Mearns Castle High School

National 5 Chemistry
# Homework Exercises

Instructions

The purpose of this booklet is to help you revise earlier work, to give you practice with past exam questions, and to improve your knowledge and understanding of National 5 chemistry. It is therefore important that your homework is your best work. As such, you should follow these instructions:

1. The key area being covered is stated at the top of each exercise. You should use your notes from this key area to help you complete the exercise.

2. Do not leave blanks! If you are unsure how to complete a question, seek help prior to the due date.

3. Each exercise should be completed in your homework jotter.

Exercise 1: Rates of Reaction

Q1.   Rapid inflation of airbags in cars is caused by the production of nitrogen gas.

The graph gives information on the volume of gas produced over 30 microseconds.
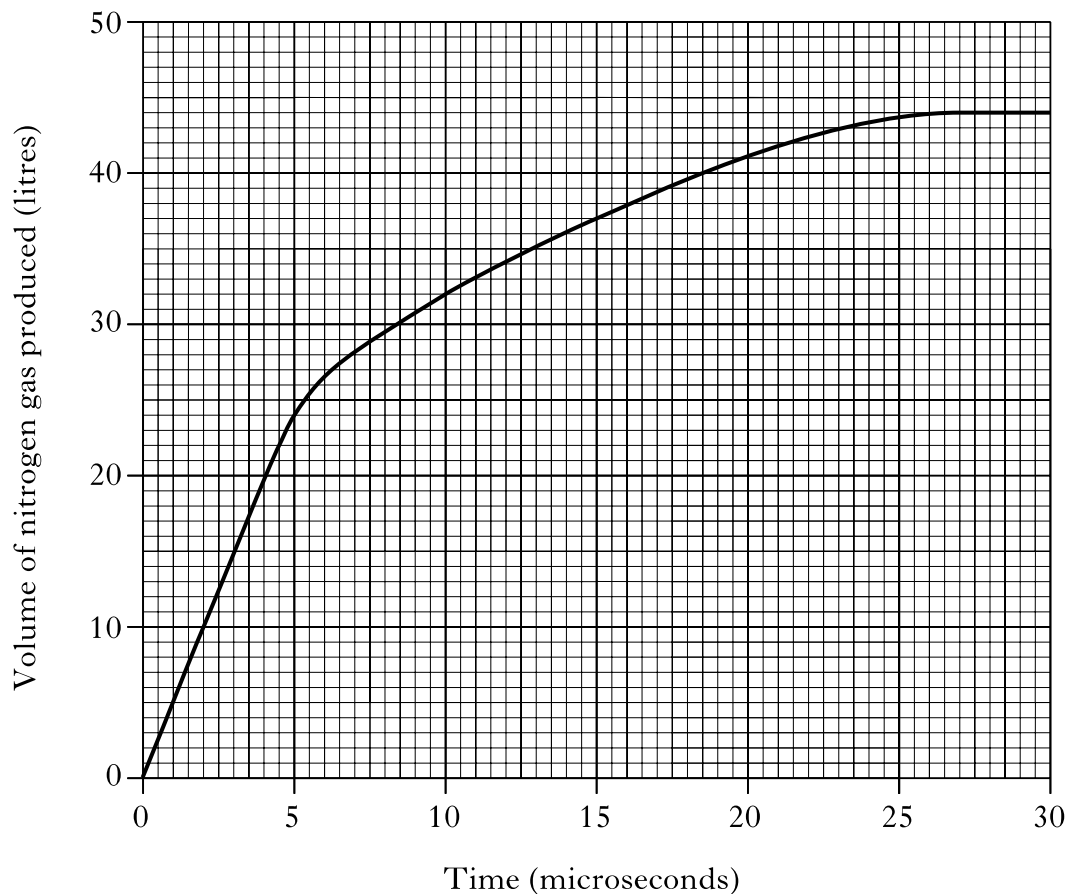
(a)   (i)   Calculate the average rate of reaction between 2 and 10 microseconds.   1

Egg shells are made up mainly of calcium carbonate. A pupil carried out an experiment to react egg shells with dilute hydrochloric acid. A gas was produced.

