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**COMBINED SCIENCE****0653/43**

Paper 4 Theory (Extended)

**October/November 2025****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.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall =  $9.8 \text{ m/s}^2$ ).

**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. Any blank pages are indicated.

- 1 (a) Fig. 1.1 shows part of the human alimentary canal and associated organs.

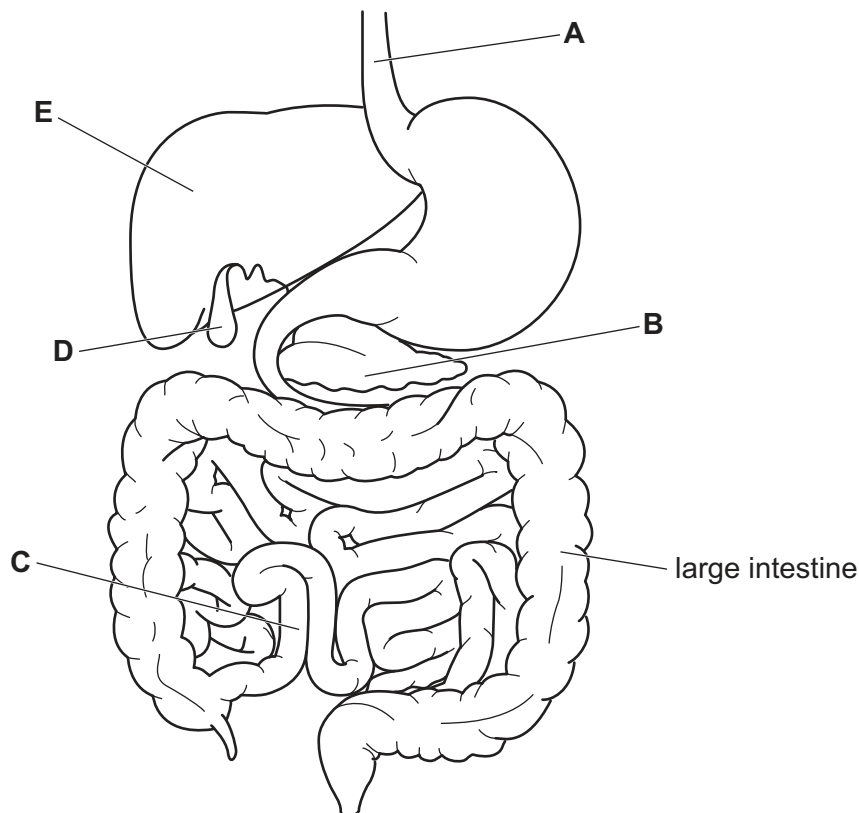


Fig. 1.1

- (i) Use the letters on Fig. 1.1 to identify the:

gall bladder .....

part where absorption takes place .....

part that secretes amylase. ....

[3]

- (ii) The large intestine has three different parts.

One part is called the anus.

Name the other **two** parts of the large intestine.

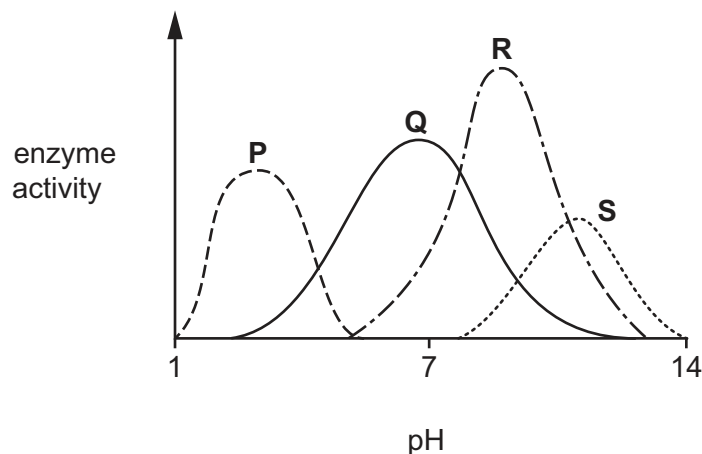
1 .....

