

# Part 2

## Practice Exam 1

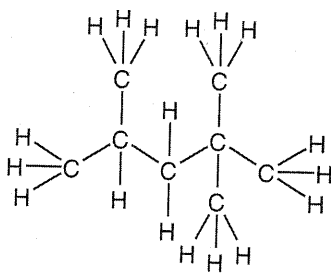
### Section A – Multiple-choice questions

#### Instructions for Section A

Answer all questions. Circle the response that is **correct** or that **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0. Marks will **not** be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

#### Question 1



The systematic name for the hydrocarbon shown above is

- A. 2,2,4-trimethylpentane.                      B. octane.  
C. 2,2-dimethylhexane.                        D. 2,4,4-trimethylpentane.

#### Question 2

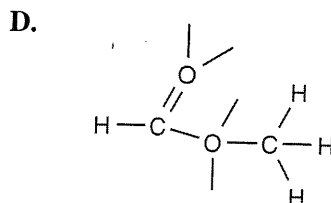
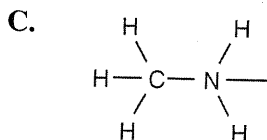
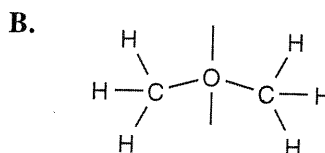
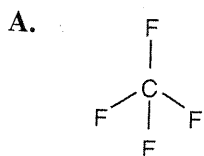
Which of the following statements concerning the Periodic Table published by the Russian chemist D. Mendeleev in 1869 is **incorrect**?

Mendeleev

- A. related the chemical properties of elements in groups to their electron shell configuration.  
B. left gaps in his table where no element was known to fit and he predicted properties of these undiscovered elements.  
C. arranged elements in vertical groups based on their chemical properties.  
D. arranged elements in rows in order of increasing atomic mass.

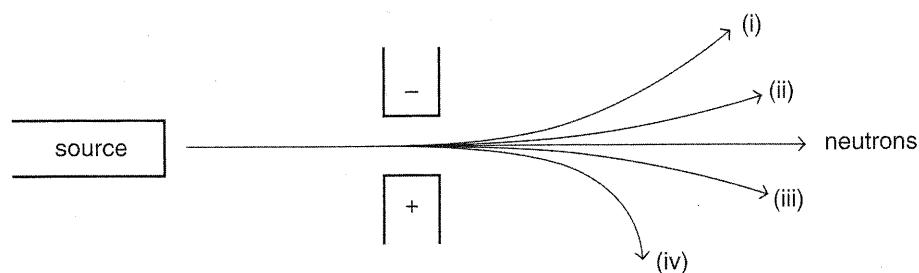
#### Question 3

For which of the following molecular substances would hydrogen bonding be possible?



## Question 4

A beam of neutrons is not deflected in an electric field, as shown in the diagram below.



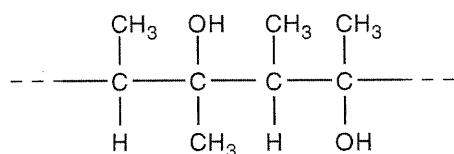
Which of the following identifies how beams of protons, electrons and alpha particles (all travelling at the same speed) would be affected by the electric field?

	protons	electrons	alpha particles
A.	(ii)	(iv)	(i)
B.	(i)	(iv)	(ii)
C.	(iii)	(ii)	(iv)
D.	(iii)	(i)	(ii)

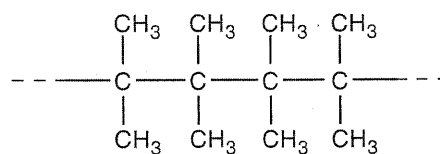
## Question 5

Which one of the following polymers would be expected to have the highest boiling point, assuming that all polymer chains are the same length?

