(c) Extension parts of the syllabus

Some parts of the syllabus form the extension. Only questions in Section B of the examination paper will involve these parts.

Sections	Topics of the extension part
1 Planet Earth	—
2 The Microscopic World	• Predicting the chemical properties of unfamiliar elements in Groups I, II, VII and 0 of the Periodic Table
3 Metals	• Empirical formulae derived from experimental data • Corrosion resistance of aluminum • Anodisation as a method to enhance corrosion resistance of aluminium
4 Acids and Alkalis	• Strength of acids and alkalis • Preparation of soluble and insoluble salts based on neutralisation • Simple volumetric work involving acids and alkalis • Rate of reaction
5 Chemical Cells and Electrolysis	• Nitric acid of different concentrations as oxidizing agent to give NO and NO_2 • Reactions in chemical cells consisting of half cell(s) other than metal-metal ions systems • Reactions in zinc-carbon cell • Electrolysis
6 Products from Important Processes	• Manufacture of chlorine by electrolysis of brine • Designing and performing experiments to make chlorine bleach • Molar volume of gases at room temperature and pressure • Calculations involving molar volume of gases • Chemical plants
7 Fossil Fuels and Carbon Compounds	—
8 Plastics and Detergents	• Condensation polymerization as exemplified by the formation of nylon and polyester • Production of soaps by reacting fats or oils with an alkali • Cleaning abilities of soaps and soapless detergents in hard water • Environmental problems associated with the use of detergents
9 Detection and Analysis	• Designing and performing an investigation to deduce the chemical nature of a given sample

9 Detection and Analysis

Concept Map

Detection and **Analysis**

Separation of mixtures

Paper chromatography
• Chromatography can be used to separate two or more solutes (solids) which are soluble in the same solvent.

Evaporation, filtration and crystallization
• Evaporation (see (a)) is the method of separating soluble solids from a solution.
• Filtration (see (b)) is the method of separating insoluble substances from a solution.
• Crystallization (see (c)) is the method of separating a soluble salt from a solution.

