1) A car engine running on petrol produces pollutants which include nitrogen monoxide and carbon monoxide.

(a) Explain how each of these is produced

(i) Nitrogen Monoxide

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……[2]

(ii) Carbon Monoxide

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……[2]

(b) Describe one polluting effect of each of these gases.

(i) Nitrogen Monoxide

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……...[2]

(ii) Carbon Monoxide

……

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……

……[2]

(c) Name one other pollutant produced by a petrol engine and give its polluting effect.

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……..[2]

(d) Catalytic converters are fitted to the exhaust systems of cars to reduce pollutants. The converter contains
. The converter contains a heterogeneous catalyst.

(i) Explain what you understand by the terms heterogeneous and catalyst.

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……[3]

(ii) Write a balanced chemical equation for the reaction between carbon monoxide and nitrogen monoxide to form carbon dioxide and nitrogen

[2]
[Total:15]

2) The yellow lamps which illuminate streets and motorways contain sodium vapour. When the vapour is electrically heated it emits yellow light.

(a) Atoms of naturally-occurring sodium contain 11 protons and 12 neutrons.

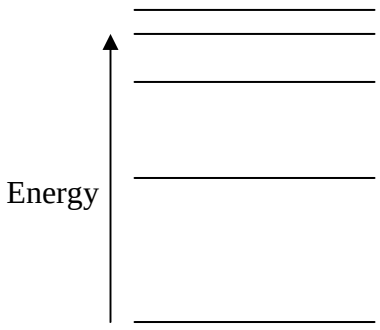
Complete the table below

Particle	Number in atom	Relative mass of each particle	Charge on each particle
Proton	11	1	+1
Neutron	12		
Electron		Very small	

[2]

(b) The lines below represent some of the electron energy levels of sodium atom.

(i) Draw labeled arrows on the diagram to show what happens to an electron when a sodium atom. absorbs energy and then emits light.



[2]

(ii) Explain why sodium vapour emits only certain frequencies of visible light.

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……[4]

(c) Sodium and potassium are in the same group of the Periodic Table.

(i) Give then electron arrangement of sodium and potassium.
(eg the electron arrangement of carbon can be represented as 2.4)

Sodium ……..

Potassium ……..[2]

(ii) Explain why sodium and potassium react in a similar way but potassium is more reactive than sodium.

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…….[3]

[Total: 13]

3) Ethoxyethane, CH_3-CH_2-O-CH_2- CH_3 (Boiling point 35 ºC) was one of the first substances to be used as an anaesthetic.

(a) (i) Draw the full structural formula for ethoxyethane.

[1]

(ii) Name the homologous series to which ethoxyethane belongs.

……..[1]

(iii) Explain why the C-O-C bond angle in ethoxyethane has a value of about 109º.

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……

……

…….[4]

(b) The alcohol CH_3-CH_2- CH_2- CH_2-OH is an isomer of ethoxyethane.

(i) Name this alcohol ……...[2]

(ii) Draw the skeletal formula for this alcohol.

[2]

(iii) Explain what is meant by the term isomer

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……

…….[3]

(c) (i) Construct a balanced equation for the complete combustion of ethoxyethane vapour by filling in the spaces in the equation below.

CH_3-CH_3-O-CH_2- CH_3(g) + …. O_2(g) → ….CO_2(g) + …… H_2O(g) [2]

(ii) Use your equation in (c)(i) to deduce the volume of oxygen which would react exactly with 1.0dm³ of ethoyxethane vapour. Use this value to calculate the approximate volume of air which would be needed for this combustion. Assume that all volumes are measured at the same temperature and pressure.

Volume of oxygen …… dm³

Volume of air ……. dm³ [2]

(iii) Use your equation in (c)(i) and the data in the table below to calculate a value for the enthalpy change of combustion of ethoxyethane.

Bond	Bond enthalpy/KJmol-1
C-C	+347
C-O	+358
C-H	+413
O=O	+498
O-H	+464
C=O	+805

Answer……..[4]

(iv) This answer is not identical to enthalpy change of combustion of ethoxyethane found in a data book. Suggest and explain one reason for this difference.

