Cambridge Assessment International Education

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CANDIDATE NAME									
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2192269648

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.
- 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. Blank pages are indicated.

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

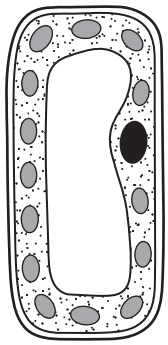

Fig. 1.1

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.

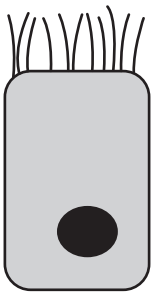

Fig. 1.2

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

.....

.....

..... [2]

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

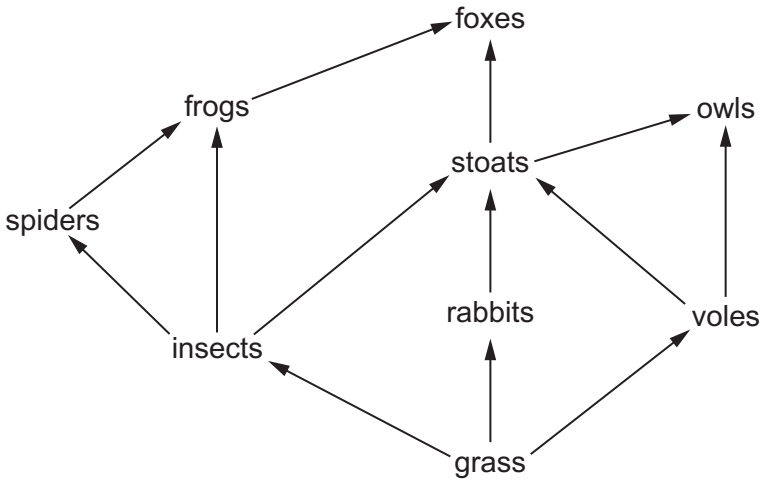

Fig. 1.3

(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]

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

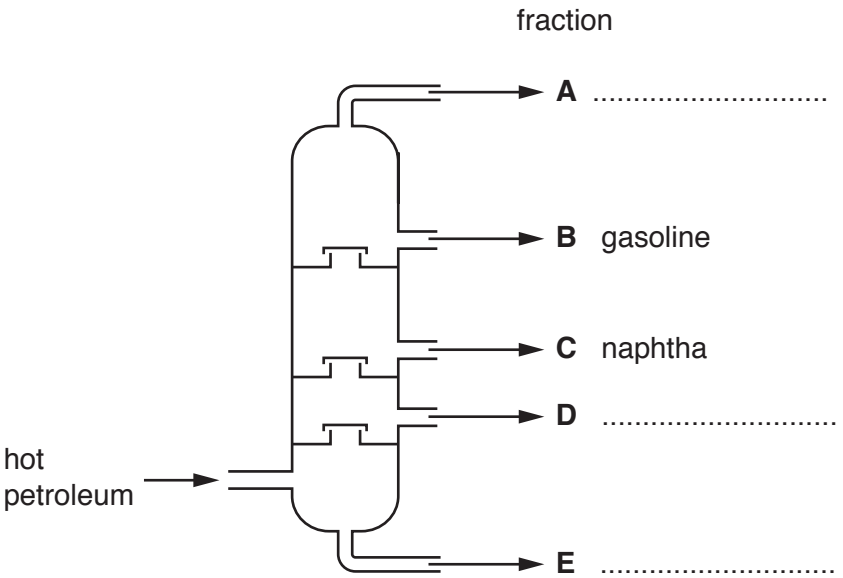

Fig. 2.1

(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]

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(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.

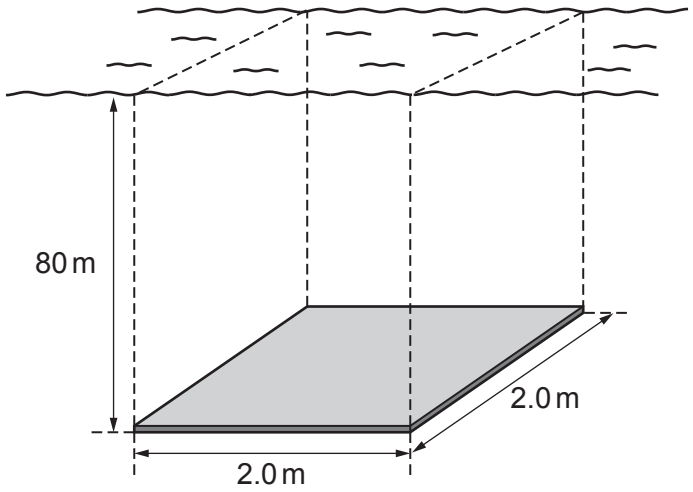

Fig. 3.1 (not to scale)

The surface of the sheet measures 2.0 m × 2.0 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 3.30×10^6 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.

