Cambridge Assessment International Education

Cambridge IGCSE™

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CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **October/November 2025**

2 hours

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 m / s^2).

INFORMATION

- The total mark for this paper is 120.
- 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 **32** pages. Any blank pages are indicated.

DC (IP/CT) 352886/4

[Turn over

1 Organisms are made up of cells, tissues and organs.

(a) The boxes on the left show levels of organisation.

The boxes on the right show parts of an organism.

Draw **one** straight line from each level of organisation to the correct part of the organism.

level of organisation	**part of organism**
organ	lymphocyte
tissue	ribosome
cell	lung
	intercostal muscle

[3]

(b) Fig. 1.1 is a photograph of blood seen under a light microscope.

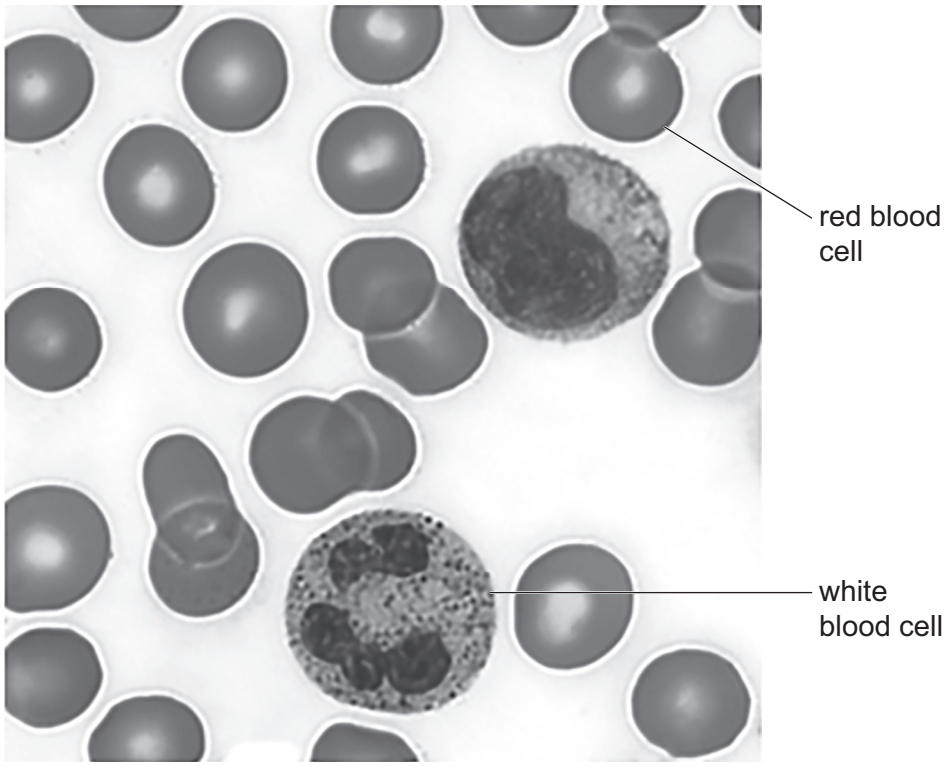


Fig. 1.1

(i) State the function of the white blood cell labelled in Fig. 1.1.

.....

..... [1]

(ii) State the name of the pigment in red blood cells that binds to oxygen.

..... [1]

(c) Plant leaf cells contain chloroplasts.

Red blood cells do not contain chloroplasts.

(i) State the name of the pigment in chloroplasts.

..... [1]

(ii) State **two other** differences between the structure of a red blood cell and the structure of a plant leaf cell.

1 .....

2 .....

[2]

(d) Eggs and sperm are specialised cells.

Describe how the sperm cell is specialised to:

swim to the egg .....

.....

penetrate the egg .....

.....

[2]

[Total: 10]

Question 2 starts on page 6.

2 A student investigates transpiration.

Fig. 2.1 is a diagram of the apparatus they use.