(a) heat

(b) filtrate

(c) crystals of solute
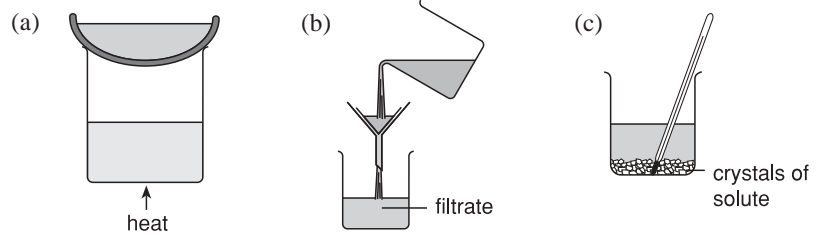
Simple distillation and fractional distillation
• Simple distillation (see (a)) is used to separate a single liquid from one or more solids in a solution.
• Fractional distillation (see (b)) is used to separate a mixture of miscible liquids.
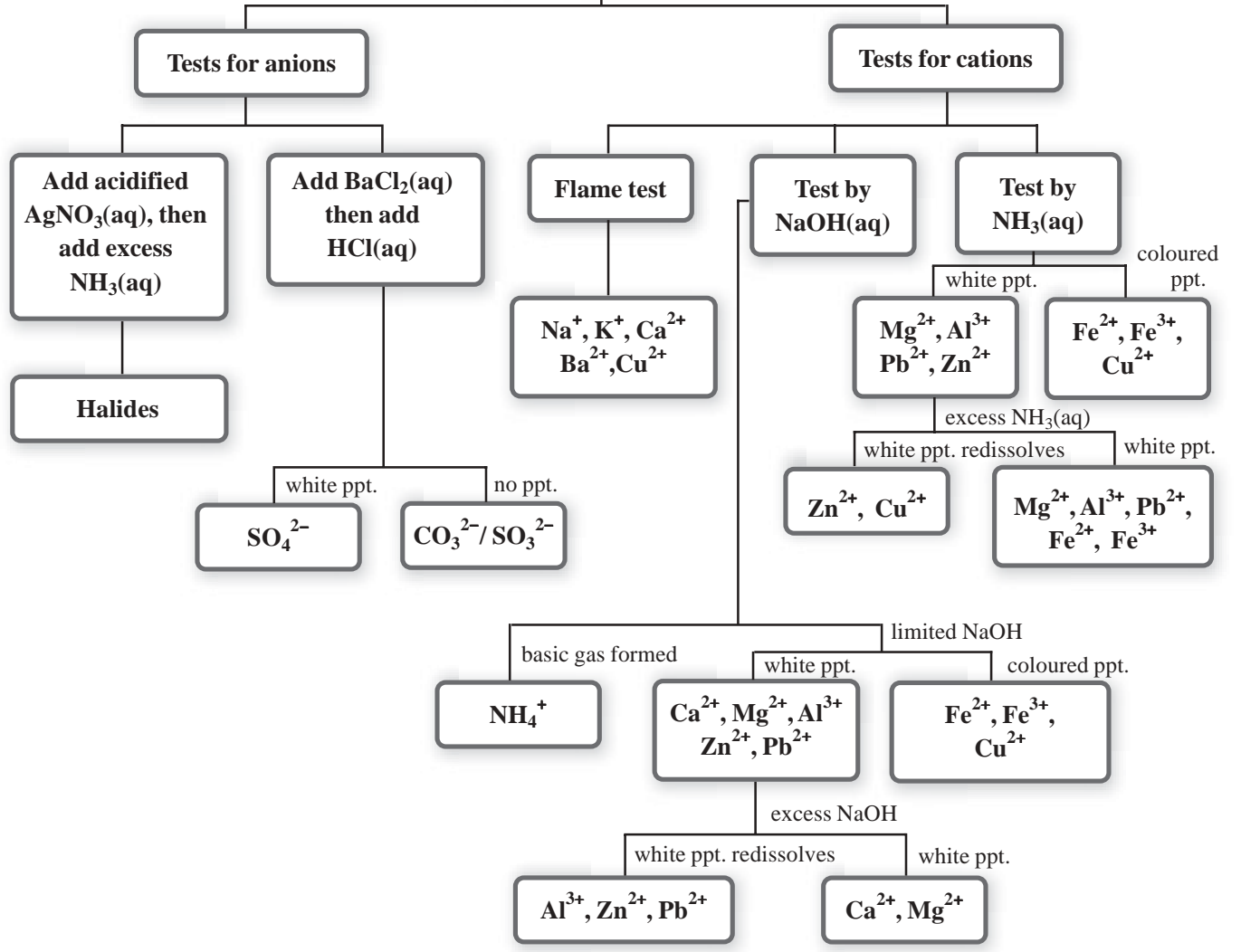
(a) heat gently

(b) heat gently

Test for substances
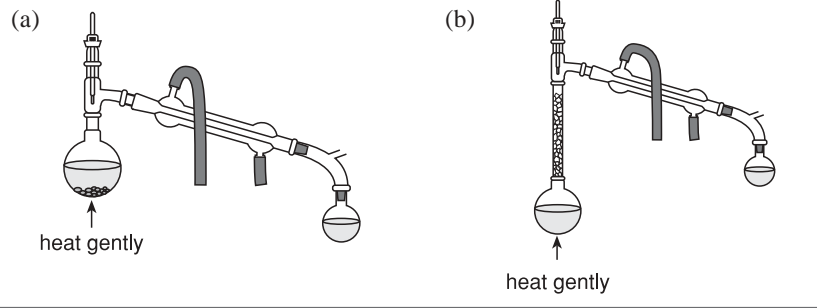
Tests for gases or vapours
Oxygen, hydrogen, carbon dioxide, sulphur dioxide, ammonia, chlorine, water and nitrogen

