

Level 3 Cambridge Technical in Applied Science

05847/05848/05849/05874/05879 Unit 1: Science fundamentals

Time allowed: 2 hours

C340/2506

You must have:

- the Data Sheet (inside this document)
- a ruler (cm/mm)

You can use:

- a scientific or graphical calculator
- an HB pencil



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

Date of birth

D	D	M	M	Y	Y	Y	Y
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INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.

INFORMATION

- The total mark for this paper is **90**.
- The marks for each question are shown in brackets [].
- The Periodic Table is on the back page.
- This document has **32** pages.

ADVICE

- Read each question carefully before you start your answer.

1

- (a) There are three forces in the nucleus of an atom.

Complete the table by placing **one** tick (✓) in each row to match each force with what it is responsible for.

	Electromagnetic force	Strong nuclear force	Weak nuclear force
Keeping nuclei stable			
Radioactive decay			
Repulsion between protons			
Binding protons and neutrons together			

[4]

- (b) Complete the sentences about the Periodic Table.

Use words from the list.

atomic	compounds	elements	groups
mass	number	periods	shells

The Periodic Table is an arrangement of the chemical ordered by
increasing

The rows are called and the columns are called

[4]

- (c) The table below shows the electron configurations and atomic radii of magnesium, silicon and chlorine.

	Magnesium	Silicon	Chlorine
Electron configuration	2,8,2	2,8,4	2,8,7
Atomic radius/nm	0.160	0.118	0.099

Explain why the atomic radius **decreases** from magnesium to silicon to chlorine.

.....

.....

.....

.....

.....

..... [3]

- (d) Magnesium reacts with chlorine to form an ionic compound, magnesium chloride MgCl_2 .

- (i) Explain what is meant by an ionic bond.

.....

.....

..... [1]

- (ii) Draw a dot and cross diagram to show the ionic bonding in magnesium chloride.

Show outer electrons only.

[3]

- 2 An understanding of the chemical reactivity and physical properties of metals is essential because they have a vast range of applications.

- (a) The position of a metal in the reactivity series can be determined by adding the metal to a solution of metal ions and observing whether there is a reaction or not.

The table shows the results when copper, gold and tin are added to solutions of different metal compounds.

Key:

✓ = reaction occurs

✗ = no reaction occurs

Solution	Metal		
	Copper	Gold	Tin
Copper(II) sulfate		✗	✓
Gold(III) chloride	✓		✓
Tin(II) chloride	✗	✗	

- (i) Deduce the order of reactivity shown by the results in the table.

Write the names of the metals in order of **decreasing** reactivity.

..... > > [1]
Most reactive **Least reactive**

- (ii) Copper, Cu, reacts with gold(III) chloride, AuCl_3 .

Complete the chemical equation so that it is balanced.

.....Cu + $\text{AuCl}_3 \rightarrow$ CuCl_2 +Au [2]

(iii) Identify the type of reaction shown in the reaction between copper and gold(III) chloride.

Put a ring around the correct answer.

addition

displacement

substitution

[1]

(iv) The rate of reaction between copper and gold(III) chloride depends on a number of factors.

Which change causes an **increase** in the rate of reaction?

Tick (✓) **one** box.

Decrease in pressure

☐

Decrease in surface area of the metal

☐

Increase in light intensity

☐

Increase in temperature of the solution

☐

[1]

(b) Gold is found in a colloidal medicine used to relieve some types of skin inflammation.

The colloid is a mixture of gold particles dispersed in water.

(i) Identify the type of colloid from the description of gold in water.

Tick (✓) **one** box.

Emulsion

☐

Foam

☐

Gel

☐

Sol

☐

[1]

(ii) Colloids are different from solutions and suspensions.

State **one** way in which a colloid is different from:

- a solution
-
- a suspension
-

[2]

(c) Copper (Cu) and tin (Sn) are metals that are often used in mixtures known as alloys.

(i) Identify the alloy that is 90% by mass of Cu and 10% by mass of Sn.

Tick (✓) **one** box.