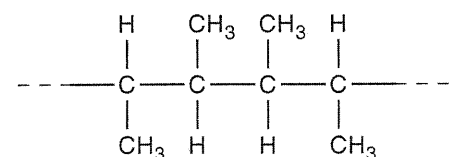
A.



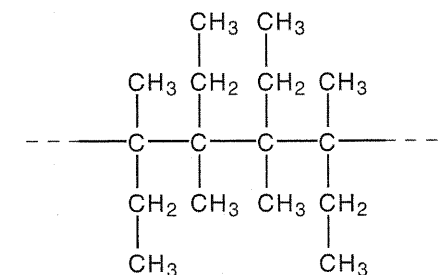
B.



C.



D.



## Question 6

Bromine and iodine are in the same group in the Periodic Table. A bromine atom and an iodine atom would be expected to have

- |    |                                    |    |   |
|----|------------------------------------|----|---|
| A. | the same electronic configuration. | B. | the same number of protons in their nuclei. |
| C. | similar atomic mass.               | D. | similar chemical properties.                |

**Question 7**

Which of the following is a list of atoms in **increasing** order of electronegativity?

- A. sodium, chlorine, bromine  
 B. sodium, bromine, chlorine  
 C. bromine, chlorine, sodium  
 D. chlorine, bromine, sodium

**Question 8**

Which of the molecules listed below has its shape **incorrectly** stated?

	Molecule	Shape
A.	OF <sub>2</sub>	V-shaped
B.	PH <sub>3</sub>	pyramidal
C.	CF <sub>4</sub>	tetrahedral
D.	H <sub>2</sub> S	linear

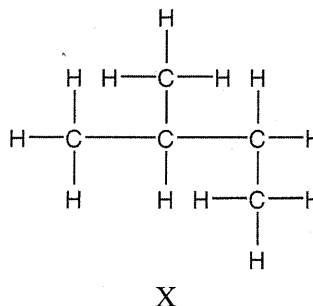
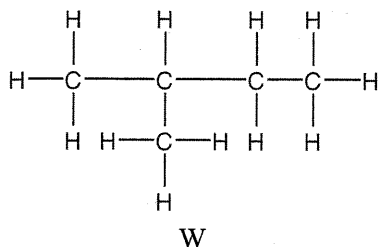
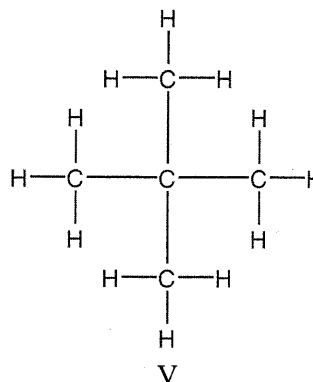
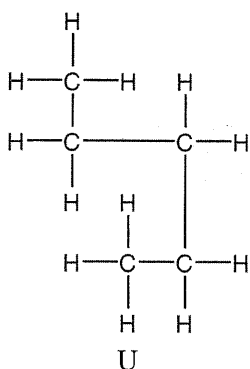
**Question 9**

Which of the following conducts electricity by the movement of ions?

- A. molten magnesium oxide  
 B. solid zinc  
 C. molten sulfur  
 D. solid calcium chloride

**Question 10**

The diagrams below represent four hydrocarbons.



The two diagrams which represent the same hydrocarbon are

- A. U and W.      B. U and V.      C. V and X.      D. W and X.

**Question 11**

An atom of an element weighs  $4.49 \times 10^{-23}$  g. The element is most likely to be

- A. boron (B).      B. cobalt (Co).      C. aluminium (Al).      D. hydrogen (H).

**Question 12**

Which of the following contains the largest number of oxygen atoms?

- A. 1 mole of oxygen,  $O_2$       B.  $6 \times 10^{23}$  atoms of oxygen  
 C. 24 g of oxygen,  $O_2$       D. 24 g of ozone,  $O_3$

**Question 13**

A mixture of sodium chloride and sodium sulfate contains 0.4 mol of chloride ion and 0.3 mol of sulfate ion. The amount (in mol) of sodium in the mixture is

- A. 0.3      B. 0.4      C. 0.7      D. 1.0

**Question 14**

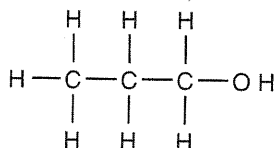
Which of the following statements regarding d subshells is **not** correct?