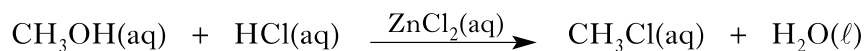Q2.   The volume of gas produced during the reaction was measured.

| Time (min)	Volume of gas (cm^3)
0	0
2	47
4	92
6	114
8	118
10	118

Plot these results as a line graph.

Q3   Chloromethane, CH₃Cl, can be produced by reacting methanol solution with dilute hydrochloric acid using a solution of zinc chloride as a catalyst.

$$CH_3OH(aq) \ + \ HCl(aq) \ \xrightarrow{\ ZnCl_2(aq)\ } \ CH_3Cl(aq) \ + \ H_2O(\ell)$$

The graph shows how the concentration of the hydrochloric acid changed over a period of time when the reaction was carried out at 20 °C.   1
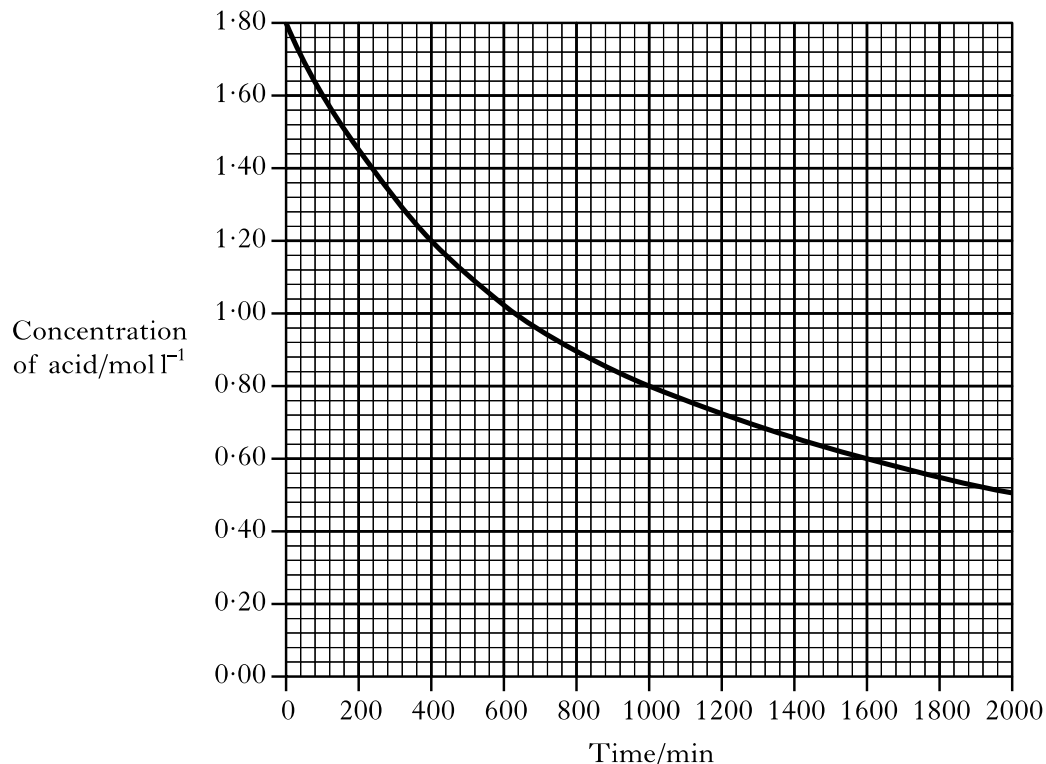
Calculate the average rate, in mol l–1 min–1, in the first 400 minutes.

Q4.   Use collision theory to explain the fact that chopping up potatoes into smaller pieces increases the rate at which they cook.