Brass

☐

Bronze

☐

Steel

☐

[1]

(ii) Copper and tin are also found in amalgam alloys that are used for tooth fillings.

Identify another metal that is present in amalgam.

Put a (ring) around the correct answer.

lead

mercury

sodium

[1]

(iii) Solder is an alloy which is used in electronics.

The table shows information about two different types of solder.

Solder **A** is an alloy of tin and copper.

Solder **B** is an alloy of tin and lead.

	Percentage by mass of tin (%)	Melting point (°C)
Solder A	99.3	227
Solder B	61.9	183

Calculate the difference in mass of tin in 5g of solder **A** and in 5g of solder **B**.

Difference in mass of tin = g [2]

(d) Pure tin has a metallic lattice structure and a melting point of 232°C .

(i) Explain what is meant by a metallic lattice in terms of the types and arrangement of particles present.

.....

.....

.....

..... [2]

(ii) Explain why solder **A** has a **lower** melting point than tin.

.....

.....

.....

..... [2]

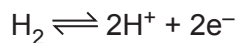
3 Metal ions have different roles in cell function.

(a) State the term used for an ion that activates an enzyme.

..... [1]

(b) Nickel ions are found in the enzyme hydrogenase within living cells.

Hydrogenase catalyses the reaction:



(i) State what the symbol $\rightleftharpoons$ indicates about the reaction.

..... [1]

(ii) Identify the type of reaction which occurs when hydrogen molecules are converted to hydrogen ions.

Tick (✓) **one** box.

Addition

☐

Condensation

☐

Oxidation

☐

Reduction

☐

[1]

(c) Nickel ions are found in enzymes that use water to break bonds in organic molecules.

(i) Identify this type of enzyme.

Tick (✓) **one** box.

Hydrolase

☐

Lactase

☐

Oxidase

☐

Protease

☐

[1]

- (ii) Urease is another type of enzyme activated by nickel.

Urea is broken down in the human body by water in the presence of urease.

Complete the equations to show the complete breakdown of urea, NH_2CONH_2 .



[2]

- (d) Sodium ions exchange places with another metal ion in order to maintain an isotonic balance within body cells.

Identify this metal ion.

Tick (✓) **one** box.

Calcium

☐

Lithium

☐

Manganese

☐

Potassium

☐

[1]

- (e) Some compounds containing metal ions are used to treat conditions in humans.

- (i) Name **one** condition which can be treated with lithium carbonate.

..... [1]

- (ii) Cisplatin is a compound of platinum.

Cisplatin is used in cancer treatment.

Explain how cisplatin affects cancer cells.

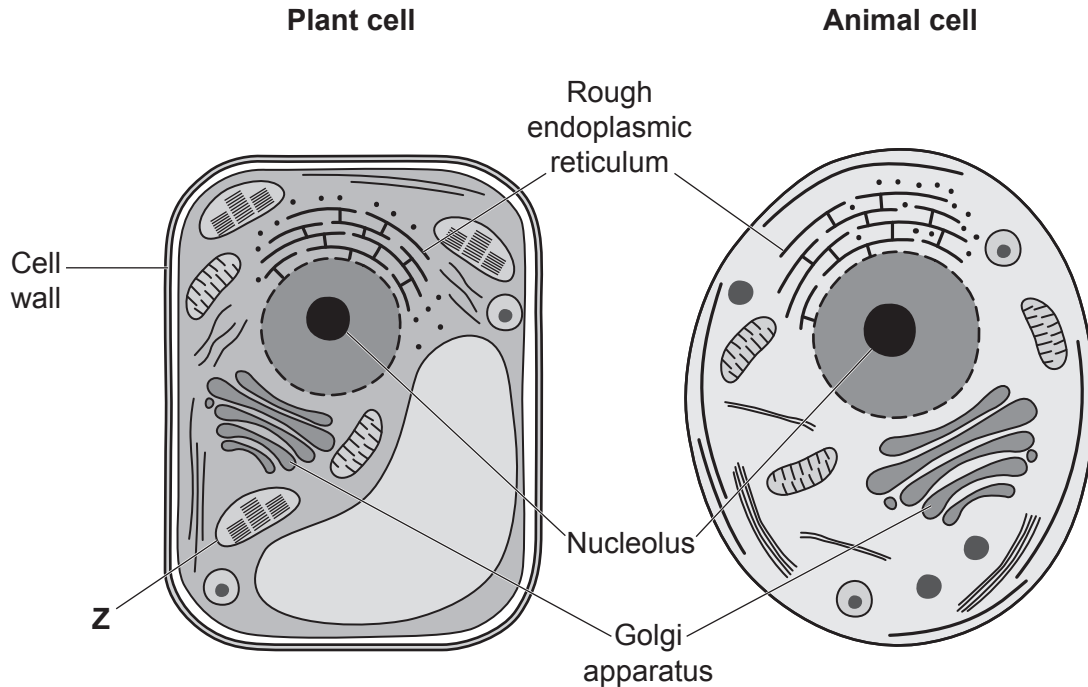
.....

