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1. (a) Many scientists contributed to the development of the periodic table. One of these was Dmitri Mendeleev. In his table, he arranged the elements in order of increasing relative atomic mass.

In the modern periodic table, elements are arranged in order of increasing atomic number.

- (i) Explain the term **atomic number**.

.....  
 .....  
 (1)

- (ii) When the elements are arranged in order of increasing relative atomic mass, iodine would appear in group 6.

Give one reason why iodine must appear in group 7.

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 .....  
 (1)

- (b) Gallium is the element below aluminium in the periodic table.

When Mendeleev produced his periodic table, gallium had not been discovered. He left a gap for gallium below aluminium and predicted the properties of gallium and its compounds.

The table below shows Mendeleev's predictions and the properties we now know gallium to have.

	<b>Mendeleev's prediction</b>	<b>properties of gallium</b>
relative atomic mass	about 68	70
melting point (°C)	low	30
reaction of oxide with acids	forms colourless solution	forms colourless solution

Give one piece of evidence from the table that shows that Mendeleev's predictions were correct.

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 .....  
 (1)



(c) Aluminium oxide and gallium oxide are ionic compounds.

- (i) The formula of aluminium oxide is  $Al_2O_3$ .  
The symbol for an atom of gallium is Ga.

Suggest the formula of gallium oxide.

.....  
**(1)**

- (ii) Calculate the relative formula mass of aluminium oxide,  $Al_2O_3$ .

(relative atomic masses: O = 16, Al = 27)

Answer .....  
**(1)**

- (iii) Predict one property of gallium oxide that is not given in the table.

.....  
.....  
**(1)**

- (d) Mendeleev did not know of the existence of the noble gases.  
Helium and neon are noble gases and do not form any compounds.  
Why do helium and neon not form any compounds?

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.....  
**(1)**

**(Total 7 marks)**

**Q1**



2. Fractions are formed by the fractional distillation of crude oil. In this way too little of the petrol fraction is produced. However, too much of some other fractions is produced and petrochemical companies process these other fractions to produce more petrol.

(a) Large molecules in some crude oil fractions are converted into smaller, more useful ones.

What is the name of the process?

.....  
(1)

(b) The process in (a) produces both alkanes and alkenes.

(i) Bromine water can be used in tests to distinguish between alkanes and alkenes. Bromine water is orange in colour.

Describe what happens when an alkane is shaken with bromine water and when an alkene is shaken with bromine water.

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 .....  
 .....  
 .....  
(2)

(ii) Propane is an alkane.

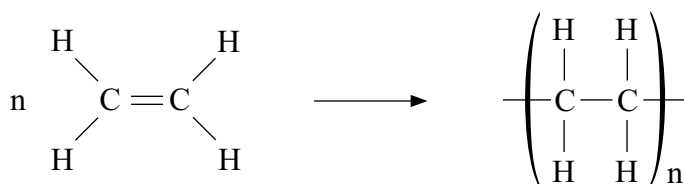
Draw the structural formula of a molecule of propane, showing all covalent bonds.

(2)



(c) Alkenes can be converted into polymers.

(i) Ethene is an alkene which can be converted, under suitable conditions, into poly(ethene).



Explain how molecules of ethene combine together to form a poly(ethene) molecule.

.....  
 .....  
 .....

(2)

(ii) There are several ways of disposing of used polymers. These include burning, putting in a landfill site and recycling for further use.

Why is putting polymers in a landfill site not a good idea?

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 .....

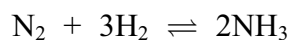
(1)

(Total 8 marks)

Q2



3. Nitrogen and hydrogen react together, under suitable conditions, to form ammonia, NH<sub>3</sub>.



- (a) During the reaction, an equilibrium can be reached.  
Describe one feature of a reaction that has reached equilibrium.

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 .....  
 (1)

- (b) The atom economy of a reaction can be calculated using

$$\text{atom economy} = \frac{\text{mass of useful product}}{\text{total mass of products}} \times 100\%$$

- (i) What is the atom economy of the reaction in which nitrogen and hydrogen form ammonia?

.....  
 .....  
 Answer ..... %  
 (1)

- (ii) Explain a possible advantage of a reaction having a high atom economy.

.....  
 .....  
 .....  
 (1)

- (c) (i) Draw the dot and cross diagram to show the arrangement of the electrons in a molecule of ammonia, NH<sub>3</sub>.  
Show outer electrons only.

(2)



(ii) Give the name of the type of bond between nitrogen and hydrogen atoms in an ammonia molecule.

.....  
(1)

(d) Ammonia has a simple molecular structure.

It is a gas at room temperature. The boiling point of liquid ammonia is  $-34^{\circ}\text{C}$ .

Explain why liquid ammonia has a low boiling point.

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.....  
.....  
(2)

Q3

(Total 8 marks)



4. (a) Rock salt is a valuable raw material.  
It can be extracted from underground deposits, some of which are found in Cheshire.

When molten sodium chloride, NaCl, is electrolysed, ions move to the positive and negative electrodes.

Sodium ions, Na<sup>+</sup>, move to the negative electrode.

- (i) Give the name or formula of the ion that moves to the positive electrode.

..... (1)

- (ii) Write the balanced half equation for the reaction of a sodium ion to form sodium at the negative electrode.

..... (2)

- (iii) Give the electronic configuration of a sodium ion, Na<sup>+</sup>.

..... (1)

- (b) A 1.00 g sample of a titanium chloride contained 0.311 g of titanium.

Calculate the empirical formula of the titanium chloride.

(Relative atomic masses: Ti = 48.0, Cl = 35.5)

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 .....  
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 .....  
 .....

empirical formula = ..... (3)

**(Total 7 marks)**

Q4

**TOTAL FOR PAPER: 30 MARKS**

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