Tests for ions

Tests for anions

Add acidified AgNO$_3$(aq), then add excess NH$_3$(aq)

Halides

Add BaCl$_2$(aq) then add HCl(aq)

white ppt.
SO$_4$$^{2-}$

no ppt.
CO$_3$$^{2-}$/ SO$_3$$^{2-}$

Tests for cations

Flame test

Na$^+$, K$^+$, Ca^{2+} Ba^{2+},Cu^{2+}

Test by NaOH(aq)

Test by NH$_3$(aq)

white ppt.
Mg^{2+}, Al^{3+} Pb^{2+}, Zn^{2+}

coloured ppt.
Fe^{2+}, Fe^{3+}, Cu^{2+}

excess NH$_3$(aq)
white ppt. redissolves
Zn^{2+}, Cu^{2+}

white ppt.
Mg^{2+},Al^{3+},Pb^{2+}, Fe^{2+}, Fe^{3+}

basic gas formed
NH$_4$$^+$

limited NaOH
white ppt.
Ca^{2+}, Mg^{2+}, Al^{3+} Zn^{2+}, Pb^{2+}

coloured ppt.
Fe^{2+}, Fe^{3+}, Cu^{2+}

excess NaOH
white ppt. redissolves
Al^{3+}, Zn^{2+}, Pb^{2+}

white ppt.
Ca^{2+}, Mg^{2+}

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7.4 Alkenes

Learning Focus

- Study the systematic naming of alkenes.
- Outline the physical and chemical properties of alkenes.
- Learn the uses of alkenes.

A. Introduction of alkenes

- Alkenes（烯烴）are unsaturated hydrocarbons（不飽和烴）with a C = C double bond.

- They form another homologous series with the general formula of C_nH_{2n}.

- They can be obtained from the cracking of petroleum.

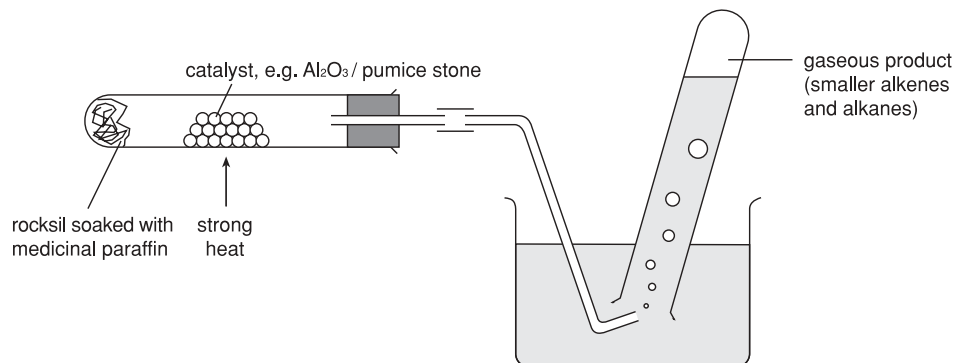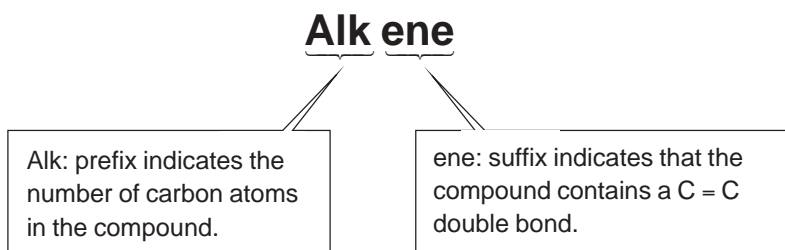- The following set-up is used for cracking medicinal paraffin:

catalyst, e.g. Al_2O_3 / pumice stone

gaseous product (smaller alkenes and alkanes)

rocksil soaked with medicinal paraffin

strong heat

Figure 7.10

B. The naming of alkenes

(a) Straight chain alkenes

- The general formula of alkenes is C_nH_{2n}.