..... [1]

- 4 Eukaryotic cells share many of the same organelles but there are some differences between plant and animal cells.

Fig. 4.1 shows a plant cell and an animal cell.

Fig. 4.1



- (a) Draw lines to link each **organelle** to its **function**.

Organelle	Function
Golgi apparatus	production of proteins
nucleolus	production of lysosomes
rough endoplasmic reticulum	production of ribosomes

[2]

(b) Fig. 4.1 shows some organelles in the plant cell that are **not** found in the animal cell.

(i) Identify organelle **Z** in the plant cell.

..... [1]

(ii) Plant cells also have cell walls which are **not** found in animal cells.

State **one** function of the plant cell wall.

.....
 [1]

(iii) Identify the name of the polysaccharide found in a plant cell wall.

Tick (✓) **one** box.

Cellulose ☐

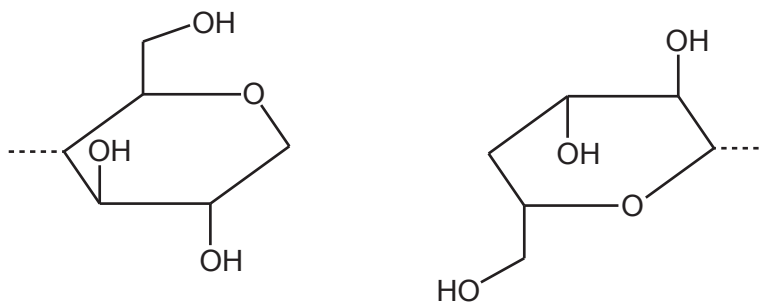
Glycogen ☐

Starch ☐

[1]

(iv) The monomers in the polysaccharide forming the plant cell wall are connected by glycosidic links.

Draw a glycosidic link between the two monomer residues shown below.



[1]

(c) Many of the organelles found in eukaryotic cells are membrane-bound. These are **not** found in prokaryotic cells.

(i) Which organelle is found in **both** eukaryotic and prokaryotic cells?

..... [1]

(ii) The nucleus is a membrane-bound organelle. It is found in eukaryotic cells but **not** in prokaryotic cells.

The nucleus contains the following three structures:

chromosome

gene

nucleotide

Write the names of the three structures in order of **increasing** size.

.....
Smallest **Largest**

[2]

13
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DO NOT WRITE ON THIS PAGE

5 Isomers are molecules with the same molecular formula but different arrangements of atoms.

(a) There are two structural isomers with the molecular formula C_4H_{10} .

(i) What is the name of the straight chain isomer of C_4H_{10} ?

Tick (✓) **one** box.

Butane

☐

Ethane

☐

Methane

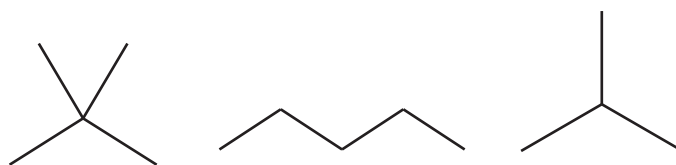
☐

Propane

☐

[1]

(ii) Put a ring around the skeletal formula of the **other** isomer of C_4H_{10} .

