OLDEST PAPER

Name: ..... **School Year:** .....

School: .....

Answer all questions in the spaces provided.

Write your answers clearly. Show all working.

The total marks allocated to the paper are 40 marks (Section A 10 marks, Section B 30 marks)

The time allocated to the paper is 30 minutes.

Scoring:	Section A ..... / 10	Section B ..... / 30	**Total** ..... **/ 40**

SECTION A General chemistry knowledge

1. Circle all of the following elements that exist as diatomic molecules. (1 mark)

helium nitrogen chlorine sulfur

2. Calculate the relative formula mass of $Mg(OH)_2$. (1 mark)
(Relative atomic masses: Mg = 24, O = 16 and H = 1)

.....

3. State the charge (i.e. +1, +2, -1, -2 etc.) on each of these complex ions; (3 marks)

Ammonium, $NH_4^?$.....

Sulfate, $SO_4^?$.....

Carbonate, $CO_3^?$.....

4. The process of **fracking** is associated with the extraction of which gas from natural resources?

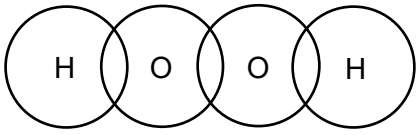
.....(1 mark)

5. Balance the following equation for the decomposition of the explosive TNT. (1 mark)

$$\text{.....}C_7H_5N_3O_6 \rightarrow \text{.....}C + \text{.....}CO + \text{.....}H_2O + \text{.....}N_2$$

6. Complete the dot and cross diagram to represent the bonding in hydrogen peroxide, H_2O_2.

(1 mark)



7. Name the scientist who discovered that electrons orbit the nucleus of an atom in distinct energy levels or shells. (1 mark)

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8. Which of the following is not a consequence of global warming. (1 mark)

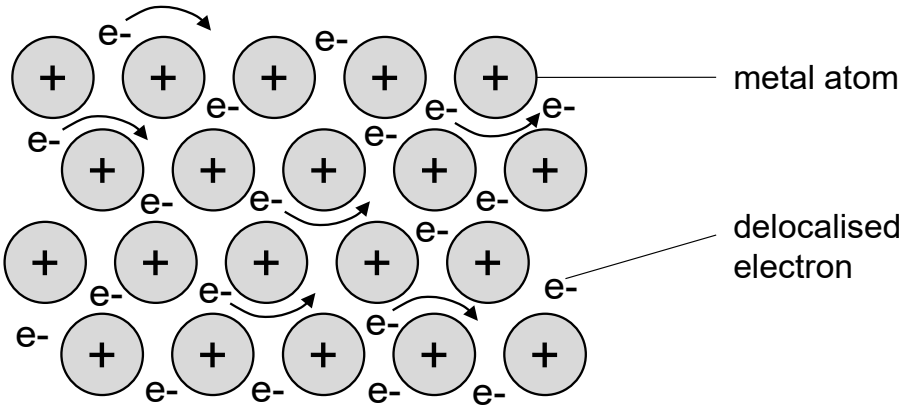
Hole in the ozone layer Sea levels rising Increase in the global mean temperature

Total: 10 marks

SECTION B Questions linked to this year's theme of Materials

9. This question is about metals, their properties and uses.

The diagram below shows the bonding in a metal.



(a) State one property of a metal.

Use an understanding of the bonding in the metal to explain why the metal has this property. (2 marks)

Property .....

Explanation .....

(b) Metals are held together by metallic bonds. This is the electrostatic attraction between the positive metal centre and the negative delocalised electrons.

Predict which of the two metals lithium and sodium will have the higher melting point.

Explain your answer. (3 marks)

Metal with higher melting point .....

Explanation .....

.....

.....

(c) The table below provides some information about the materials used to make the Olympic medals for the recent 2018 Winter Olympics in PyeongChang.

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Medal	**Composition**	**Overall mass in g**
Gold	A silver medal with a purity of 99.9% plated with 6 g of gold	586
Silver	Solid silver medal with a purity of 99.9%	580
Bronze	An alloy made of 90% copper and 10% zinc by mass	493

i. What is the mass of copper in a bronze medal? (1 mark)

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ii. What is the mass of silver in a gold medal? (1 mark)

.....

iii. If silver sells at £4.52 for 10 g and gold at £342 for 10 g, calculate the cost of a gold medal. (3 marks)

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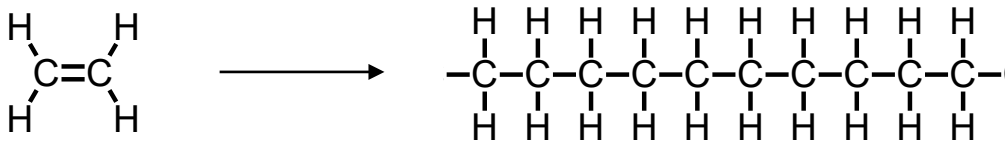
10. This question is about polymers.