    1

Q5.   A student investigated the reaction between dilute sulphuric acid and sodium carbonate.

a)   One experiment involved measuring the volume of carbon dioxide produced over set time intervals:

Time/s	0	10	30	40	50	60	70
Volume of carbon dioxide/cm³	0	12	29	34	36	37	37

i)   Draw a line graph to show these results   2

ii)   The experiment was repeated at a higher temperature. The volume and concentration of acid and the mass of sodium carbonate used were kept the same. Sketch a dotted line on your graph to show what this reaction would look like.

    1

b)   Calculate the average rate of reaction, in cm³s-1, in the first 40 seconds.   2

Exercise 2: Atoms

Marks

Q1. The following questions relate to the elements listed below:

A – chlorine   B – lithium   C – magnesium   D - helium

Which element has **similar chemical properties** to each of the following atoms:

a)   an atom with an electron arrangement of 2, 8, 1   1

b)   an atom with an electron arrangement of 2, 8   1

c)   an atom with an atomic number of 9   1

d)   an atom with an atomic number of 20   1

Q2. A student made some statements about the particles found in atoms:

A	It has a positive charge.
B	It has a negative charge.
C	It has a relative mass of almost zero.
D	It has a relative mass of 1.
E	It is found in the nucleus.
F	It is found outside the nucleus.

a)   Which 2 statements apply to **both** a proton and a neutron?   1
b)   Which 2 statements apply to an electron?   1

Q3. Copy and complete the following table:

Element	Symbol	Atomic number	Electron arrangement
beryllium		4	
	Ge		
		38	

4

Exercise 3: Bonding

Marks

Q1. For each of the compounds listed below, state the type of bonding

a) Sodium chloride   1
b) Hydrogen oxide   1
c) CCl_4 1
d) $MgCl_2$ 1

Q2. In ammonia (NH_3) molecules, the atoms are held together by three covalent bonds.

a) What is a covalent bond?   1
b) Draw a diagram to show the <u>shape</u> of an ammonia molecule?   1
c) Draw a diagram to show how the outer electrons are shared in an ammonia   1
   molecule.

Q3.

The table contains information about some substances.

Substance	Melting point/°C	Boiling point/°C	Conducts as a solid	Conducts as a liquid
A	−7	59	no	no
B	1492	2897	yes	yes
C	1407	2357	no	no
D	606	1305	no	yes
E	−39	357	yes	yes
F	−78	−33	no	no

a) Which substance is ionic?   1
b) Which substance is made up of molecules?   1
c) Which substance could be diamond?   1

Exercise 4: Atomic Structure and Bonding

Marks

Q1.   Tritium is a naturally occurring isotope of hydrogen. It can be represented as

$$^{3}_{1}\text{H}$$

(a)   Complete the table to show the number of particles in an atom of tritium.   1

Type of particle	Number of particles
proton	
neutron	
electron	

(b)   Hydrogen has three isotopes.   1

Isotope of hydrogen	Mass number
protium	1
deuterium	2
tritium	3

The relative atomic mass of hydrogen is 1.

Which isotope of hydrogen is the most abundant?

_____

Q2.   The nuclide notation for an isotope of hydrogen is $^{1}_{1}\text{H}$.

An isotope of copper has atomic number 29 and mass number 63.

a)   Write the nuclide notation for this isotope of copper.   1
b)   How many neutrons are present in this isotope of copper?   1

_____

c)   A sample of copper was found to contain equal amounts of two isotopes. One has   1
mass number 63 and the other has mass number 65.

What is the relative atomic mass of this sample of copper?

_____

Q3.   The properties of a substance depend on its type of bonding and structure.

There are four types of bonding and structure.

