Cambridge IGCSE™

CANDIDATE NAME								

CENTRE NUMBER						CANDIDATE NUMBER				

COMBINED SCIENCE **0653/31**

Paper 3 Theory (Core) **October/November 2021**

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. Any blank pages are indicated.

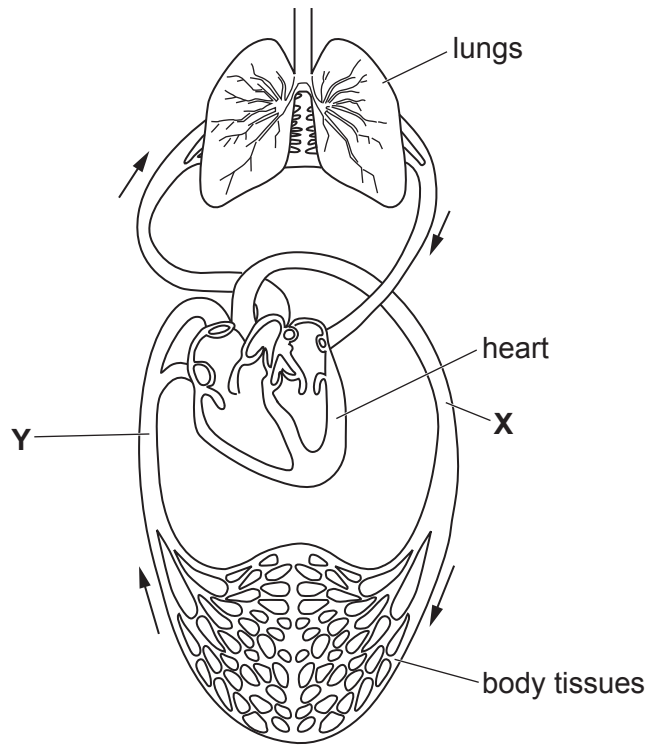**1 (a)** Fig. 1.1 is a diagram of the circulatory system in humans.

Fig. 1.1

(i) The arrows show the direction of blood flow through the blood vessels.

Blood vessels **X** and **Y** are two of the main blood vessels attached to the heart.

Identify blood vessels **X** and **Y** shown in Fig. 1.1.

X ....

Y ....

[2]

(ii) State the function of the heart.

.... [1]

(iii) Circle the name of the tube that connects the lungs to the nose and mouth.

alveoli   bronchi   bronchiole   larynx   trachea

[1]

(b) Complete these sentences about the blood.

Choose words from the list.

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

      chlorophyll   **glucose**   **haemoglobin**   **nitrogen**

             oxygen   **phagocytosis**   **egestion**

There are two types of blood cells, red blood cells and white blood cells.

Red blood cells transport the gas, ...

The gas binds to a chemical in red blood cells called ....

White blood cells produce antibodies.

White blood cells are also involved in the process of ....

[3]

