



# Cambridge IGCSE™

---

## CO-ORDINATED SCIENCES

0654/22

Paper 2 Multiple Choice (Extended)

February/March 2022

45 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet  
Soft clean eraser  
Soft pencil (type B or HB is recommended)

---

### INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A, B, C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

### INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

---

This document has **20** pages. Any blank pages are indicated.

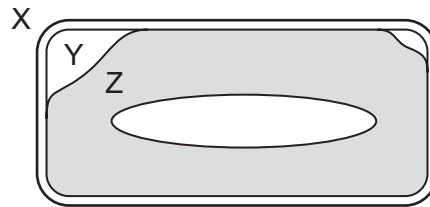


1 Plant nutrition needs light and water.

Which row shows what else needs to be taken in?

	carbon dioxide	ions	organic compounds
<b>A</b>	✓	✓	✓
<b>B</b>	x	x	✓
<b>C</b>	✓	✓	x
<b>D</b>	✓	x	x

2 The diagram shows a cell starting to plasmolyse.



In which direction is osmosis occurring?

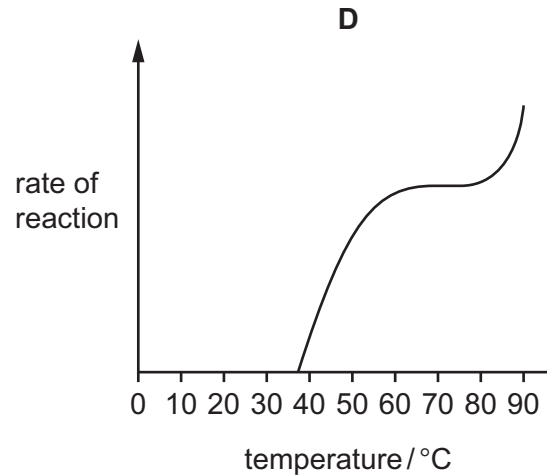
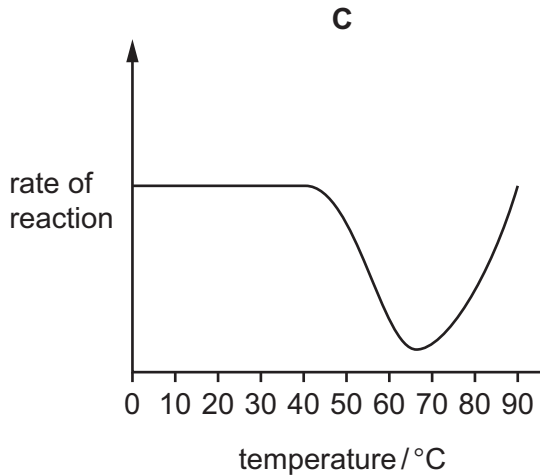
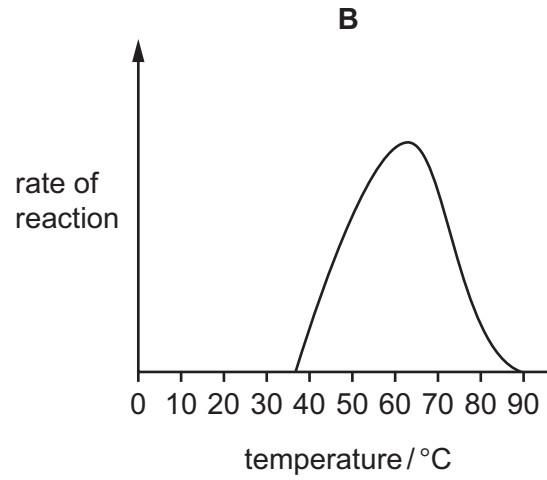
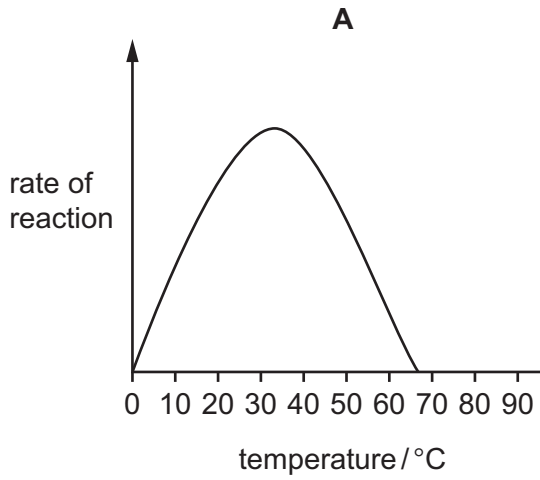
- A** X to Y      **B** Y to X      **C** Y to Z      **D** Z to Y