- A. The energy of the d subshell in any shell is greater than the energy of the p subshell in that shell.  
 B. There are five orbitals in the d subshell.  
 C. Each orbital in the d subshell holds a maximum of two electrons.  
 D. The d subshell of a shell always fills before the s subshell of the next highest shell.

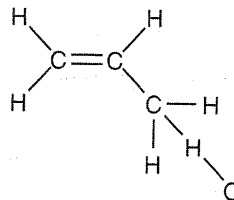
**Question 15**

An organic compound has the formula  $C_3H_6O$ . Which of the following could be its structural formula?

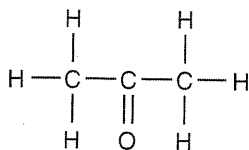
A.



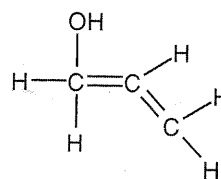
B.



C.



D.

**Question 16**

The first ionisation energy of an element is the energy needed to remove the most loosely bound electron from an atom of the element. The first ionisation energy of sodium is  $502 \text{ kJ mol}^{-1}$ .

This is lower than the first ionisation energy of magnesium ( $744 \text{ kJ mol}^{-1}$ ) because

- A. the outermost electron in magnesium is further from the nucleus than the outermost electron in sodium.  
 B. the nuclear charge of magnesium is greater than the nuclear charge of sodium.  
 C. the electron removed from magnesium comes from a p subshell, while the electron removed from sodium comes from an s subshell.  
 D. magnesium has three isotopes, while sodium has only one.

**Question 17**

Which of the following lists the order in which the three subatomic particles were discovered?

- A. proton, electron, neutron                      B. electron, proton, neutron  
C. neutron, proton, electron                     D. electron, neutron, proton

**Question 18**

Which of the following comparisons between ethane ( $C_2H_6$ ) and ethene ( $C_2H_4$ ) is **incorrect**?

- A. Only ethene, not ethane, may act as a monomer in the formation of addition polymers.  
B. The carbon-carbon bond length is longer in ethane than in ethene.  
C. Both have the same chemical properties because they are both hydrocarbons.  
D. Both have a molecular formula which is different from their empirical formula.

**Question 19**

Which of the lists below shows the liquids in order of **increasing** surface tension?

- A. mercury, water, ethanol, pentane                      B. pentane, ethanol, water, mercury  
C. water, pentane, ethanol, mercury                     D. mercury, ethanol, pentane, water

**Question 20**

The surface energy of a solid reflects the strength of cohesive forces in the solid. Candle wax, iron and diamond have surface energies of  $50 \text{ mJ m}^{-2}$ ,  $1360 \text{ mJ m}^{-2}$  and  $9820 \text{ mJ m}^{-2}$  respectively.

Which of the following best represents the major type of cohesive forces in each solid?

- |    | <b>candle wax</b> | <b>iron</b>       | <b>diamond</b>    |
|----|-------------------|-------------------|-------------------|
| A. | dispersion forces | ionic bonds       | metallic bonds    |
| B. | ionic bonds       | metallic bonds    | dispersion forces |
| C. | dispersion forces | metallic bonds    | covalent bonds    |
| D. | covalent bonds    | dispersion forces | ionic bonds       |

## Section B – Short-answer questions

**Instructions for Section B**

Answer all questions in the spaces provided in this book. Do **not** respond to a question anywhere other than in the space immediately following the question. Where lines are provided under a question, the number of lines is intended to be more than sufficient for your response.

To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state, for example  $\text{H}_2(\text{g})$ ;  $\text{NaCl}(\text{s})$ .

