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.
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INFORMATION

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- The number of marks for each question or part question is shown in brackets [].
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This document has **20** pages. Blank pages are indicated.

- 1 (a) Fig. 1.1 represents a plant cell.

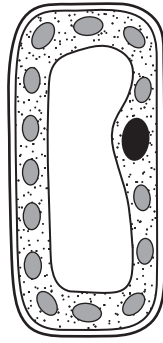


Fig. 1.1

Add labels to Fig. 1.1 to name **two** structures that are **only** present in plant cells. [2]

- (b) Fig. 1.2 represents an animal cell from the trachea.



Fig. 1.2

Describe how the structure of this cell is adapted to its function.

.....

.....

..... [2]

- (c) Fig. 1.3 shows part of a food web.

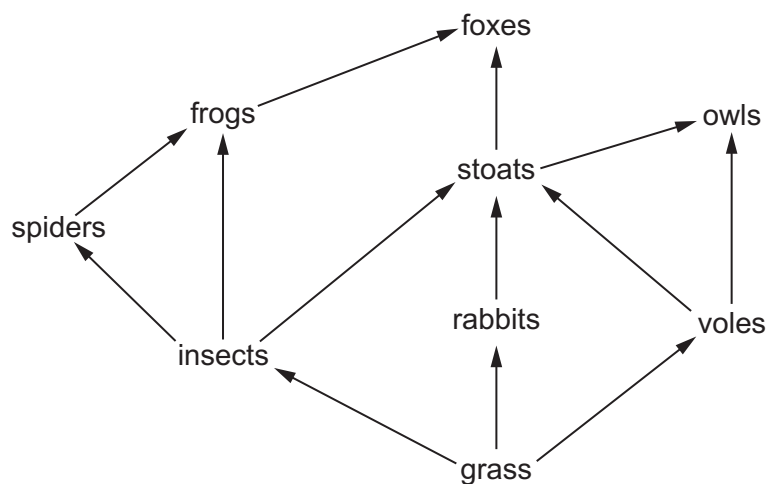


Fig. 1.3

- (i) Define the term *consumer*.

.....
 [1]

- (ii) List **all** of the tertiary consumers shown in the food web in Fig. 1.3.

Explain how you identified these consumers using the term *trophic level*.

tertiary consumers

 explanation
 [2]

- (iii) Complete the food chain containing five organisms from the food web in Fig. 1.3.



[1]

- (iv) Describe what the arrows in the food chain represent.

..... [1]

- (d) Use words from the list to complete the sentences about photosynthesis.

chemical chlorophyll cytoplasm glucose
light oxygen starch thermal

Each word may be used once, more than once or not at all.

During photosynthesis energy is transferred into

..... energy by molecules. [2]

[Total: 11]

2 The fractional distillation of petroleum is shown in Fig. 2.1.

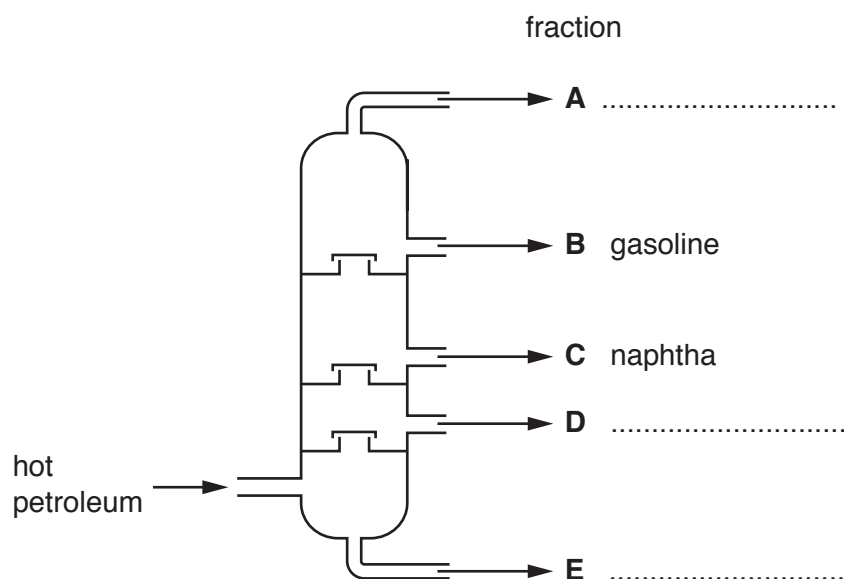


Fig. 2.1

(a) **A, B, C, D** and **E** are five fractions.