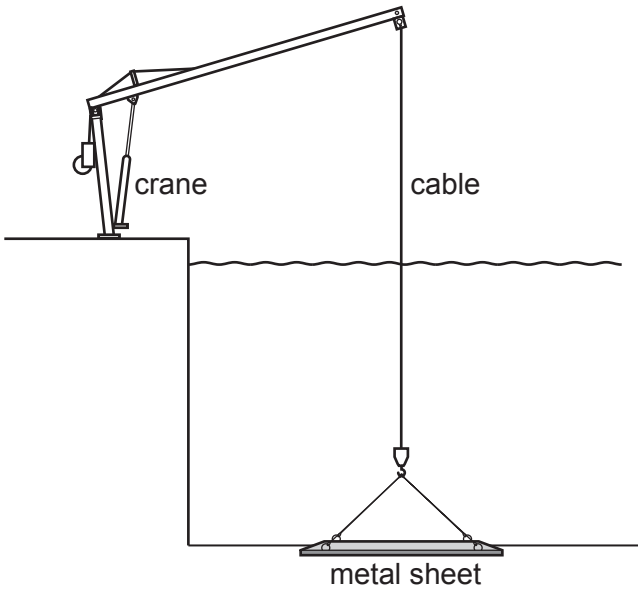

Fig. 3.2 (not to scale)

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.

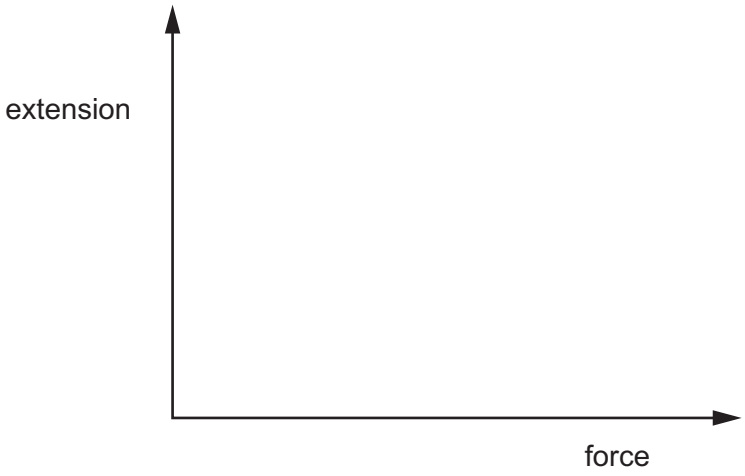

Fig. 3.3

[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.

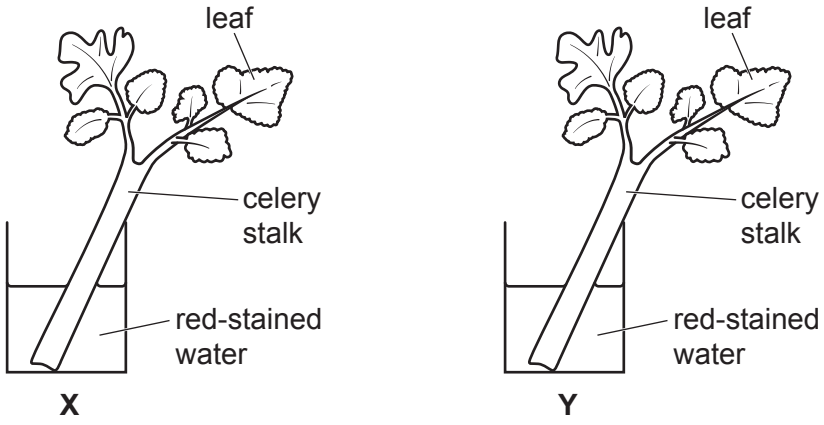

Fig. 4.1

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]

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(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.