**Question 1**

The table below contains incomplete information about two ions, A and B.

Ion	Mass number	Atomic number	Number of neutrons	Number of electrons	Valency of ion
A	56		30		+2
B		17	18	18	

- a. Provide the missing numbers to complete the table.

2 marks

- b. Write the electronic configuration, using subshell notation, of an **atom** of element A.

\_\_\_\_\_

1 mark

- c. Atoms of an element are most stable when found in their **ground state**.

- i. Explain what is meant by the 'ground state' of an atom.

\_\_\_\_\_  
\_\_\_\_\_

- ii. Write a possible electronic configuration for an **atom** of **element B** which is in an **excited** state.

\_\_\_\_\_

1 + 1 = 2 marks

- d. Give the formula for the compound formed between ions of A and B.

\_\_\_\_\_

1 mark

Total 6 marks

## Question 2

a. In 1910 the English chemist F. Soddy, working with radioactive substances, found that some elements had identical chemical properties but different relative masses. He called such elements isotopes.

i. Why do isotopes of elements have identical chemical properties?

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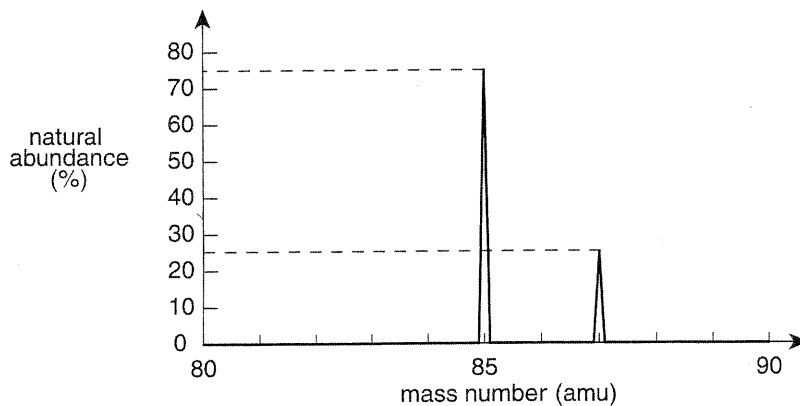


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ii. The mass spectrum of an element containing two isotopes is shown below.



Using the data above, calculate the relative atomic mass of the element (to one decimal place).

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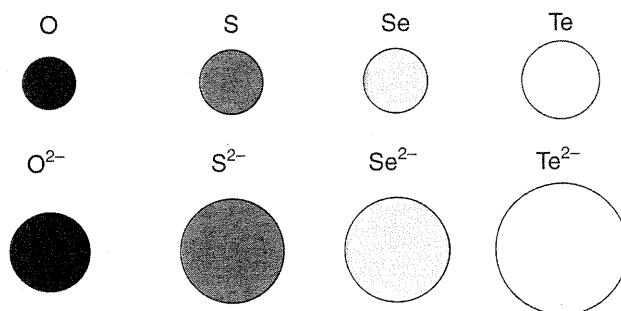
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2 + 2 = 4 marks

b. The atomic and ionic sizes for the Group 16 elements are shown below.



i. Explain why atomic size increases down the group.

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ii. Explain why the negative ion is larger than the neutral atom of the same element.

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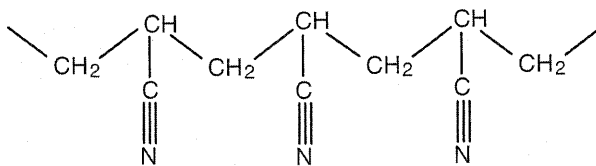


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1 + 2 = 3 marks  
Total 7 marks

