

## LEVEL 3 CAMBRIDGE TECHNICAL IN APPLIED SCIENCE

**05847/05848/05849/05874/05879**

## Unit 1: Science fundamentals

**Time allowed: 2 hours plus your additional time allowance**

## You must have:

## a ruler

## the Data Sheet (Insert)

## copy of The Periodic Table

**You may use:**

**a scientific or graphical calculator**

# Modified Enlarged 18 pt

**Please write clearly in black ink.**

**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.**

**Answer ALL the questions.**

**Write your answer to each question in the space provided.**

**If additional answer space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.**

**The Periodic Table is supplied separately.**

## **INFORMATION**

**The total mark for this paper is 90.**

**The marks for each question are shown in brackets [ ].**

**Answer ALL the questions**

**1 (a) Atoms are made up of subatomic particles.**

**TABLE 1.1 shows the type, relative charge and relative mass of subatomic particles A, B and C within an atom.**

**Complete the table. [3]**

**TABLE 1.1**

<b>Subatomic particle</b>	<b>Type</b>	<b>Relative charge</b>	<b>Relative mass</b>
<b>A</b>	<b>electron</b>		<b>very small</b>
<b>B</b>		<b>+1</b>	
<b>C</b>			<b>1</b>

**(b) An isotope of the element TELLURIUM contains 78 neutrons and 52 protons.**

**(i) Give the mass number and atomic number for this isotope of tellurium. [2]**

**mass number** \_\_\_\_\_

**atomic number** \_\_\_\_\_

- (ii) Tellurium is in Group 6 of the Periodic Table.  
Complete the sentences. [3]**

**One atom of tellurium has \_\_\_\_\_  
electrons.**

**Tellurium has \_\_\_\_\_ electrons  
in its outermost \_\_\_\_\_ .**

- (iii) Tellurium reacts with potassium to form  
potassium telluride.**

**Name the type of bond between potassium and  
tellurium.**

\_\_\_\_\_ **[1]**

- (iv) Write the formula of potassium telluride.**

\_\_\_\_\_ **[2]**

- (c) The atomic diameters of some atoms in Period 5 of the Periodic Table are shown in TABLE 1.2.

**TABLE 1.2**

<b>ATOM</b>	<b>ATOMIC DIAMETER (<math>\times 10^{-12}</math> m)</b>
<b>Antimony</b>	<b>266</b>
<b>Tellurium</b>	<b>246</b>
<b>Iodine</b>	<b>230</b>

- (i) Explain why the atomic diameter of iodine is less than the atomic diameter of antimony.

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[3]

- (ii) Some isotopes of tellurium decay to become isotopes of iodine.

What is the name of the type of force which causes this decay?

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[1]

## 2 Iron is an important metal. It affects our daily lives.

For example:

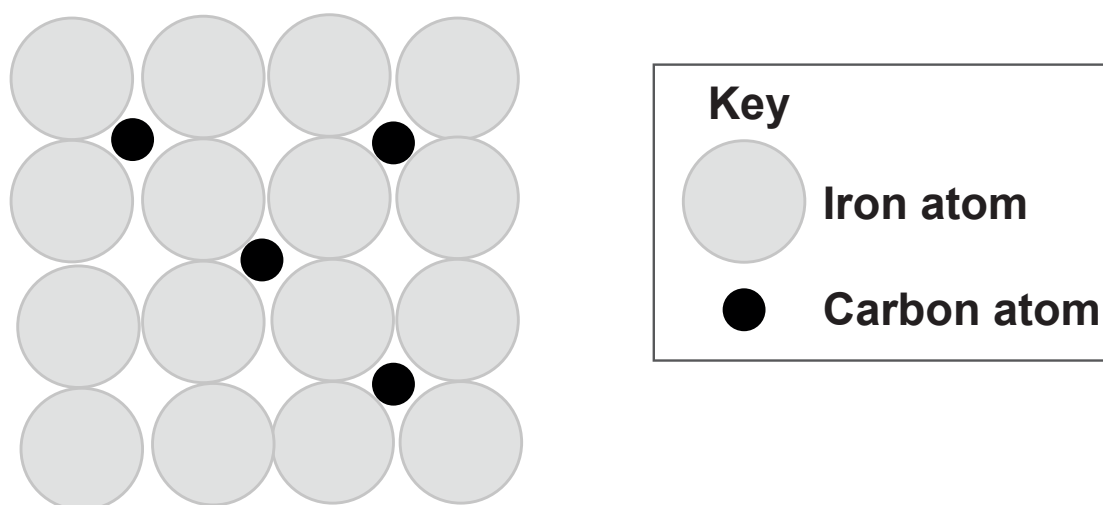
Iron metal is used in the manufacture of steel for construction.