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$$

(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.

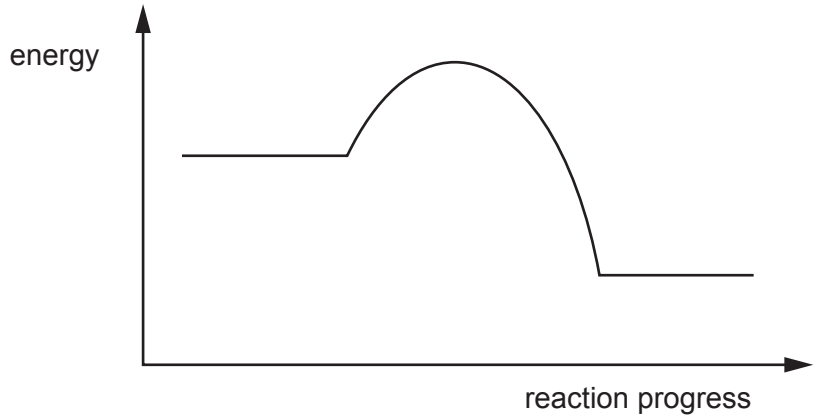

Fig. 5.1

(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 (↕) 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.

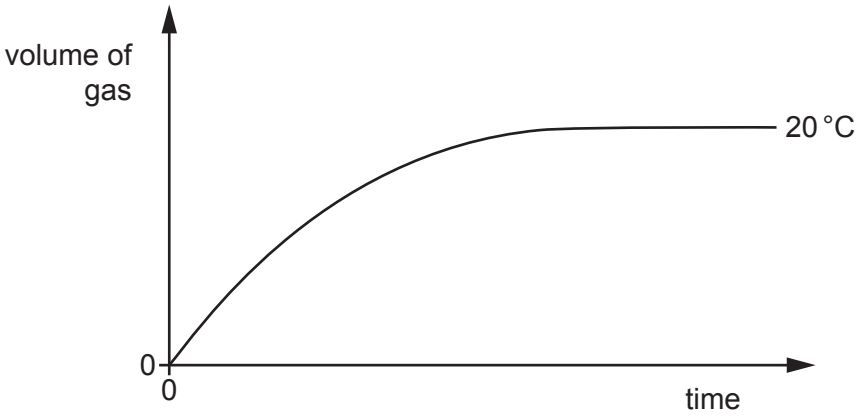

Fig. 5.2

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]

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(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.

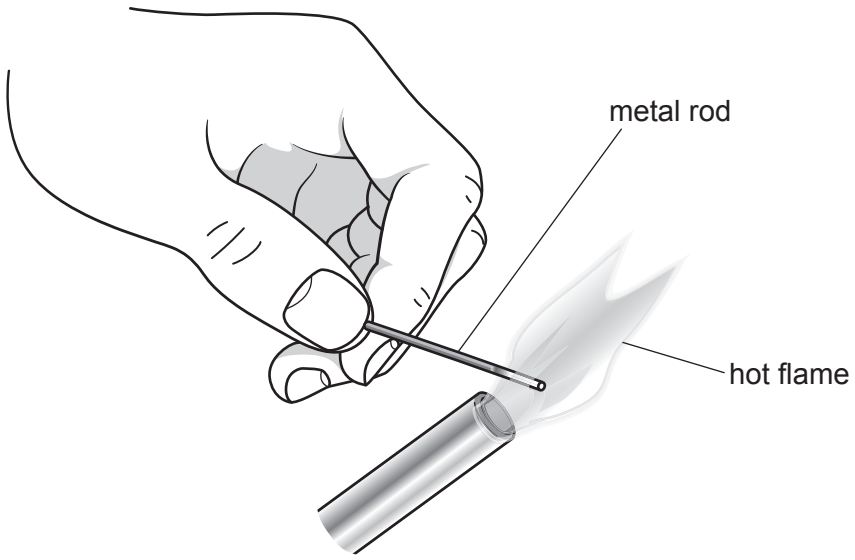

Fig. 6.1

(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]

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(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.