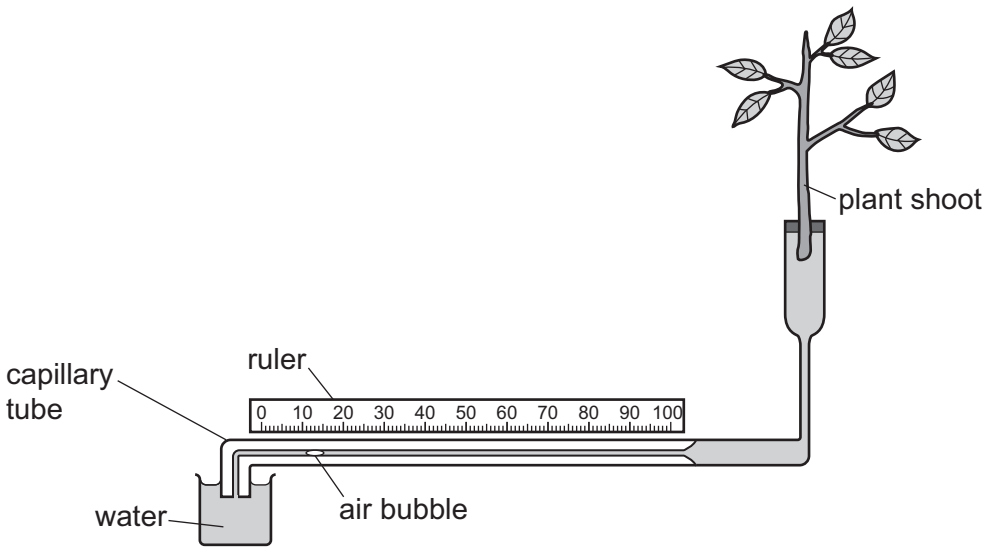


Fig. 2.1

The student measures the distance the air bubble moves along the capillary tube in 20 minutes.

The student changes the environmental conditions and repeats the experiment.

Table 2.1 shows their results.

Table 2.1

environmental condition	distance the air bubble moves in 20 minutes / mm
high wind speed at 15 °C	25
no wind at 15 °C	10

(a) (i) The air bubble moves along the capillary tube as water is lost by transpiration.

Explain the effect that high wind speed conditions have on the rate of transpiration.

.....

.....

.....

.....

..... [3]

(ii) The student repeats the experiment.

The environmental conditions are no wind and a temperature of 25 °C.

Suggest the effect on the distance moved by the air bubble compared to no wind and a temperature of 15 °C.

Explain your answer.

effect on distance .....

explanation .....

.....

.....

.....

.....

[2]

(b) (i) Plants transport water in xylem vessels.

State **one other** substance transported in xylem.

..... [1]

(ii) Translocation is a type of transport in plants.

Complete the sentence about translocation.

Translocation is the movement of ..... and

..... from sources to sinks through

..... vessels. [2]

(c) Blood is transported around the body of humans and fish by the blood vessels.

(i) Fish have a single circulatory system.

Describe the single circulatory system of a fish.

.....

.....

..... [1]

(ii) Humans have a double circulatory system.

State **one** advantage of a double circulatory system compared to a single circulatory system.

.....

.....

..... [1]

[Total: 10]

3 **(a)** Amylase is an enzyme in the digestive system in humans.

(i) State **two** places in the digestive system where amylase is secreted.

1 .....

2 .....
[2]

(ii) Complete the sentence about amylase.

Amylase breaks down starch to simple ..... [1]

(b) A student mixes amylase and starch solution at different temperatures.

The student records the time it takes the amylase to break down the starch.

(i) The student finds that the amylase breaks down the starch quicker as the temperature increases from 15 °C to 35 °C.

Explain why.

.....

.....

.....

.....

.....

..... [3]

(ii) The student finds that the amylase does **not** break down any of the starch at 55 °C.

Explain why.

.....

.....

.....

..... [2]

(c) Bile is also found in the digestive system.

Outline the role of bile in the digestive system.

.....

.....

.....

..... [2]

[Total: 10]

4 **(a)** Table 4.1 shows some information about two endocrine glands.

Complete Table 4.1.

Table 4.1

endocrine gland	hormone released from gland
adrenal	.....
pancreas	.....

[2]

(b) Fig. 4.1 is a diagram of a cross-section through human skin.