Iron(II) ions have a key biological role in living organisms.

- (a) Small amounts of carbon are added to iron to produce steel. Steel is stronger than pure iron.

A diagram of steel is shown in FIG. 2.1.

FIG. 2.1



- (i) State the name for the type of mixture shown in FIG. 2.1.

- (ii) Explain why the presence of carbon atoms makes steel stronger than pure iron.

Use FIG. 2.1 in your answer.

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[2]

- (b) A laboratory technician investigates the rate of reaction of steel nails with hydrochloric acid.



- (i) Briefly describe how the technician could measure the rate of this reaction.

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[2]

- (ii) The technician repeats the experiment using powdered steel instead of steel nails, and explains why the rate of the reaction changes.

Put a ring around the word(s) that complete each sentence. [3]

Powdered steel has a greater **PRESSURE** / **SURFACE AREA** / **TEMPERATURE** than steel nails.

This means that there are **LESS FREQUENT** / **MORE FREQUENT** / **THE SAME AMOUNT OF** collisions between particles.

The rate of reaction **DECREASES** / **INCREASES** / **STAYS THE SAME**.



- (iii) The reaction between the iron in the steel and hydrochloric acid can be shown using an ionic equation.



The reaction is a redox reaction.

Use the equation to explain, in terms of electron transfer, how this reaction involves both reduction and oxidation.

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[3]

- (c)  $\text{Fe}^{2+}$  ions have an important biological role in the transport of oxygen in human blood.

Describe how  $\text{Fe}^{2+}$  ions are involved in the transport of oxygen from the lungs to the cells.

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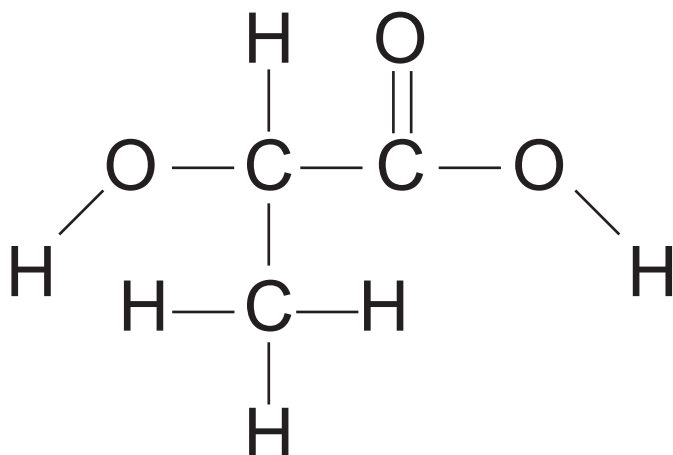
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[2]

### 3 Lactic acid is a by-product of anaerobic respiration.

The molecular formula of lactic acid is  $C_3H_6O_3$ , and its structural formula is shown in FIG. 3.1.

FIG. 3.1



- (a) The chemical properties of lactic acid are due to the presence of its two functional groups.

One of the functional groups in lactic acid is a carboxylic acid group.

What is the name of the other functional group found in lactic acid?

Tick (✓) ONE box. [1]

Alcohol

☐

Aldehyde

☐

Alkene

☐

Ketone

☐

(b) Lactic acid ( $\text{C}_3\text{H}_6\text{O}_3$ ) can be a reactant or a product in an organic reaction.

For the reactions below, name the type of organic reaction and explain your answer.



Type of organic reaction \_\_\_\_\_

Explanation \_\_\_\_\_ [2]



Type of organic reaction \_\_\_\_\_

Explanation \_\_\_\_\_ [2]



Type of organic reaction \_\_\_\_\_

Explanation \_\_\_\_\_ [2]

