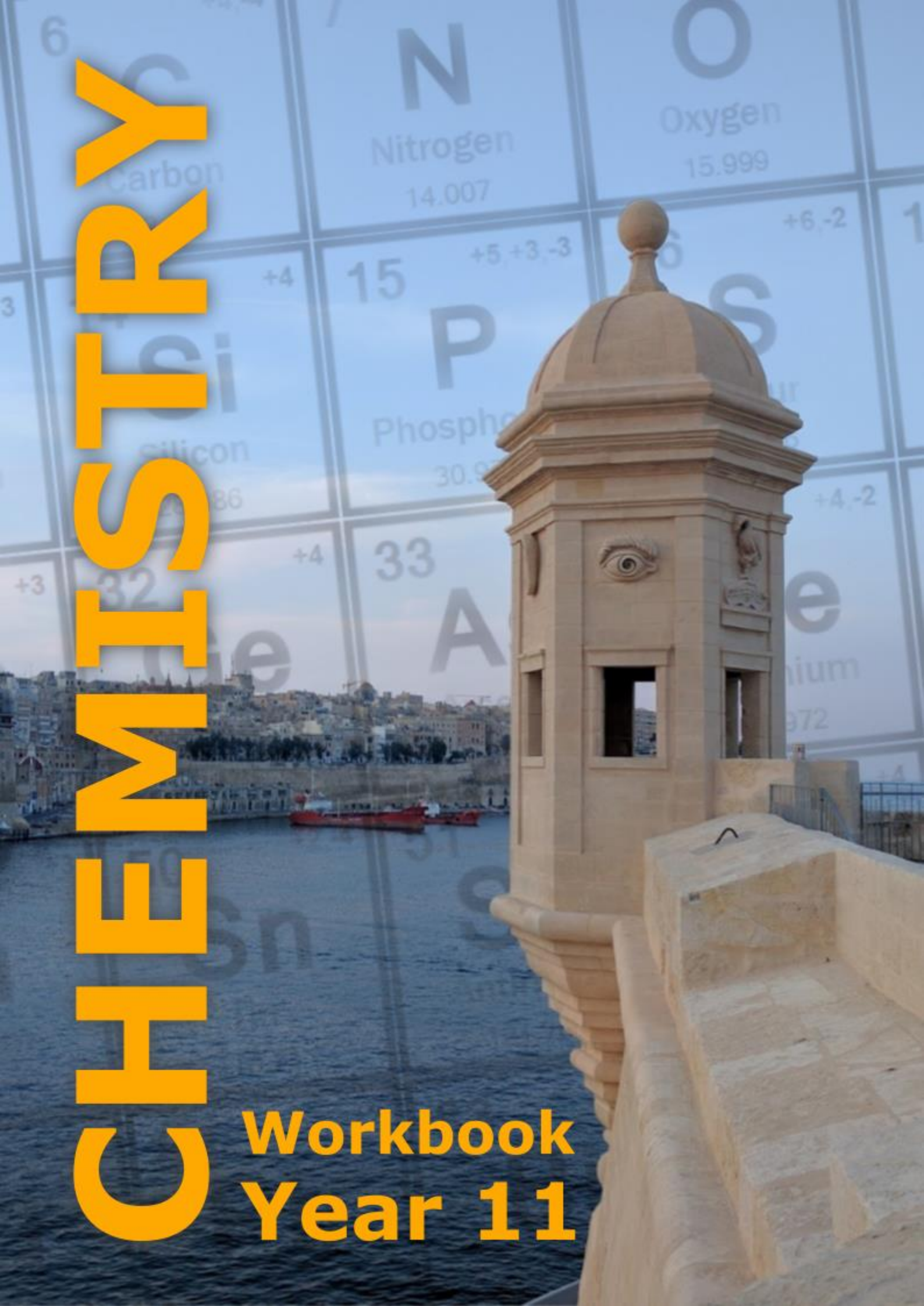
CHEMISTRY
Workbook
Year 11

This workbook will be available in digital format (PDF) only. It is intended to be used by secondary school students and teachers in Malta and Gozo. This workbook is a companion to the Chemistry Year 11 textbook.

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Acknowledgements

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Michael Mercieca (EO) contributed towards the compilation of this workbook.

How to use this workbook

The exercises found in this workbook are structured in a way that is closely linked to the Chemistry textbook. In fact, the headings in this workbook run parallel to those in the textbook. This to allow easy access for both students and teachers.

Contents

1 Identification of soluble substances and measurement of their concentration - LO 7

1.1 Chromatography

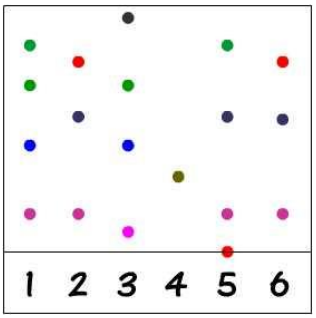
1) Chromatography can be used to _____ mixtures of coloured compounds. (1)

2) For a coloured compound to travel up the chromatography paper it needs to be _____ in the solvent. (1)

3) Chromatography was carried out on six sweets.

a) Which sweet contains one dye? _____ (1)

b) Complete a table of results to show which two sweets probably contain the same mixture of dyes. Show your working on the chromatogram.



Dye	Sweets

(4)

c) Explain why one of the dyes from sweet 5 is on the base line.

_____ (1)

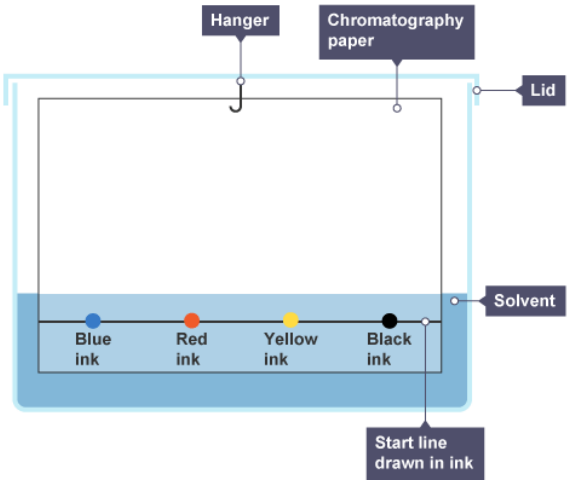
d) Water was used as a solvent in this experiment. Suggest whether the same result would be obtained if ethanol is used as a solvent. Explain your answer.

_____

_____ (2)

4) A student set up a chromatogram as shown in the diagram below.