The names of these five fractions are bitumen, diesel oil, gasoline, naphtha and refinery gas.

(i) Identify these fractions by completing Fig. 2.1. Two have been done for you. [1]

(ii) Fraction **A** is a mixture of compounds. They are all hydrocarbons.

Describe **two** other ways in which the compounds in fraction **A** are similar.

1.

2. [2]

(iii) State **one** use for naphtha.

..... [1]

(b) Methane, CH_4 , and pentane, C_5H_{12} , are members of the homologous series of alkanes.

(i) State what is meant by a *homologous series*.

.....

 [2]

- (ii) Write the balanced symbol equation for the complete combustion of pentane, C_5H_{12} , in oxygen.

..... [2]

[Total: 8]

- 3 Fig. 3.1 shows a sheet of metal on the sea floor. The dotted lines show the column of sea water vertically above the sheet which exerts a pressure on the metal sheet.

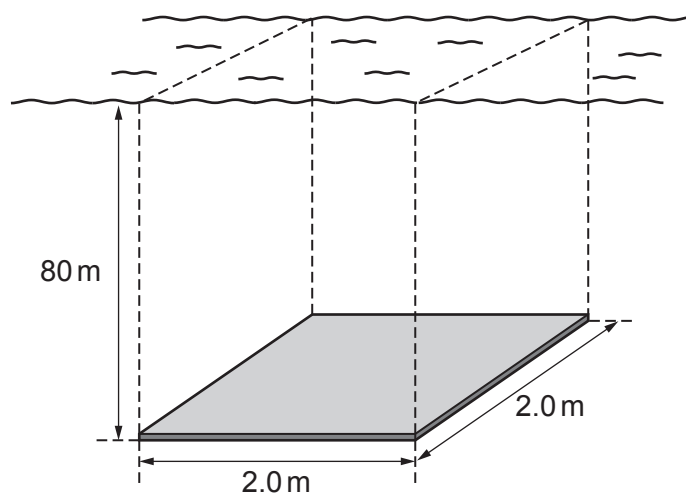


Fig. 3.1 (not to scale)

The surface of the sheet measures $2.0\text{ m} \times 2.0\text{ m}$. The sheet is 80 m below the sea surface.

- (a) (i) Calculate the volume of the column of sea water vertically above the sheet.

volume = ... m^3 [1]

- (ii) The density of sea water is 1030 kg/m^3 .

The Earth's gravitational field strength is 10 N/kg .

Show that the weight of the column of sea water on top of the sheet is $3.30 \times 10^6\text{ N}$.

[3]

- (iii) Calculate the pressure of this column of sea water on the metal sheet.

Give the unit.

pressure = ... unit [3]

(b) Fig. 3.2 shows a crane lifting the metal sheet off the sea floor.

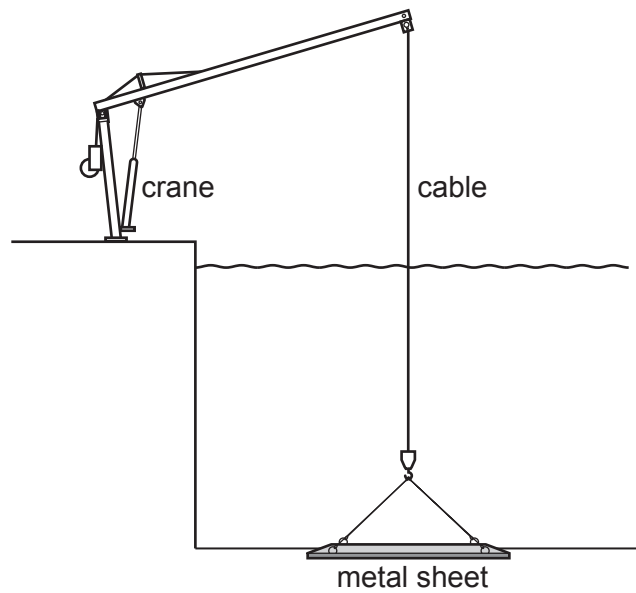


Fig. 3.2 (not to scale)

The cable stretches according to Hooke's Law as the lifting force increases.