2 .....

[2]



(b) The graph in Fig. 1.2 shows the effect of pH on four different enzymes, **P**, **Q**, **R** and **S**.



**Fig. 1.2**

(i) Identify the enzyme in Fig. 1.2 with optimum activity in the stomach.

..... [1]

(ii) Explain the effect of pH 7 on the activity of enzyme **S**.

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

(c) Lipase is an enzyme in the digestive system.

Complete the sentence about the function of lipase.

Lipase breaks down ..... and ..... into two types of smaller molecules called ..... and ..... [2]

[Total: 11]



2 (a) Fig. 2.1 shows a food web.

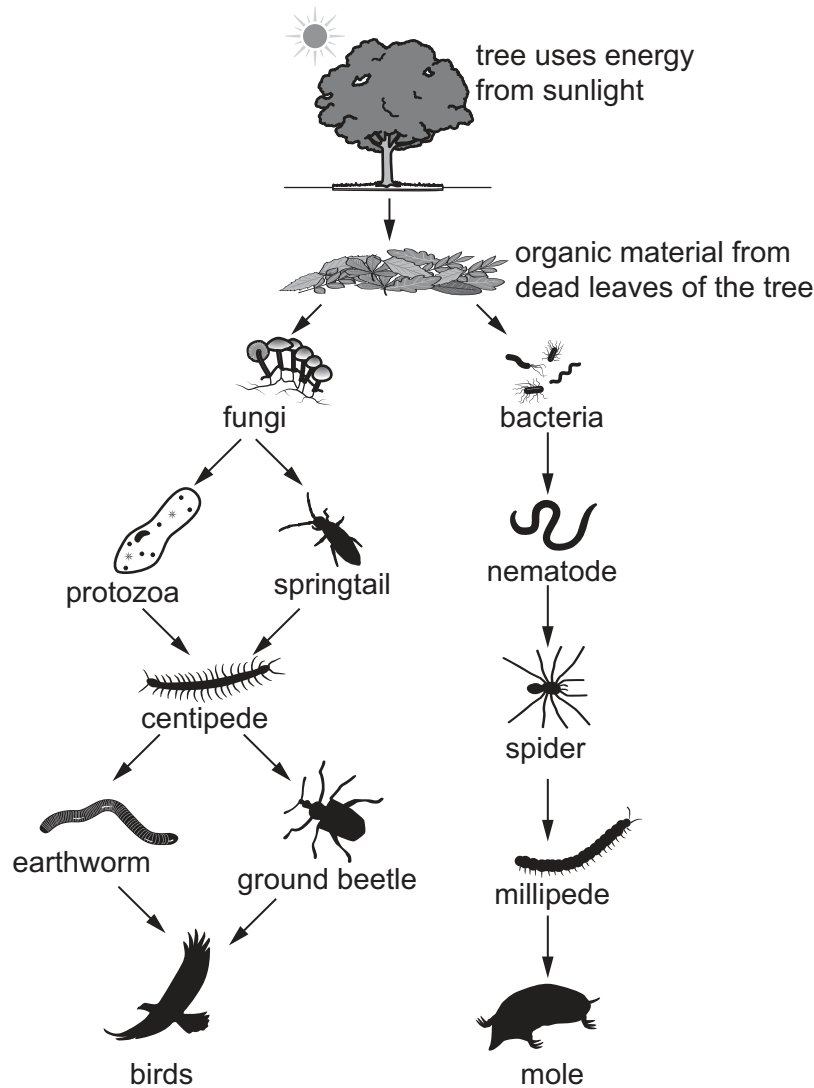


Fig. 2.1

(i) Circle the word that describes the tree in Fig. 2.1.

**carnivore      decomposer      herbivore      producer**

[1]

(ii) Circle the word that describes the fungi in Fig. 2.1.

