Section A [5 marks]

Answer **all** questions.

Write your answers in the boxes provided at the end of the Section.

1 Copper is used in electrical wirings to conduct electricity. Why is copper able to conduct electricity?

A Copper has a 'sea' of delocalised electrons.

B Copper has free-moving ions.

C Copper has a 'sea' of delocalised ions.

D Copper has free-moving atoms.

2 Calcium phosphate is the main mineral found in human bones and teeth. What is the chemical formula of calcium phosphate?

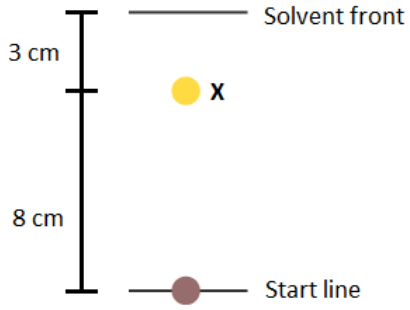
A $CaPO_3$

B $CaPO_4$

C $Ca_3(PO_3)_2$

D $Ca_3(PO_4)_2$

3 The following chromatogram was obtained by a student. What is the R_f value of the spot marked '**X**'?



A $\frac{8}{3+8}$

B $\frac{3}{3+8}$

C $\frac{3+8}{8}$

D $\frac{3}{8}$

4 A solid substance was found to be unable to conduct electricity. When pure water was used to dissolve the substance, the solution could conduct electricity. What could be the structure of the substance, and why can the solution conduct electricity?

	Structure	Reason for being able to conduct electricity
A	giant metallic structure	Water can conduct electricity.
B	giant metallic structure	It has free-moving electrons.
C	giant ionic structure	It has free-moving ions.
D	giant ionic structure	Water can conduct electricity.

5 The following diagram shows a set-up used to obtain clean water from dirty river water in a rural village.

Which method of separation is used to obtain clean water in this case?

A using a separating funnel

B filtration

C distillation

D evaporation

Write your answers for Section A in the boxes below.

1.	2.	3.	4.	5.

[Total: 5]

Section B [30 marks]
Answer **all** questions.
Write your answers in the spaces provided.

B1 Use the list of substances to answer the questions.

sulfur dioxide
graphite
oxygen
sodium sulfate
dry ice

(a) **(i)** Which substance is ionic?

..... [1]

(ii) Which substance has a giant molecular structure?

..... [1]

(iii) Which **two** substances contain two elements from Group VI?

[1]

.....

(iv) If the substances above were mixed, which substance can be obtained by sublimation?

..... [1]

(v) Which substance can conduct electricity in the solid state?

..... [1]

(vi) Write down the chemical formula for **one** of the compounds.

..... [1]

(b) Draw the 'dot'-and-'cross' diagram for ammonia. Show outer electrons only.

[2]

[Total: 8 marks]

B2 Write down a method of separation used to obtain the underlined component of the mixture below.

(a) **(i)** oil and <u>water</u>

..... [1]

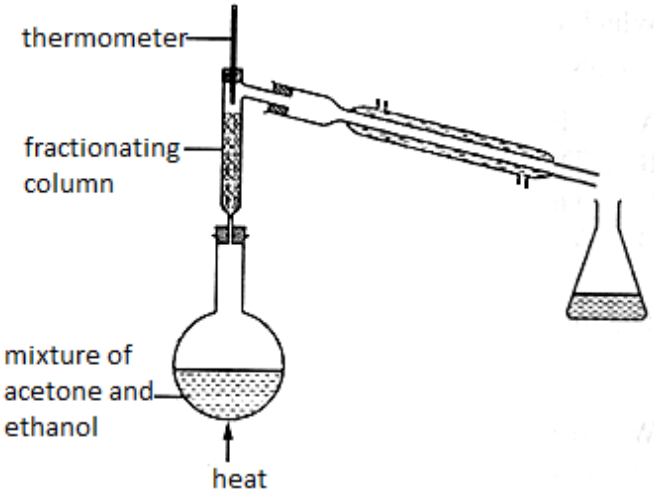
(ii) <u>salt</u> and oil

..... [1]

(iii) <u>sugar</u> and water

..... [1]

(b) The set-up below shows the apparatus used for distillation of a mixture of acetone and ethanol. The boiling point of acetone and ethanol are 56 °C and 78 °C respectively.



(i) After heating the mixture from room temperature for some time, the thermometer reading stops increasing and remains at a constant temperature. What is the reading on the thermometer when the temperature is constant?

..... [1]

(ii) Using arrows, show where water enters and exits the condenser. [1]

(iii) Using the axes provided below, sketch a graph to show the change in temperature of the mixture against time.

[2]

[Total: 7 marks]

B3 **(a)** Write the chemical equations for the following reactions.

(i) Sodium metal reacts with water to form hydrogen gas and sodium hydroxide.

..... [1]

(ii) Nitric acid reacts with calcium oxide to form calcium nitrate and water.

..... [1]

(iii) Propene (C_3H_6) burn in oxygen to form carbon dioxide and water.

..... [1]

(b) Draw the 'dot'-and-'cross' diagram for calcium oxide. Show outer electrons.