**(c) Compounds of molecular formula  $C_3H_6O_3$  show different types of isomerism.**

**(i) Lactic acid shows optical isomerism.**

**Identify the reason why lactic acid has optical isomers.**

**Tick (✓) ONE box. [1]**

**There are four different groups attached to one carbon atom.**

☐

**There are two hydroxyl groups on different carbon atoms.**

☐

**There is a non-linear bond arrangement around the oxygen atoms.**

☐

**There is restricted rotation around the double bond.**

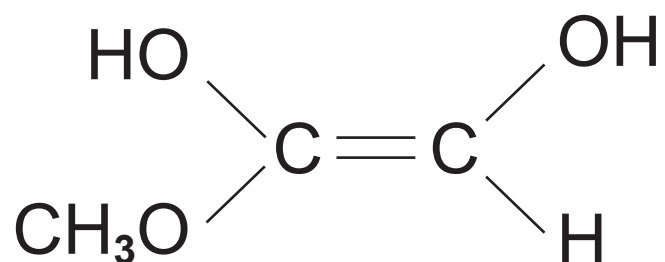
☐

- (ii) One isomer of lactic acid is  
1,2-dihydroxymethoxyethene.

This compound shows geometric isomerism.

One geometric isomer is shown in FIG. 3.2.

FIG. 3.2

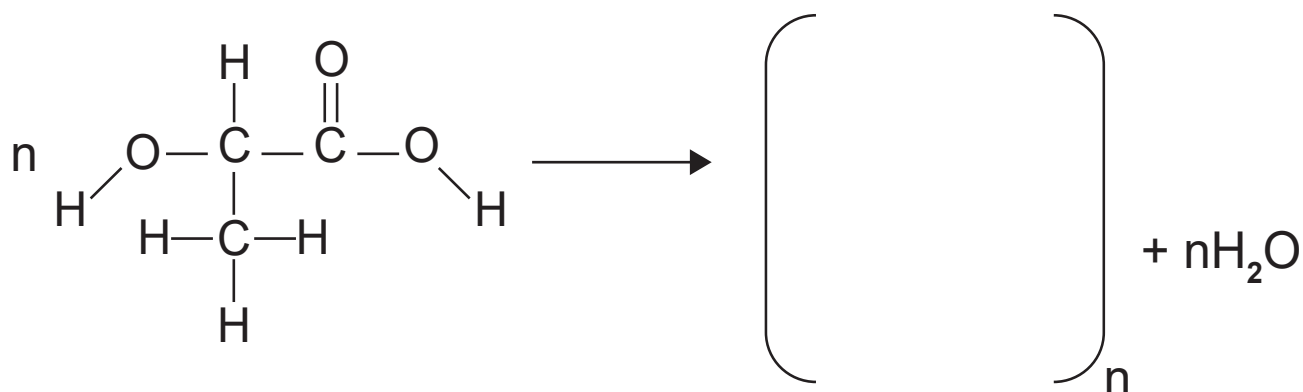


Draw the other geometric isomer of  
1,2-dihydroxymethoxyethene. Use the space below. [1]

- (d) One key reaction of lactic acid is the formation of the polymer polylactate.

Complete the equation in FIG. 3.3 by drawing the structural formula of ONE unit of polylactate in the brackets. [1]

FIG. 3.3

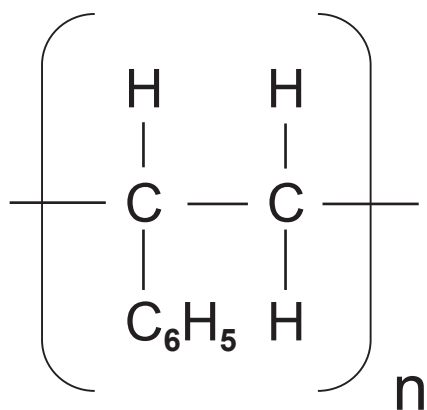


- (e) Polylactate is a biodegradable polymer that could replace other synthetic polymers for certain uses.

Polystyrene is one non-biodegradable polymer that could be replaced by polylactate.

A unit of polystyrene is shown in FIG. 3.4.

FIG. 3.4



- (i) Give the empirical formula of polystyrene.

\_\_\_\_\_ [1]

- (ii) Polystyrene can be processed into Styrofoam™, which is used as the material in fast food packaging.

Styrofoam™ is a colloidal foam, a mixture in which microscopic particles of one substance are dispersed in another medium.