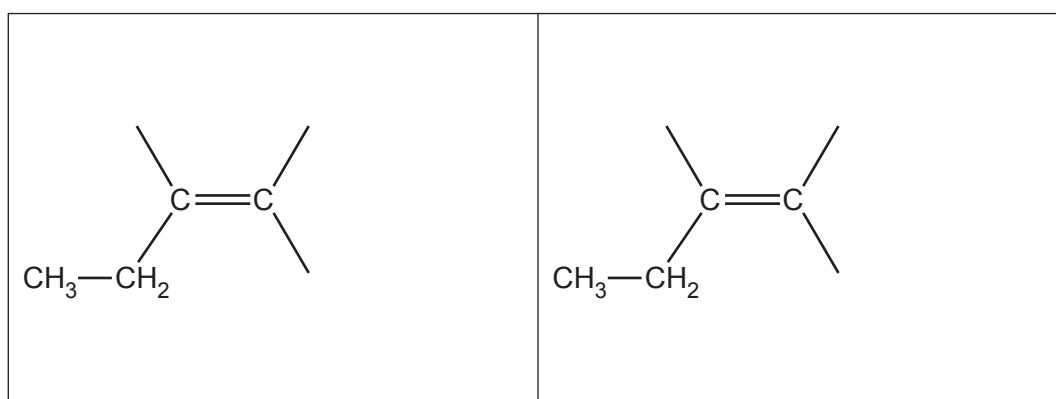


[1]

(b) Two structural isomers of C_5H_{10} are pent-1-ene and pent-2-ene.

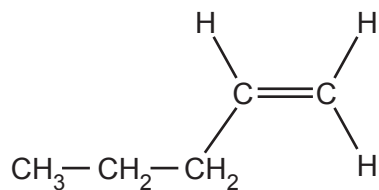
(i) Pent-2-ene has two geometric isomers.

Complete the **two** structural formulae to show the two geometric isomers.



[2]

(ii) The structural formula of pent-1-ene is shown below.



Explain why pent-1-ene does **not** have geometric isomers even though it has a double bond.

.....

 [2]

(c) Methanol and propanoic acid react to form an ester and water.

(i) Complete the word equation for this reaction.

methanol + propanoic acid → + water

[1]

(ii) Identify the structural formula of the ester formed.

Tick (✓) **one** box.

CH₃CH₂CH₂COOH

☐

CH₃CH₂COOCH₃

☐

CH₃COOCH₂CH₃

☐

HCOOCH₂CH₂CH₃

☐

[1]

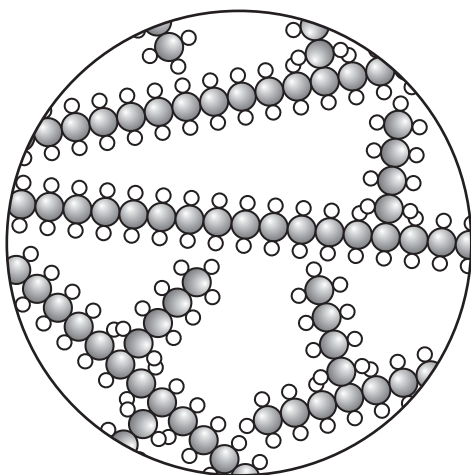
(d) Poly(ethene) exists as branched and unbranched structures as shown below.

Key:

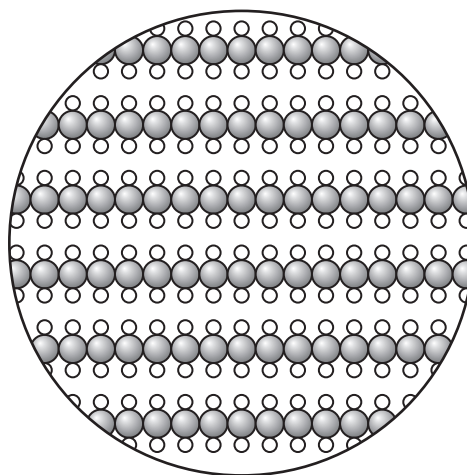
● Carbon atom

○ Hydrogen atom

Branched poly(ethene)



Unbranched poly(ethene)



The two types of poly(ethene) have different densities.