[2]

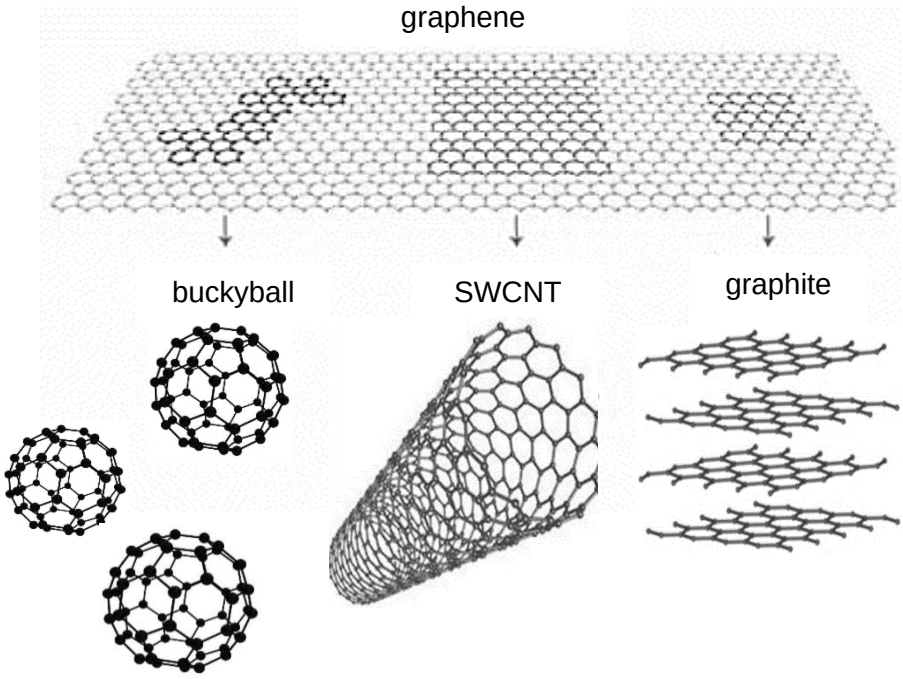
[Total: 5]

B4 Carbon is a highly versatile element that has many *allotropes*. Allotropes are different forms of the same element which includes diamond, fullerene, graphite and Single-Walled Carbon Nanotubes (SWCNT). Carbon atoms, having four valence electrons, have a preference for sharing electrons instead of transferring electrons to form a bond.

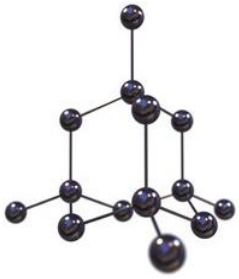
Diamond occurs naturally underneath the Earth's surface while fullerene, graphite and SWCNT can be made in a laboratory from a flat 2-dimensional honeycomb lattice of carbon atoms known as graphene. A schematic structure of how graphene can be made into fullerene, SWCNT and graphite is shown on the next page.

Fullerene is formed when the carbon atoms are arranged in the form of spherical molecules. One of the most common fullerene is known as buckminsterfullerene, also known as buckyball, which is a molecule made of 60 carbon atoms.

SWCNT can be visualised as one flat graphene sheet of carbon atoms rolled into a cylindrical shape while graphite can be visualised as the stacking of multiple graphene sheets. Each carbon atom in buckyball, SWCNT and graphite is bonded to three other carbon atoms. This would mean that these three structures have a delocalised electron per carbon atom that is able to conduct electricity.



Diamond is another allotrope of carbon with the following structure. Unlike the four allotropes above, each carbon atom in diamond is bonded to four other atoms.



diamond

The physical properties of diamond, fullerene, graphite and SWCNT are shown in the table below. The electrical conductivity is measured in S/cm where high values reflect good electrical conductivity.

carbon allotrope / properties	diamond	buckyball	graphite	SWCNT
electrical conductivity (S/cm)	0.001	0.00001	4000	1 000 000
relative electron movement speed	low	very low	high	very high
melting point (^{o}C)	4030	600	3600	3550
relative cost	high	very high	low	high
solubility in organic solvents	no	yes	no	no
flexibility	no	yes	no	yes

(a) Explain, in terms of electronic configuration, why carbon has a tendency to form molecules but **not** ions.

.....

.....

[1]

(b) **(i)** With reference to the table, state the relationship between the relative electron movement speed and electrical conductivity.

.....

.....

[1]

(ii) With reference to their structures, explain why SWCNT is a much better conductor of electricity than diamond.

.....

.....

.....

[3]

(c) Scientists consider buckyball to have a simple molecular structure.

(i) Give two pieces of evidence from the table that support this.

.....

.....

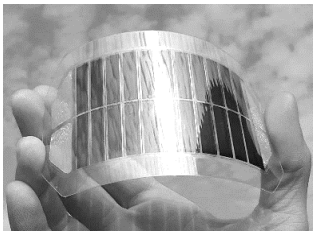
[2]

(ii) Using information from the passage, suggest the chemical formula of buckyball.

.....

[1]

(d) One useful application of carbon allotropes is in the development of solar panel cells that convert light to electrical energy as shown below.



Suggest and explain which of the four carbon allotropes will be most suitable to be used in the development of flexible solar cells.

.....

.....

[2]

[Total: 10]

**********End of Paper**********