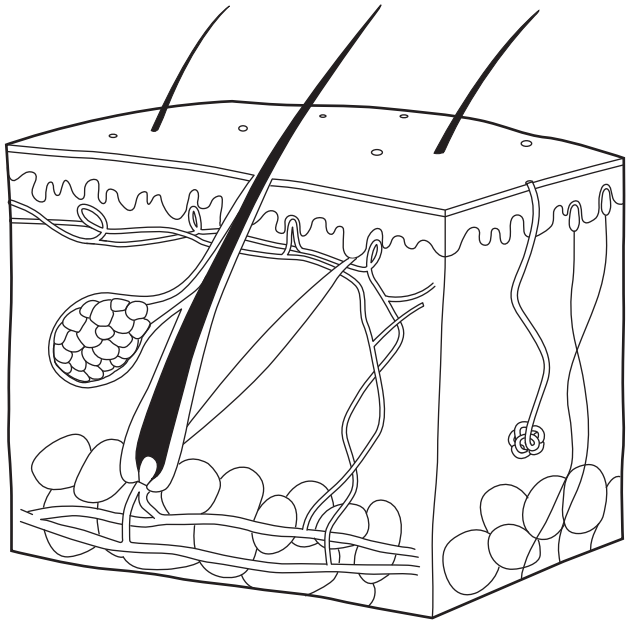


Fig. 4.1

(i) On Fig. 4.1 draw a label line and the letter **S** to identify a sweat gland. [1]

(ii) On a hot sunny day the body temperature increases.

Describe how the body responds to reduce body temperature.

.....

.....

.....

.....

..... [3]

(c) (i) Fig. 4.2 shows an incomplete reflex arc.

Complete the reflex arc shown in Fig. 4.2.

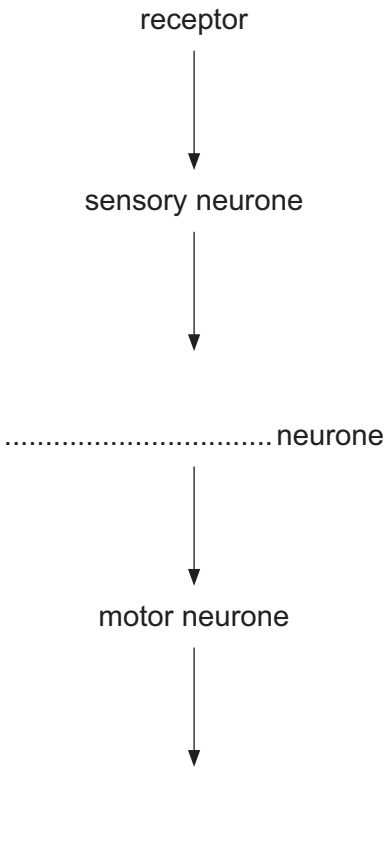


Fig. 4.2

[2]

(ii) State the names of the **two** parts of the central nervous system.

..... and .....

[1]

(iii) The speed of the nerve impulse in the sensory neurone of the arm is 74.0 m/s.

The speed of the nerve impulse in the motor neurone is 1.51 times slower.

Calculate the speed of the nerve impulse in the motor neurone.

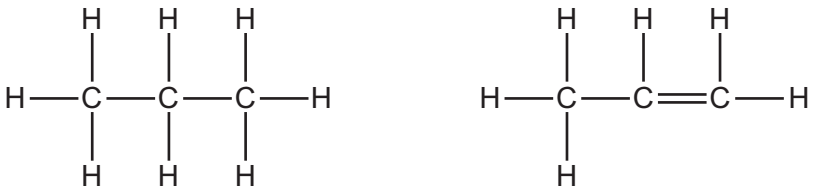
Give your answer to 3 significant figures.

speed = ... m/s [1]

[Total: 10]

5 Propane and propene are both hydrocarbons.

Fig. 5.1 shows the displayed formulas.



propane **propene**

Fig. 5.1

(a) (i) The molecular formula for propane is C_3H_8.

Butane has four carbon atoms.

Write the molecular formula for butane.

..... [1]

(ii) Propene is an unsaturated hydrocarbon.

Explain the terms unsaturated and hydrocarbon.

unsaturated .....

.....

hydrocarbon .....

.....

[2]

(iii) Complete the displayed formula for but-2-ene.

C C C C

[2]

(b) Aqueous bromine is used to tell the difference between propane and propene.

Table 5.1 shows the effect of propane and of propene on aqueous bromine.

Table 5.1

	effect on aqueous bromine
propane	no effect – remains orange
propene	.....

Complete Table 5.1. [1]

(c) Cracking is used to make propene.

Describe how propene is made by cracking.

Include the conditions used.

.....