- The name of a straight chain alkene is composed of a prefix and a suffix.

Alk ene

Alk: prefix indicates the number of carbon atoms in the compound.

ene: suffix indicates that the compound contains a C = C double bond.

C. The preparation of soap `Extension`

- By heating a mixture of animal fats or vegetable oils and concentrated sodium hydroxide solution, glycerol（甘油）and soap（肥皂）are formed.
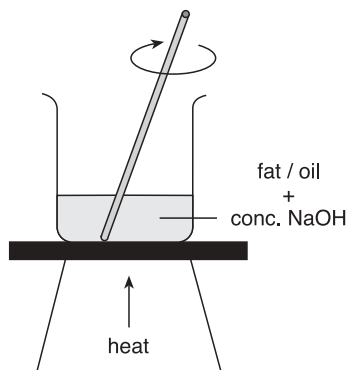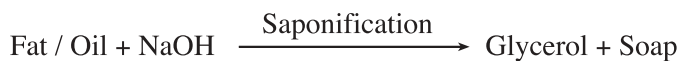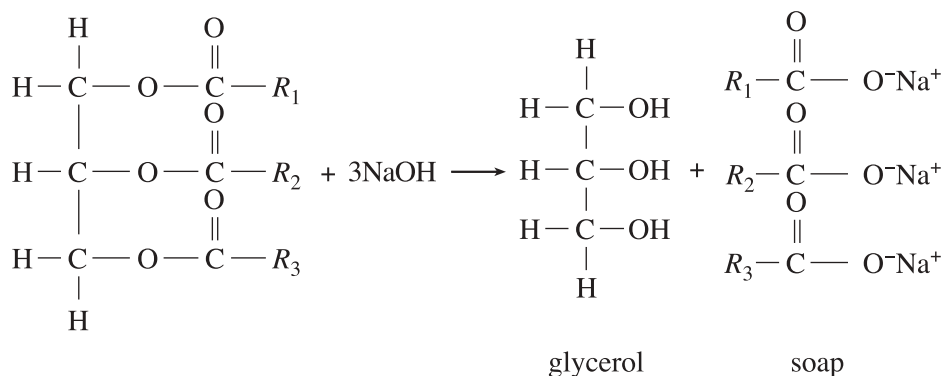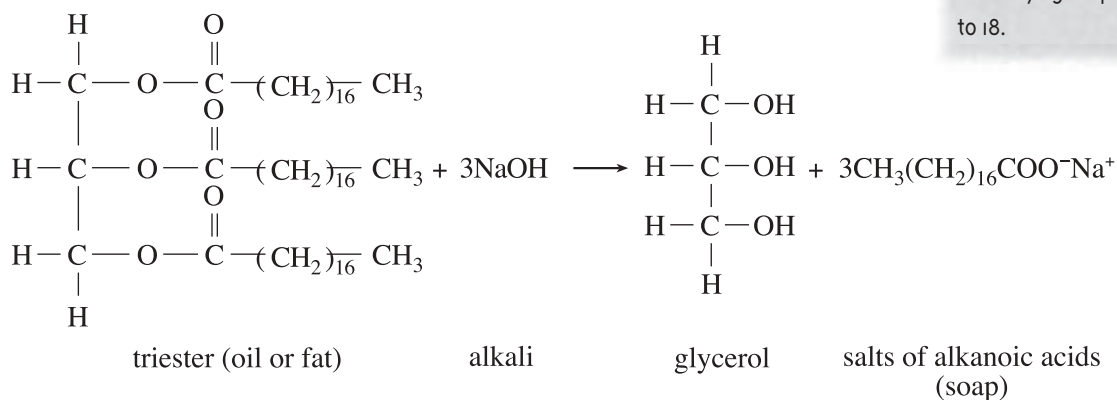
$$\text{Fat / Oil} + \text{NaOH} \xrightarrow{\text{Saponification}} \text{Glycerol} + \text{Soap}$$

fat / oil
+
conc. NaOH

heat

Figure 8.21

> **Reminder**
> - Potassium hydroxide solution can be used instead of sodium hydroxide solution.
> - Saponification（皂化作用）is a process which is used for making soap.