On Fig. 3.3, sketch the graph of the extension of the cable as the force increases.

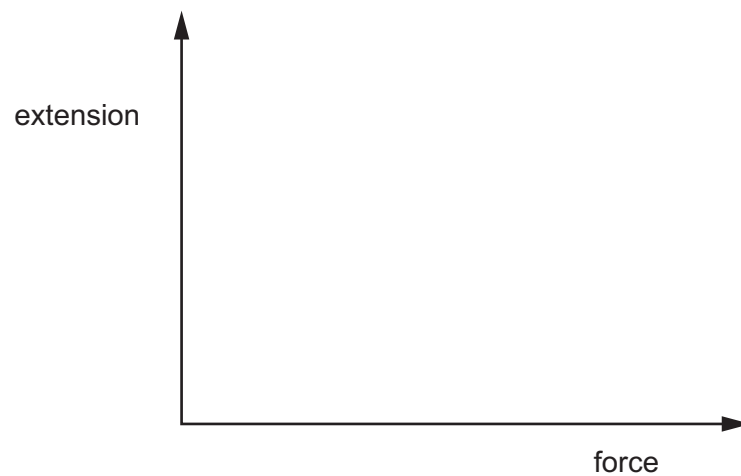


Fig. 3.3

[1]

[Total: 8]

- 4 (a) Fig. 4.1 shows two similar stalks of celery, **X** and **Y**. They are placed in water containing a red stain. **X** and **Y** are left in environments of different humidity for 15 minutes.

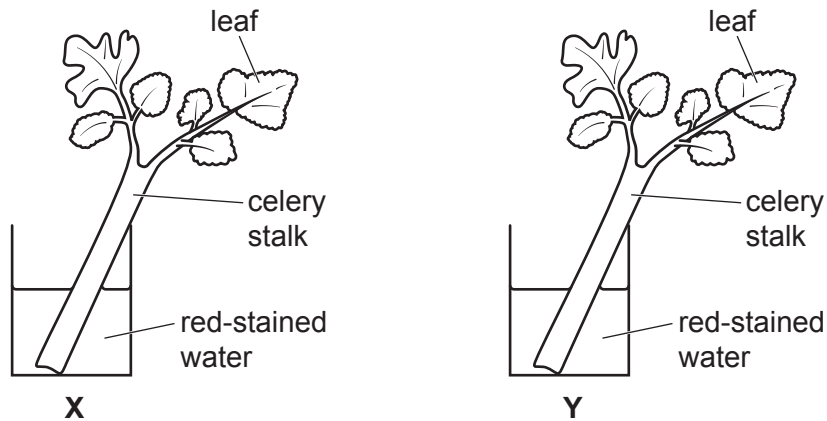


Fig. 4.1

The distance the red-stained water travels in each stalk is measured. The results are shown in Table 4.1.

Table 4.1

stalk	distance moved upwards by the red stain/mm
X	45
Y	72

- (i) Calculate the difference in distance moved by the red-stained water in stalk **X** and in stalk **Y**.

difference in distance = ... mm [1]

- (ii) Explain your answer to (a)(i) in terms of the humidity of the environments of **X** and **Y**.

.....

 [3]

- (b) Name the tissue which transports water upwards through the stalks of the celery.

..... [1]

(c) Plants get nitrate ions from water entering through their roots.

(i) Describe the importance of nitrate ions in the plant.

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

(ii) Describe the effect of nitrate ion deficiency in the plant.

..... [1]

[Total: 7]

- 5 The equation for the reaction between magnesium carbonate and dilute hydrochloric acid is shown.



- (a) The reaction between magnesium carbonate and dilute hydrochloric acid is exothermic.

The energy level diagram for this reaction is shown in Fig. 5.1.