## Question 3

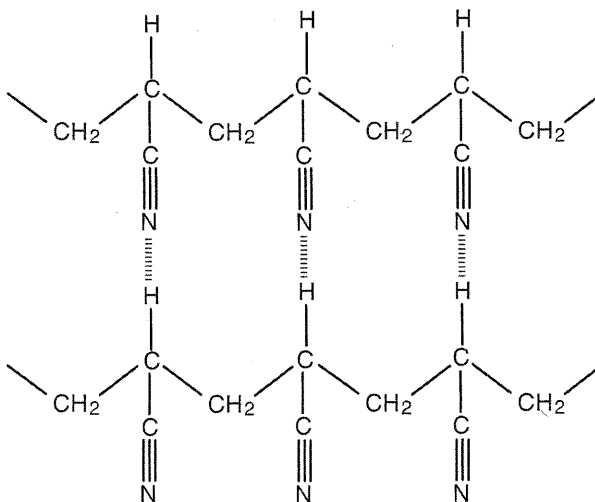
The molecule acrylonitrile can be polymerised to give a synthetic fibre with properties similar to wool. A section of the polymer chain of polyacrylonitrile is shown below.



- a. i. Draw a structural diagram for the acrylonitrile monomer used to form this polymer.

- ii. Name the type of polymerisation involved in forming this polymer.

- iii. The small cyano ( $\text{C} \equiv \text{N}$ ) group permits close packing of chains and interchain bonding as shown below.



Name the type of interchain bonding shown.

1 + 1 + 1 = 3 marks

- b. i. Write the empirical formula of polyacrylonitrile.

- ii. The molar mass of a particular polyacrylonitrile is  $5.04 \times 10^4 \text{ g mol}^{-1}$ . How many acrylonitrile monomers were polymerised to produce each polyacrylonitrile molecule?

1 + 1 = 2 marks

Total 5 marks



**Question 4**

The following article concerns research into 'smart metals'.

Metals have long fascinated humans because of the range of properties they demonstrate. They can be **pounded, shaped and bent**. They are good conductors of heat and electricity. Some also have the ability to take on different shapes depending on the temperature to which they are exposed. These metals are **alloys** that appear to be able to 'remember' the shapes they originally had at various temperatures.

One example is the alloy used in teeth braces. At room temperature the alloy is flexible, allowing easy attachment to the teeth. As the alloy reaches mouth temperature, it becomes less flexible, 'remembers' its original shape and tightens to pull on the teeth.

- a. In terms of their structure, explain how metals are able to be 'pounded, shaped and bent', i.e. metals are malleable. Include a diagram in your answer.

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3 marks

- b. The properties of metals enable them to be used in a wide range of devices. State **one** property of each metal which best explains their use in each of the following devices.

- i. tungsten in electric light filaments

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- ii. mercury in thermometers

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1 + 1 = 2 marks

- c. i. What is meant by the term 'alloy'?

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- ii. The 'smart metals' described in the passage show one way in which the properties of an alloy may differ from those of the parent metals. Describe **one** other difference in properties between alloys and their parent metals.

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1 + 1 = 2 marks

Total 7 marks

**Question 5**

- a. Complete the table below by providing the formula and type of structure of each solid substance.

Name of substance	Formula of substance	Structural type (molecular, covalent network lattice, layer lattice, ionic lattice, metallic lattice)
copper(II) hydroxide		
ammonia		
diamond		

6 marks

- b. The two organic compounds whose names, formulas and boiling points are shown below have a similar molecular mass.

Methanal	Methanol
$\text{H}_2\text{CO}$	$\text{CH}_3\text{OH}$
$-21^\circ\text{C}$	$65^\circ\text{C}$

- i. Draw valence structures for molecules of each of the two compounds, including all bonding and non-bonding electron pairs.

$\text{H}_2\text{CO}$	$\text{CH}_3\text{OH}$
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- ii. In terms of structure and bonding, account for the difference in boiling point of the two compounds.

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2 + 2 = 4 marks

Total 10 marks

**Question 6**

Plants need a continual supply of nitrogen but they cannot use atmospheric nitrogen ( $\text{N}_2$ ) directly.  $\text{N}_2$  must first be converted to a soluble form which plants can absorb, i.e.  $\text{NO}_3^-$  or  $\text{NH}_4^+$ .