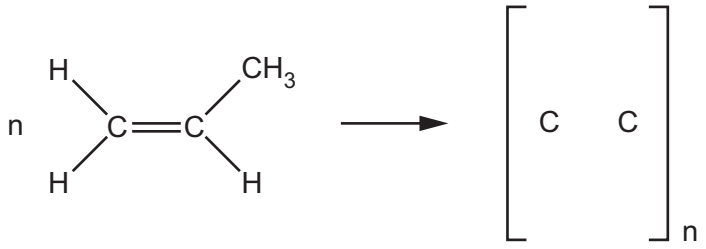
.....

.....

..... [3]

(d) Poly(propene) is the polymer made by the addition polymerisation of propene.

Complete the equation to show the formation of poly(propene).



[2]

[Total: 11]

6 Fig. 6.1 shows part of the Periodic Table.

																	He
														O			
Na												Al		P	S	Cl	Ar
K																	
																I	

Fig. 6.1

(a) (i) State the symbol of an element with 8 electrons in its outer shell.

Choose your answer from Fig. 6.1.

..... [1]

(ii) State the symbol of an element that forms a positive ion.

Choose your answer from Fig. 6.1.

..... [1]

(iii) State the symbol of the element with the electronic configuration 2,8,3.

Choose your answer from Fig. 6.1.

..... [1]

(b) Sodium reacts with chlorine to make the ionic compound sodium chloride, NaCl.

Draw a dot-and-cross diagram to show the ions in sodium chloride.

You only need to show the outer-shell electrons.

Include the charges on the ions.

[2]

(c) Fig. 6.2 shows a carbon atom.

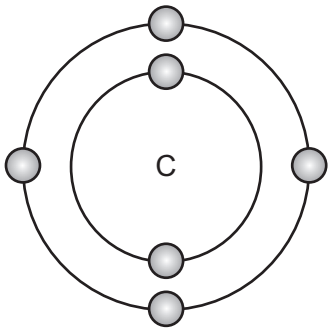


Fig. 6.2

(i) Carbon is in Period 2 of the Periodic Table.

Use Fig. 6.2 to explain why carbon is in Period 2.

.....

..... [1]

(ii) Carbon exists as isotopes, carbon-12 and carbon-13.

Explain why both isotopes have the same chemical properties.

.....

..... [1]

(iii) Graphite is one form of the element carbon.

Fig. 6.3 shows the structure of graphite.

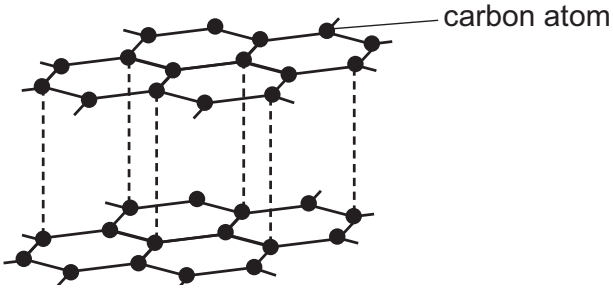


Fig. 6.3

Graphite is used to make electrodes because it conducts electricity.

Explain why graphite conducts electricity.

.....

.....

..... [2]

(iv) Graphite electrodes are used in the electrolysis of aqueous copper(II) sulfate.

State the name of the product made at each electrode.

anode .....

cathode .....

[2]

[Total: 11]

7 **(a)** Aqueous iron(III) sulfate contains iron(III) ions, Fe^{3+}, and sulfate ions, SO_4^{2-}.

Deduce the formula of iron(III) sulfate.

formula .....

[1]

(b) Aqueous sodium hydroxide is used to test for iron(III) ions, Fe^{3+}.

The iron(III) ions react with the hydroxide ions, OH^-, from the aqueous sodium hydroxide.

A precipitate of iron(III) hydroxide, $Fe(OH)_3$ is made.

(i) State the colour of the precipitate.

..... [1]

(ii) Construct the balanced ionic equation for the reaction.

Include state symbols.

..... [3]

(c) Iron is obtained from iron(III) oxide in a blast furnace.

The equation for the reaction is shown.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

(i) State if iron(III) oxide is oxidised or reduced in this reaction.

Explain your answer.

iron(III) oxide is .....

explanation .....

.....

[1]

(ii) The iron(III) oxide reacts with the carbon monoxide in a blast furnace to make iron.