3 Which chemical element is found in all proteins, but **not** in all carbohydrates or fats?

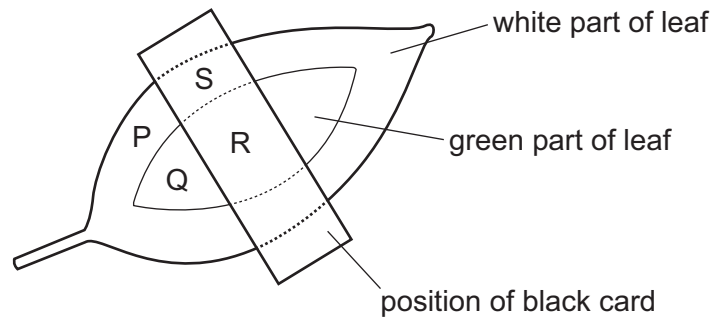
- A** carbon  
**B** hydrogen  
**C** oxygen  
**D** nitrogen

- 4 The Pompeii worm lives in deep-sea hydrothermal vents where **average** temperatures are often as high as 68 °C.

Which graph represents the activity of enzymes found in the Pompeii worm?



- 5 A plant has leaves which have white parts and green parts. One of the leaves is partly covered by a piece of black card on both sides. The plant is left in the light for two days.



The leaf is then removed and tested for the presence of starch.

Which row is correct?

	P	Q	R	S
<b>A</b>	✓	✗	✗	✓
<b>B</b>	✗	✓	✓	✗
<b>C</b>	✗	✓	✗	✗
<b>D</b>	✓	✗	✓	✓

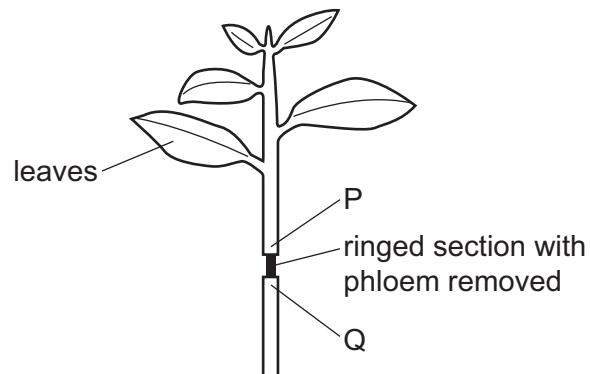
key

✓ = starch present

✗ = starch absent

- 6 What is assimilation?
- A** the movement of digested food molecules into the cells of the body where they are used, becoming part of the cells
  - B** the movement of digested food molecules through the wall of the intestine into the blood
  - C** the passing out of food that has not been digested, as faeces, through the anus
  - D** the taking of food and drink into the body through the mouth

- 7 The diagram shows a plant shoot that is ringed. This removes the phloem from a section of the shoot.

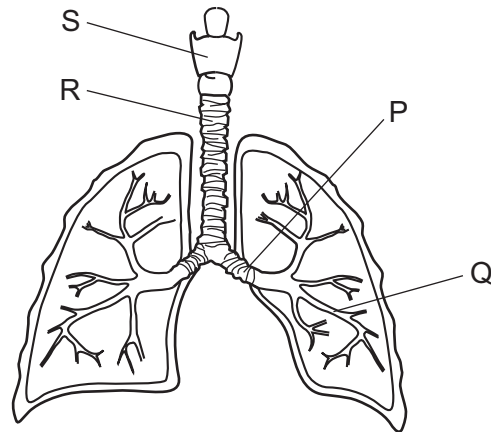


The plant is left in bright light for 24 hours. Plant tissues are then tested for the presence of sucrose above the ringed section at P and below the ringed section at Q.