Discrete covalent molecular	Covalent network	Ionic lattice	Metallic lattice

(a)   Complete the table to match up each type of bonding and structure with its properties.   2

Bonding and structure type	Properties
	do not conduct electricity and have high melting points
	have high melting points and conduct electricity when liquid but not when solid
	conduct electricity when solid and have a wide range of melting points
	do not conduct electricity and have low melting points

(b)   A section of a covalent network compound is shown below.   1

● = silicon

◯ = oxygen
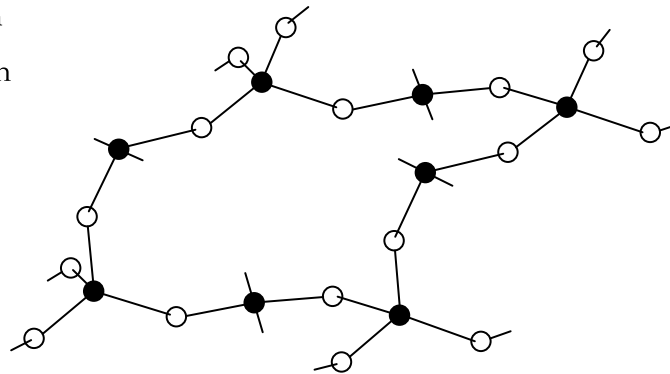
Write the formula for this covalent network compound.

_____

Q4.　　　　Information on some two-element molecules is shown in the table.

Name	Formula	Shape of molecule
hydrogen fluoride	HF	
water	H_2O	
ammonia	NH_3	

(a)　　　　Complete the table to show the shape of a molecule of ammonia.　　　　1

(b)　　　　The hydrogen fluoride molecule can be represented as:　　　　1
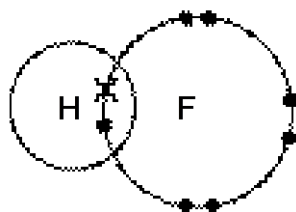
Showing all outer electrons, draw a similar diagram to represent a molecule of water, H_2O.

Q5.   Nitrogen trifluoride, NF₃, is used in the manufacture of plasma screens.

a)   Draw a diagram showing all outer electrons to represent a molecule of nitrogen trifluoride.   1

b)   The atoms in nitrogen trifluoride are held together by covalent bonds.   1

Circle the correct words to complete the sentence.

A covalent bond forms when two $\left\{ \begin{array}{c} \text{positive} \\ \text{negative} \\ \text{neutral} \end{array} \right\}$ nuclei are held together

by their common attraction for a shared pair of $\left\{ \begin{array}{c} \text{protons} \\ \text{neutrons} \\ \text{electrons} \end{array} \right\}$.

Q6.   A student investigated how the concentration of sodium chloride in water affected the freezing point.

(a)   What type of bond is broken in sodium chloride when it dissolves in water?   1

_____

(b)   The table shows information about the freezing point of different sodium chloride solutions.   1

Concentration of sodium chloride solution (mol/l)	0	0·09	0·18	0·27	0·37	0·46
Freezing point (°C)	0	−0·2	−0·5	−0·8	−1·1	−1·5

Describe the relationship between the concentration and freezing point.

(c)   Predict the freezing point of a 0·55 mol/l sodium chloride solution.   1

_____ °C

Q7.   The table below gives information about some particles

A	B	C
$^{34}_{16}S^{2-}$	$^{24}_{12}Mg^{2+}$	$^{39}_{19}K$

D	E	F
$^{40}_{19}K$	$^{40}_{20}Ca$	$^{35}_{17}Cl^{-}$

a)   Identify the two isotopes   1

b)   Identify the two particles with the electron arrangement 2,8,8   1

c)   Identify the atom with 20 neutrons   1

Q8.   Calcium and strontium have similar chemical properties.

a)   Suggest why these elements have similar chemical properties   1

b)   Explain why strontium has a relative atomic mass of 87.6 yet no strontium atom has this mass.   1