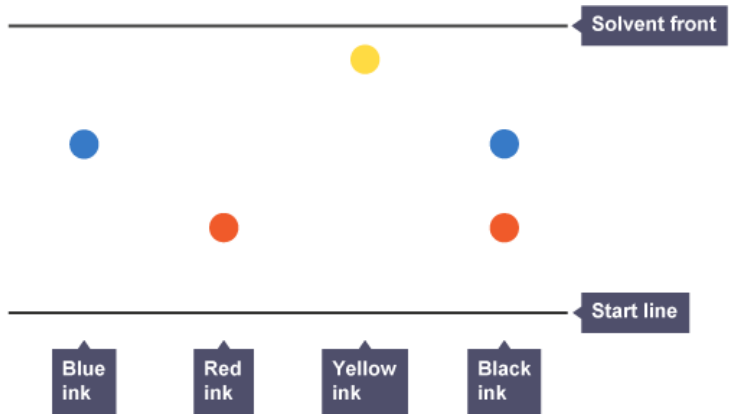
a) What mistakes in the setup can you recognise?



_____

_____ (2)

b) The student then set up the apparatus without making any mistakes. The chromatogram obtained is shown below. State which of the inks is a compound and give its constituent inks.



_____

_____ (2)

1.2 Identifying gases, cations, and anions

1) Identify the following substances. Give balanced chemical equations including state symbols for all chemical changes involved.

a) Compound A gives no visible change on addition of sodium hydroxide solution. A is soluble and on addition of acidified silver nitrate gives a white precipitate. A imparts a golden yellow colour on heating it in a blue Bunsen flame.

Compound A: _____ (2)

_____

_____ (3)

b) Compound B liberates ammonia on addition of sodium hydroxide solution. A solution of compound B gives a white precipitate when mixed with acidified barium chloride solution.

Compound B: _____ (2)

_____

_____ (6)

c) On addition of hydrochloric acid, compound C liberates gas D which turns limewater milky. Compound C imparts a lilac colour to a flame.

Compound C: _____ (2)

Gas D: _____ (1)

_____ (3)

2) What test/s would you carry out to identify the following substances? Include the expected observations in your answers.

a) Hydrogen gas:

_____

_____ (2)

b) Ammonia gas

_____

_____ (2)

c) Chlorine gas

_____

_____ (2)

d) Copper(II) sulfate

_____

_____

_____

_____ (4)

e) Lithium bromide

_____

_____

_____

_____ (4)

3) The table below shows a number of tests which were carried out on compounds 'A' to 'H'. All observations made from these tests are included in the table. (n/a means test was not carried out.)

	Appearance	Add HCl(aq)	Add NaOH(aq)	Flame test	Add acidified $BaCl_2$(aq)	Add acidified $AgNO_3$(aq)	Add KI(aq)	Add NaOH(aq) and aluminium while heating
A	White powder	n/a	No visible change	Golden yellow coloration	White precipitate that reacts with acid to give a pungent smelling gas	n/a	n/a	n/a
B	White powder	Gives a gas that turns lime water milky	No visible change	Orange red flame	n/a	n/a	n/a	n/a
C	White crystalline solid	n/a	White precipitate, insoluble in excess	No visible change	White precipitate that does not react with acid	n/a	n/a	n/a
D	White crystalline solid	n/a	White precipitate, soluble in excess	n/a	n/a	n/a	No visible change	Gas released which turns damp red litmus blue
E	Bluish-green crystals	n/a	Blue precipitate, insoluble in excess	n/a	n/a	White precipitate	n/a	n/a
F	Yellowish crystals	n/a	Rust brown precipitate	n/a	No visible change	Cream precipitate	n/a	n/a
G	White crystalline solid	n/a	White precipitate, soluble in excess	n/a	n/a	n/a	Yellow precipitate	Gas released which turns damp red litmus blue
H	White crystalline solid	n/a	On heating, a pungent gas that turns red litmus blue is liberated	No visible change	n/a	Pale yellow precipitate	n/a	n/a

a) Identify each compound in the table from the observations of the tests carried out.

i) A: _____ (2)

ii) B: _____ (2)

iii) C: _____ (2)

iv) D: _____ (2)

v) E: _____ (2)

vi) F: _____ (2)

vii) G: _____ (2)

viii) H: _____ (2)

b) Write a balanced chemical equation, including state symbols, of compound A with dilute hydrochloric acid.

_____ (3)

c) Write a net ionic equation of compound C with barium chloride solution.

_____ (3)

d) Write a net ionic equation of compound E with sodium hydroxide solution.

_____ (3)

e) Write a net ionic equation of compound G with aqueous potassium iodide.

_____ (3)

f) Write an equation, including state symbols, of compound H with aqueous silver nitrate.

_____ (3)

4) The letters A to F refer to six gases.

A: carbon dioxide	B: oxygen	C: hydrogen
D: ammonia	E: chlorine	F: water vapour

Use the letters A to F to answer the following questions. Each letter may be used once, more than once or not at all. Select, from A to F: (8)

A colourless gas that forms a white precipitate when bubbled through calcium hydroxide solution.	
A colourless pungent gas which forms dense white fumes when placed near concentrated hydrochloric acid.	
A colourless odourless gas which relights a glowing splint.	
A coloured gas which first turns moist blue litmus red then bleaches it.	
A colourless pungent gas which turns moist red litmus blue.	
A colourless odourless gas that burns with a popping sound when a lit splint is applied.	
A colourless pungent gas which is produced when dilute aqueous NaOH is added to an aqueous ammonium salt and the mixture is heated.	
A colourless gas which turns anhydrous copper(II) sulfate from white to blue.	

5) The letters A to F refer to six solid substances.

A: copper(II) sulfate	B: iron(II) chloride	C: iron(III) hydroxide
D: copper(II) oxide	E: iodine	F: graphite

a) Use the letters A to F to identify the substances from their descriptions. Each letter may be used once or more than once. (7)

- A black, dull, ionic substance. _____
- A black, shiny, brittle substance that conducts electricity. _____
- A crystalline, covalent substance. _____
- A substance whose hydrated form is crystalline and blue. _____
- A substance that will give a green solution when dissolved in water. _____
- A solid which is insoluble in water which is rusty brown in colour. _____
- A solid whose anhydrous form is used to test for the presence of water. _____

b) When a solution of iron(II) chloride is added to a solution of sodium hydroxide, a solid precipitate is produced.

i) Write a balanced chemical equation for the reaction, including state symbols.

_____ (3)

i) What colour would you expect this precipitate to be?