- The equation of the formation of triester（三酯）(oil or fat) is as follows:

glycerol   soap

All alkyl groups in triester or soap may or may NOT be equal, i.e. $R_1 = R_2 = R_3$ or $R_1 \neq R_2 \neq R_3$.

> **Reminder**
> The best carbon range in the alkyl group is from 13 to 18.

- For example, if $R_1 = R_2 = R_3 = (CH_2)_{16}CH_3$:

triester (oil or fat)   alkali   glycerol   salts of alkanoic acids (soap)

Guided Example 1

Styrene was heated with kerosene at 150°C for 45 minutes as shown in the following figure. After cooling, the mixture was poured into about five times its own volume of methanol. A white solid formed under the surface of the methanol.
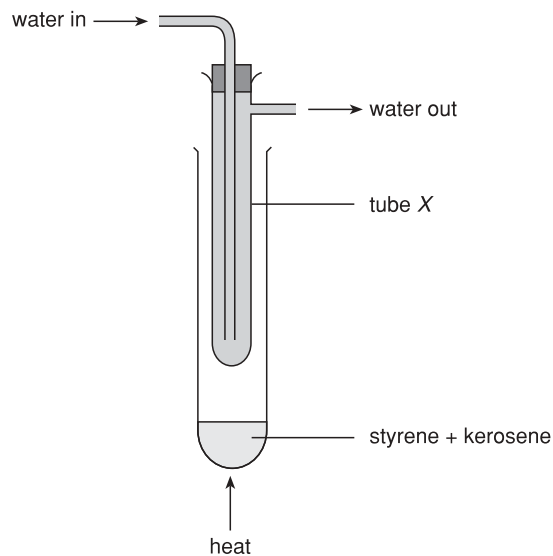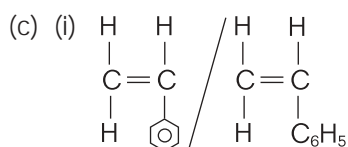
water in →

water out

tube *X*

styrene + kerosene

heat

Figure 8.1

> **Reminder**
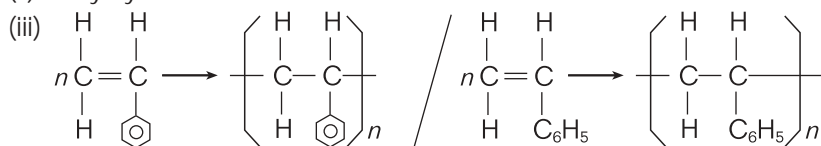> Students should know how to draw this experimental set-up, which may be set in the HKCEE.

(a) (i) The mixture was heated by using an electric heating mantle. Explain briefly.

(ii) What was the function of tube *X* in the above set-up?

(b) What was the function of kerosene in the experiment?

(c) (i) Write the structural formula of styrene.

(ii) Name the white solid.

(iii) Write an equation for the formation of this white solid.

(iv) Draw the structure for the repeating unit of the white solid.

> **Reminder**
> Most plastics are white solids.

Suggested Answer

(a) (i) This is because kerosene is *flammable*.

(ii) Tube *X* is used as a *condenser / cold finger*.

(b) Kerosene acts as a *catalyst* or *solvent* for the reaction.

(c) (i)

(ii) Polystyrene

(iii)

> **Reminder**
> In part (a)(i), 'kerosene is inflammable' is also acceptable.

(2) <u>Demand for products</u>

  – If there is a demand for the chemical products in nearby areas (e.g. Mainland China), the transportation costs will be reduced.