Exercise 5: Formula and GFM

Q1.   Work out the chemical formula for each of the following

a)   Magnesium oxide   1

b)   Aluminium chloride   1

c)   Sulphur trioxide   1

d)   Dinitrogen oxide   1

e)   Copper(II)oxide   1

f)   Iron(III)chloride   1

g)   Zinc(II) sulphate   1

h)   Calcium carbonate   1

i)   Barium dichromate   1

j)   Ammonium hydrogensulphate   1

Q2.   Give the formula mass of each of the following:

a) CH_4 1

b) H_2O 1

c) H_2SO_4 1

d) $CaCO_3$ 1

e) $Mg_3(PO_4)_2$ 1

f) $Al_2(CO_3)_3$ 1

g)   Aluminum hydride   2

h)   Copper(II) sulphate   2

Exercise 6: Formula Mass and the Mole

Marks

Q1.   Calculate the formula mass of the following

a)   Nitrogen, N_2 1

b)   Magnesium hydroxide, $Mg(OH)_2$ 1

c)   Copper(II) sulphate, $CuSO_4$ 1

Q2.   Calculate the mass of each of the following

a)   1 mole of magnesium nitride, Mg_3N_2 1

b)   6 moles of propane, C_3H_8 1

c)   0.25 moles of ammonium nitrate, NH_4NO_3 1

d)   0.36 moles of methane, CH_4

Q3.   Calculate the number of moles in each of the following
a)   15g of hydrogen, H_2 1

b)   850g of silver(I) nitrate, $AgNO_3$ 1

c)   250g of ammonium chloride, NH_4Cl 1

d)   82g of sodium chloride $NaCl$ 1

Exercise 7: Formulae and Reaction Quantities

Q1.   Hydrogen peroxide is a useful bleaching agent and is contained in many hair dyes. Over time, the hair dye becomes less effective as the hydrogen peroxide decomposes forming water and oxygen.

   The equation for the decomposition of hydrogen peroxide is:
   $$H_2O_2(aq) \longrightarrow O_2(g) + H_2O(l)$$
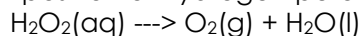
a)   Balance this equation.   1

b)   Calculate the mass of oxygen produced when 34g of hydrogen peroxide decomposes   3

Q2.   The charcoal used in some barbecues is mainly carbon.

$$C + O_2 \rightarrow CO_2$$
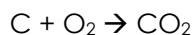
a)
   Calculate the mass of oxygen produced when 480g of charcoal burns.   3

Q3.   Urea reacts with water, breaking down to form carbon dioxide and ammonia.

$$H_2NCONH_2 \; + \; H_2O \longrightarrow CO_2 \; + \; 2NH_3$$
   urea
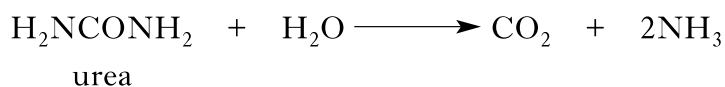
(a)   Calculate the mass of ammonia produced, in grams, when 90 g of urea breaks down.   3

Q4.   Aluminium is extracted from the ore bauxite.

(a)   The composition of a 250 g magnet is shown.

Metal	aluminium	nickel	cobalt	copper	titanium	iron
% by mass	10	25	20	4	1	40

   Calculate the mass, in grams, of aluminium in the magnet.   1
   Show your working clearly.

   _____ g

(b)   Using your answer to (a), calculate the number of moles of   1
   aluminium in the magnet.

   Show your working clearly.

   _____mol

Q5.   A student investigated the reaction between dilute sulphuric acid and sodium
       carbonate.

       Another experiment involved determining the concentration of sodium carbonate
       solution by titration.

       $H_2SO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + CO_2 + H_2O$

       0·05 mol/l sulphuric acid

       25·0 cm^3 sodium carbonate solution
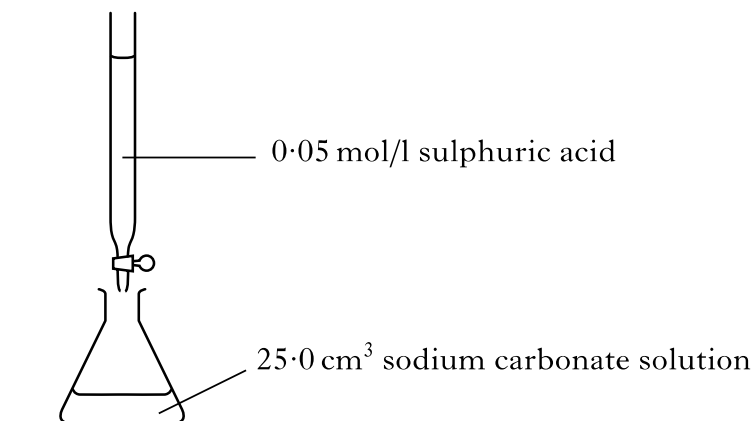
       The results showed that 20cm^3 of sulphuric acid was required to neutralise the sodium
       carbonate solution.