_____ (1)

c) Copper(II) oxide can be produced from the vigorous heating of copper(II) carbonate. Carbon dioxide is also produced in this decomposition.

i) State the colour change you would observe during this reaction.

_____ (1)

ii) Describe how you would test for the gas in part c) i) and state what you would observe. Include a balanced chemical equation that explains these observations.

_____

_____

_____

_____ (5)

1.3 Titrations and calculations involving concentrations

1) Find the concentration of a sample of hydrochloric acid if 2 moles of hydrogen chloride gas were dissolved in 4 dm^3 of water.

_____

_____

_____ (2)

2) Find the concentration of a salt solution if 0.75 moles of sodium chloride were dissolved in 1500 cm^3 of water.

_____

_____

_____ (2)

3) How many moles of substance are present in 50 dm^3 of sulfuric acid of concentration 0.5 mol dm^{-3}?

_____

_____

_____ (2)

4) 0.03 moles of sodium hydroxide are needed for an experiment. What volume of a 0.1 mol dm^{-3} solution of sodium hydroxide must be used?

_____

_____

_____ (2)

5) 212 g of sodium carbonate were dissolved in 2000 cm^3 of water. Find the concentration of the solution in mol/dm^3.

_____

_____

_____ (4)

6) 100 g of copper(II) sulfate pentahydrate were dissolved in 0.4 dm^3 of water. Calculate the concentration of the copper(II) sulfate solution.

_____

_____

_____ (4)

7) 500 cm^3 of potassium carbonate solution of concentration 0.8 mol/dm^3 were evaporated to dryness. What mass of potassium carbonate should be obtained?

_____

_____

_____ (3)

8) In an experiment, 18.625 g of potassium chloride need to be prepared by reacting 0.1 mol dm^{-3} potassium hydroxide with 0.2 mol dm^{-3} hydrochloric acid. Calculate:
   a) the quantity in moles of potassium chloride that must be prepared.

_____

_____ (2)

   b) the mass in grams of potassium hydroxide needed for this preparation.

_____

_____

_____ (2)

   c) the volume of potassium hydroxide needed.

_____

_____

_____ (2)

   d) the volume of hydrochloric acid needed.

_____

_____

_____ (2)

9) 15 cm^3 of hydrochloric acid of unknown concentration required 25 cm^3 of potassium hydroxide of concentration 1.00 mol dm^{-3} for complete neutralization. Calculate the concentration of the hydrochloric acid solution.

_____

_____

_____

_____

_____

_____

_____ (6)

10) 35 cm^3 of sodium hydroxide of unknown concentration required 10 cm^3 of phosphoric acid, H_3PO_4, of concentration 0.70 mol dm^{-3} for complete neutralization. Calculate the concentration of the sodium hydroxide solution.

_____

_____

_____

_____

_____

_____

_____ (6)

11) What volume of sodium hydroxide solution of concentration 1.50 mol dm^{-3} would be required to neutralize 45 cm^3 of sulfuric acid of concentration 1.00 mol dm^{-3}?

_____

_____

_____ (3)

12) 50 g of pure potassium carbonate were dissolved in 250 cm^3 of water. 25 cm^3 of this solution was required to neutralize 30 cm^3 of hydrochloric acid of unknown concentration.

a) How many moles of potassium carbonate are present in 50 g?

_____

_____

_____ (2)

b) If these 50 g were dissolved in 250 cm^3 of water, what would be the concentration of the resultant solution?

_____

_____

_____ (3)

c) Hence calculate the concentration of the hydrochloric acid solution.

_____

_____

_____ (3)

13) 15 g of hydrated sodium sulfite, $Na_2SO_3.7H_2O$, were dissolved in 50 cm^3 of water. This solution required 59.5 cm^3 of hydrochloric acid of unknown concentration for neutralization. Calculate the concentration of the hydrochloric acid solution.
(Remember that: acid + sulfite → salt, water, and sulfur dioxide).

_____

_____

_____

_____

_____ (3)

14) Citric acid, H_xA. is an ingredient in lemons. 25 cm^3 of citric acid solution of concentration 1.00 mol dm^{-3} required 50 cm^3 of 1.50 mol dm^{-3} NaOH solution for complete neutralization.

$$H_xA + \mathbf{x}NaOH \rightarrow Na_xA + \mathbf{x}H_2O$$

Find '**x**' in H_xA.

_____

_____

_____

_____

_____ (4)

2 Energetics - LO 15

In this section take:

- specific heat capacity as **4.2 J kg^{-1} °C^{-1}** and
- the density of water as **1 g cm^{-3}**.

2.1 Energy changes of combustion calculations

1) 200 g of water at 16 °C were placed in a metal can. The water was heated by burning some ethanol that was contained in a spirit lamp. The mass of the lamp and ethanol before burning was 40 g. After some time the lamp was extinguished, and it was found that the water in the metal can had reached a temperature of 45 °C. The mass of the cold lamp and remaining ethanol was 38 g. Calculate the enthalpy of combustion per mole of ethanol.

_____

_____

_____

_____

_____ (5)

2) 250 cm^3 of water were heated by burning propanol (C_3H_7OH) until the temperature of the water rose by 23 °C. The mass of the lamp with propanol before heating was 20.1 g while the mass of the cold lamp with propanol after heating was 18.2 g. Calculate the enthalpy of combustion per mole of propanol.

_____

_____

_____

_____

_____ (5)

3) 8.5 g of liquid ammonia are completely burned. The heat energy liberated increased the temperature of 5 litres of water from 20 °C to 27 °C. Calculate the enthalpy of combustion per mole of ammonia. Give your answer in kJ mol^{-1}.