(3) <u>Environmental impact</u>

  – Chemical plants usually release chemical wastes such as acid, toxic chemicals, etc. This leads to serious environmental pollution of different types.

  – Hong Kong is an overcrowded city. Any serious leakage of pollutants or chemicals, or explosions, would be dangerous and disastrous for nearby residents.

Glossary

Avogadro's Law	亞佛加德羅定律	hydrochloric acid	氫氯酸
brine	濃鹽水	hypochlorite ion	次氯酸根離子
catalyst	催化劑	hypochlorous acid	次氯酸
chlorine	氯	mercury cell	汞電解池
chlorine bleach	氯漂白劑	molar volume	摩爾體積
chlorine water	氯水	oleum	發煙硫酸
Contact process	接觸法	sodium amalgam	鈉汞齊
dehydrating agent	脫水劑	sodium hypochlorite	次氯酸鈉
diaphragm cell	隔膜電池	sulphur dioxide	二氧化硫
drying agent	乾燥劑	sulphuric acid	硫酸
heptane	庚烷	sulphurous acid	亞硫酸
hydrated salt	水合鹽		

Important Formulae

Molar volume of any gas = $24 \text{ dm}^3 \text{ mol}^{-1}$

Number of moles of a gas $= \dfrac{\text{Volume of gas}}{\text{Molar volume}}$

$= \dfrac{\text{Volume of gas (dm}^3)}{24 \text{ dm}^3 \text{ mol}^{-1}}$

Exam Question Analysis

Topics	Conventional Questions (Year)	Multiple-choice Questions (Year)
Chlorine and hypochlorite	93(5b), 95(8b), 97(8a), 98(9b), 02(9b), 04(9av)	94(21), 96(30, 31), 97(21), 98(42), 00(47), 03(44), 04(18, 22, 36)
Sulphuric acid and sulphur dioxide	94(8b), 96(8biii), 97(6b), 98(8a), 99(9a), 00(8cii), 01(9c, d), 03(7ci), 04(7ci)	93(25), 94(38), 95(13, 38), 96(37), 97(29, 36, 39, 45), 98(30, 32, 38), 99(24), 00(44, 45), 01(35), 02(30, 31, 38, 41), 03(22, 24, 39), 04(19, 32, 47)
Molar volume of gases	03(6aiv), 04(8aii)	96(11, 19, 32), 97(34), 98(46), 99(16), 00(48), 01(27), 02(16), 03(6), 04(3, 6, 21)
Chemical plants	——	——

Demonstration

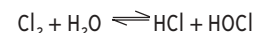## Paper I   Conventional Questions

Section A

1. A student performed experiments on chlorine-containing substances and obtained the following results:

Experiment	Procedures	Results
I	Dilute hydrochloric acid was added to bleaching solution and heated.	A greenish-yellow gas X was evolved.
II	Gas X was passed into sodium hydroxide solution.	Gas X dissolved into the sodium hydroxide solution completely.
III	Gas X was bubbled into sodium bromide solution, then tetrachloromethane was added to the solution.	Two layers of liquids were obtained.
IV	Gas X was bubbled into iron(II) sulphate solution.	The iron(II) sulphate solution turned yellowish-brown.

Guidelines
Chlorine gas is acidic.
$$Cl_2 + H_2O \rightleftharpoons HCl + HOCl$$
Thus, it can react with NaOH.

Guidelines
Iron(II) ions have reducing power:
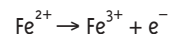$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$

Table 6.11

Demonstration

Paper I   Conventional Questions

Section A

1. The flow-chart below shows the formation of polyethene food wrap from crude oil:
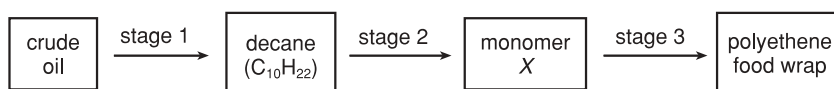
| crude oil | stage 1 → | decane ($C_{10}H_{22}$) | stage 2 → | monomer *X* | stage 3 → | polyethene food wrap |

Figure 8.29

(a) Suggest how to obtain decane from crude oil in stage 1.