Which row shows the expected results?

	presence of sucrose	
	P	Q
<b>A</b>	✓	✓
<b>B</b>	x	✓
<b>C</b>	✓	x
<b>D</b>	x	x

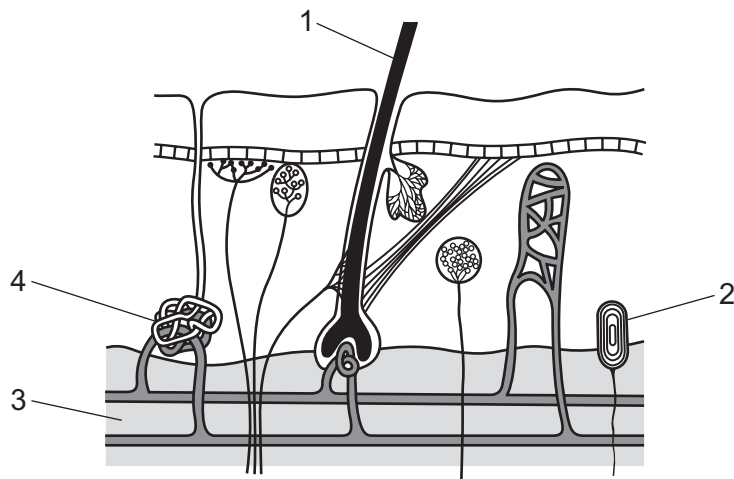
- 8 The diagram shows the main structures in the breathing system of humans.



Which row identifies the larynx, bronchus, trachea and bronchioles?

	larynx	bronchus	trachea	bronchioles
<b>A</b>	P	Q	R	S
<b>B</b>	R	P	S	Q
<b>C</b>	S	P	R	Q
<b>D</b>	S	Q	P	R

- 9 The diagram shows a section through the skin.



Which labelled structures help to maintain body temperature in the cold?

- A** 1 and 3      **B** 1 and 4      **C** 2 and 3      **D** 3 and 4

10 Which statements correctly describe the human male gamete?

- 1 contains enzymes
- 2 food stores present
- 3 flagellum present
- 4 surrounded by a jelly coating

**A** 1 and 2      **B** 1 and 3      **C** 2 and 3      **D** 3 and 4

11 The table gives statements about a human haploid nucleus.

Which row is correct?

	a single set of unpaired chromosomes	found in gametes	produced by mitosis	
<b>A</b>	x	x	✓	key ✓ = true x = false
<b>B</b>	✓	✓	x	
<b>C</b>	x	✓	✓	
<b>D</b>	✓	x	x	

12 What is the main factor which determines the number of trophic levels in food chains?

- A** competition between organisms
- B** efficiency of energy transfer between trophic levels
- C** removal of a member of a food chain
- D** unstable ecosystem due to changing environment

13 Which row shows an effect of a human activity on the environment?

	activity	effect
<b>A</b>	cutting down forests	acid rain
<b>B</b>	cutting down forests	eutrophication
<b>C</b>	overuse of fertilisers	acid rain
<b>D</b>	overuse of fertilisers	eutrophication

14 Substance P is separated into different parts using simple physical techniques.

Substance Q is only separated into simpler parts using chemical processes.

Substance R is not separated into simpler parts by either physical or chemical processes.

Which type of substance are P, Q and R?

	P	Q	R
<b>A</b>	compound	mixture	element
<b>B</b>	element	compound	mixture
<b>C</b>	mixture	element	compound
<b>D</b>	mixture	compound	element

15 Hydrogen chloride is a gas. It dissolves in water to form an acidic solution.

Three different samples of hydrogen chloride are listed.

- 1 73.0 g of hydrogen chloride gas
- 2 7.30 dm<sup>3</sup> of hydrogen chloride gas at r.t.p.
- 3 730 cm<sup>3</sup> of 1.00 mol/dm<sup>3</sup> aqueous hydrogen chloride

Which row shows the relative number of moles of hydrogen chloride in these samples?

	fewest	→	most
<b>A</b>	1	2	3
<b>B</b>	1	3	2
<b>C</b>	2	3	1
<b>D</b>	3	2	1

16 Aluminium is extracted from aluminium oxide by electrolysis.

What is added to aluminium oxide in this process?