Polymers are very large molecules formed by joining together lots of small molecules called monomers.

One common polymer is polyethene.

This is formed by joining together lots of ethene molecules in a process called addition polymerisation.

The diagram below shows the process.



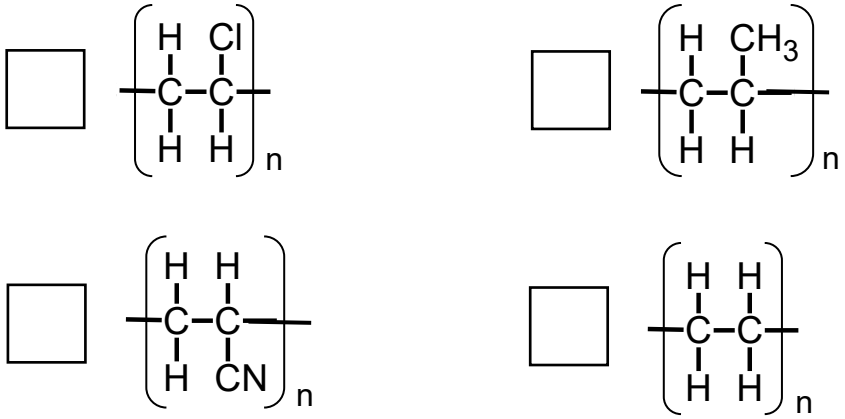
ethene polyethene

(a) State the chemical formula for a molecule of **ethene**. (1 mark)

.....

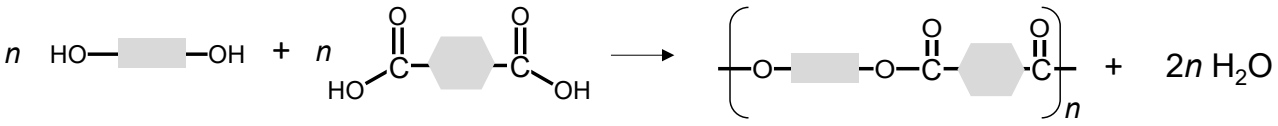
Instead of drawing out the whole polymer, you can draw a small part of it, called the **repeating unit**. The polymer is made up of this unit repeated over and over again.

(b) Which diagram correctly shows the repeating unit of polyethene? (1 mark)



Another type of polymer is a **polyester**.

This is formed when a dicarboxylic acid reacts with a diol. The diagram below shows the reaction.



diol dicarboxylic acid polyester

(c) i. Why is this type of polymerisation known as **condensation** polymerisation?

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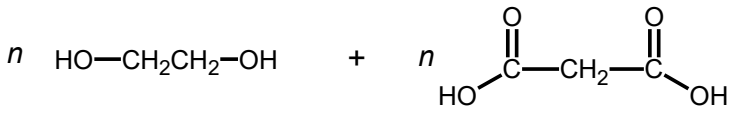
..... (1 mark)

ii. Draw the repeating unit of the polyester formed when ethanediol reacts with propanedioic acid.

Use the example above for guidance. (2 marks)



ethanediol propanedioic acid

..... + 2n H_2O

(d) Kevlar® is another example of a condensation polymer.

It is extremely strong and is used for protective clothing such as bullet proof vests and cut resistant gloves.

Kevlar® is formed from the reaction of a diamine with a diacyl chloride. **In this case 2*n* molecules of HCl are eliminated**.

Draw the repeating unit of Kevlar®. (2 marks)

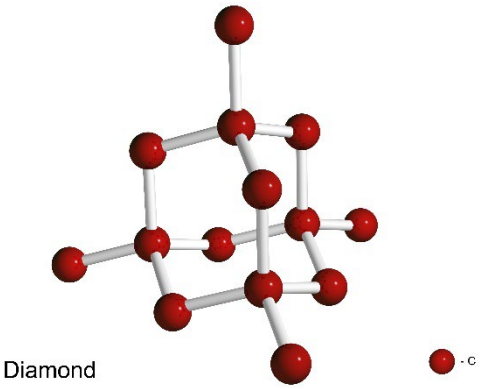
diamine diacyl chloride

..... + 2n HCl

11. This question is about **allotropes** of carbon.

Allotropes are different forms of the same element.

(a)



The image shows the structure of one allotrope of carbon, **diamond**.