(c) Fig. 1.2 shows the pulse rate of a person doing different activities.
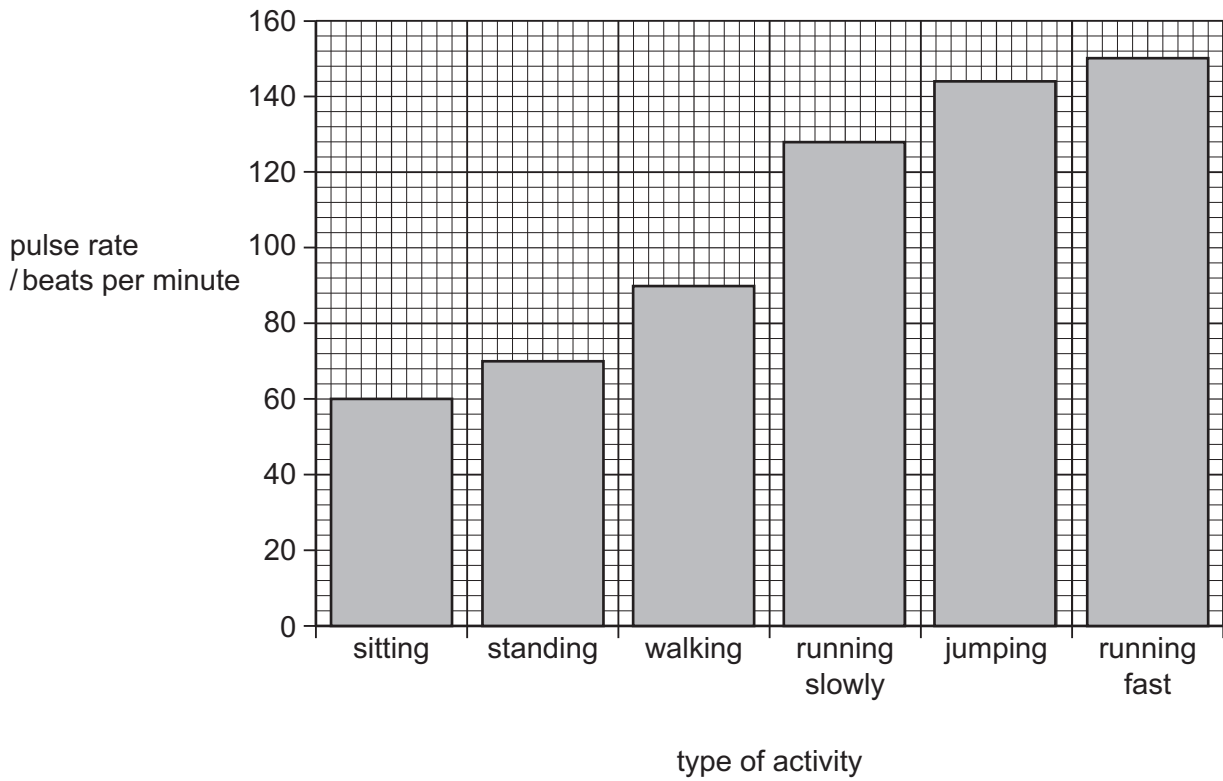

type of activity

Fig. 1.2

(i) Place a tick (✓) in **one** box to show the activity that results in a pulse rate of between 120 and 140 beats per minute.

jumping ☐   sitting ☐

running fast ☐   standing ☐

running slowly ☐   walking ☐

[1]

(ii) Calculate the difference in pulse rate between sitting and running fast.

pulse rate sitting = ... beats per minute

pulse rate running fast = ... beats per minute

difference in pulse rate = ... beats per minute
[2]

(iii) Describe how the person's **breathing** is different when walking compared to jumping.

....

.... [2]

[Total: 12]

2 **(a)** The order of reactivity for some metals is shown in Fig. 2.1.

most reactive   metal **A**

sodium

calcium

metal **B**

zinc

iron

least reactive   copper
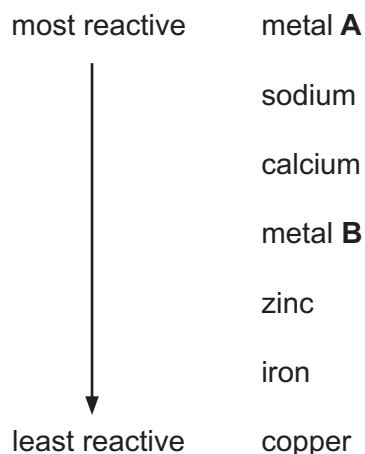
Fig. 2.1

(i) Suggest the identities of metals **A** and **B**.

A ....

B ....
[1]

(ii) State **two** observations for the reaction of sodium with water.

1 ....

2 ....
[2]

(b) Sodium is in Group I of the Periodic Table.

Iron is a transition element.

Describe **two** physical properties of iron that show that it is different from sodium.

1 ....

2 ....
[2]

(c) Brass is an alloy of zinc and one other metal.

State the name of this other metal.

.... [1]

(d) Recycling metals uses less energy and costs less money than extracting the metals from their ores.

State **one** other reason why metals need to be recycled.

....

.... [1]

(e) Sodium and chlorine react together in an exothermic reaction to form sodium chloride.

(i) State what is meant by *exothermic*.

....