…….

…….

…….

…….[2]

(v) Use the data in the table for (C)(iii) to say (giving a reason) whether you would expect the C=O bond to be longer, shorter, or about the same length as the C-O.

……

……

……[2]

The main disadvantage of ethoxyethane as an anaesthetic is that it has a low flash-point (the temperature at which a mixture of the vapour and air ignites with).

(d) Suggest why it is dangerous to use an anaestetic with a low flash-point in an operating theatre.

……

……[1]

(e) Scientists are considering using ethoxyethane as a possible alternative to petrol in a car engine. Identify and discuss, in terms of engine performance and safety, three properties of ethoxyethane which they need to take into account. (Do not include pollution issues in your answer)
(In this question, 1 mark is available for the quality of written communication)

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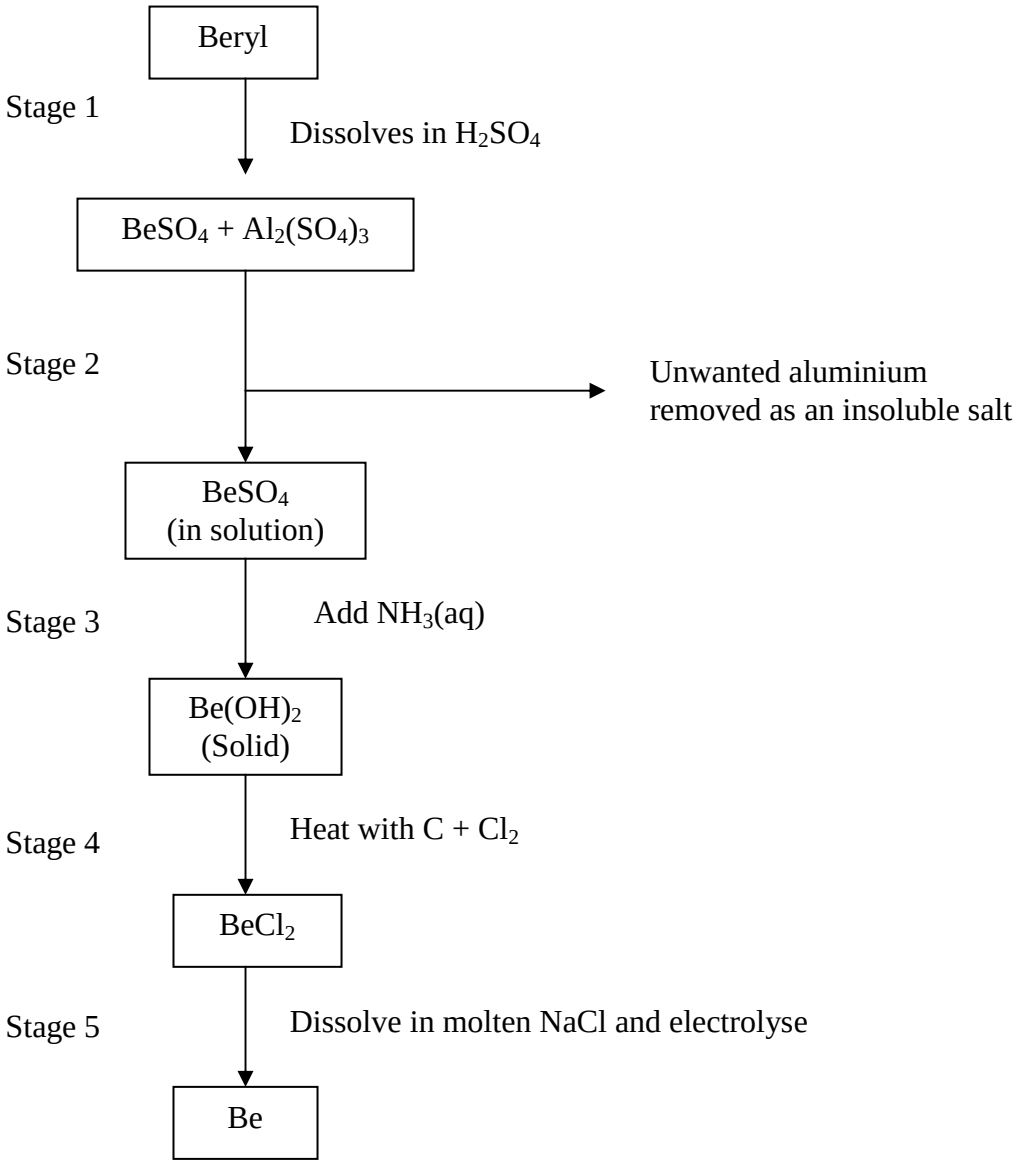
……[7]