Draw a LINE to link each COLLOIDAL FOAM COMPONENT to its correct STATE OF MATTER. [2]

**COLLOIDAL FOAM  
COMPONENT**

Dispersed phase

Dispersion medium

**STATE OF MATTER**

Solid

Liquid

Gas

**(f) Atoms of carbon are essential in the formation of polymers such as polylactate and polystyrene.**

**Other non-metal atoms, such as oxygen and hydrogen, are not essential.**

**Explain why carbon is an essential element in the formation of polymers, but hydrogen and oxygen are not essential.**

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**[4]**



**4 Animal and plant cells are classified as eukaryotic but bacterial cells are classified as prokaryotic.**

**(a) (i) Name TWO structures that are found in eukaryotic cells but not in prokaryotic cells.**

**1** \_\_\_\_\_

**2** \_\_\_\_\_

**[2]**

**(ii) Ribosomes are found in eukaryotic and prokaryotic cells.**

**Identify the molecule produced by ribosomes.**

**Tick (✓) ONE box. [1]**

**Glycogen**

☐

**Lipid**

☐

**Protein**

☐

**Starch**

☐

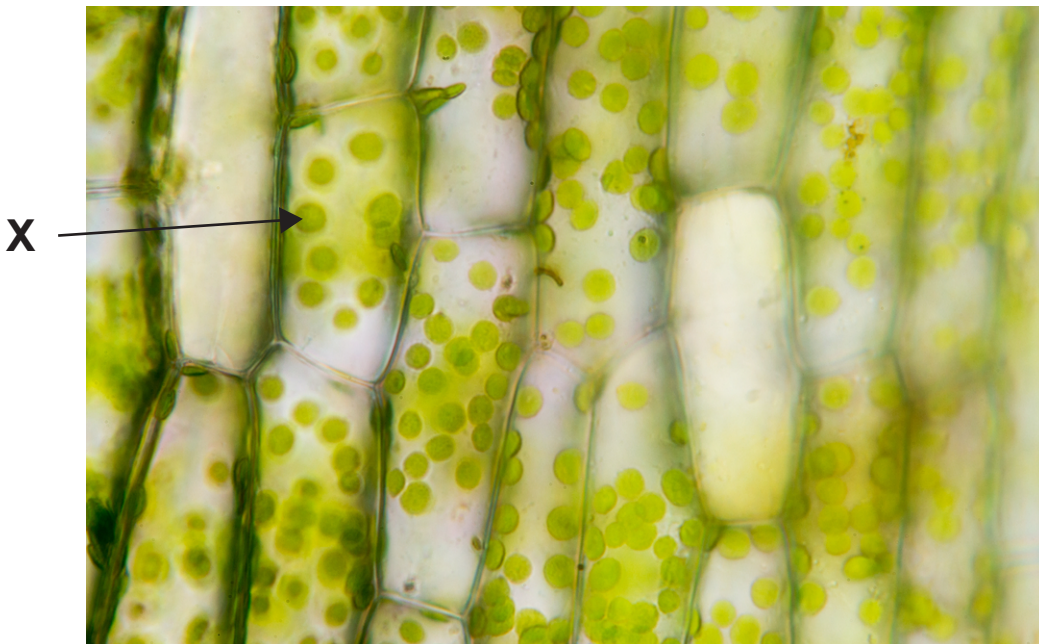
- (iii) Ribosomes interact with molecules of ribonucleic acid (RNA) as part of their function.

Put a tick (✓) in the correct box to show whether each statement is TRUE or FALSE. [3]

STATEMENT	TRUE	FALSE
RNA usually has a single-strand polynucleotide chain.		
RNA contains a ribose sugar.		
The nitrogenous base in RNA is thymine.		

- (b) FIG. 4.1 is an image of plant cells, when seen using a microscope.