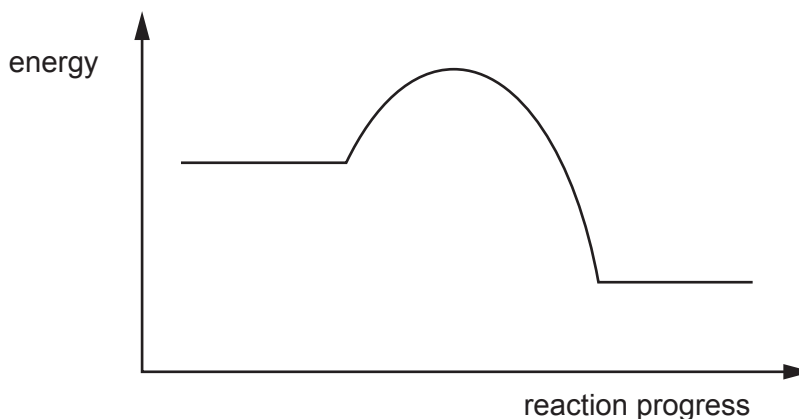


Fig. 5.1

- (i) On Fig. 5.1, write the words *reactants* and *products* in suitable places. [1]
- (ii) On Fig. 5.1, draw a double headed arrow ($\rightleftharpoons$) to show the activation energy for this reaction. [1]
- (b) A student investigates the effect of temperature on the rate of reaction between magnesium carbonate and dilute hydrochloric acid.

She uses acid with a temperature of 20 °C. She measures the volume of carbon dioxide produced.

- (i) Fig. 5.2 is a graph of her results.

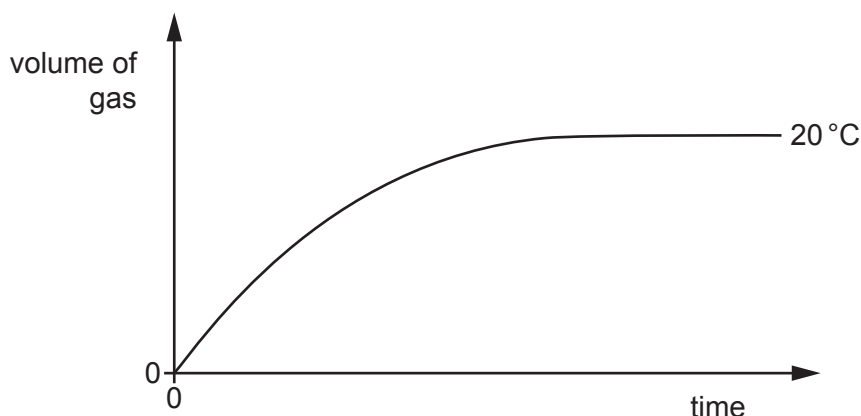


Fig. 5.2

On Fig. 5.2, sketch a graph of the results she obtains when she repeats the experiment at a temperature of 30 °C. All other variables are kept constant. [2]

- (ii) Explain your answer to (b)(i) using ideas about particle collisions.

.....

.....

..... [2]

- (c) Carbon dioxide is one product of the reaction between magnesium carbonate and dilute hydrochloric acid.

Explain why scientists are concerned about an increase in the concentration of carbon dioxide in the atmosphere.

.....

.....

.....

..... [2]

- (d) Magnesium chloride is another product of the reaction between magnesium carbonate and dilute hydrochloric acid.

State **one** substance, other than magnesium carbonate, that reacts with dilute hydrochloric acid to produce magnesium chloride.

..... [1]

[Total: 9]

- 6 Fig. 6.1 shows a man's hand holding a metal rod in a hot flame.

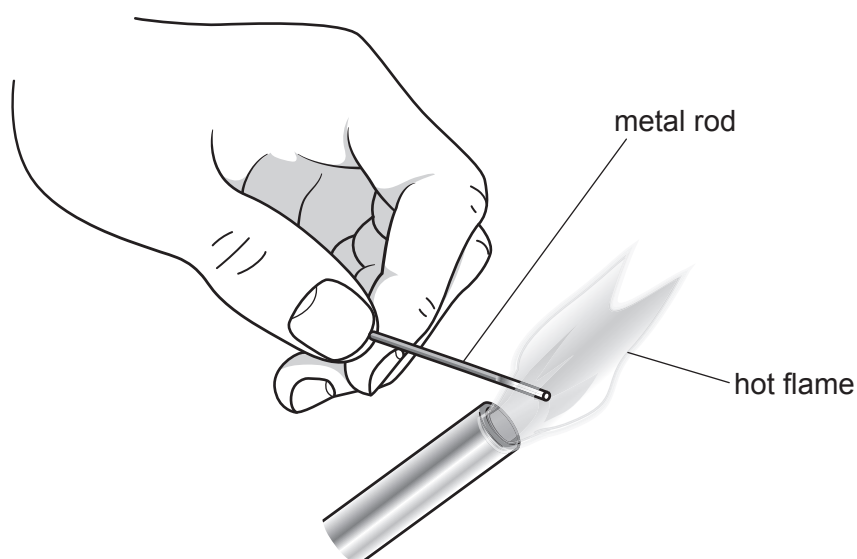


Fig. 6.1

- (a) After heating the metal rod in the flame for one minute, it glows red. The man suddenly drops the rod as the end he holds becomes too hot to hold.