**carnivore      decomposer      herbivore      producer**

[1]

(iii) Identify the animal in Fig. 2.1 that gets its energy from the spider.

..... [1]



(b) Transpiration takes place in plants.

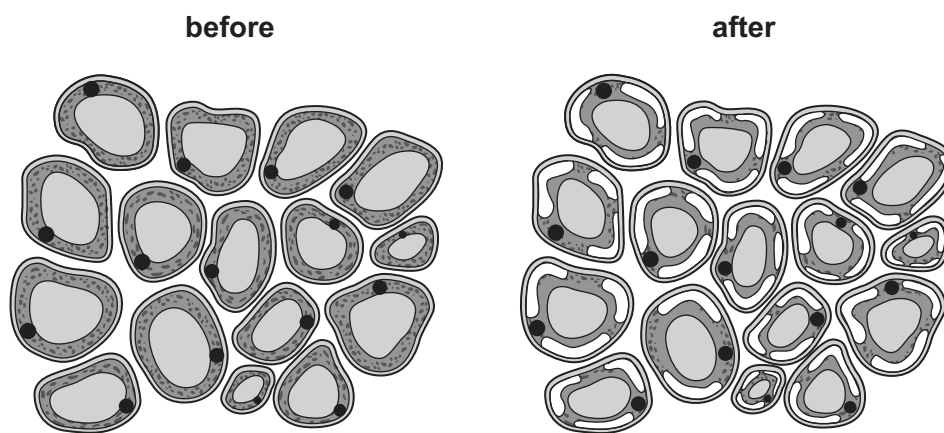
(i) Describe transpiration in plants.

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

(ii) Describe the effect of variation of wind speed on transpiration rate.

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

(c) Fig. 2.2 shows plant cells before and after being immersed in a concentrated sugar solution.



**Fig. 2.2**

Explain the effect of the concentrated sugar solution on the cells shown in Fig. 2.2.

.....  
 .....  
 .....  
 .....  
 .....  
 ..... [4]

[Total: 9]



- 3 (a) Fig. 3.1 shows the structure of a virus and a bacterial cell.

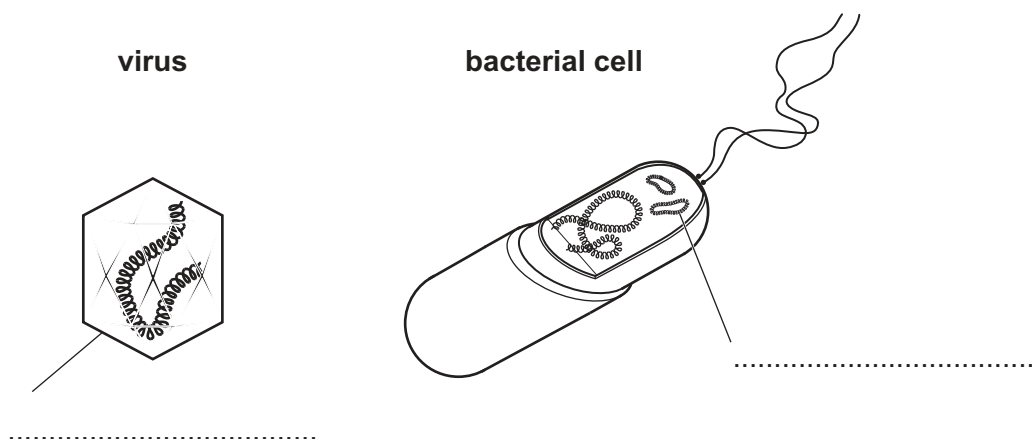


Fig. 3.1

Complete the labels on Fig. 3.1. Choose words from the list.

cell membrane

cell wall

cytoplasm

nucleus

plasmid

protein coat

[2]

- (b) Some viruses and bacteria are pathogens.

Platelets in blood help to defend against pathogens by clotting the blood.