a)   Calculate the number of moles of sulphuric acid in this volume.   1

b)   Given that the number of moles of sodium carbonate solution is 0.1, calculate the   1
       concentration of this solution.

Q6.   Methane, formula CH$_4$, burns in oxygen to produce carbon dioxide and water.
a) i) Write a word equation for this reaction   1
   ii) Write a formula equation for the reaction   1
b)   Balance the equation from part a)   1
c)   Calculate the mass of water produced when 26g of methane burns completely in   3
       oxygen.

Exercise 8: Volumetric Titrations

1. 10cm³ of 0.1 mol/l sodium hydroxide neutralised 20cm³ of hydrochloric acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$
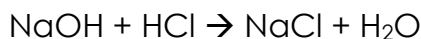
Calculate the concentration of the hydrochloric acid.

2. 20cm³ of 0.2 mol/l potassium hydroxide neutralised 25cm³ of nitric acid:

$$KOH + HNO_3 \rightarrow KNO_3 + H_2O$$
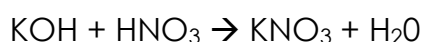
Calculate the concentration of the nitric acid.

3. 50cm³ of 1mol/l sodium hydroxide was neutralised by 23cm³ of sulphuric acid

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$$
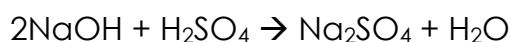
Calculate the concentration of the acid.

4. 10cm³ of lithium hydroxide solution neutralised 16.7cm³ of 0.1mol/l phosphoric acid

$$3LiOH + H_3PO_4 \rightarrow Li_3PO_4 + 3H_2O$$
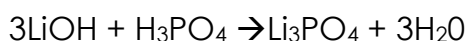
Calculate the concentration of the lithium hydroxide solution.

5. What is the concentration of sulphuric acid if 17.3 cm³ neutralises 25 cm³ of sodium hydroxide solution (concentration 0.5 mol l-1)?

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

15
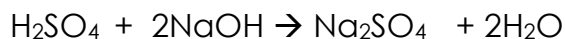
Exercise 9: Acids and Bases

Marks

Q1. When sulphur dioxide dissolves in water in the atmosphere "acid rain" is produced.

a) (Circle) the correct phrase to complete the sentence.   1

Compared with pure water, acid rain contains $\begin{Bmatrix} \text{a higher} \\ \text{a lower} \\ \text{the same} \end{Bmatrix}$ concentration of hydrogen ions.

b) Give the name of another gas which contributes to acid rain.   1

Q2.

A solution of 0·1 mol/l hydrochloric acid has a pH of 1.

a) What colour would universal indicator turn when added to a solution of hydrochloric acid?   1

b) Starting at pH 1, draw a line to show how the pH of this acid changes when diluted with water.   1
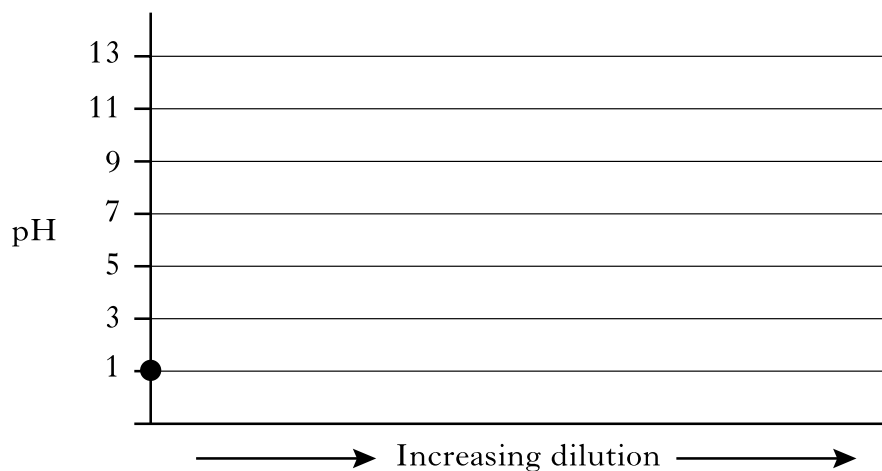
c) Sulphuric acid can be neutralized by copper carbonate