Calculate the minimum mass of iron(III) oxide required to make 28 000 g of iron.

[A_r: C, 12; O, 16; Fe, 56]

minimum mass of iron(III) oxide = ... g [3]

[Total: 9]

8 A student investigates the reaction between calcium carbonate and dilute hydrochloric acid.

Carbon dioxide is made in the reaction.

(a) Describe the test for carbon dioxide gas and include the observation for a positive result.

test .....

observation .....

[2]

(b) The student measures, every minute, the total volume of carbon dioxide made.

Fig. 8.1 shows the student's results.

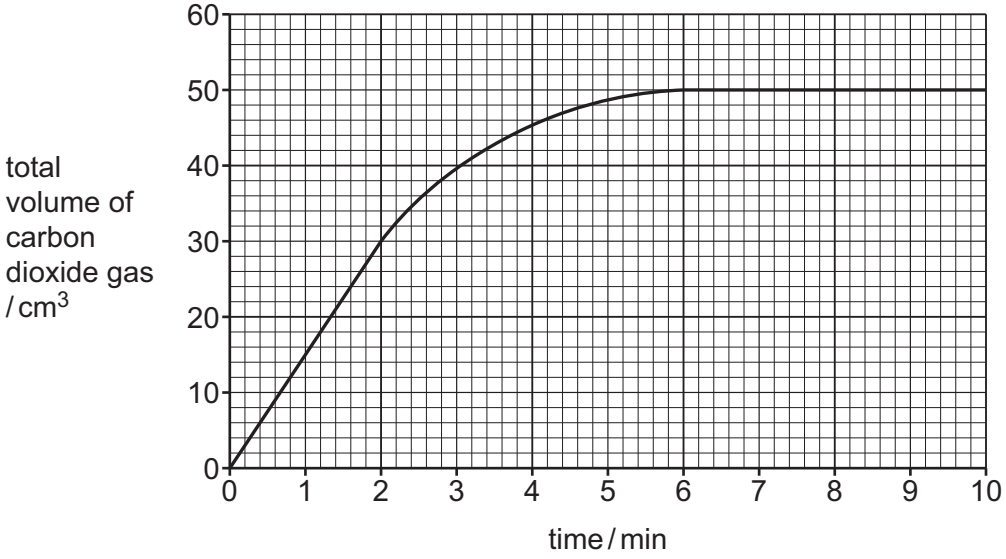


Fig. 8.1

(i) State the time when the reaction stops.

time = ... minutes [1]

(ii) Calculate the average rate of the reaction during the first two minutes of the experiment.

rate = ... cm^3 / minute [2]

(iii) 50 cm^3 of carbon dioxide gas is made in the experiment.

Calculate the amount of carbon dioxide gas made in moles, at room temperature and pressure.

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

moles of carbon dioxide gas = ... [2]

(c) The reaction between calcium carbonate and dilute hydrochloric acid is faster if the concentration of the acid used is greater.

Explain why, using collision theory.

.....

.....

.....

..... [2]

[Total: 9]

9 **(a)** **(i)** Describe how electrical power is generated from geothermal resources.

.....

.....

.....

..... [3]

(ii) Geothermal resources do not rely on radiation from the Sun.

State **two other** energy resources for generating electrical power which do not rely on radiation from the Sun.

1 .....

2 .....

[2]

(b) The radiation incident on a 1.0 m^2 panel of solar cells is 1400 W.

The efficiency of the solar cells is 32%.

(i) Calculate the useful power output of the panel of solar cells.

power = ... W [2]

(ii) Calculate the area of the panel of solar cells required to supply a 2.5 kW oven.

area = ... m^2 [2]

(iii) A panel of solar cells has a mass of 8.4 kg.

The panel is lifted 6.0 m from the ground to the roof of a house.

Calculate the gain in gravitational potential energy of the panel.

gain in energy = ... J [2]

[Total: 11]

10 **(a)** Microwaves are transverse electromagnetic waves.

(i) State a use of microwaves.

..... [1]

(ii) Describe a transverse wave.

.....

..... [2]

(b) Fig. 10.1 shows a ray of visible light travelling in air incident on the boundary between air and glass at an angle of 48°.

The refractive index of the glass is 1.25.