State **two** other body defences against pathogens.

1 .....

2 .....

[2]

- (c) Antibiotics are drugs used to treat bacterial infections.

Describe what is meant by the term drug.

.....

..... [1]



(d) Vaccines are drugs used to help protect the body from bacterial infections.

Describe how vaccinations protect the body from bacterial infection.

.....

.....

.....

..... [2]

[Total: 7]



- 4 A student investigates the rate of reaction between large pieces of magnesium carbonate,  $\text{MgCO}_3$ , and dilute hydrochloric acid,  $\text{HCl}$ , using the apparatus shown in Fig. 4.1.

The student records the time taken to produce  $10\text{ cm}^3$  of gas.

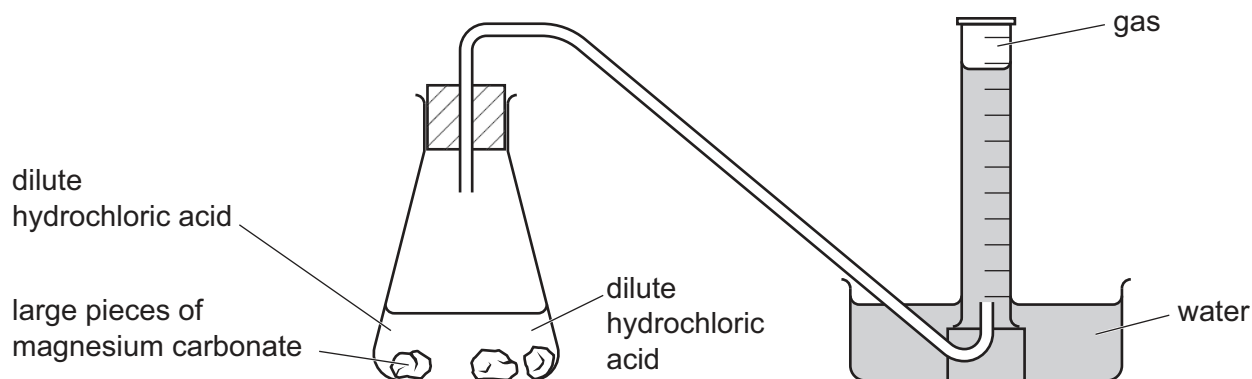


Fig. 4.1

- (a) Three products are formed in the reaction: magnesium chloride  $\text{MgCl}_2$ , a gas and one other product.

Give the balanced symbol equation for this reaction.

..... [2]

- (b) The student repeats the experiment using:

- small pieces of magnesium carbonate
- magnesium carbonate powder.

All other conditions are kept constant.

Table 4.1 shows the time taken to produce  $10\text{ cm}^3$  of gas and the rate of reaction.

Table 4.1

| magnesium carbonate | time taken to produce $10\text{ cm}^3$ of gas in s | rate of reaction in $\text{cm}^3$ per s |
|---------------------|----------------------------------------------------|-----------------------------------------|
| large pieces        | 15.2                                               | 0.66                                    |
| small pieces        | 8.3                                                | 1.2                                     |
| powder              | 5.1                                                |                                         |

- (i) Calculate the rate of reaction in  $\text{cm}^3$  per s for magnesium carbonate powder.

Write your answer in Table 4.1.

[1]



- (ii) State and explain how the size of the magnesium carbonate pieces affects the rate of this reaction.

.....

.....

.....

.....

.....

..... [3]

- (c) Fig. 4.2 shows an atom of magnesium and an atom of chlorine.

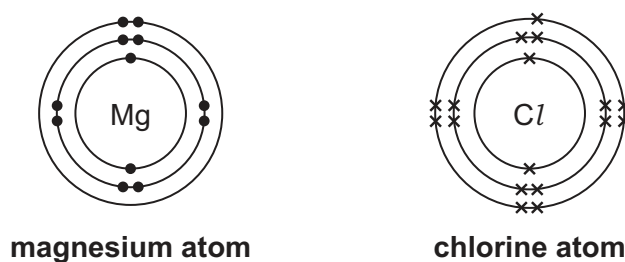


Fig. 4.2

Complete the dot-and-cross diagram in Fig. 4.3 to show the ionic bonding in magnesium chloride,  $\text{MgCl}_2$ .