_____

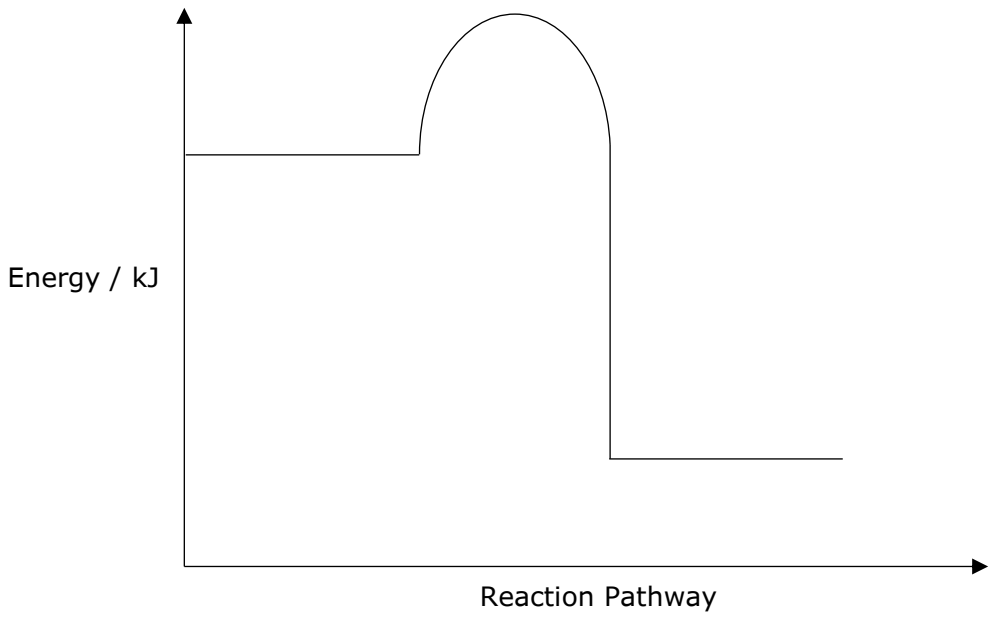
_____

_____

_____

_____ (5)

4) After monitoring the energy change during the combustion of butane, the following energy level diagram was obtained.



a) State whether the diagram above shows an exothermic or an endothermic reaction. Give a reason for your answer.

_____

_____ (2)

b) On the diagram above label the following terms:

Reactants, Products, Change in enthalpy (ΔH), Activation Energy (E_A). (4)

c) Explain what you understand by:

i) ΔH

_____

_____ (2)

ii) E_A

_____

_____ (2)

d) Would the ΔH of the above reaction have a positive or a negative value? What units are used to measure ΔH?

_____

_____ (2)

e) On the diagram above, draw how the sketch would change, if a catalyst was used. Explain the role of the catalyst during a chemical reaction and how it would affect the reaction pathway.

_____

_____ (2)

f) During an experiment 2000 g water were heated by some butane. The temperature of the water rose from 23 °C to 30 °C. If 3 g of butane were burnt in the process, calculate the heat of combustion per mole of butane.

_____

_____

_____

_____

_____ (5)

5) Consider the equilibrium between nitrogen dioxide and dinitrogen tetraoxide:

$$N_2O_4 \rightleftharpoons 2NO_2 \quad \Delta H = +ve$$

a)

i) A positive value for ΔH implies that the overall reaction is endothermic. Explain how the overall change results to be endothermic, in terms of energy used to break bonds of the reactants and energy produced when new bonds of products are formed.

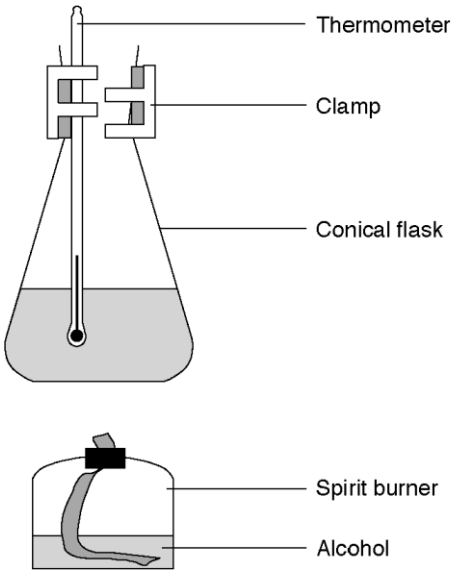
_____

_____ (2)

ii) Draw an energy level diagram for an endothermic reaction. On your diagram, label the axes, ΔH and activation energy, E_A.

(4)

b) A student set up the following apparatus to investigate the heat of combustion of ethanol.



i) Define heat of combustion.

_____

_____ (1)

ii) State whether combustion reactions are exothermic or endothermic reactions.

_____ (1)

iii) Name **four** things the student could do during the experiment in order to obtain more accurate results.

_____

_____ (4)

iv) 0.6 g of ethanol heated 100 g of water and increased its temperature by 30 °C. Calculate the heat of combustion of ethanol.

_____

_____

_____

_____

_____ (5)

2.2 Determining the heat change of reactions

1) When 25 cm^3 of 1 mol dm^{-3} hydrochloric acid are added to 25 cm^3 of 1 mol dm^{-3} sodium hydroxide solution, a temperature rise of 6 °C was noted. Calculate the enthalpy of neutralisation of the reaction.

_____

_____

_____

_____

_____ (5)

2) When 40 cm^3 of 2 mol dm^{-3} nitric acid are mixed with 40 cm^3 of 2 mol dm^{-3} potassium hydroxide solution, a temperature rise of 13.6 °C is noted.

a) State whether the reaction is an exothermic or endothermic reaction.

_____ (1)

b) Calculate the enthalpy of neutralisation of the reaction.

_____

_____

_____

_____

_____ (5)

c) Explain why replacing nitric acid with the same volume of 2 mol dm^{-3} hydrochloric acid will liberate the same amount of heat.

_____

_____ (2)

3) 20 cm^3 of 1 mol dm^{-3} hydrochloric acid were added to 20 cm^3 of 1 mol dm^{-3} sodium hydroxide. The solutions had an initial temperature of 18.0 °C. The final maximum temperature of the reaction mixture was 24.8 °C. Calculate the enthalpy of neutralisation per mole of this reaction.

_____

_____

_____

_____

_____ (5)

4)

a) 30 ml of 0.6 mol dm^{-3} ammonium hydroxide was reacted with 30 ml of 0.6 mol dm^{-3} hydrochloric acid. A temperature rise of 3.7 °C was noted. Calculate the heat of neutralisation for the reaction.

_____

_____

_____

_____

_____ (5)

b) Explain why the heat of neutralisation of sodium hydroxide solution and hydrochloric acid has a greater value than that of ammonium hydroxide and hydrochloric acid.

_____

_____ (2)

3 Dynamic equilibria (LO 12)

1) Classify whether these reactions are: neutralisation, combustion, thermal decomposition, precipitation, displacement and redox reactions.

a) $CaCO_3 \rightarrow CaO + CO_2$ _____

b) $HNO_3 + KOH \rightarrow KNO_3 + H_2O$ _____

c) $Cl_2 + 2NaI \rightarrow 2NaCl + I_2$ _____

d) $2AgNO_3 + MgSO_4 \rightarrow Mg(NO_3)_2 + Ag_2SO_4$ _____

e) $2H_2 + O_2 \rightarrow 2H_2O$ _____

f) $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$ _____

(6)

2) When ammonium chloride is heated it decomposes to form ammonia and hydrogen chloride gas.

a) Write a balanced chemical equation for this reaction.