i) State the products of the reaction between sulphuric acid and copper(II) carbonate.   1

ii) Give a balanced chemical equation for this neutralization reaction.   2

Q3. During a titration, sodium hydroxide solution is neutralized by sulphuric acid

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$$
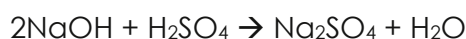
Given that 25cm3 of 1moll^{-1} solution of sodium hydroxide is neutralised by 22.5cm^3 of sulphuric acid, calculate the concentration of the acid.   3

Exercise 10: Unit 1 Mixed Questions

Q1.   Marks

A student carried out some experiments between zinc and excess 1moll-1 hydrochloric acid.
The graph below shows the results of her experiments:
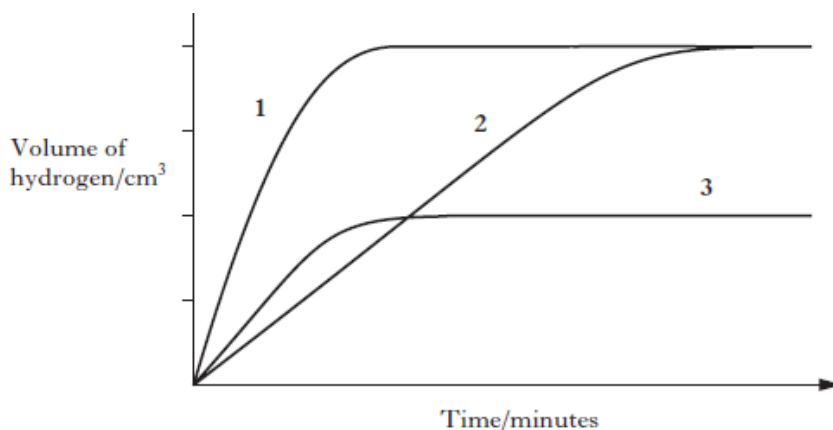
a)   Which experiment (1, 2, or 3) took longest to finish?   1

b)   In all 3 experiments, she kept the temperature the same, and used the same volume of 1mol/l hydrochloric acid.

i)   Suggest 1 variable which could have been changed from experiment **1** to produce   1
        the results from experiment **2.**

ii)   1g of zinc was used in experiment 1. What mass of zinc was used in experiment 3?   1

Q2.

(i) Information about an atom of boron is given in the table below.

Particle	Number
proton	5
electron	5
neutron	6

Use this information to complete the nuclide notation for this atom   1
of boron.

$$\overline{}\,B$$

(ii) Atoms of boron exist which have the same number of protons but a different number of neutrons from that shown in the table.

What name can be used to describe the different atoms of boron?   1

_____

Q3.

In a sample of oxygen there are two different types of oxygen atom:

$^{18}_{8}O$ and $^{16}_{8}O$
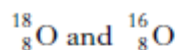
(i) What **term** is used to describe these different types of oxygen atom?

1

_____

(ii) Complete the table for each type of oxygen atom.

Type of atom	Number of protons	Number of neutrons
$^{18}_{8}O$		
$^{16}_{8}O$		

2

Q4.

The table contains information about some substances.