.... [1]

(ii) Fig. 2.2 shows the electronic structures of a sodium **ion**, Na⁺, and a chloride **ion**, Cl⁻, in sodium chloride.
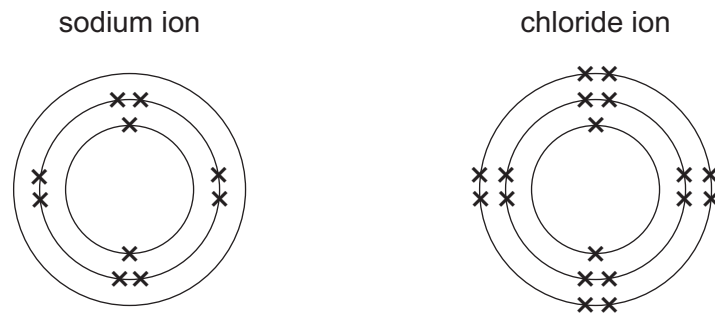
sodium ion   chloride ion

Fig. 2.2

Complete Fig. 2.3 to show the electronic structures of a sodium **atom**, Na, and a chlorine **atom**, Cl.

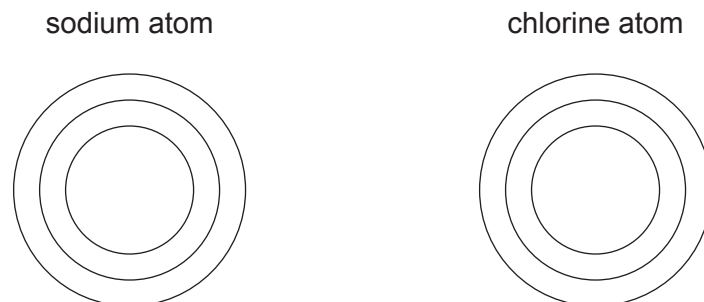sodium atom   chlorine atom

Fig. 2.3

[2]

[Total: 10]

3 (a) Fig. 3.1 shows a wave.
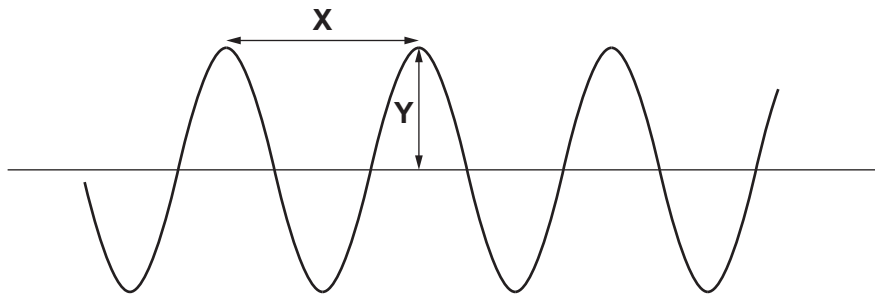
Fig. 3.1

Use Fig. 3.1 to complete the two sentences about the wave.

- **X** shows the .... of the wave.

- **Y** shows the .... of the wave.

[2]

(b) Table 3.1 shows the frequency ranges of sounds emitted by different species of whale.

Table 3.1

species	frequency range/Hz
beluga whale	40–60 000
blue whale	10–39
dwarf minke whale	50–9 400
fin whale	16–40

State which species of whale emits sounds that are **all** heard by a healthy human ear.

Give a reason for your answer.

species of whale ....

reason ....

....

[2]

(c) A whale is swimming at a constant speed.

(i) State the size of the resultant force on the whale.

Give a reason for your answer.

resultant force = ... N
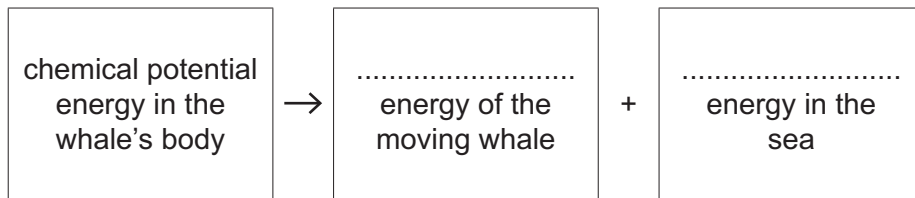
reason ....

....
[1]

(ii) The whale swims at a constant speed of 6.1 m/s for 15 minutes.

Calculate the distance the whale travels in this time.

distance = ... m [3]

(iii) Energy is transferred while the whale is swimming.