_____ (2)

b) The equation written in part (a) is a reversible change. Explain what this means.

_____ (1)

c) When ammonium chloride is placed in a test tube and heated over the Bunsen burner it appears to 'sublime'. Explain why such change cannot be called sublimation.

_____

_____ (2)

3) How would an increase in pressure affect the position of the equilibrium in the following reactions?

a) $2NO_2(g) \rightleftharpoons N_2O_4(g)$

_____ (1)

b) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

_____ (1)

c) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

_____ (1)

4) In which direction, left or right, will the equilibrium shift if the following changes are made?

$$2NO(g) + H_2(g) \rightleftharpoons N_2O(g) + H_2O(g) \quad \Delta H = +36 \text{ kJ}$$

a) Is this reaction exothermic or endothermic?

_____ (1)

b) In which direction will the equilibrium shift if the system is cooled. Explain your answer.

_____

_____ (2)

c) In which direction will the equilibrium shift if the pressure is increased. Explain your answer.

_____

_____ (2)

5) In this reaction: $CO_2(g) + H_2(g) \rightleftharpoons CO(g) + H_2O(g)$ ΔH is negative

a) Is heat absorbed or released by the forward reaction?

_____ (1)

b) In which direction will the equilibrium shift if these changes are made?

i) Temperature is increased

_____ (1)

ii) System is cooled

_____ (1)

iii) Pressure is increased

_____ (1)

6) For the reaction, $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ $\Delta H = +111$ kJ

a) Will a high pressure of a low pressure produce more PCl_5? Explain.

_____

_____ (2)

b) Will a low temperature or a high temperature produce more PCl_5? Explain.

_____

_____ (2)

7) For the reaction: $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ $\Delta H = -51.8$ kJ

a) Explain why a change in pressure will not affect the position of the equilibrium.

_____

_____ (1)

b) More hydrogen and iodine would be produced if the system is cooled. Do you agree with this statement? Explain your answer.

_____

_____ (2)

8) The following reaction shows the production of ammonia in industry.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ}$$

a) Define dynamic equilibrium.

_____ (1)

b) State the condition required dynamic equilibrium to be achieved.

_____ (1)

c) How will the position of the equilibrium shift if the temperature of the reaction is increased? Explain your answer.

_____

_____ (2)

d) How will the position of the equilibrium change if the pressure increases? Explain your answer.

_____

_____ (2)

e) In the Haber process the best yield of ammonia is obtained by applying compromised conditions that is a temperature of 450 °C and a pressure of 200 atm. Explain why such compromise conditions are used.

_____

_____ (2)

f) The production of ammonia in industry is important since it is used to produce artificial fertiliser. Give one misuse of the fertilisers and explain how it affects the environment.

_____

_____ (2)

4 Fossil fuels (LO 13)

4.1 The importance of fossil fuels including their risks and benefits

1) Which of the following is NOT a fossil fuel? Underline the correct answer. (1)
   - Ethanol
   - Coal
   - Petroleum
   - Natural gas

2) Name **TWO** other fossil fuels besides crude oil (petroleum).

_____ (2)

3)

a) In a fossil-fuel world, control over oil and gas reserves is an essential component of national power," warns Michael Klare, Professor of Peace and World Security Studies at Hampshire College in Massachusetts, the US.
(https://energypost.eu/twenty-first-century-energy-wars-oil-gas-fuelling-global-conflicts/)

Klare stated that control over fossil fuels are triggering violent conflicts all over the world. Give **TWO** plausible reasons why this is so.

_____

_____ (2)

b) Explain why, fossil fuels are a significant source of energy for transport and production of electricity.

_____

_____

_____

_____ (4)

c) Crude oil is widely used as a feedstock for chemical production.
   i) Explain the above statement.

_____

_____ (2)

   ii) Give **TWO** products which are derived from the use of fossil fuels as raw materials.

_____ (2)

4) Using crude oil products as fuels, causes some environmental problems. Outline the environmental problems that are associated with each of the following:
   a) transporting crude oil across the sea in tankers.

_____

_____ (2)

   b) burning oil products to release the energy they contain.

_____

_____ (2)

5) There are risks and benefits of the transport of finite fuels (derived from crude oil) to and storage on an island like Malta.
   a) Identify **ONE** risk and **ONE** benefit regarding the above.

_____

_____ (2)

   b) Explain the meaning of using crude oil as a finite fuel.

_____ (1)

4.2 Crude oil and its fractions

1) Crude oil (petroleum) is a mixture of hydrocarbons, which can be separated into several components.
   a) Explain what is meant by hydrocarbons.

_____ (1)

   b) Name the technique that can be used for this separation.

_____ (1)

   c) Give any **TWO** products that are formed from the separation of crude oil.

_____ (2)

2) Underline the correct words to complete the following sentences. (4)
   a) Crude oil is a (mixture / compound) of different molecules.
   b) The molecules in crude oil (are / aren't) chemically bonded to each other.
   c) If crude oil were heated, the (first / last) thing to boil off would be residue.
   d) Diesel has (larger / smaller) molecules than petrol.

3) Complete the following paragraph using words from the word bank below. A word may be used once, more than once or not at all. (8)

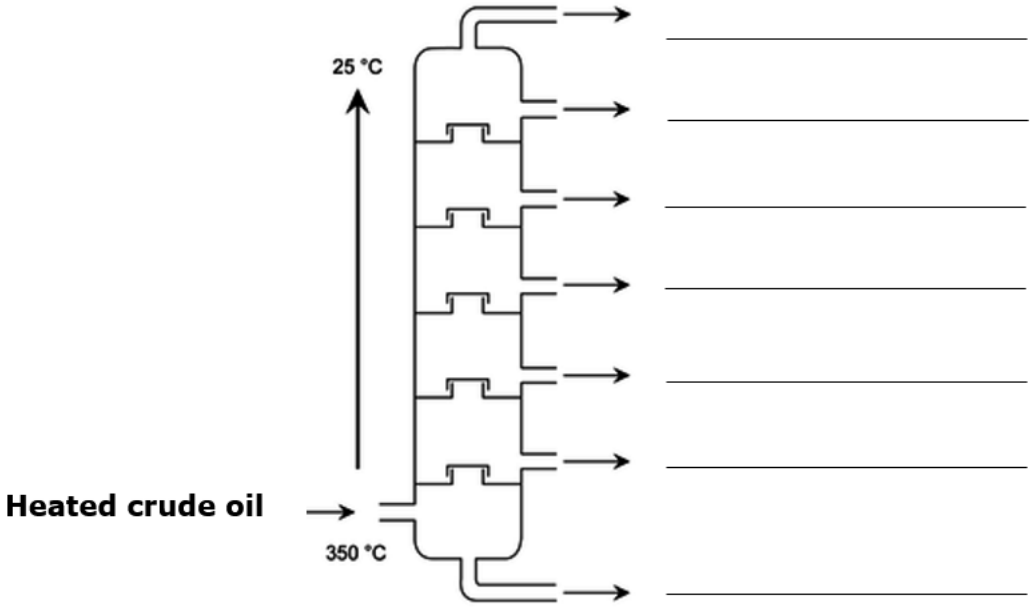
Fuels, fractions, fractional distillation, hydrocarbons, gases, liquids, petrol, transportation, roofing, solids