Show **only** the outer-shell electrons and include the charges on the ions.

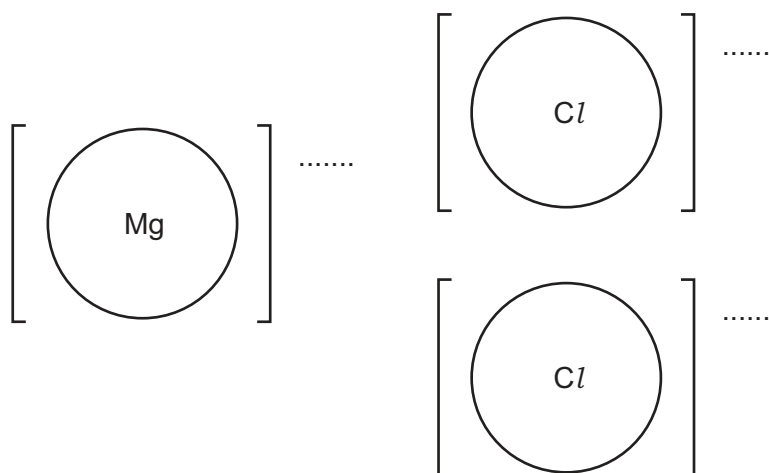


Fig. 4.3

[3]

[Total: 9]



5 Group VII elements are known as the halogens.

(a) (i) Halogens can be represented by the formula  $X_2$ .

State the term used to describe molecules with the formula  $X_2$ .

..... [1]

(ii) Complete Table 5.1:

- state the appearance of bromine at room temperature and pressure (r.t.p.)
- predict the appearance of astatine at r.t.p.

Table 5.1

| halogen  | appearance at r.t.p.  |
|----------|-----------------------|
| chlorine | pale yellow-green gas |
| bromine  |                       |
| iodine   | grey-black solid      |
| astatine |                       |

[2]

(b) Aqueous potassium iodide is colourless.

Aqueous chlorine is added to aqueous potassium iodide in a test-tube.

State the colour change observed.

Explain why this colour change occurs.

colour change .....

explanation .....

.....

.....

[3]

(c) (i) State why chlorine is used in the treatment of the domestic water supply.

..... [1]

(ii) State **one** other stage in the treatment of the domestic water supply.

..... [1]

[Total: 8]





6 Pentene is an alkene that contains one double carbon–carbon bond.

(a) Fig. 6.1 shows the structure of one form of pentene.

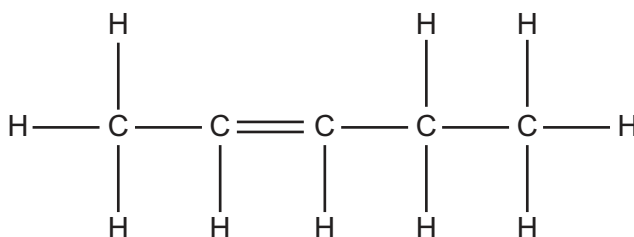


Fig. 6.1

(i) Use Fig. 6.1 to deduce the molecular formula of pentene.

..... [1]

(ii) The double carbon–carbon bond in pentene can be in different positions.

Complete Fig. 6.2 to show the structure of **one** other form of pentene.



Fig. 6.2

[1]

(iii) Pentene is a member of a homologous series.

State what is meant by a homologous series.

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



(iv) Draw lines to show which descriptions are true for pentene.