Complete the boxes to show the energy transfers that take place.

| chemical potential energy in the whale's body | → | ....
energy of the moving whale | + | ....
energy in the sea |

[2]

[Total: 10]

4 **(a)** Table 4.1 shows the names and functions of some organs associated with the alimentary canal.

Complete Table 4.1.

Table 4.1

organ	function
pancreas	produces enzymes used in the .... intestine for digestion
....	produces bile which is stored in the gall bladder
salivary gland	makes saliva and releases it into the .... for digestion

[3]

(b) Enzymes in saliva break down large starch molecules into smaller glucose molecules.

(i) Glucose is a reducing sugar.

State the name of the test solution used to identify the presence of a reducing sugar in food.

.... [1]

(ii) Circle the name of **one** other large molecule made from glucose molecules.

amino acids **fatty acids** **glycerol** **glycogen**

[1]

(c) Food labels show the quantities of nutrients found in the food.

Fig. 4.2 shows a food label from a box of burgers.

Each grilled burger (94 g) contains

Energy	Fat	Saturated fat	Sugars	Salt
898 kJ	12 g	5.8 g	0.7 g	0.6 g

Fig. 4.2

(i) A person eats **two** burgers.

Calculate the mass of salt the person eats.

.... g [1]

(ii) The label does **not** show a value for fibre.

State the importance of eating fibre in a balanced diet.

....

.... [1]

[Total: 7]

5 (a) The boxes on the left of Fig. 5.1 show some separation and collection methods.

The boxes on the right of Fig. 5.1 show some substances and the mixtures they come from.

Complete Fig. 5.1 to show the method used to separate and collect each substance from its mixture.

Draw one line from each box on the left to one box on the right.

Distillation of water from salty water has been done as an example for you.
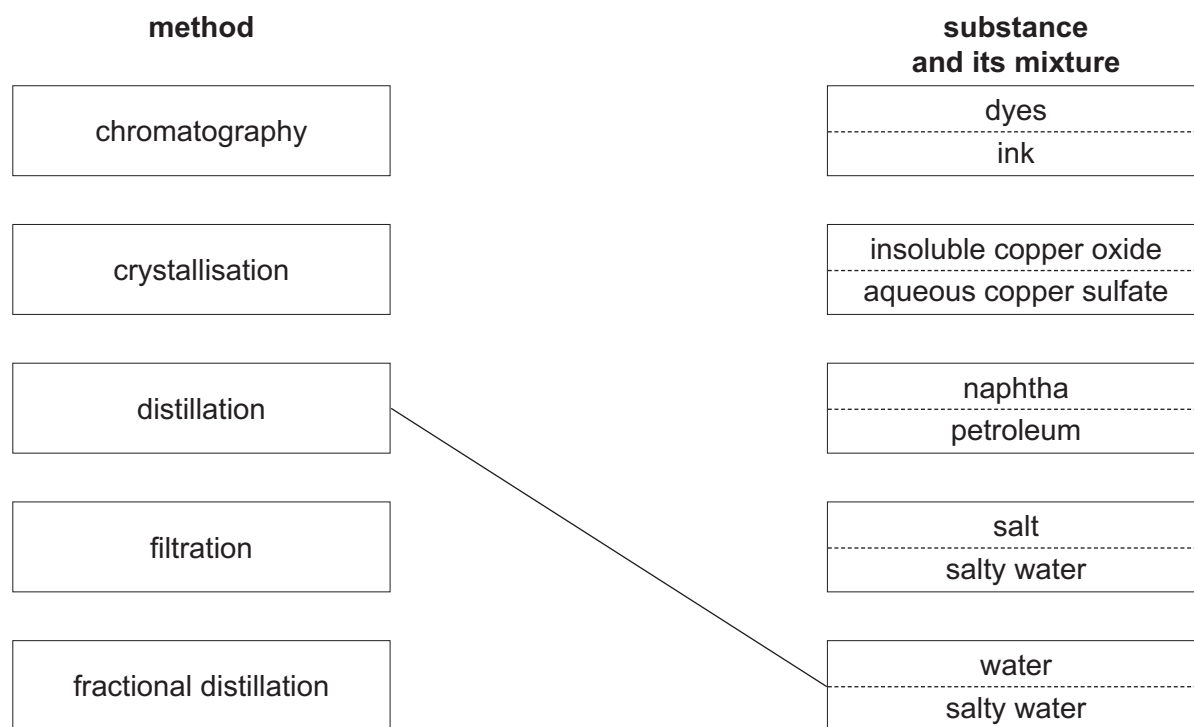
method		substance and its mixture
chromatography		dyes / ink
crystallisation		insoluble copper oxide / aqueous copper sulfate
distillation		naphtha / petroleum
filtration		salt / salty water
fractional distillation		water / salty water

Fig. 5.1

[2]

(b) Evaporation is also used to separate some mixtures.