Crude oil is a mixture of _____. Industrially, this mixture is separated by a process called _____ into components called _____. The substances that boil first include _____, which are used as _____. Other components of crude oil boil at higher temperatures, for instance _____. This is also used as a _____, however it is commonly used in _____.

4) This question is about the fractions obtained from crude oil

a) Label the diagram of a fractionating column to show where the following substances are separated.

Petrol, Kerosene, Residue, Refinery gases, Naphtha, Fuel oil, Diesel oil



b) State **ONE** use of kerosene.

_____ (1)

c) State **ONE** use of residue (bitumen).

_____ (1)

d) Name the separation technique used in the process above.

_____ (1)

e) What type of organic compound is present in all these fractions?

_____ (1)

f) Give the name of the fraction which has the lowest boiling point.

_____ (1)

g) Which physical property allows the above fractions to be separated? Circle the correct answer. (2)

Melting point Boiling point Viscosity Density

5) Describe how crude oil is separated in industry.

_____

_____

_____

_____

_____

_____ (8)

6) A group of chemistry students wanted to separate a mixture of hexane and water - two **immiscible** liquids.

a) Define the term "immiscible".

_____ (1)

b) What is the name of the apparatus used to separate the mixture?

_____ (1)

c) In the box below, draw a labelled diagram of the experiment setup used to separate the mixture of hexane and water.

(4)

4.3 Pollution related to fossil fuels

1) A typical passenger vehicle emits about 4.6 metric tonnes of carbon dioxide per year. This number can vary based on a vehicle's fuel, fuel economy and the number of miles driven per year.
(https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle)

a) This amount of carbon dioxide in the Earth's atmosphere is adversely impacting our planet.

i) Give the name of the phenomenon that is negatively affecting our planet.

_____ (1)

ii) Explain briefly how the Earth is being affected by this excessive amount of carbon dioxide.

_____

_____ (2)

iii) State **TWO** ways how this may negatively impact society.

_____ (2)

iv) Give the formula of **TWO** other gases that cause the same effect.

_____ (2)

v) Most of the CO_2 in the atmosphere comes from burning fossil fuels. Give the name of the gas produced when fossil fuels are not burnt completely.

_____ (1)

b) The catalytic converter is a device present in modern vehicles that reduces the emissions of oxides of carbon and nitrogen. Explain briefly how this is done.

_____

_____ (1)

2) Nitrogen dioxide and sulfur dioxide are two gases which cause air pollution.

a) How do these gases get into the atmosphere?

_____

_____ (2)

b) Both gases cause acid rain.

i) Give balanced equations (including state symbols) to explain the above statement and name the acids formed in each reaction.

_____

_____

_____

_____ (6)

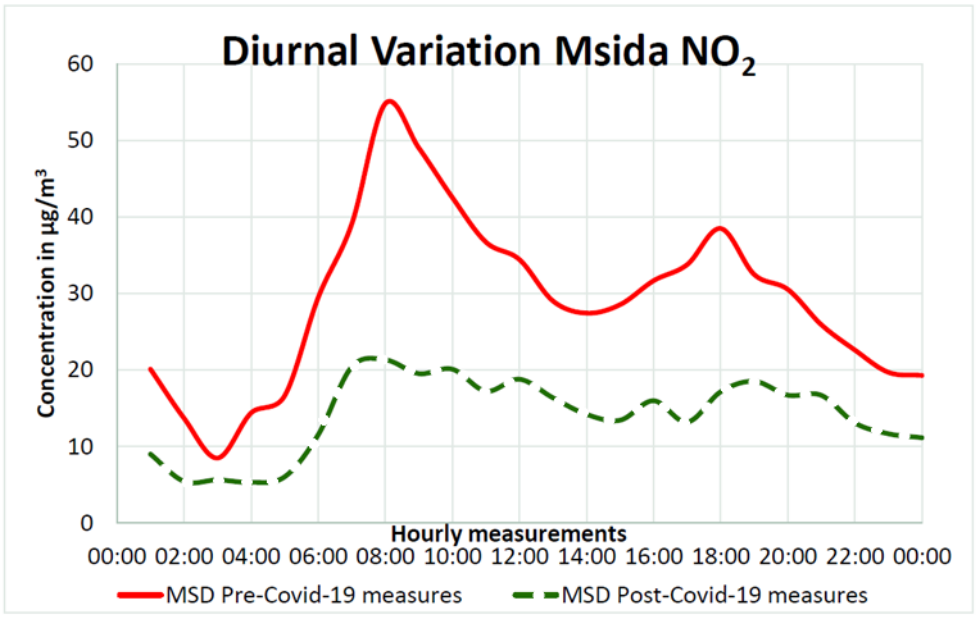
ii) Give **TWO** disadvantages associated with acid rain.

_____

_____ (2)

3) The first cases of Coronavirus in Malta were detected in March 2020. A number of precautionary measures were implemented to stop the spread of the virus. These included: the closure of schools, university, childcare centres, bars, restaurants, and gyms. In addition, many employers allowed their employees to telework (work from home). Vulnerable persons were obliged to stay inside.

Following a study by ERA Malta, the following graph shows the changes in the diurnal variation of NO_2 at the traffic site in Msida where the 7-day (Monday to Sunday) diurnal average of the levels of NO_2 after the COVID-19 measures were compared to the 7-day average of pre-COVID days in January.



(Environment & Resources Authority Malta 2020)

a) Compare the diurnal NO_2 concentration in Msida during pre-COVID-19 measures with that during post-COVID-19 measures.

_____

_____ (1)

b) Explain your answer to part a).

_____

_____ (2)

c) The study was based primarily on the levels of nitrogen dioxide. Why do you think the town of Msida was chosen as one of the areas for this study?