(b) (i)   What are the TWO main processes involved in stage 2?
    (ii) Name the monomer *X*.
    (iii) Write an equation for the formation of monomer *X* from decane. (Assume that the cracking of decane gives monomer *X* and alkane *Y* only.)

(c) What are the TWO main processes involved in the production of polyethene food wrap from monomer *X* in stage 3?

(d) Calculate the percentage by mass of carbon in polyethene.

(9 marks)

> **Guidelines**
> The relative atomic masses can be obtained from the Periodic Table provided.

Suggested Answer

(a) By *fractional distillation* of crude oil 1

(b) (i)   *Cracking* of decane 1
        Monomer *X* can be obtained from the mixture (in cracking)
        by *fractional distillation*. 1
    (ii) Ethene 1
    (iii) $C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$ 1

(c) Monomer *X* is converted to polyethene by *addition polymerization*. ... 1
    Polyethene is then *moulded* to produce the polyethene food wrap. ... 1

(d) % by mass of carbon in polyethene
    $$= \frac{12 \times 2}{12 \times 2 + 4 \times 1} \times 100\%$$ 1
    $= 85.7\%$ 1

> **Guidelines**
> The total atomic masses of the repeating unit of polyethene.

Paper II   Multiple-choice Questions

Section A

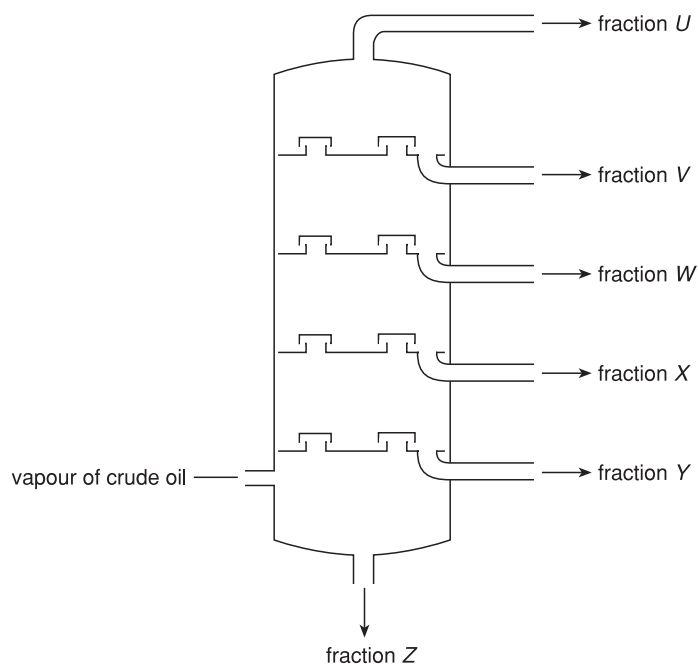Questions 1 and 2 refer to the following diagram, which shows a fractionating column used in the petroleum industry:

Figure 7.28

> **Guidelines**
> Higher levels (lower fractions) contain smaller number of carbon atoms.

1. Which of the following statements is correct?

    A. Fraction U has the lowest boiling point.
    B. Fraction W is more volatile than fraction U.
    C. Fraction Y burns with a more sooty flame than fraction V.
    D. Fraction Z is the least viscous.

Answer: A

2. Which of the following statements is correct?

    A. Fraction U is used for motor car fuel.
    B. Fraction W is used for jet aeroplane fuel.
    C. Fraction Y is used for surfacing roads.
    D. Fraction Z is used for the manufacture of town gas.

Answer: B

> **Guidelines**
> U is petroleum gas.
> V is petrol or naphtha.
> W is kerosene.
> X is gas oil.
> Y is fuel oil.
> Z is bitumen.