During evaporation, a liquid becomes a gas.

(i) Explain why evaporation is a physical change and **not** a chemical change.

....

.... [1]

(ii) Describe how the structure of a gas is different to the structure of a liquid in terms of particle arrangement and particle motion.

particle arrangement ....

....

particle motion ....

....
[2]

(c) Copper sulfate and water are made when copper oxide reacts with an acid.

State the name of this acid.

.... [1]

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

.... [1]

[Total: 7]

6   Fig. 6.1 shows a gas flame being used to heat a metal kettle of water until the water boils.

water inside kettle

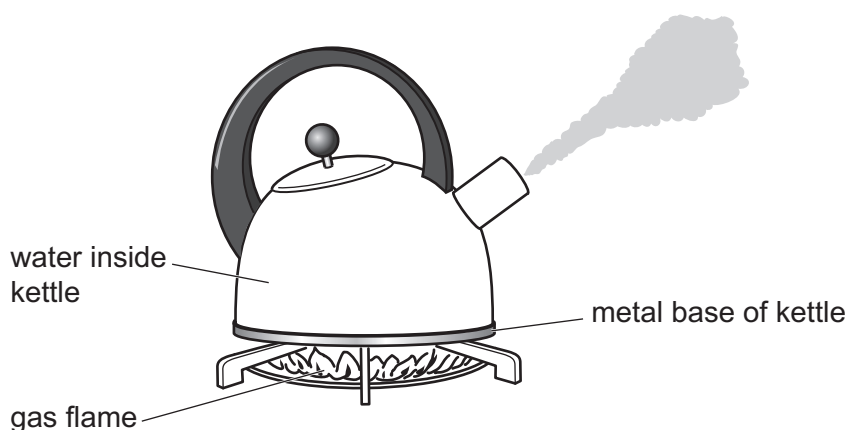metal base of kettle

gas flame

Fig. 6.1

(a) (i)   State the boiling point of water in degrees Celsius.

.... °C [1]

   (ii)   Identify the main method of thermal energy transfer:

      •   through the metal base of the kettle ....

      •   through the water in the kettle ....
[2]

(b)   Natural gas is a non-renewable source of energy.

   State two **renewable** sources of energy.

   1 ....

   2 ....
[2]

(c) Fig. 6.2 shows a student standing in front of a plane mirror. The student is pouring water from the kettle into a cup.

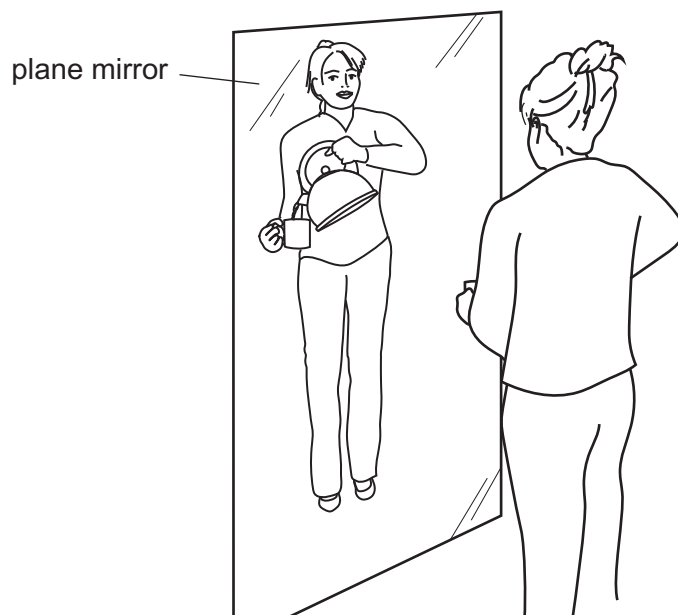There is an image of the student in the plane mirror.

plane mirror

Fig. 6.2

The image of the student in the mirror is *laterally inverted*.