FIG. 4.1



**Animal cells do NOT have plant cell walls or structure X seen in FIG. 4.1.**

**(i) Identify structure X.**

\_\_\_\_\_ **[1]**

**(ii) State the function of structure X.**

\_\_\_\_\_ **[1]**

**(iii) The reactions taking place in structure X involve the splitting of water.**

**Identify the metal ion which is a cofactor for the water-splitting enzyme involved in these reactions.**

\_\_\_\_\_ **[1]**

**(c) The plasma membrane cannot be seen in FIG. 4.1.**

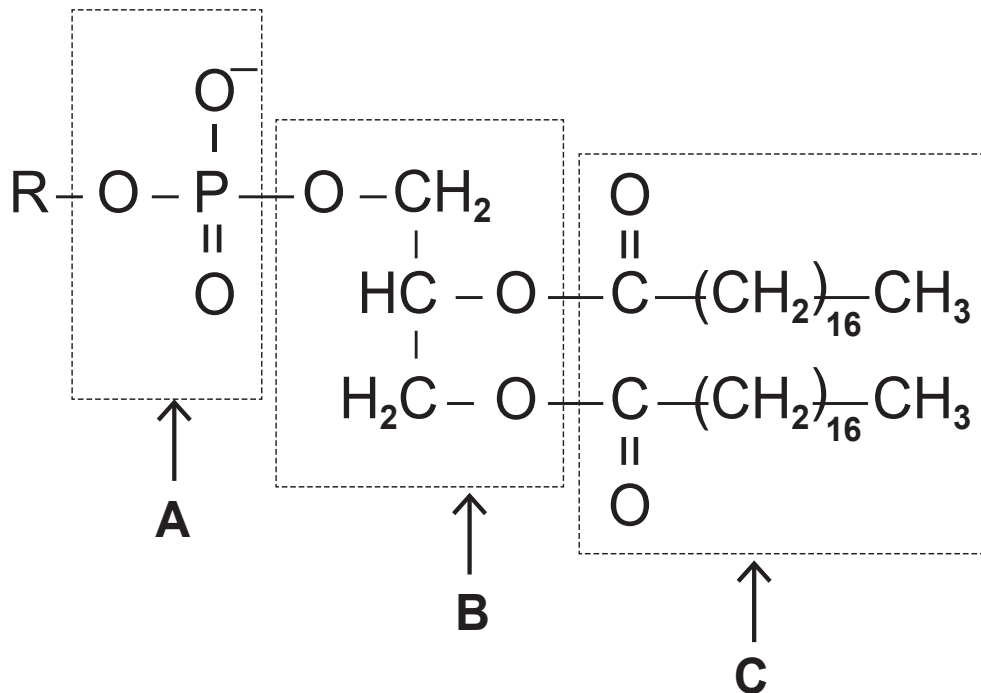
**(i) Outline the role of the plasma membrane.**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ **[3]**

(ii) The plasma membrane contains phospholipids.

The structure of a phospholipid is shown in FIG. 4.2.

FIG. 4.2



Identify the groups labelled A, B and C. [3]

A \_\_\_\_\_

B \_\_\_\_\_

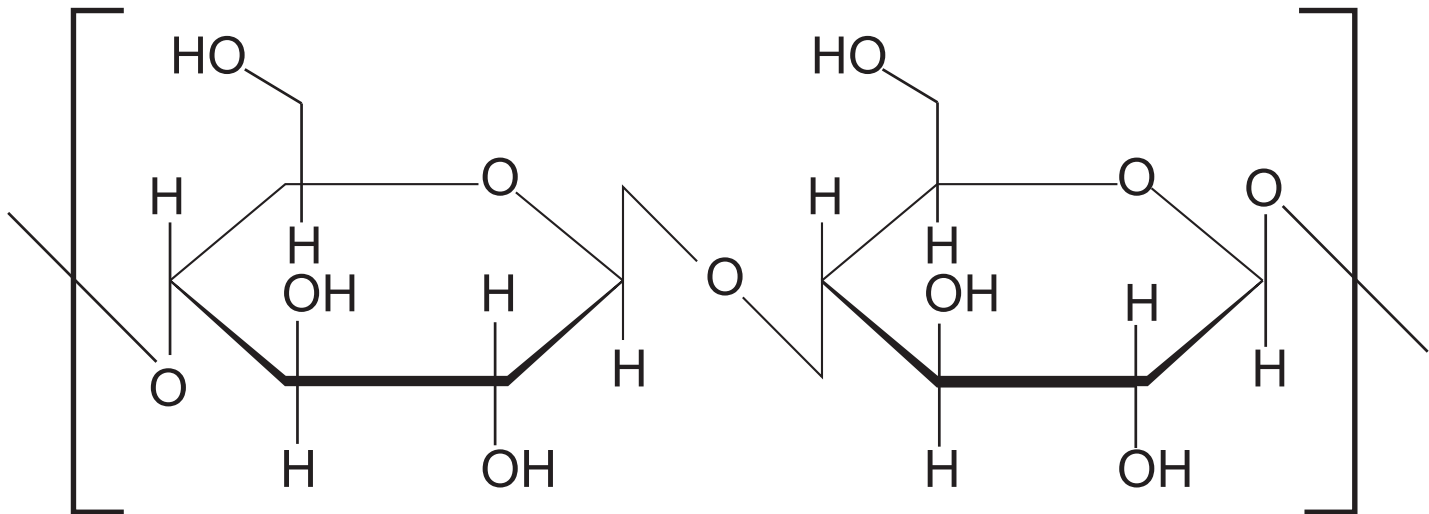
C \_\_\_\_\_

(d) The cell wall is made of cellulose, a complex carbohydrate.