- A** concentrated aqueous sodium chloride
- B** cryolite
- C** dilute sulfuric acid
- D** water



17 Which statements about the reduction of copper(II) oxide by heating with carbon are correct?

- 1 Copper(II) ions lose electrons.
- 2 Copper(II) oxide acts as an oxidising agent.
- 3 Copper(II) oxide loses oxygen.
- 4 Oxide ions are reduced.

**A** 1 and 2      **B** 1 and 4      **C** 2 and 3      **D** 3 and 4

18 Copper carbonate is insoluble in water.

Which method can be used to make copper carbonate?

- A** adding aqueous sodium carbonate to aqueous copper sulfate and filtering off the product
- B** adding solid calcium carbonate to aqueous copper sulfate and filtering off the product
- C** adding solid copper oxide to solid calcium carbonate and heating the mixture
- D** heating copper metal in carbon dioxide

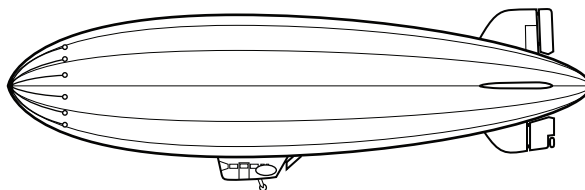
19 Which test and its result identifies aqueous bromide ions?

- A** adding acidified aqueous silver nitrate forming a cream precipitate
- B** adding acidified aqueous silver nitrate forming a white precipitate
- C** adding aluminium foil and heating with sodium hydroxide forming a gas that turns red litmus paper blue
- D** adding dilute acid forming a gas that produces a white precipitate when bubbled through limewater

20 Which row about the trends in the elements going down Group I of the Periodic Table is correct?

	reactivity	melting point
<b>A</b>	decreases	decreases
<b>B</b>	decreases	increases
<b>C</b>	increases	decreases
<b>D</b>	increases	increases

21 An airship containing an unreactive gas floats in air, as shown.



Which gas is used to fill the airship?

- A carbon dioxide
- B helium
- C hydrogen
- D nitrogen

22 Duralumin and magnalium are alloys used in the manufacture of aircraft.

They both contain aluminium and another metallic element.

The alloys are made up of .....1..... of each element.

They are used because they are .....2..... than the pure metals.

Which words complete gaps 1 and 2?

	1	2
<b>A</b>	atoms	harder
<b>B</b>	atoms	softer
<b>C</b>	molecules	harder
<b>D</b>	molecules	softer

23 Iron is extracted in the blast furnace.

Which reactions are involved in removing acidic impurities as slag?

- 1  $C + O_2 \rightarrow CO_2$
- 2  $C + CO_2 \rightarrow 2CO$
- 3  $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
- 4  $CaCO_3 \rightarrow CaO + CO_2$
- 5  $CaO + SiO_2 \rightarrow CaSiO_3$

- A** 1 and 2 only
- B** 1, 2 and 3
- C** 3, 4 and 5
- D** 4 and 5 only

24 Which statements about the reactions in a catalytic converter are correct?

- 1 The catalyst needs to be hot for the reactions to work.
- 2 Carbon dioxide is converted to carbon monoxide.
- 3 It converts pollutant gases into gases present in clean air.
- 4 Nitrogen and oxygen combine to form nitrogen monoxide.

**A** 1 and 2      **B** 1 and 3      **C** 2 and 4      **D** 3 and 4

25 Which substances neutralise acids?

- 1 lime
- 2 limestone
- 3 calcium hydroxide

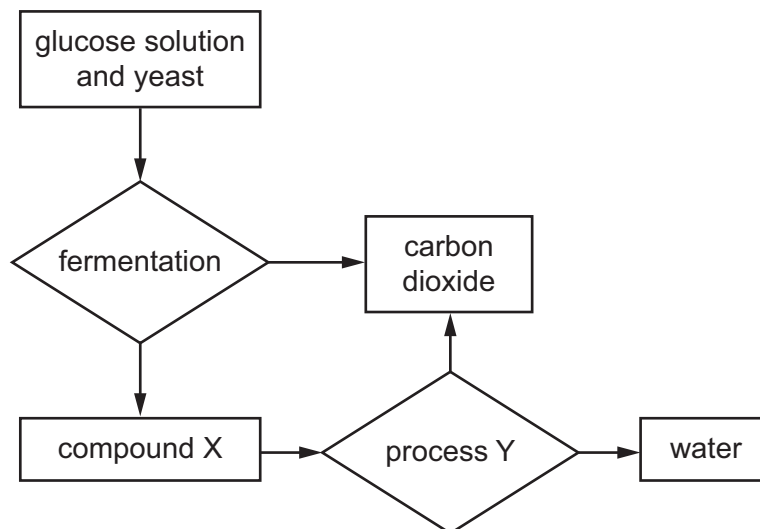
**A** 1 and 2 only    **B** 1 and 3 only    **C** 2 and 3 only    **D** 1, 2 and 3