- a. An industrial method for this conversion involves the production of nitrogen-containing fertilisers. A good fertiliser has a high percentage of nitrogen by mass. Two possible fertilisers are ammonium chloride,  $\text{NH}_4\text{Cl}$  and sodium nitrate  $\text{NaNO}_3$ .

Which of these compounds contains the highest percentage by mass of nitrogen? Show your working.

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2 marks

b. A particular fertiliser has the percentage composition shown in the table below.

Element	Percentage by mass
nitrogen	35.0
hydrogen	5.00
oxygen	60.0

i. Determine the empirical formula of this fertiliser.

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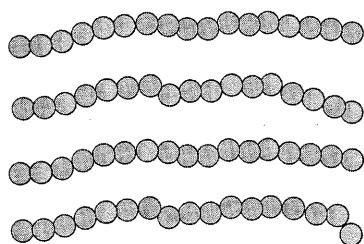
ii. The fertiliser is known to be an ionic compound. Suggest a likely formula for the fertiliser.

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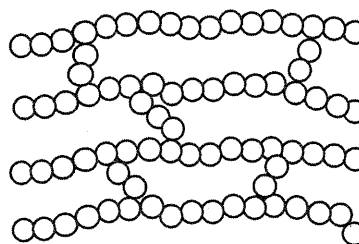
2 + 1 = 3 marks  
Total 5 marks

**Question 7**

a. The diagrams below are a schematic representation of two polymer types.



polymer A



polymer B

Complete the table below by identifying the type of polymer found in each of the plastics listed.

Plastic	Use of plastic	Type of polymer (A or B)
phenol-methanal	frying-pan handles	
nylon 6,6	drip-dry clothing	
polypropene	ice-cream containers	

3 marks

b. i. Classify polymer B as thermoplastic or thermosetting.

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ii. Briefly describe a simple laboratory procedure to distinguish a thermoplastic polymer from a thermosetting polymer.

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1 + 1 = 2 marks  
Total 5 marks

**Question 8**

During a practical class investigating surface chemistry, a student sprinkled dry talcum powder on the surface of water in a Petri dish.

A few drops of oleic acid were then added. The talcum powder was observed to 'move' outwards from the area where the oleic acid was added.

- a. Oleic acid ( $C_{18}H_{34}O_2$ ) has the semi-structural formula  $C_{17}H_{33}COOH$ .

Explain the structural features of oleic acid which enable it to act as a surfactant.

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1 mark

- b. With the aid of a labelled diagram, explain how the oleic acid molecules align themselves at the surface of the water, causing the talcum powder to spread.

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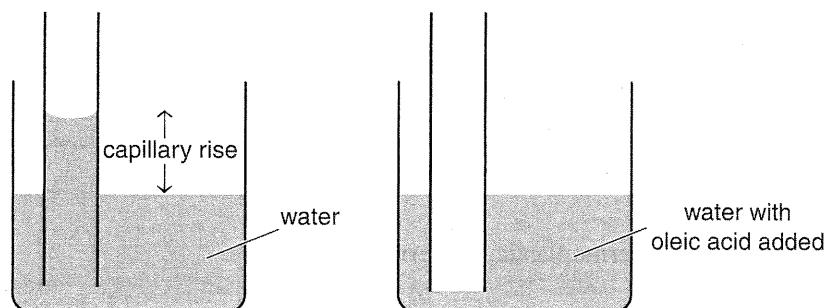
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2 marks

- c. Water is poured into a beaker and a thin capillary tube is placed in the water. Water containing a few drops of oleic acid is poured into a second beaker and a thin capillary tube is placed into the solution. The capillary rise observed for water is shown below.



- i. On the diagram above, sketch the expected capillary rise for the water/oleic acid solution.  
 ii. Explain why the capillary rise is different when oleic acid is added to the water.

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1 + 1 = 2 marks

Total 5 marks