It is formed from a chain of glucose molecules.

A section of cellulose is shown in FIG. 4.3.

**FIG. 4.3**



(i) State ONE function of the cell wall.

[1]

(ii) Cellulose is a useful structural material for the cell wall.

Put a tick (✓) in the correct box to show whether each statement is TRUE or FALSE. [2]

STATEMENT	TRUE	FALSE
Cellulose is a polysaccharide.		
Cellulose contains microfibrils which form cross-links.		
The tightly-packed chains found in cellulose are easily separated.		

**5 Many metal ions have important uses in medical treatments.**

**(a) Identify the metal ion that is used to treat hypertension.**

**Tick (✓) ONE box. [1]**

**$\text{Cu}^{2+}$**

☐

**$\text{Fe}^{3+}$**

☐

**$\text{Li}^+$**

☐

**$\text{Ni}^{2+}$**

☐

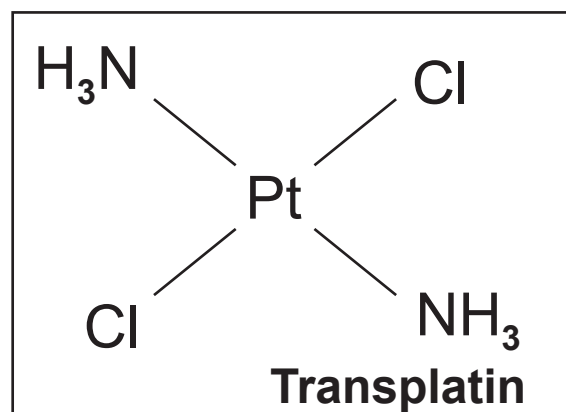
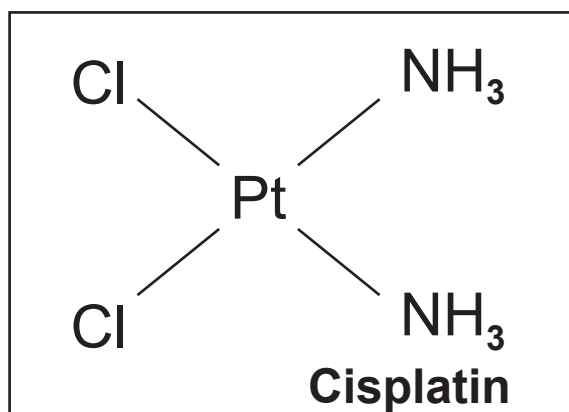
**(b) The platinum(II) ion,  $\text{Pt}^{2+}$ , is a component of the chemotherapy drug Cisplatin.**

**Cisplatin has an isomer called Transplatin.**

**Transplatin does not have the same medical properties.**

**The molecular structures of Cisplatin and Transplatin are shown in FIG. 5.1.**

**FIG. 5.1**



**(i) Describe how Cisplatin acts as a chemotherapy drug.**

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**[2]**

**(ii) Use differences in the molecular structures shown in FIG. 5.1 to suggest why Transplatin cannot be used to replace Cisplatin.**