- (i) Describe how the metal atoms transfer the thermal energy from the flame to the man's hand.

.....

.....

.....

..... [2]

- (ii) Suggest why the metal rod took as long as one minute to become too hot to hold.

.....

..... [1]

- (b) (i) When heated, the metal rod glows red, then yellow as it gets hotter.

When the rod is removed from the flame, the yellow colour changes to red, and as it cools further, visible light is no longer emitted.

The man can still feel thermal energy radiating from the cooling rod.

State the type of electromagnetic radiation coming from the rod at this stage of cooling.

..... [1]

- (ii) The metal rod is a shiny silver colour before it is heated.

After heating, the rod is covered with a dull black layer of the oxide of the metal.

State the effect this change will have on the rate of cooling of the rod.

Explain your answer.

.....

.....

..... [2]

- (c) An astronomer using a telescope sees red light reflected from the planet Mars.

The astronomer knows that Mars at this time is 60 000 000 km from Earth.

- (i) State the speed at which the red light travels from Mars to Earth.

..... [1]

- (ii) Calculate the time taken for the red light to travel from Mars to Earth.

time = ... s [2]

[Total: 9]

- 7 (a) Fig. 7.1 shows a diagram of the internal structure of the heart and the blood vessels to and from the heart.

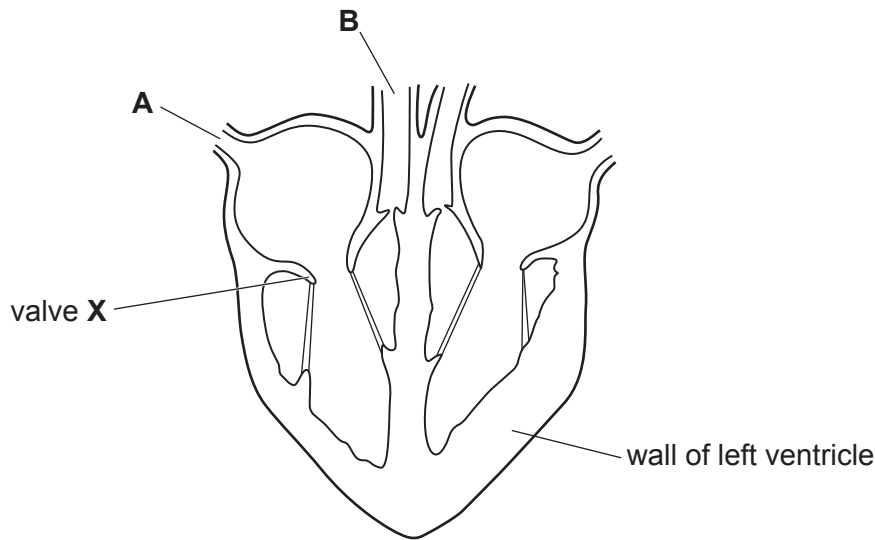


Fig. 7.1

- (i) On Fig. 7.1, label the septum of the heart. [1]
- (ii) Describe the action of the atrium, ventricle and valve X to cause blood to flow from vessel A to vessel B.

.....

.....

.....

.....

.....

..... [4]

- (b) The coronary arteries provide blood to the heart muscle.

- (i) Suggest how a blockage of the coronary arteries affects heart function.

.....

.....

..... [2]

- (ii) State **two** factors which increase a person's chance of developing coronary heart disease.

1.

2.

[2]

[Total: 9]

- 8 (a) Copper is a transition metal.

State **two** properties of copper that are **not** properties of Group I metals.

1.
2. [2]

- (b) Zinc is extracted from zinc oxide, ZnO.

- (i) The formula of an oxide ion is O^{2-} .

Deduce the charge of a zinc ion.

Explain your answer.

charge

explanation [2]

- (ii) Explain why zinc can be extracted from zinc oxide by reduction with carbon.

Use ideas about the reactivity series in your answer.