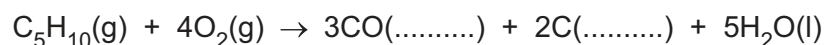
One has been drawn for you.

|                                                                                          | description                                               |
|------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| <div style="border: 1px solid black; padding: 5px; display: inline-block;">pentene</div> | is the main constituent of natural gas                    |
|                                                                                          | reacts with hydrogen in the presence of a nickel catalyst |
|                                                                                          | reacts with steam in the presence of an acid catalyst     |
|                                                                                          | is a saturated hydrocarbon                                |
|                                                                                          | decolourises aqueous bromine                              |

[2]

(b) Pentene combusts in a limited supply of oxygen to form two air pollutants: carbon monoxide and carbon particulates.

(i) Complete the balanced symbol equation by adding the missing state symbols.



[1]

(ii) Name this type of combustion reaction.

..... [1]

(iii) State **one** adverse effect of carbon particulates on human health.

..... [1]

[Total: 9]



7 A student assembles the circuit in Fig. 7.1.

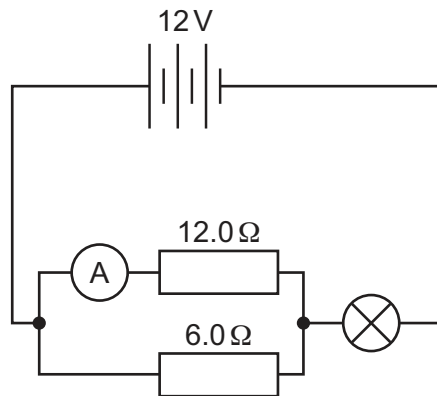


Fig. 7.1

The reading on the ammeter is  $0.80\text{ A}$ .

The potential difference (p.d.) across the  $12.0\ \Omega$  resistor is  $9.6\text{ V}$ .

(a) Determine the p.d. across the lamp.

p.d. = ..... V [1]

(b) Determine the current in the  $6.0\ \Omega$  resistor.

current = ..... A [2]



(c) Calculate the charge flowing through the **lamp** in 2.0 minutes.

State the unit of charge.

charge = ..... unit ..... [5]

[Total: 8]



8 Fig. 8.1 shows a motor and an object at rest on the ground.

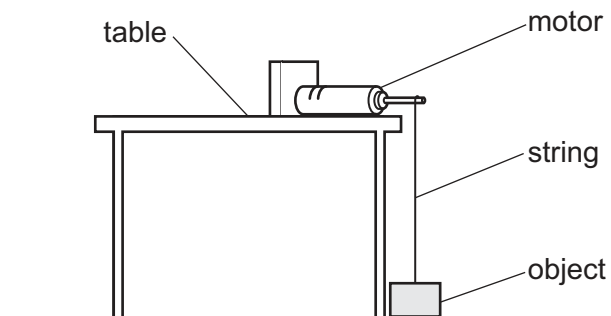


Fig. 8.1

The object has a mass of 2.9 kg.

Ignore any friction or air resistance.

(a) Calculate the weight of the object.

weight = ..... N [2]

(b) The motor lifts the object with force  $L$ .

The object accelerates upwards from rest with a constant acceleration of  $2.5 \text{ m/s}^2$ .

Calculate  $L$ .

$L = \dots\dots\dots$  N [3]



(c) The motor now lifts the object upwards at constant speed through vertical distance  $h$ .

(i) The total energy input to the motor is 150 J.

The motor has an efficiency of 66%.

Calculate the useful energy output of the motor.

useful energy output = ..... J [2]

(ii) Use your answer in (c)(i) to calculate  $h$ .

$h$  = ..... m [2]

[Total: 9]



- 9 (a) Fig. 9.1 shows a convection heater in a closed room.