Use an understanding of the bonding in diamond to explain why it has a high melting point. (2 marks)

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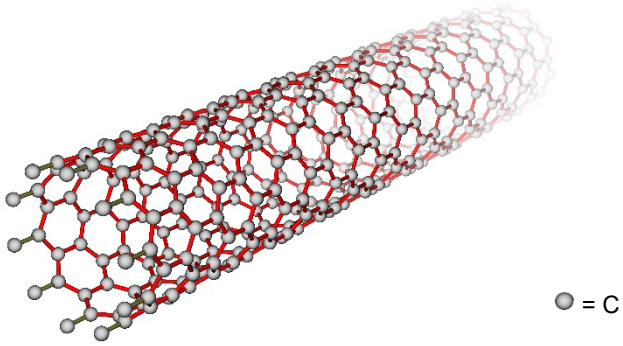
(b) Another allotrope of carbon is a **carbon nanotube**.



i. How many other carbon atoms is each carbon atom bonded to. (1 mark)

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ii. Predict if carbon nanotubes conduct electricity.

Use an understanding of the bonding to explain why / why not. (2 marks)

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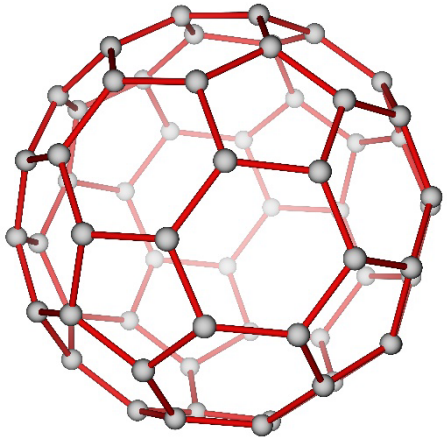
(c) In 1985 Sir Harry Kroto and his co-workers discovered that C_{60} molecules could form spontaneously from a condensing carbon vapour.

The C_{60} molecules were named **Buckminster fullerene**.

The image shows a molecule of Buckminster fullerene.

This is often referred to as a bucky ball owing to the molecule having the same symmetry pattern as a football.



● = C

i. A bucky ball has a diameter of 1.01 nm.

Express this diameter in units of metres using standard form. (1 mark)

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ii. Bucky balls are often used as catalysts because they have a large surface area to volume ratio.

Calculate the surface area to volume ratio of a bucky ball. (4 marks)

The surface area of a sphere = $4\pi r^2$

The volume of a sphere = $\frac{4}{3}\pi r^3$

π = 3.14

Show all working.

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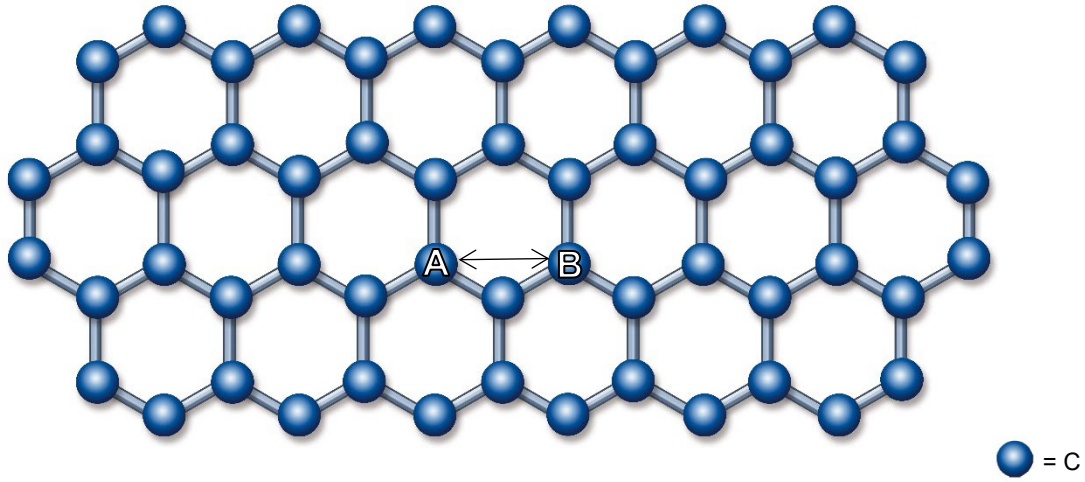
(d) Scientists at the University of Manchester received the Nobel Prize for Physics in 2010 for experiments they had carried out on a fourth allotrope of carbon, **graphene**.

Graphene is a single layer of carbon atoms joined together in hexagons.



If the C-C bond length in graphene is 0.142 nm, calculate the distance across a single hexagon, labelled distance **AB** on the image. (3 marks)

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