This lateral inversion is a *characteristic* of the image.

(i) Describe how Fig. 6.2 shows that the image of the student is *laterally inverted*.

....

....

.... [2]

(ii) State **one** other *characteristic* of the image in the mirror.

.... [1]

[Total: 8]

7 (a) Fig. 7.1 shows the life cycle of a plant.
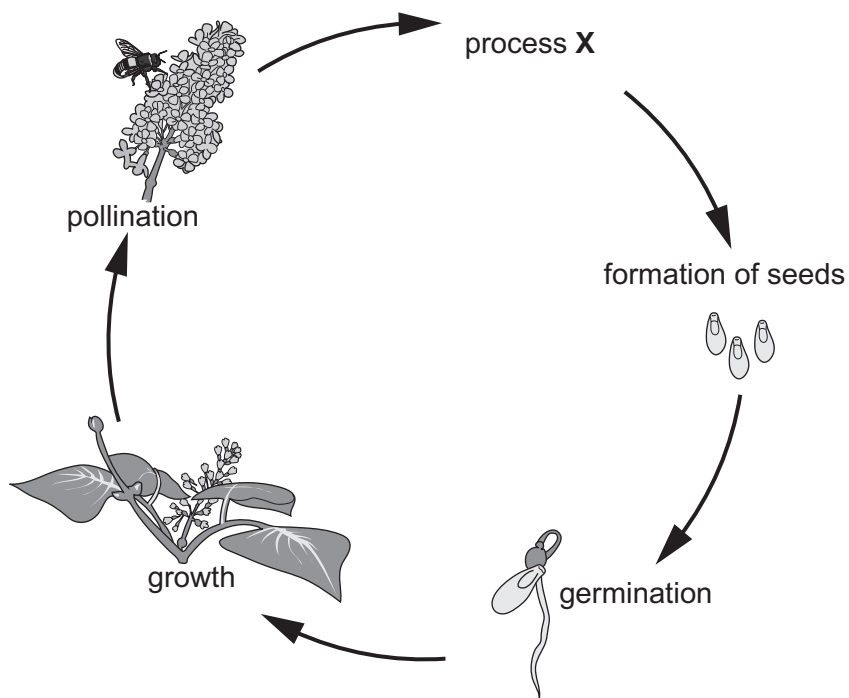
Fig. 7.1

(i) Identify process **X** in Fig. 7.1.

.... [1]

(ii) Explain why plants need amino acids for growth.

....

....

.... [2]

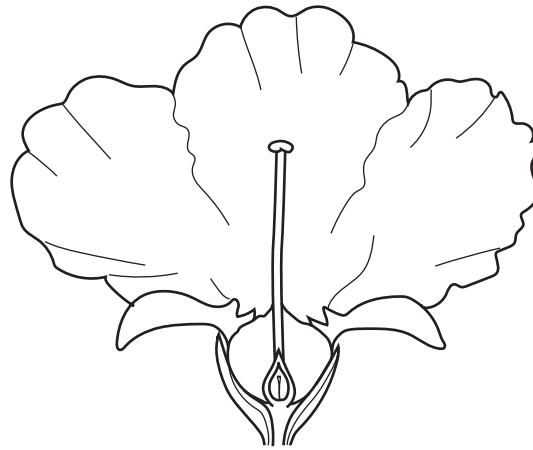**(b)** Fig. 7.2 shows some of the parts of an insect-pollinated flower.

Fig. 7.2

(i) On Fig. 7.2, draw a label line and the letter **P** to show where pollination occurs. [1]

(ii) The male parts of the flower are **not** visible in Fig. 7.2.

State the name of **one** male part of the flower **not** visible in Fig. 7.2.

.... [1]

(c) Plants can also reproduce asexually.

Complete these sentences to define the term asexual reproduction.

Asexual reproduction is a process resulting in the production of ....

identical offspring from .... parent.

[2]

(d) The roots of a plant grow down into the ground in response to gravity.

State the name of this response.

.... [1]

[Total: 8]

 [Turn over

8 Methane, CH$_4$, is a hydrocarbon.

(a) State what is meant by *hydrocarbon*.