Identify which type of poly(ethene) has the higher density.

Use the diagrams to explain your answer.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- 6 Different types of tissue in the human body are found in organs to perform specific functions. The skin is an organ.

Epithelial and connective tissues are found in skin and work together to protect the body.

- (a) The upper layer of skin is made of epithelial tissue.

- (i) Identify this type of epithelial tissue.

Tick (✓) **one** box.

Ciliated

☐

Squamous

☐

Striated

☐

[1]

- (ii) Complete the following sentences.

Put a ring around each correct option.

The layers of epithelial cells provide protection for the human body because the cells are **thin** / **thick** and **large** / **small** .

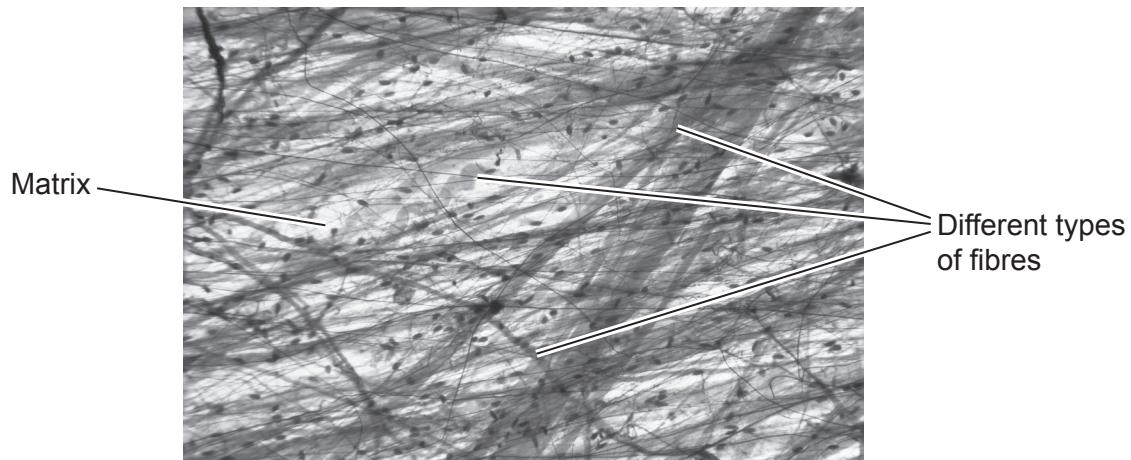
The presence of many layers of these cells on the surface of the skin restricts the movement of molecules passing through by **diffusion** / **translation** .

[2]

- (b) Epithelial tissue in skin is supported by connective tissue.

Fig. 6.1 shows a light microscope image of connective tissue.

Fig. 6.1



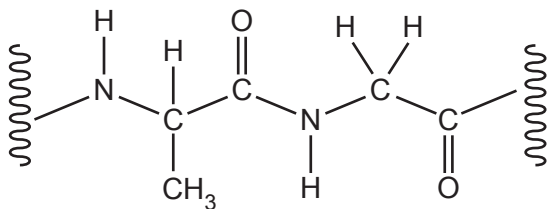
- (i) Name the **two** types of fibres found in the connective tissue shown in **Fig. 6.1**.

..... [2]

- (ii) Both types of fibres in **Fig. 6.1** are polypeptides.

Fig. 6.2 shows a section of a polypeptide.