26 Which statements about ethene and but-1-ene are correct?

- 1 Only ethene reacts with bromine water.
- 2 They are both formed by cracking alkanes.
- 3 They both react with steam to form alcohols.
- 4 They have different general formulae.

**A** 1 and 2      **B** 1 and 4      **C** 2 and 3      **D** 3 and 4

27 The flow chart shows some chemical substances and processes.

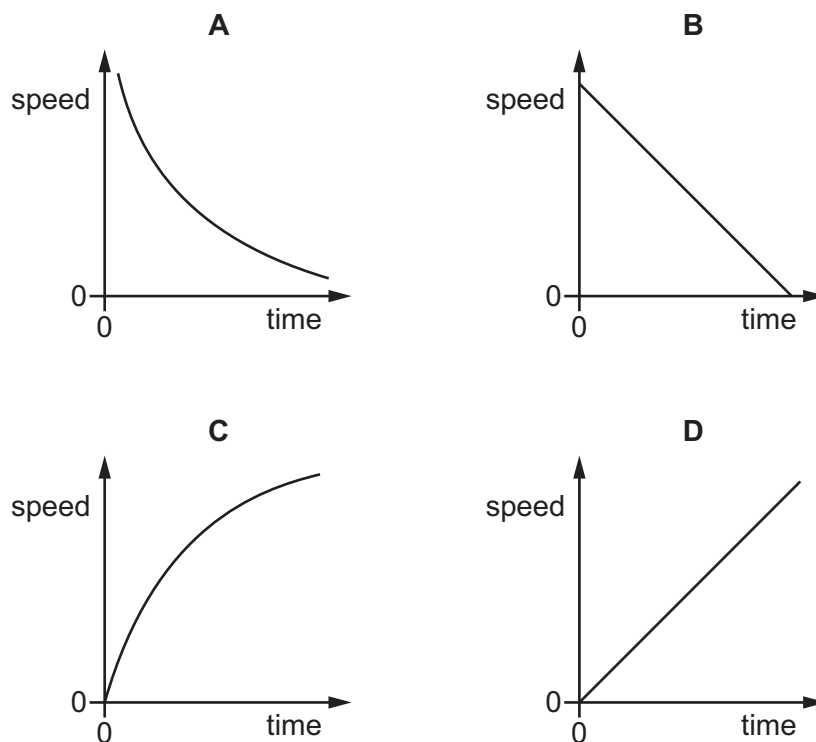


Which row identifies compound X and process Y?

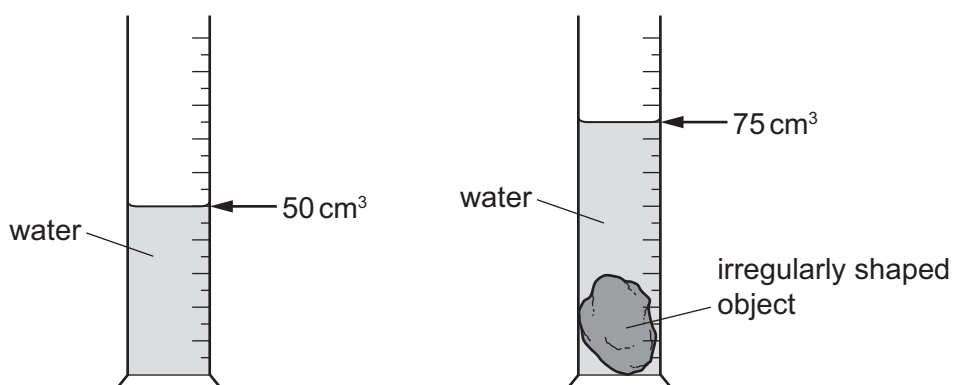
	compound X	process Y
<b>A</b>	ethanol	combustion
<b>B</b>	ethanol	cracking
<b>C</b>	ethene	combustion
<b>D</b>	ethene	cracking

28 An object falls freely in a vacuum.

Which speed–time graph represents the motion of the object?