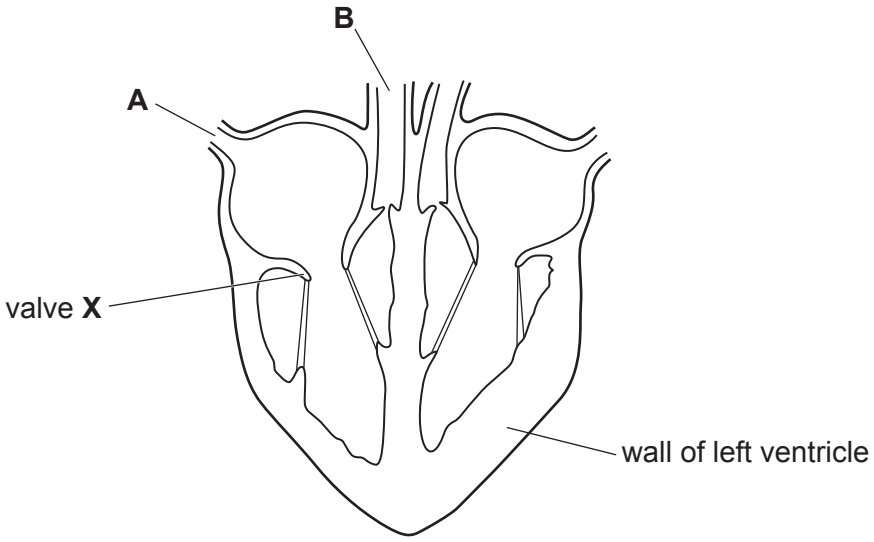

Fig. 7.1

(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]

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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]

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9 Fig. 9.1 shows two circuits.

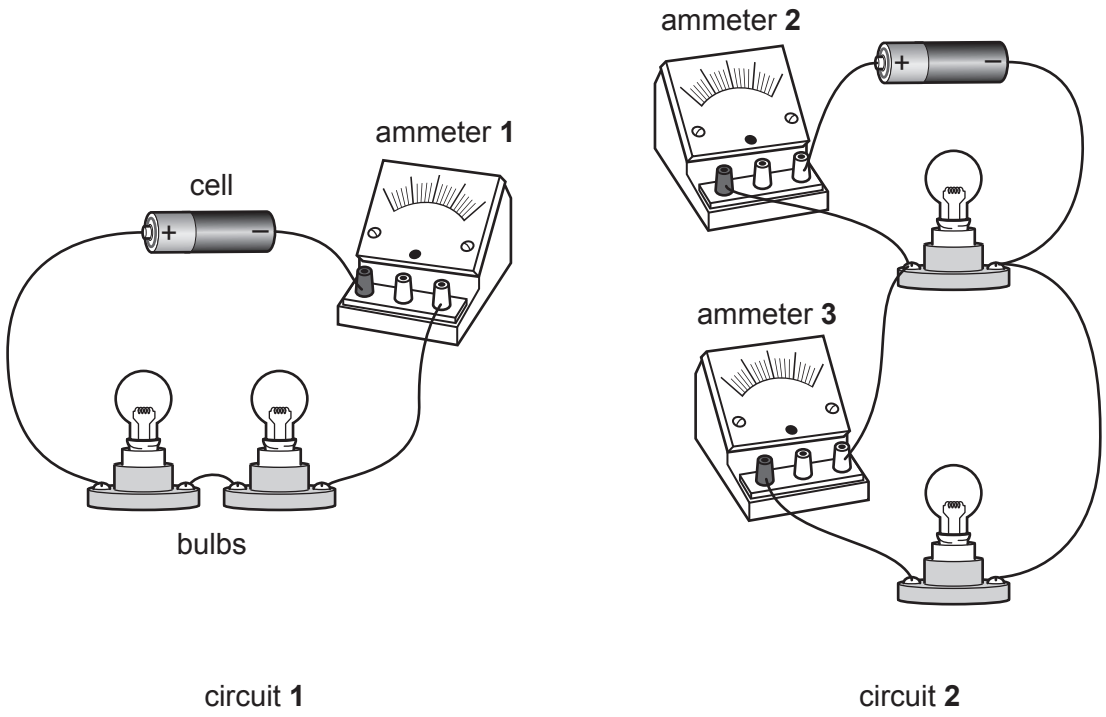


Fig. 9.1

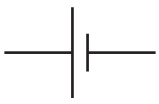
In circuit **1** the bulbs are connected in series.

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.

cell



[3]

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(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 2.0 A.

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 Ω.

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											III	IV	V	VI	VII	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.).