Practice

Paper I Conventional Questions

Section A

1. For each of the following experiments, state an expected observation and write a chemical equation for the reaction involved.

   (a) Chlorine gas is bubbled into a potassium bromide solution.
   (b) Concentrated sulphuric acid was added dropwise to some sugar cube.
   (c) Sulphur dioxide was bubbled into an acidified potassium dichromate solution.
   (d) Dilute hydrochloric acid was added to chlorine bleach.

   (8 marks)

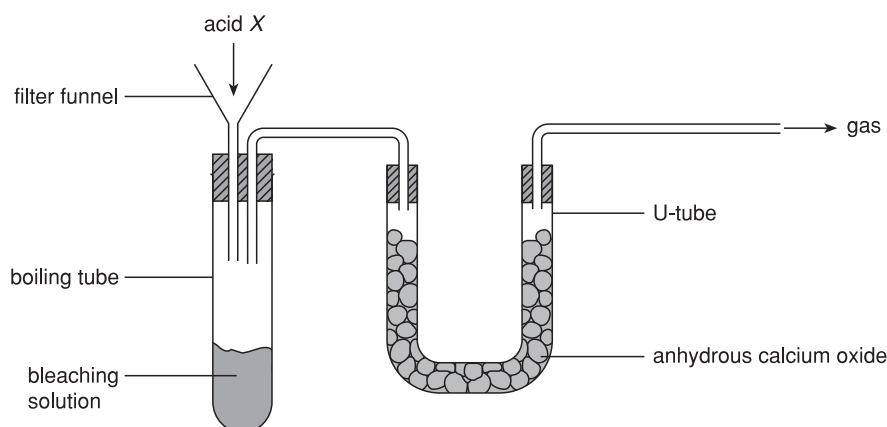2. The following set-up illustrate how to prepare the gas Y:

Figure 6.40

   (a) (i) Name the acid X used.
       (ii) Write an equation for the reaction in boiling tube.
       (iii) Explain whether this reaction is an example of a redox reaction.

   (b) There are TWO mistakes in the above set-up.
       (i) What are they?
       (ii) Suggest how each of the TWO mistakes could be corrected.
       (iii) Draw a diagram to show how a jar of the gas Y can be collected.

   (c) What would be observed if the gas Y is passed into test tubes containing aqueous solution of a reddish-purple vegetable dye? Write an equation for the reaction involved.

   (11 marks)

Question Commands

The following table lists the question command(s) which showing the requirements of answering questions:

Question commands	Examples
What / Which ... (Simple answer is usually required.)	What gas evolves? Correct answer: Sulphur dioxide / SO_2 What is the direction of electron flow in the external circuit? Correct answer: From left to right Which of the following compounds can be used to make an addition polymer? Correct answer:
Suggest a formula ...	The oxide of aluminium is insoluble in water, suggest the formula for this oxide. Correct answer: Al_2O_3 Incorrect answer: Aluminium oxide
Name ... (Formula / Structure is NOT accepted.)	Name an element which is a metalloid. Correct answer: Boron Incorrect answer: B
Write the chemical equation ... (Although either chemical / ionic equation is accepted. The best answer should be a chemical equation.)	Write a chemical equation for the reaction when adding dilute hydrochloric acid to zinc granules. Correct answer: $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ (chemical equation) Poor answer: $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$ (ionic equation)
Write the chemical equation ...	Write a chemical equation for the reaction between sodium and water. State symbols should be given. Correct answer: $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$ (Score 2 marks) Poor answer: $2Na + 2H_2O \rightarrow 2NaOH + H_2$ (Score 1 mark only) (Remarks: 1 mark for equation and 1 mark for state symbols)
Write an ionic equation ...	Write an ionic equation for the reaction when adding hydrochloric acid to sodium carbonate. Correct answer: $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$ Incorrect answer: $2HCl + Na_2CO_3 \rightarrow H_2O + CO_2 + 2NaCl$