....

.... [2]

(b) Methane is an alkane. An alkane contains only single covalent bonds.

Fig. 8.1 is a dot-and-cross diagram of a molecule of methane, CH$_4$. Only the outer shell electrons are shown.
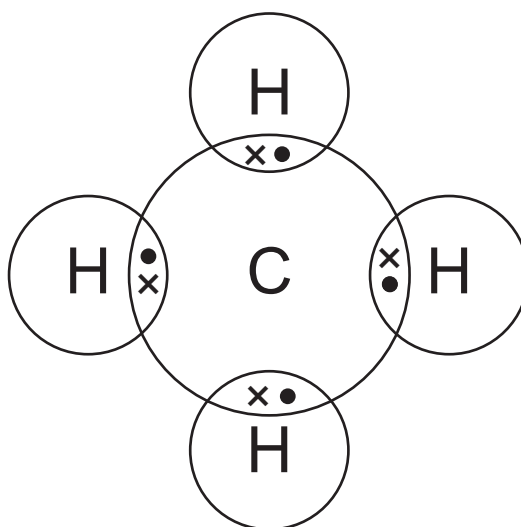
Fig. 8.1

Use Fig. 8.1 to describe what is meant by *single covalent bonds*.

....

....

.... [2]

(c) The complete combustion of methane produces carbon dioxide and water.

   (i) Balance the equation for the complete combustion of methane.

$$CH_4 \ + \ .... \ O_2 \ \rightarrow \ CO_2 \ + \ .... \ H_2O$$

[2]

  (ii) State and explain whether the carbon in methane is oxidised or reduced in this reaction.

carbon ....

explanation ....

....

[1]

 (iii) Explain why argon, a noble gas, does not react with oxygen.

Use ideas about electronic structure in your answer.

....

.... [1]

(d) Describe how the bonding in alkenes is different from the bonding in alkanes.

....

.... [1]

[Total: 9]

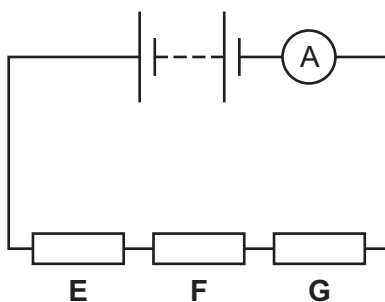**9** Fig. 9.1 shows three identical resistors, **E**, **F** and **G**, connected to a battery and an ammeter.

Fig. 9.1

(a) The resistors each have a resistance of 10 Ω.

(i) Calculate the combined resistance of resistors **E**, **F** and **G** in this circuit.

resistance = ... Ω [1]

(ii) The ammeter reading is 0.12 A.

Calculate the potential difference across the three resistors.

State the unit of your answer.

potential difference = ... unit .... [3]

(b) State the name of the circuit component with the electrical symbol shown.

.... [1]

(c) Fig. 9.2 shows resistors **E**, **F** and **G** in a different circuit with three ammeters, **A₁**, **A₂**, and **A₃**, and a switch, **S**.
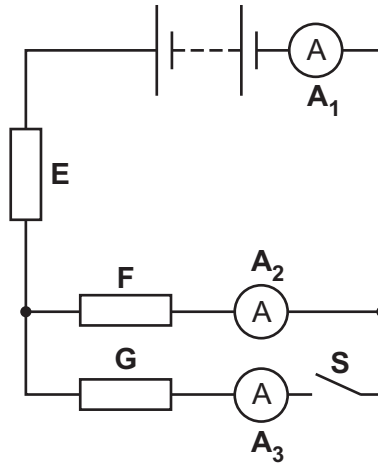
Fig. 9.2

(i) State the type of circuit arrangement for resistors **F** and **G**.

.... [1]

(ii) Switch **S** is closed.

State which ammeter, **A₁**, **A₂** or **A₃**, shows the highest reading.

Give a reason for your answer.

ammeter ....

reason ....

....
[1]

(iii) Switch **S** is opened.

Describe how the reading on ammeter **A₂** compares with the reading on ammeter **A₁**.

Give a reason for your answer.

description ....

reason ....

....
[2]

[Total: 9]

22

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23

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group							
I	II	III	IV	V	VI	VII	VIII

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 –		

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.).