29 An irregularly shaped object is lowered into a measuring cylinder of water.



As the object is lowered into the water, the water level rises from  $50 \text{ cm}^3$  to  $75 \text{ cm}^3$ . The object has a mass of  $50 \text{ g}$ .

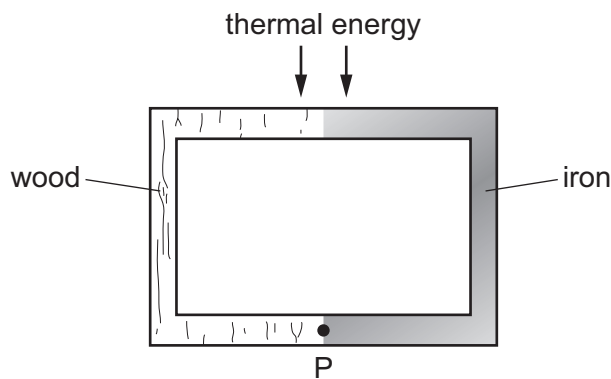
What is the density of the object?

- A**  $0.50 \text{ g/cm}^3$     **B**  $0.67 \text{ g/cm}^3$     **C**  $1.5 \text{ g/cm}^3$     **D**  $2.0 \text{ g/cm}^3$

30 Which source of energy is non-renewable?

- A hydroelectric
- B nuclear fission
- C tides
- D waves

31 The diagram shows an object made partly of wood and partly of iron. Thermal energy is supplied in the position shown. Point P is marked at the bottom of the object.



How does most thermal energy reach point P?

- A by conduction through the iron
- B by conduction through the wood
- C by convection through the iron
- D by convection through the wood

32 Light undergoes total internal reflection in an optical fibre.

Which statement explains why this reflection occurs?

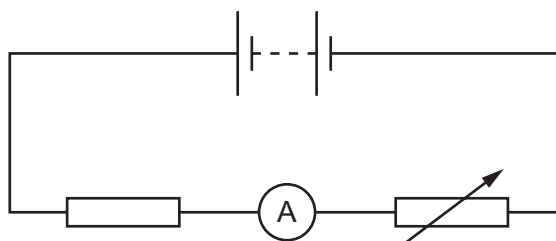
- A The angle of incidence is equal to the angle of refraction.
- B The angle of incidence is greater than the angle of reflection.
- C The angle of incidence is greater than the critical angle.
- D The angle of incidence is less than the critical angle.

33 Which statement about sound waves is **not** correct?

- A They are caused by vibrations.
- B They are longitudinal.
- C They transfer energy.
- D They travel in a vacuum.

- 34 A circuit contains a battery, a fixed resistor, an ammeter and a variable resistor.

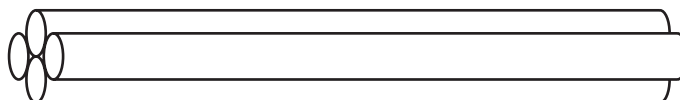
The reading on the ammeter is 1.8 mA.



How much charge flows through the variable resistor in 30 s?

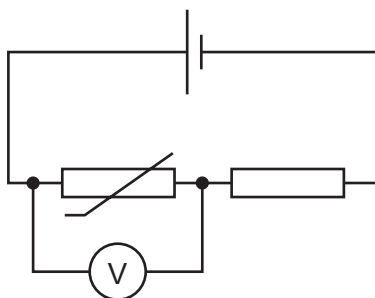
- A 0.054 C      B 17 C      C 54 C      D 17 000 C
- 35 A copper wire has a resistance of  $8.0 \Omega$ .

Four of these wires are arranged side by side to form a cable, as shown.



What is the resistance of this cable?

- A  $0.50 \Omega$       B  $2.0 \Omega$       C  $32 \Omega$       D  $128 \Omega$
- 36 The diagram shows a circuit containing a resistor and an NTC thermistor.