[Total: 33]

4) The element beryllium, Be, is at the top of Group 2 of the periodic table. It is a fairly hard, grey metal which is used for 'windows in X-ray apparatus. When Chadwick bombarded beryllium with alpha particles in 1932, he obtained the first evidence for the existence of neutrons. A mixture of radium and beryllium is still sometimes used as a source of neutrons.

Beryllium metal is made from its ore, beryl, as follows.



(a) (i) By considering stage 1 in the diagram, name an element (other than beryllium) which must be present in beryl

……[1]

(ii) Suggest a technique for separating beryllium sulphate from the aluminium salt in stage 2

……[1]

(iii) Complete the equation for the reaction in stage 4:

$Be(OH)_2 + C + Cl_2 \rightarrow BeCl_2 + CO +$ …… [1]

(iv) From your knowledge of the trends in group 2, predict the solubility in water of beryllium hydroxide as very soluble, fairly soluble or 'insoluble give your reason why.

……

……..[2]

(b) (i) Beryllium chloride, $BeCl_2$, can exist as covalent molecules. Draw a dot-cross diagram for a beryllium chloride molecule, showing the outer electrons only.

[2]

(ii) Predict the shape of a beryllium chloride molecule.

……..[2]

(c) Magnesium is directly below beryllium in the periodic table but, unlike beryllium chloride, magnesium chloride is ionic.
One factor that affects whether a Group 2 compound is ionic or covalent is the enthalpy change of the process shown below.

$M(g) \rightarrow M^{2+}(g) + 2e^-$ (where M is a Group 2 metal). Equation 4.1

(i) The process in Equation 4.1 can be thought of as taking place in two stages.

The first stage can be represented as $M(g) \rightarrow M^+(g) + e^-$

Write an equation (with state symbols) for the second stage and name the enthalpy change involved.

Equation ……..

Name of enthalpy change ……

……..

……..[3]

(ii) Suggest which of magnesium or beryllium has the higher value of enthalpy change of
$M(g) \rightarrow M^{2+}(g) + 2e^-$
What information in (c) supports your answer?

……..

……..

……..[1]

(d) A sample of magnesium has three isotopes as show in the table.

Mass Number	%
24	70
25	19
26	11

(i) Explain (in terms of protons and neutrons) what the term isotope means using the isotopes of magnesium as examples (Magnesium has an atomic number of 12.)

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……[3]

(ii) Calculate the relative atomic mass of this sample of magnesium (to one decimal place) using this data.

Answer…….[3]

(e) Another beryllium compound has the percentage composition by mass shown in the table. The relative atomic masses of the elements present in the compound dare also shown. Calculate the formula of the compound.
Show your working.

Element	Ar	%
Be	9.0	12.9
C	12.0	17.3
O	16.0	69.8

Answer……..[3]

(f) When Chadwick bombarded beryllium with alpha particles, neutrons were released. Complete the following nuclear equation for this processs by writing numbers on the dotted lines.

……. ^{9}Be + $^{\cdots\cdots}$He → …. ^{12}C + $^{\cdots\cdots}$n

***** Helium and the neutron suppose to have a dotted line above them the 9 on ^{9}Be is the mass number

(g) The alpha particles were obtained from the decay of radium -226

(i) What name is given to unstable isotopes like radium-226?

…….[1]

(ii) Write the nuclear equation for the decay of radium-226.

[3]
[Total:29]
[Final Total:90]