_____ (1)

d) Give a plausible explanation how this pollutant continuously originates in this area.

_____

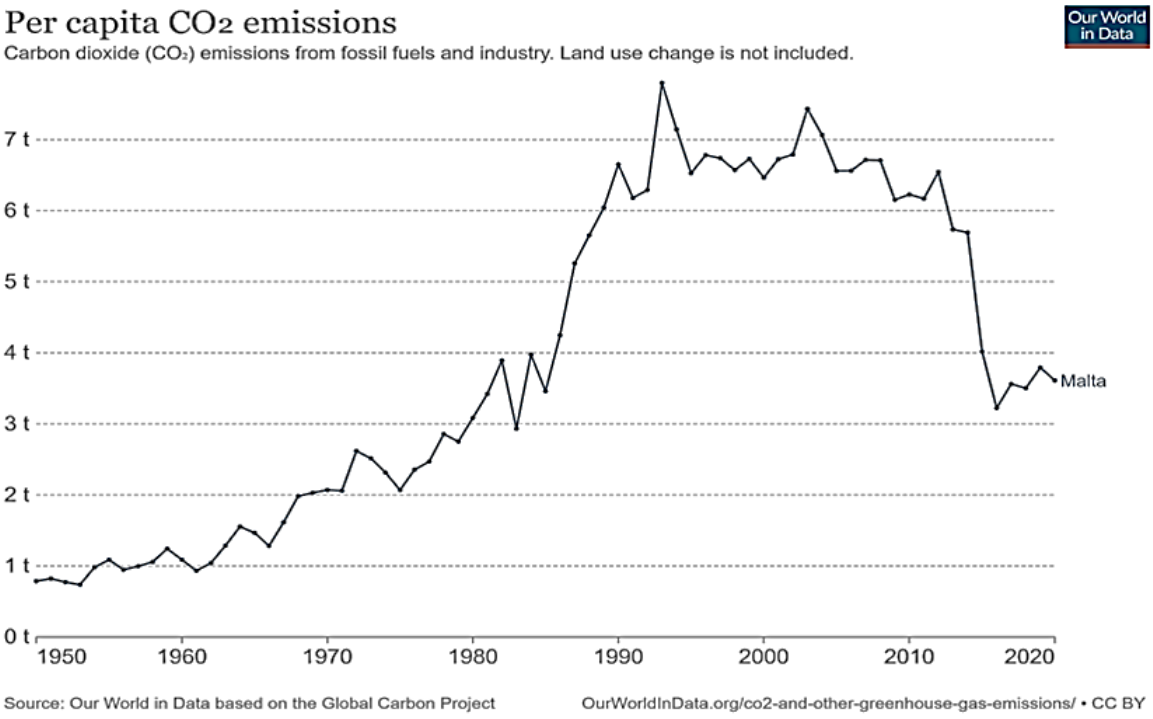
_____ (2)

e) State **TWO** examples how the emission of this pollutant can be reduced.

_____

_____ (2)

4) Annual emissions figures are often used to compare countries' contribution to climate change. To understand the 'footprint' of the average person in a given country, the chart below shows per capita emissions for Malta.



a) Interpret the chart with relation to the per capita CO_2 emissions from 1950 to 2020.

_____

_____ (2)

b) Give **TWO** human activities that are thought to have contributed to the above fluctuation in carbon dioxide levels over the last 150 years.

_____

_____ (2)

c) Discuss how you can reduce the emissions of carbon dioxide to minimise your contribution towards global warming.

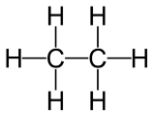
_____

_____ (2)

5 Organic compounds (LO 14)

5.1 Classifying organic molecules

1) Complete the following table about organic compounds found in different homologous series. The first one has been done for you. (36)

Name of organic compound	Name of homologous series	General Molecular Formula	Molecular Formula	Displayed Formula
Ethane	Alkanes	C_nH_{2n+2}	C_2H_6	
Butene				
Ethyne				
Ethanol				
Ethanoic acid				
Propanol				

Name of organic compound	Name of homologous series	General Molecular Formula	Molecular Formula	Displayed Formula
Butyne				
Pentene				
Propanoic acid				
Pentane				

5.2 Alkanes

1) Complete the following table which is about the first 5 compounds in the homologous series of alkanes. (15)

Alkane	Molecular Formula	Structural Formula	Physical state at room temperature
Methane			
Ethane			
Propane			
Butane			
Pentane			

2) Alkanes are hydrocarbons which are used as fuels.
   a) Write the general molecular formula of an alkane.

_____ (1)

   b) What is meant by the term hydrocarbon?

_____ (1)

   c) Are alkanes saturated OR unsaturated organic compounds. Explain.

_____

_____

_____ (3)

   d) Write a balanced chemical equation to show the complete combustion of pentane C_5H_{12}

_____ (2)

e) Why are reactions of incomplete combustion of hydrocarbons considered to be dangerous?

_____

_____ (2)

3) Halogenated organic compounds are produced when alkanes react with halogens under certain conditions.
   a) Name the type of reaction which takes place.

_____ (1)

   b) Why do alkanes undergo the type of reaction mentioned in part (a).

_____ (2)

   c) State a condition required for the reaction to take place.

_____ (1)

   d) Write a balanced chemical equation to show how methane reacts with chlorine gas.

_____ (2)

4) Draw the displayed formula of an organic compound which:
   a) Has 2 carbon atoms and can undergo polymerisation.

(1)

   b) Has 3 carbon atoms and which reacts with hydrogen in a mole ratio of 1:1

(1)

   c) Is produced when ethane reacts with chlorine in diffused light in a mole ratio of 1:1

(1)

   d) Is produced when propene reacts with bromine.

(1)

e) Is a liquid which is the product between ethanol and ethanoic acid.

(1)

f) Is produced when propanol is oxidised.

(1)

g) Decolourises bromine in the dark.

(1)

h) Is a saturated hydrocarbon with four carbon atoms.

(1)

i) Is produced by the fermentation process.

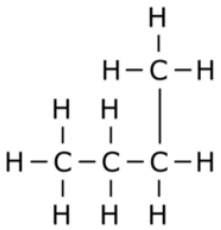
(1)

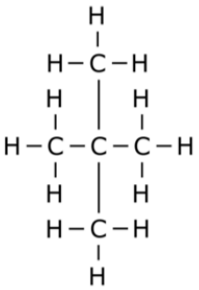
5.3 Isomerism

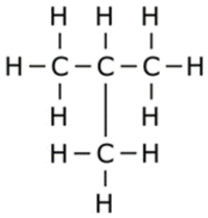
1) Define isomerism.