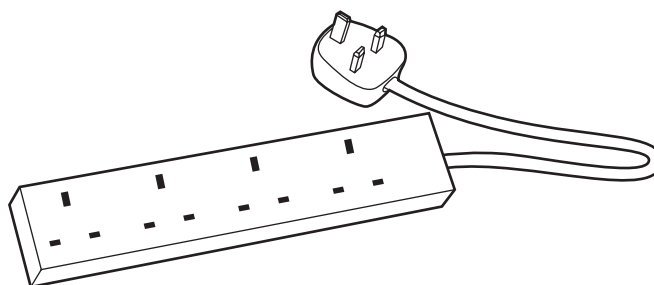


The temperature of the thermistor increases.

What happens to the resistance of the thermistor and what happens to the reading on the voltmeter?

	resistance of thermistor	reading on voltmeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

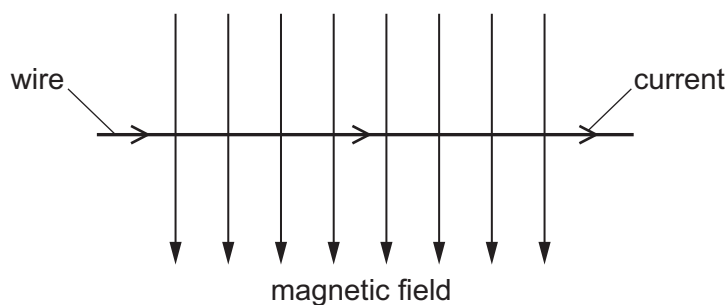
- 37 An electrical extension block has four sockets, a cable which can safely take a current of 6 A and a plug. It is protected by a fuse rated at 5 A.



The extension block is used with four appliances and the 5 A fuse blows. The owner replaces the 5 A fuse with a 13 A fuse.

Why is the extension block now dangerous?

- A The appliances may not receive enough current.
  - B The cable may overheat before the fuse blows.
  - C The sockets may burn out before the fuse blows.
  - D The 13 A fuse may blow too soon.
- 38 The diagram shows a wire in a magnetic field. There is a current in the wire in the direction shown. The direction of the magnetic field is also shown.



The magnetic field causes a force on the wire.

In which direction does this force act?

- A into the page
- B out of the page
- C towards the bottom of the page
- D towards the top of the page



- 39 How do the ionising effect and the penetrating ability of alpha-emissions compare with those of beta-emissions?

	ionising effect	penetrating ability
<b>A</b>	alpha more ionising than beta	alpha more penetrating than beta
<b>B</b>	alpha more ionising than beta	alpha less penetrating than beta
<b>C</b>	alpha less ionising than beta	alpha more penetrating than beta
<b>D</b>	alpha less ionising than beta	alpha less penetrating than beta

- 40 A radioactive isotope has a half-life of 18 years. A sample contains 80 million atoms of this isotope.

How long does it take for the number of atoms of this isotope in the sample to decrease to 10 million?

- A** 2.25 years
- B** 6.0 years
- C** 54 years
- D** 180 years



**BLANK PAGE**

---

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at [www.cambridgeinternational.org](http://www.cambridgeinternational.org) after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