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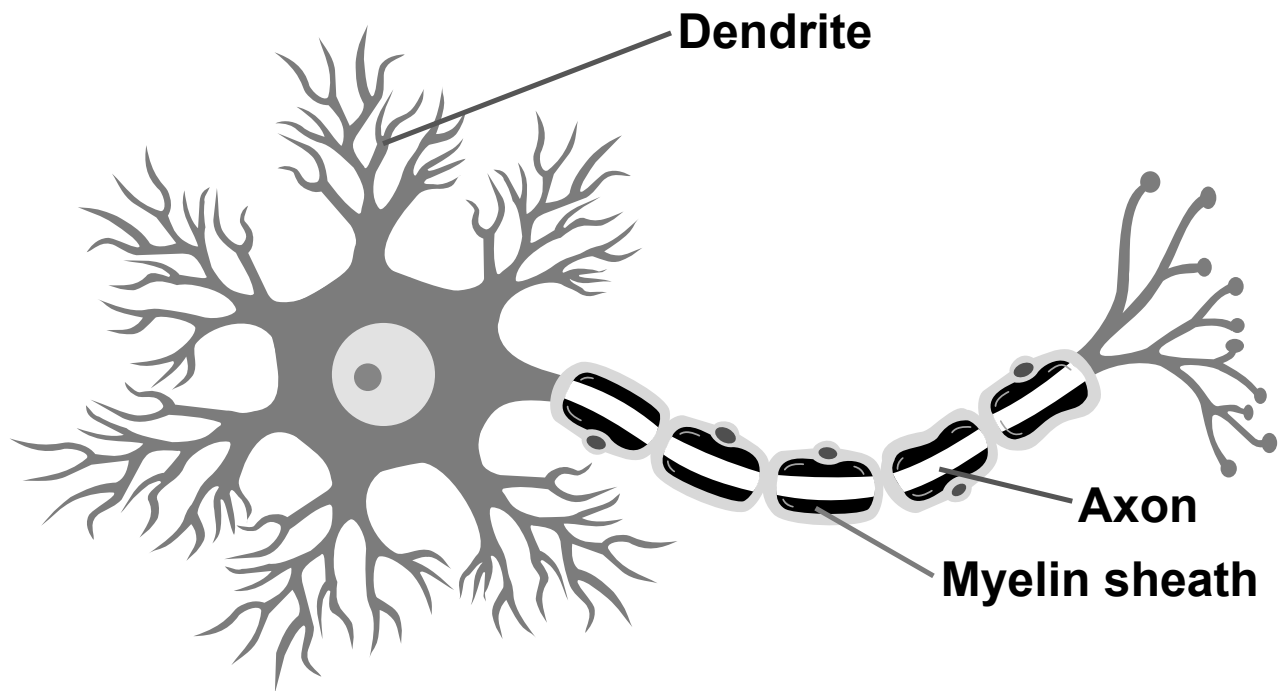
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**[2]**

(c) Sodium and potassium ions are involved in the transmission of nerve impulses along nerves.

FIG. 5.2 shows a diagram of a nerve cell called a motor neuron.

**FIG. 5.2**





- (i) The **THREE** structures labelled in **FIG. 5.2** enable the nerve cell to transmit a nerve impulse.

Draw a **LINE** to link each **STRUCTURE** to its correct **FUNCTION**. [3]

**STRUCTURE****Axon****Dendrite****Myelin sheath****FUNCTION****To communicate with  
other nerve cells****To insulate the axon****To enable nerve impulses  
to run to and from  
different parts of the body**

- (ii) Sodium and potassium ions work together to transmit a nerve impulse.

This process involves six steps as shown below.

The steps are NOT in the correct order.

STEP	ACTION
A	Potassium ions diffuse out of the cell.
B	Sodium ions diffuse into the cell.
C	Charge moves along the nerve cell.
D	Depolarisation occurs.
E	Action potential created.
F	Repolarisation occurs.

Write a letter for each step in each box to show the **CORRECT** order. [4]