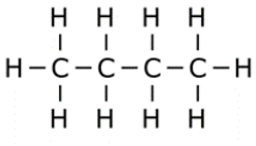
_____ (1)

2) Identify by circling the molecule/s from the following displayed formulae, the isomers of C_4H_{10}. (2)









3) Draw the displayed formulae of ALL the isomers of C_5H_{12}.

(3)

5.4 Cracking

1)

a) What is meant by the term "cracking" as used in the petrochemicals industry?

_____ (1)

b) What is an advantage of cracking?

_____ (1)

c) State a condition which is required for cracking to take place.

_____ (1)

d) Complete the following chemical equation to show the organic products made on cracking decane. (2)

$C_{10}H_{22} \rightarrow$ _____ + _____

2)

a) Name the process represented by the following reaction:

$C_{15}H_{32} \rightarrow 2C_2H_4 + C_3H_6 + C_8H_{18}$

_____ (1)

b) Name **two** unsaturated products in the reaction above.

_____ (2)

c) What is the importance of the process shown in part (a)?

_____

_____ (2)

5.5 Alkenes and their addition reactions

1) Complete the following table which includes the first 5 members in the alkene homologous series. (10)

Name	Molecular Formula	Structural formula
Ethene		
Propene		
Butene		
Pentene		
Hexene		

2)

a) Write the general molecular formula of alkenes.

_____ (1)

b) What do all alkenes have in common in their structural formula?

_____ (1)

c) Are alkenes saturated OR unsaturated organic compounds? Explain.

_____

_____

_____ (3)

d) What type of reactions are carried out by alkenes, besides combustion reactions?

_____ (1)

3)

a) Alkenes can carry out a hydration reaction. Write a balanced chemical equation to show the hydration reaction of ethene. Name the product.

_____ (3)

b) Alkenes also carry out hydrogenation reactions.
i) What is the importance of this reaction in industry?

_____ (1)

ii) Draw the displayed formula of the organic product made by the hydrogenation of butene.

(1)

5.6 Alkynes

1) What are alkynes?

_____ (2)

2) Compare the reactivity of alkynes with that of alkenes.

_____

_____

_____ (3)

3) Draw the displayed formula of propyne.

(1)

5.7 Distinguishing between saturated and unsaturated hydrocarbons

1) Describe a simple chemical test which can distinguish between an alkane and an alkene.

_____

_____

_____ (3)

5.8 Alcohols

1)

a) Complete the following table which includes the first 5 members in the alkanols/ alcohol homologous series. (10)

Alcohol Name	Molecular Formula	Structural Formula
Methanol		
Ethanol		
Propanol		
Butanol		
Pentanol		

b) What is the functional group of an alcohol?

_____ (1)

c) Give three uses of ethanol.

_____ (3)

2) Ethanol can be manufactured by the anaerobic breakdown of glucose.

a) Name the type of reaction which takes place when glucose is converted to ethanol.

_____ (1)

b) Name

i) the micro-organism which is responsible for the breakdown of glucose

_____ (1)

ii) the gas which is produced in the process.

_____ (1)

iii) an important condition for the reaction to take place.

_____ (1)

c) Write a balanced chemical equation for the reaction which takes place when glucose is converted to ethanol.

_____ (2)

d) Why is it important that oxygen is not allowed to enter the apparatus where the reaction is taking place?

_____

_____ (2)

e) How is the ethanol produced in the reaction above separated from the reaction mixture?

_____ (1)

f) Give an advantage and a disadvantage of preparing ethanol from glucose.

Advantage: _____ (1)

Disadvantage: _____ (1)

3) Ethanol can also be manufactured from ethene.

a) Name the type of reaction which takes place.

_____ (1)

b) Explain how ethene is obtained from crude oil.

_____

_____ (2)

c) Write a balanced chemical equation to show how ethanol is produced from ethene.

_____ (2)

d) Name **two** advantages and **one** disadvantage of preparing ethanol from ethene.

Advantages _____ (2)

Disadvantage _____ (1)

4) When ethanol is heated with acidified potassium dichromate(VI) a new organic compound is produced.

a) What type of reaction is taking place? _____ (1)

b) Name the organic product and draw its structural formula.

_____ (1)

(2)

c) To which homologous series does the organic product in part b) belong?

_____ (1)

d) Name **one** observation that is made during the reaction.

_____ (1)

5.9 Carboxylic acids

1) Give the general formula of carboxylic acids.

_____ (1)

2) Describe how ethanol can be oxidised to ethanoic acid using acidified potassium dichromate and by aerial oxidation.

_____

_____

_____

_____

_____

_____ (4)

3) Draw the displayed formula of butanoic acid and indicate by using a circle its functional group.

(2)

5.10 Esters

1) Esters are organic compounds made by reacting together an organic acid and an alcohol in an esterification reaction.
   a) Give one characteristic of esters.

_____ (1)

   b) Name the ester produced in the reaction between ethanol and ethanoic acid and draw its displayed formula. Using a circle, identify the ester functional group.

_____ (1)

(3)

c) Write a balanced chemical equation to represent the reaction which produces the ester that you mentioned in part b).

_____ (1)

5.11 Polymers

1) Ethene can be converted into a very useful solid material but a much larger molecular mass.
   a) Name this useful solid material and give **two** of its uses.

_____

_____

_____ (3)

   b) Name the type of reaction which takes place when ethene is converted into a useful solid material.

_____ (1)

   c) Draw displayed formulae to show how the molecule in part a) is produced using three monomer units.

(3)

   d) What environmental problem is associated with this solid material and what could be a possible solution to this problem?

_____

_____ (2)

2) Polymers are produced from unsaturated monomers in a polymerisation reaction.
   a) Define the term polymer.

_____ (1)

   b) Explain why monomers need to be unsaturated.

_____ (1)

   c) PTFE and PVC are examples of polymers formed by addition polymerisation.
      i) Name **one** use for PTFE.

_____ (1)

ii) Draw the displayed formula of the monomer of PTFE.

(2)

iii) Draw displayed formulae to show how the molecule in part a) is produced using three monomer units.

(3)

iv) Name **one** use for PVC.

_____ (1)

v) Write the equation to show the production of PVC from its monomer using displayed formulae.

(2)

PERIODIC TABLE OF THE ELEMENTS

1	2										3	4	5	6	7	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86

Key: a X Y b

relative atomic mass
SYMBOL
Name
atomic number