## The Periodic Table of Elements

Group																		
I	II	III										IV	V	VI	VII	VIII		
3 <b>Li</b> lithium 7	4 <b>Be</b> beryllium 9	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;"> <b>Key</b>            atomic number            atomic symbol            name            relative atomic mass         </div>																2 <b>He</b> helium 4
11 <b>Na</b> sodium 23	12 <b>Mg</b> magnesium 24																	5 <b>B</b> boron 11
19 <b>K</b> potassium 39	20 <b>Ca</b> calcium 40	13 <b>Al</b> aluminium 27	14 <b>Si</b> silicon 28	15 <b>P</b> phosphorus 31	16 <b>S</b> sulfur 32	17 <b>Cl</b> chlorine 35.5	18 <b>Ar</b> argon 40											
37 <b>Rb</b> rubidium 85	38 <b>Sr</b> strontium 88	31 <b>Ga</b> gallium 70	32 <b>Ge</b> germanium 73	33 <b>As</b> arsenic 75	34 <b>Se</b> selenium 79	35 <b>Br</b> bromine 80	36 <b>Kr</b> krypton 84											
55 <b>Cs</b> caesium 133	56 <b>Ba</b> barium 137	39 <b>Zn</b> zinc 65	40 <b>Cd</b> cadmium 112	41 <b>In</b> indium 115	42 <b>Sn</b> tin 119	43 <b>Sb</b> antimony 122	44 <b>Xe</b> xenon 131											
87 <b>Fr</b> francium —	88 <b>Ra</b> radium —	45 <b>Fe</b> iron 56	46 <b>Ni</b> nickel 59	47 <b>Cu</b> copper 64	48 <b>Zn</b> zinc 65	49 <b>Ga</b> gallium 70	50 <b>Ge</b> germanium 73											
		26 <b>Fe</b> iron 56	27 <b>Co</b> cobalt 59	28 <b>Ni</b> nickel 59	29 <b>Cu</b> copper 64	30 <b>Zn</b> zinc 65	31 <b>Ga</b> gallium 70											
		76 <b>Os</b> osmium 190	77 <b>Ir</b> iridium 192	78 <b>Pt</b> platinum 195	79 <b>Au</b> gold 197	80 <b>Hg</b> mercury 201	81 <b>Tl</b> thallium 204											
		108 <b>Hs</b> hassium —	109 <b>Mt</b> meitnerium —	110 <b>Ds</b> darmstadtium —	111 <b>Rg</b> roentgenium —	112 <b>Cn</b> copernicium —	113 <b>Nh</b> nihonium —											
		104 <b>Rf</b> rutherfordium —	105 <b>Db</b> dubnium —	106 <b>Sg</b> seaborgium —	107 <b>Bh</b> bohrium —	108 <b>Hs</b> hassium —	109 <b>Mt</b> meitnerium —											
		72 <b>Hf</b> hafnium 178	73 <b>Ta</b> tantalum 181	74 <b>W</b> tungsten 184	75 <b>Re</b> rhenium 186	76 <b>Os</b> osmium 190	77 <b>Ir</b> iridium 192											
		91 <b>Zr</b> zirconium 91	92 <b>Nb</b> niobium 93	93 <b>Mo</b> molybdenum 96	94 <b>Tc</b> technetium —	95 <b>Ru</b> ruthenium 101	96 <b>Rh</b> rhodium 103											
		40 <b>Zr</b> zirconium 91	41 <b>Nb</b> niobium 93	42 <b>Mo</b> molybdenum 96	43 <b>Tc</b> technetium —	44 <b>Ru</b> ruthenium 101	45 <b>Rh</b> rhodium 103											
		48 <b>Ti</b> titanium 48	49 <b>V</b> vanadium 51	50 <b>Cr</b> chromium 52	51 <b>Mn</b> manganese 55	52 <b>Fe</b> iron 56	53 <b>Co</b> cobalt 59											
		21 <b>Sc</b> scandium 45	22 <b>Ti</b> titanium 48	23 <b>V</b> vanadium 51	24 <b>Cr</b> chromium 52	25 <b>Mn</b> manganese 55	26 <b>Fe</b> iron 56											
		89–103 actinoids	89 <b>Y</b> yttrium 89	90 <b>Zr</b> zirconium 91	91 <b>Nb</b> niobium 93	92 <b>Mo</b> molybdenum 96	93 <b>Tc</b> technetium —											
		lanthanoids	57–71	72 <b>Hf</b> hafnium 178	73 <b>Ta</b> tantalum 181	74 <b>W</b> tungsten 184	75 <b>Re</b> rhenium 186											
		89–103 actinoids	89 <b>La</b> lanthanum 139	90 <b>Ce</b> cerium 140	91 <b>Pr</b> praseodymium 141	92 <b>Nd</b> neodymium 144	93 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> neodymium 144	61 <b>Pm</b> promethium —											
		actinoids	89 <b>Ac</b> actinium —	90 <b>Th</b> thorium 232	91 <b>Pa</b> protactinium 231	92 <b>U</b> uranium 238	93 <b>Np</b> neptunium —											
		lanthanoids	57 <b>La</b> lanthanum 139	58 <b>Ce</b> cerium 140	59 <b>Pr</b> praseodymium 141	60 <b>Nd</b> 												