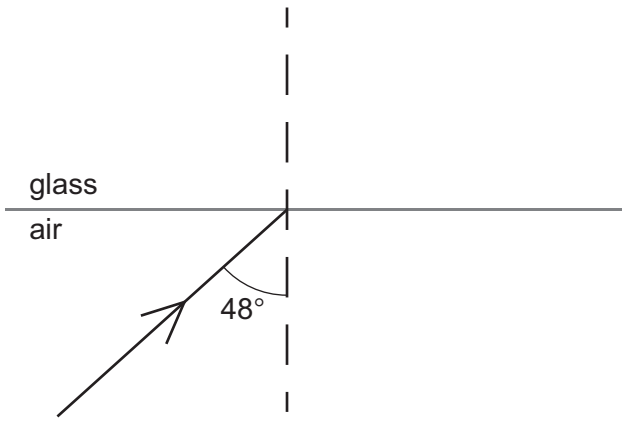


Fig. 10.1

(i) Calculate the angle of refraction of the light ray.

angle = ... ° [3]

(ii) Draw the refracted ray on Fig. 10.1. [2]

(c) Fig. 10.2 shows a ray of visible light travelling in glass.

The light is incident on the boundary between glass and air at an angle greater than the critical angle.

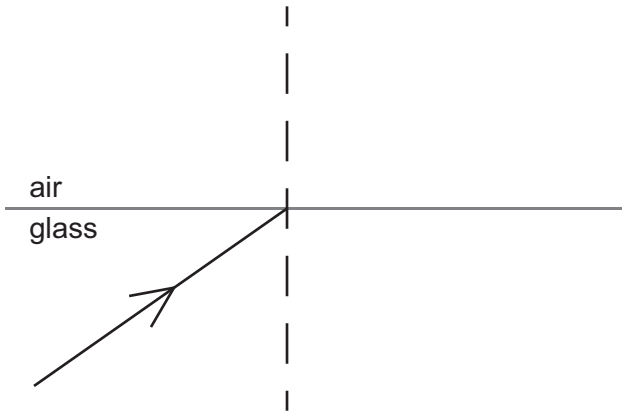


Fig. 10.2

Continue the path of the light ray. [2]

[Total: 10]

Question 11 starts on page 26.

11 Fig. 11.1 shows a cell connected to two resistors in parallel.

The potential difference (p.d.) across the terminals of the cell is 3.0 V.

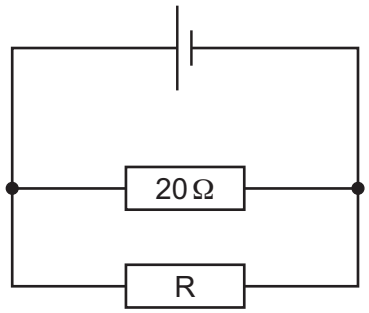


Fig. 11.1

(a) (i) The current in the cell is 0.25 A.

Calculate the charge which flows through the cell in 5.0 minutes.

charge = ... C [2]

(ii) State the p.d. across the 20 Ω resistor.

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

(iii) The current in the 20 Ω resistor is 0.15 A.

Calculate the current in resistor R.

current = ...A [1]

(iv) Calculate the total resistance of the circuit.

resistance = ... Ω [2]

(b) The branch of the circuit containing resistor R is removed from the circuit.

(i) State and explain the change, if any, to the current in the cell.

.....

.....

..... [2]

(ii) State and explain the change, if any, to the current in the 20 Ω resistor.

.....

.....

..... [2]

[Total: 10]

12 **(a)** An atom of gold is represented as $^{197}_{79}Au$.

(i) Determine the number of protons in the nucleus of this atom.

..... [1]

(ii) Determine the number of neutrons in the nucleus of this atom.

..... [1]

(iii) A different atom of gold is represented as $^{198}_{79}Au$.

Circle the word which describes these two gold atoms.

ions **isotopes** **electrons** **charged**

[1]

(b) $^{198}_{79}Au$ is radioactive. It undergoes beta decay with a half-life of 2.7 days.

(i) Complete the equation for this nuclear decay.

$$^{198}_{79}Au \rightarrow \underset{.....}{\overset{.....}{Hg}} + \underset{.....}{\overset{.....}{\beta}}$$

[2]

(ii) Define the term half-life.

.....

..... [2]

(iii) Initially a sample of $^{198}_{79}Au$ has a mass of 280 g.

Calculate the mass remaining after 8.1 days.

mass = ... g [2]

[Total: 9]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).