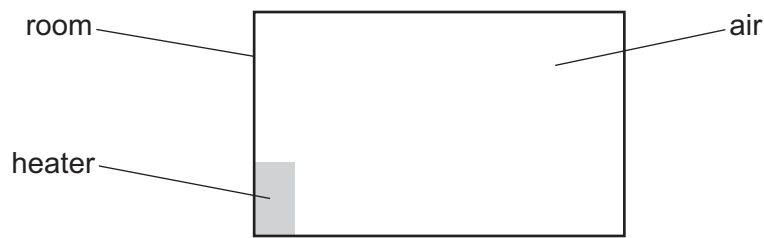


Fig. 9.1

The heater is on the floor on the left hand side of the room.

The heater warms the room by convection.

- (i) State **one** other method of thermal energy transfer.

..... [1]

- (ii) Explain how the heater warms the room by convection.

Use ideas about density in your answer.

You may draw on Fig. 9.1 if you wish.

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

- (iii) Explain why the air in the room exerts a greater pressure on the walls when the temperature of the air increases.

Use ideas about particles in your answer.

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



- (b) Complete Table 9.1 to describe the difference between a transverse wave and a longitudinal wave.

Use **one** word in each gap.

**Table 9.1**

| wave         | direction of ..... compared to<br>direction of propagation |
|--------------|------------------------------------------------------------|
| transverse   | at right angles                                            |
| longitudinal | .....                                                      |

[2]

- (c) The Big Bang Theory includes statements about the beginning of the Universe that are supported by astronomical observations.

Give **two** statements about the beginning of the Universe included in the Big Bang Theory.

1 .....

.....

2 .....

.....

[2]

[Total: 10]

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The Periodic Table of Elements

| Group                      |                             |                                                                                             |                             |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                                       |                             |                               |                              |                             |                        |
|----------------------------|-----------------------------|---------------------------------------------------------------------------------------------|-----------------------------|---------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|--------------------------------|-------------------------------|-------------------------------|-----------------------------|---------------------------------------|-----------------------------|-------------------------------|------------------------------|-----------------------------|------------------------|
| I                          | II                          |                                                                                             |                             |                                 |                             |                              |                             |                              |                              |                                |                               | III                           | IV                          | V                                     | VI                          | VII                           | VIII                         |                             |                        |
| 3<br>Li<br>lithium<br>7    | 4<br>Be<br>beryllium<br>9   | <div>Key</div> <div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div> |                             |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             | <div>1<br/>H<br/>hydrogen<br/>1</div> |                             |                               |                              |                             | 2<br>He<br>helium<br>4 |
|                            |                             |                                                                                             |                             |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                                       |                             |                               |                              |                             |                        |
|                            |                             |                                                                                             |                             |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                                       |                             |                               |                              |                             |                        |
| 11<br>Na<br>sodium<br>23   | 12<br>Mg<br>magnesium<br>24 | 21<br>Sc<br>scandium<br>45                                                                  | 20<br>Ca<br>calcium<br>40   | 22<br>Ti<br>titanium<br>48      | 23<br>V<br>vanadium<br>51   | 24<br>Cr<br>chromium<br>52   | 25<br>Mn<br>manganese<br>55 | 26<br>Fe<br>iron<br>56       | 27<br>Co<br>cobalt<br>59     | 28<br>Ni<br>nickel<br>59       | 29<br>Cu<br>copper<br>64      | 30<br>Zn<br>zinc<br>65        | 31<br>Ga<br>gallium<br>70   | 32<br>Ge<br>germanium<br>73           | 33<br>As<br>arsenic<br>75   | 34<br>Se<br>selenium<br>79    | 35<br>Br<br>bromine<br>80    | 36<br>Kr<br>krypton<br>84   |                        |
| 37<br>Rb<br>rubidium<br>85 | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89                                                                    | 38<br>Sr<br>strontium<br>88 | 40<br>Zr<br>zirconium<br>91     | 41<br>Nb<br>niobium<br>93   | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium<br>— | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103   | 46<br>Pd<br>palladium<br>106   | 47<br>Ag<br>silver<br>108     | 48<br>Cd<br>cadmium<br>112    | 49<br>In<br>indium<br>115   | 50<br>Sn<br>tin<br>119                | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128  | 53<br>I<br>iodine<br>127     | 54<br>Xe<br>xenon<br>131    |                        |
| 55<br>Cs<br>caesium<br>133 | 56<br>Ba<br>barium<br>137   | 57–71<br>lanthanoids                                                                        | 56<br>Ba<br>barium<br>137   | 72<br>Hf<br>hafnium<br>178      | 73<br>Ta<br>tantalum<br>181 | 74<br>W<br>tungsten<br>184   | 75<br>Re<br>rhenium<br>186  | 76<br>Os<br>osmium<br>190    | 77<br>Ir<br>iridium<br>192   | 78<br>Pt<br>platinum<br>195    | 79<br>Au<br>gold<br>197       | 80<br>Hg<br>mercury<br>201    | 81<br>Tl<br>thallium<br>204 | 82<br>Pb<br>lead<br>207               | 83<br>Bi<br>bismuth<br>209  | 84<br>Po<br>polonium<br>—     | 85<br>At<br>astatine<br>—    | 86<br>Rn<br>radon<br>—      |                        |
| 87<br>Fr<br>francium<br>—  | 88<br>Ra<br>radium<br>—     | 89–103<br>actinoids                                                                         | 88<br>Ra<br>radium<br>—     | 104<br>Rf<br>rutherfordium<br>— | 105<br>Db<br>dubnium<br>—   | 106<br>Sg<br>seaborgium<br>— | 107<br>Bh<br>bohrium<br>—   | 108<br>Hs<br>hassium<br>—    | 109<br>Mt<br>meitnerium<br>— | 110<br>Ds<br>darmstadtium<br>— | 111<br>Rg<br>roentgenium<br>— | 112<br>Cn<br>copernicium<br>— | 113<br>Nh<br>nihonium<br>—  | 114<br>Fl<br>flerovium<br>—           | 115<br>Mc<br>moscovium<br>— | 116<br>Lv<br>livermorium<br>— | 117<br>Ts<br>tennessine<br>— | 118<br>Og<br>oganesson<br>— |                        |