Fig. 6.2



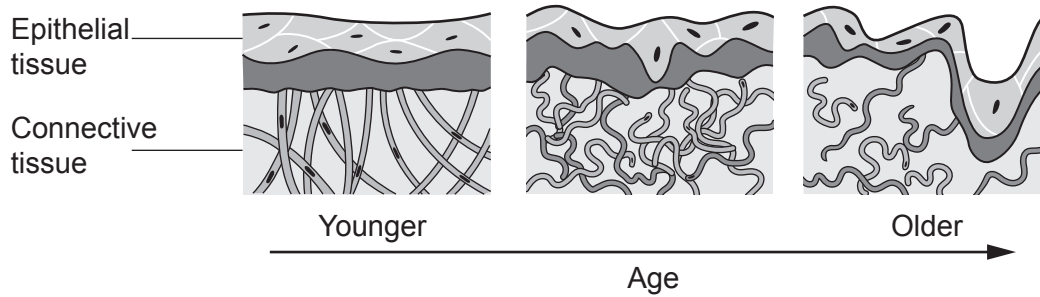
Polypeptides are chains of amino acids joined by peptide bonds.

Draw the structures of the **two** separate amino acids that make up this section of the polypeptide.

--	--

(iii) **Fig. 6.3** shows a diagram of human skin tissue at different ages.

Fig. 6.3



Use **Fig. 6.3** to describe how skin changes with age.

..... [3]

- (c)** Blood can be described as a special type of tissue.

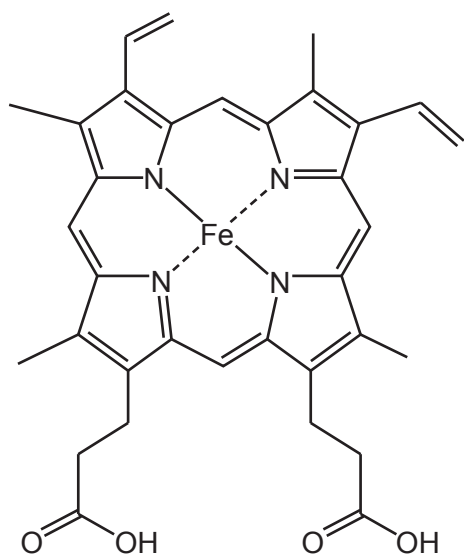
Blood is composed of red and white blood cells moving around in watery plasma within blood vessels.

- (i) Red blood cells contain haemoglobin. This molecule can bind with and transport oxygen molecules.

Each haemoglobin molecule contains haem groups.

Fig. 6.4 shows the structure of a haem group.

Fig. 6.4



Identify the charge on the iron ion in the centre of the structure.

Tick (✓) **one** box.

- | | |
|----|--|
| 1+ | |
| 2+ | |
| 3+ | |
| 4+ | |

[1]

- (ii) Haem groups are also found in another molecule in the human body.

Name the molecule and state the location of this molecule in the human body.

Name

Location

[2]

- (iii) Haemocyanin is also a type of molecule known to carry oxygen.

Complete the sentences using words from the list.

calcium	copper	fungi	humans
invertebrates	iron	manganese	plants

Oxygen is carried by within haemocyanin.

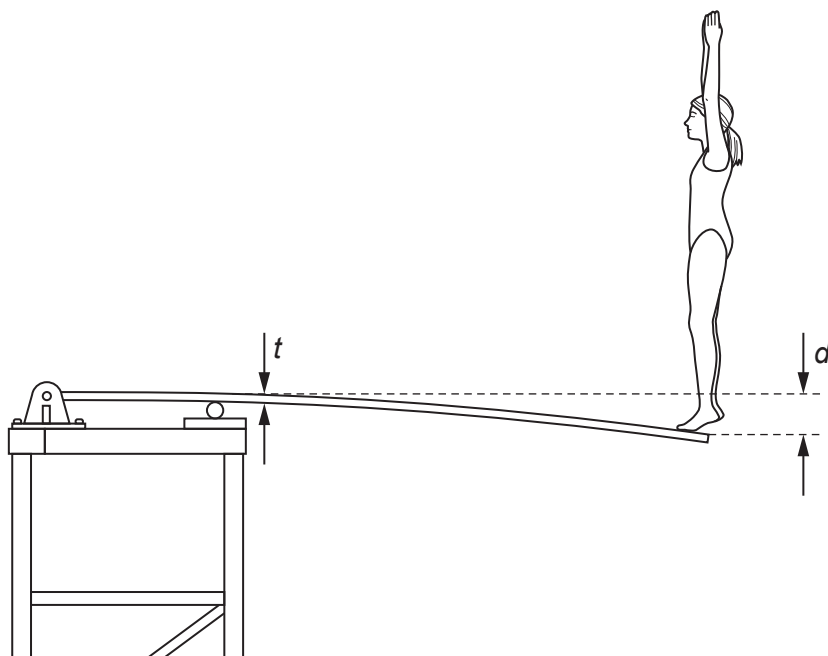
Haemocyanin is found in

[2]

- 7 A diving board is made from a material with special mechanical properties.