..... [1]

- (c) Molten sodium chloride can be electrolysed.

- (i) Explain why energy is needed to melt sodium chloride.

..... [1]

- (ii) Explain why sodium chloride must be molten, and **not** solid, during electrolysis.

..... [1]

- (iii) Predict the products of this electrolysis at the anode and at the cathode.

anode
cathode [2]

[Total: 9]

9 Fig. 9.1 shows two circuits.

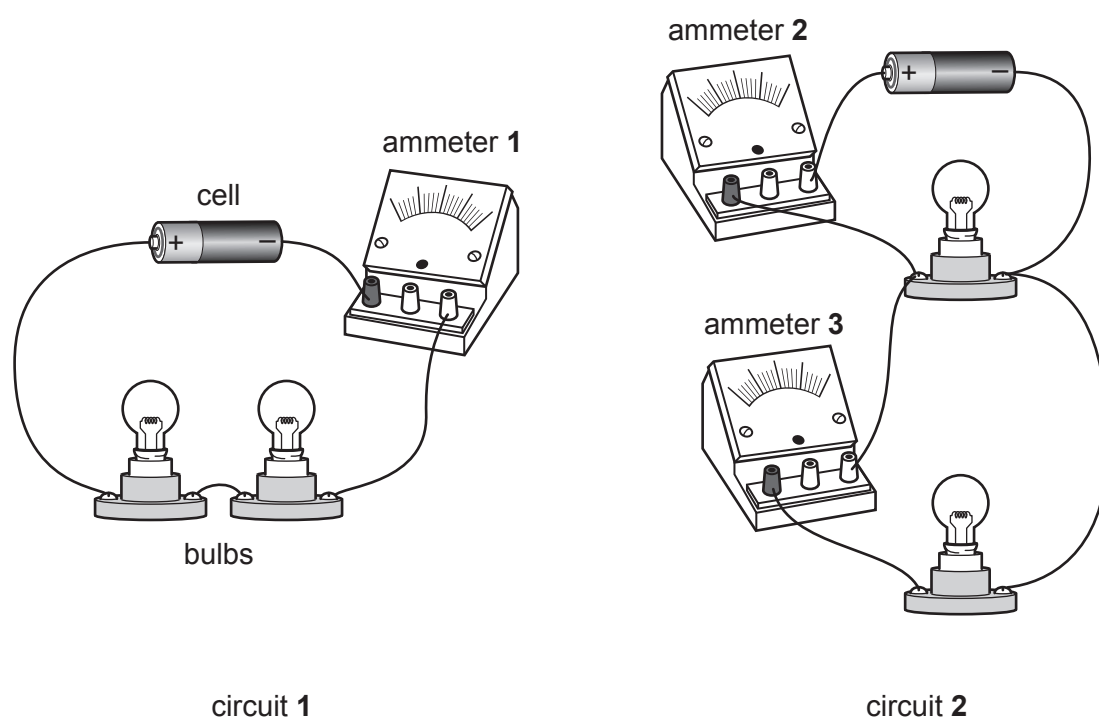


Fig. 9.1

In circuit **1** the bulbs are connected in series.

In circuit **2** the bulbs are connected in parallel.

The cells, the ammeters and all the bulbs are identical in both circuits.

- (a) Complete the circuit diagram for circuit **2** shown in Fig. 9.1. Include in your circuit diagram a switch that will turn off one bulb, but leave the other lit.



[3]

- (b) State which of the three ammeters in Fig. 9.1 shows the highest reading.

Give reasons for your answer.

ammeter

.....

 [2]

- (c) Circuit 1 is switched on.

Ammeter 1 shows a current of 2.0A.

A voltmeter connected across the cell in circuit 1 gives a reading of 1.4 V.

- (i) State the potential difference (p.d.) across **one** of the lamps in circuit 1.

potential difference = ... V [1]

- (ii) Calculate the total energy supplied by the cell in circuit 1 in 300 seconds.

energy = ... J [2]

- (d) The resistance of each bulb in circuit 2 when lit is $0.70\ \Omega$.

Calculate the combined resistance of the two bulbs.

resistance = ... Ω [2]

[Total: 10]

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The Periodic Table of Elements

Group																		
I	II	Key										III	IV	V	VI	VII	VIII	
		atomic number atomic symbol name relative atomic mass																
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		2 He helium 4
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 —			

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