	D			F	
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Start  End

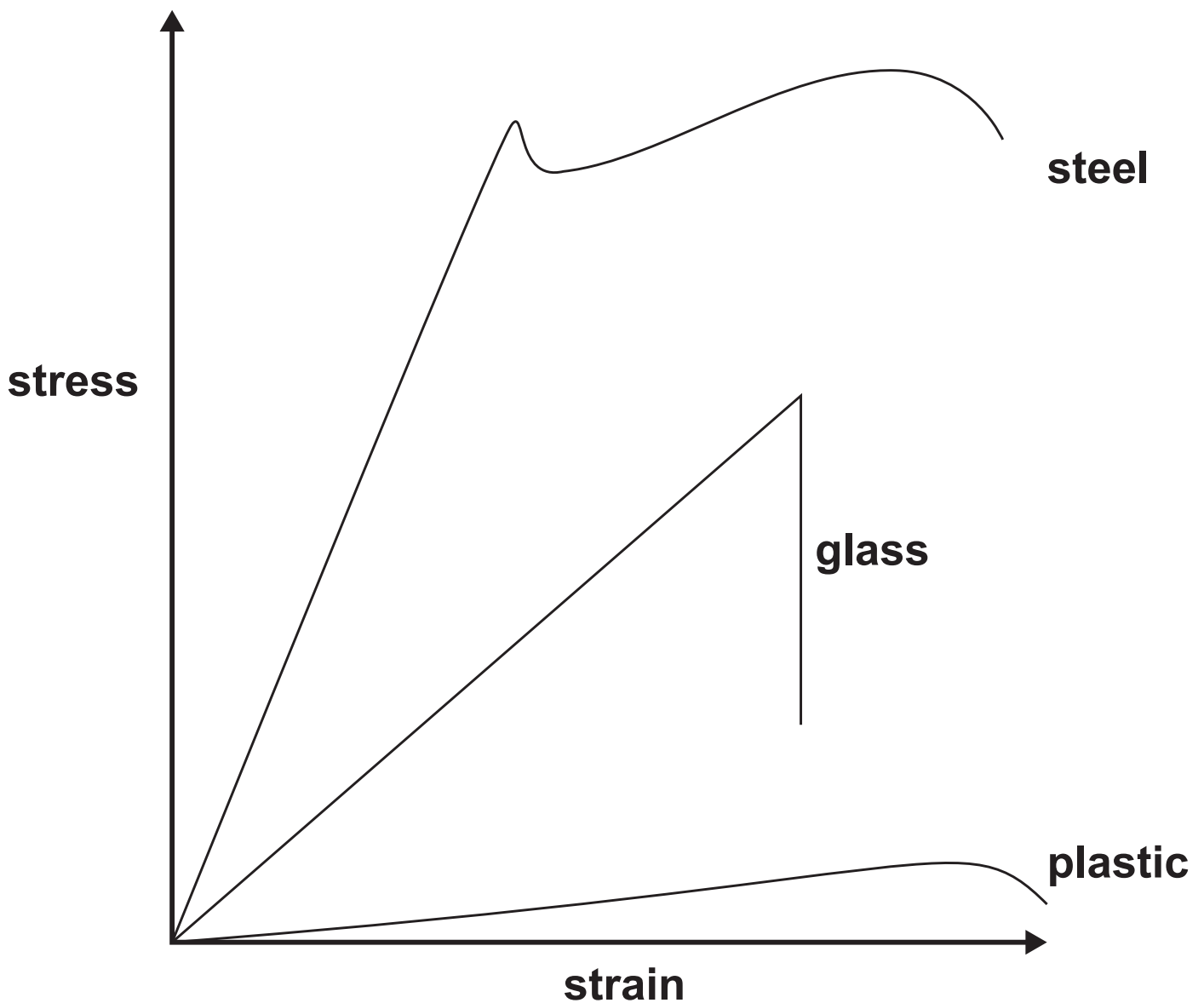
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**6 A tensile test is performed on a specimen of steel.**

**A stress of  $1.6 \times 10^8 \text{ N/m}^2$  produces a strain in the specimen of 0.01.**

**The stress–strain graphs for steel, glass and a type of plastic are shown in FIG. 6.1.**

**FIG. 6.1**



**Calculate the Young's modulus of the steel, and use FIG. 6.1 to compare the mechanical properties of steel, glass and plastic.**

**Use the equation: Young's modulus = stress  $\div$  strain**

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[6]

- 7 (a) The CURRENT,  $I$ , in a conductor can be calculated using the equation  $I = nAvq$ .

For copper, the CHARGE CARRIER DENSITY,  
 $n = 8.5 \times 10^{28} \text{ m}^{-3}$ .

The CHARGE on an electron,  $q = 1.6 \times 10^{-19} \text{ C}$ .

- (i) The current,  $I$ , in a copper rod is 5.0 A.

The copper rod has an area  $A$  of  $1 \times 10^{-3} \text{ m}^2$ .

Calculate the velocity  $v$  of the electrons in the copper rod.

Give your answer to 2 significant figures and include its units.

$v =$  \_\_\_\_\_ units = \_\_\_\_\_

(ii) The current,  $I$ , in the copper rod is 5.0A.

The potential difference across the copper rod is  $8.6 \times 10^{-4} \text{ V}$ .

Calculate the resistance  $R$  of the rod.

Use the equation:

resistance = potential difference  $\div$  current

Include the units in your answer.

Show your working.

$R =$  \_\_\_\_\_ units = \_\_\_\_\_

[3]

- (b) The copper rod used in (a)(i) and (a)(ii) is replaced by an insulator with the same dimensions and potential difference.

Explain why the current in the insulator is different.

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[2]

**END OF QUESTION PAPER**



## ADDITIONAL ANSWER SPACE

**If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s) – for example 3(f) or 5(b)(i).**

[illegible]







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