The material must resist the effect of repeated loading and unloading cycles when divers use the board.

The diagram below shows a diver at the end of a diving board.



The end of the diving board has moved down by distance d .

The distance d is given by the equation:

$$d = \frac{4FL^3}{Sw t^3}$$

where:

- S is the stiffness of the material used to make the board
- F is the force exerted by the diver
- L is the length of the diving board
- w is the width of the board
- t is the thickness of the board.

Explain why stiffness is an important mechanical property for a diving board.

Describe how changes in S , F , L , w and t affect the size of d and explain which of these factors affect the size of d the most.

[6]

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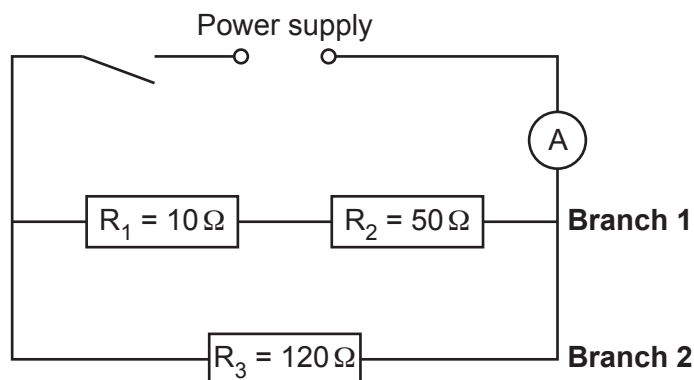
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- 8 Resistors R_1 , R_2 and R_3 are connected in a circuit as shown in the diagram below.



You will need to use the following equations in your answers.

- Resistors in series $R_t = R_1 + R_2 + R_3$
- Resistors in parallel $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
- Potential difference (V) = current (A) $\times$ resistance (Ω)
- Charge (C) = current (A) $\times$ time (s)
- Power (W) = potential difference (V) $\times$ current (A)

(a)

- (i) Calculate the combined resistance of the resistors that are connected in series in **Branch 1**.

Combined resistance = Ω [1]

- (ii) Show that the combined resistance of the circuit is $40\ \Omega$.

[1]

(b) The current reading on the ammeter is 0.3A.

(i) Calculate the potential difference of the power supply.

Potential difference = V [1]

(ii) Use your answer in (b)(i) to calculate the power produced in the circuit.

Power = W [1]

(iii) Calculate the charge transferred in the circuit in one minute.

Charge transferred in one minute = C [1]

(iv) Determine the current in each branch of the circuit.

Current in **Branch 1** = A

Current in **Branch 2** = A
[2]

(c) The current in a wire can also be calculated using the equation $I = nAvq$.

Use the equation $I = nAvq$ to suggest **two** properties of the wire in resistor R_3 which would cause it to have a higher resistance than resistor R_1 .

1.

.....

2.

.....

[2]

END OF QUESTION PAPER

This image shows a blank sheet of white paper designed for writing. It features a series of evenly spaced horizontal blue lines across its entire width. A single vertical red line runs down the left side, creating a narrow margin. The paper is otherwise completely empty, with no text or markings.

The Periodic Table of the Elements

(1)	(2)	Key atomic number Symbol name relative atomic mass										(3)	(4)	(5)	(6)	(7)	(0)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H hydrogen 1.0	2 He helium 4.0	3 Li lithium 6.9	4 Be beryllium 9.0	5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2	11 Na sodium 23.0	12 Mg magnesium 24.3	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulphur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium 101.1	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	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		
57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium 144.9	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.2	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.0	71 Lu lutetium 175.0	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

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