|             |                              |                            |                                 |                              |                             |                             |                             |                               |                            |                               |                              |                           |                               |                              |                              |
|-------------|------------------------------|----------------------------|---------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|----------------------------|-------------------------------|------------------------------|---------------------------|-------------------------------|------------------------------|------------------------------|
| lanthanoids | 57<br>La<br>lanthanum<br>139 | 58<br>Ce<br>cerium<br>140  | 59<br>Pr<br>praseodymium<br>141 | 60<br>Nd<br>neodymium<br>144 | 61<br>Pm<br>promethium<br>— | 62<br>Sm<br>samarium<br>150 | 63<br>Eu<br>europium<br>152 | 64<br>Gd<br>gadolinium<br>157 | 65<br>Tb<br>terbium<br>159 | 66<br>Dy<br>dysprosium<br>163 | 67<br>Ho<br>holmium<br>165   | 68<br>Er<br>erbium<br>167 | 69<br>Tm<br>thulium<br>169    | 70<br>Yb<br>ytterbium<br>173 | 71<br>Lu<br>lutetium<br>175  |
|             | 89<br>Ac<br>actinium<br>—    | 90<br>Th<br>thorium<br>232 | 91<br>Pa<br>protactinium<br>231 | 92<br>U<br>uranium<br>238    | 93<br>Np<br>neptunium<br>—  | 94<br>Pu<br>plutonium<br>—  | 95<br>Am<br>americium<br>—  | 96<br>Cm<br>curium<br>—       | 97<br>Bk<br>berkelium<br>— | 98<br>Cf<br>californium<br>—  | 99<br>Es<br>einsteinium<br>— | 100<br>Fm<br>fermium<br>— | 101<br>Md<br>mendelevium<br>— | 102<br>No<br>nobelium<br>—   | 103<br>Lr<br>lawrencium<br>— |

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