Substance	Melting point/°C	Boiling point/°C	Conducts as a solid	Conducts as a liquid
A	−7	59	no	no
B	1492	2897	yes	yes
C	1407	2357	no	no
D	606	1305	no	yes
E	−39	357	yes	yes
F	−78	−33	no	no

a)   Identify the substance which exists as molecules   1
b)   Identify the substance which could be sodium chloride   1

Q5. Metal salts can be produced by different methods.

Lead(II) iodide can be produced by reacting lead(II) nitrate solution with sodium iodide solution.
The equation for this reaction is:

$$Pb(NO_3)_2(aq) \quad + \quad NaI(aq) \longrightarrow \quad PbI_2(s) \quad + \quad NaNO_3(aq)$$
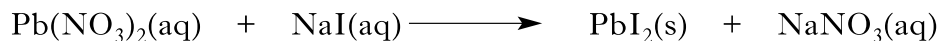
a) Balance the above equation.   1

b) Calculate the mass of one mole of lead(II)nitrate   1

c) Calculate the mass of lead(II)iodide produced when 0.2moles of lead nitrate is reacted.   2

Q6.

A pupil carried out a titration using the chemicals and apparatus shown below.

burette containing
sulphuric acid, 0·20 mol/l

	Rough titre	1st titre	2nd titre
Initial burette reading/cm³	0·5	21·7	0·3
Final burette reading/cm³	21·7	42·4	20·8
Volume used/cm³	21·2	20·7	20·5

conical flask

20 cm³ potassium hydroxide solution + indicator
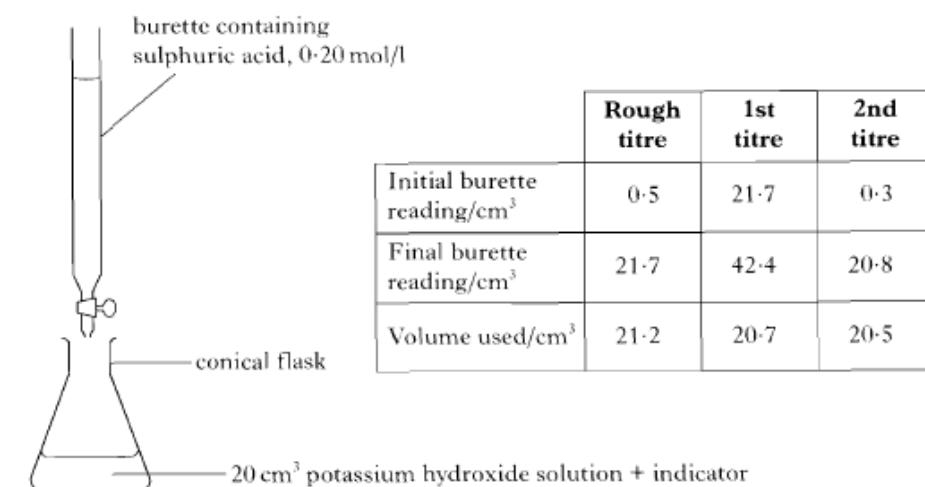
(a) What average volume should be used to calculate the number of moles of sulphuric acid needed to neutralise the potassium hydroxide solution?   1

(b) Calculate the number of moles of sulphuric acid in this average volume.
Show your working clearly.   1

c) The equation for the titration reaction is

$$H_2SO_4 \quad + \quad 2KOH \quad \rightarrow \quad K_2SO_4 \quad + \quad 2H_2O$$
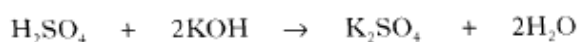
Calculate the number of moles of potassium hydroxide in 20 cm³ of the potassium hydroxide solution.
Show your working clearly.   1

Q7. Sodium hydroxide solution is neutralised by nitric acid.

a) Name the salt produced in the reaction.   1

b) If universal indicator was added to the acid, what colour would be observed?   1

c) What happens to the pH of the acid as it is neutralised?   1

Exercise 11: Alkanes

Marks

Q1.   Draw full structural formulae for:

a)   Pentane   1

b)   Octane   1

c)   2,2 dimethyl pentane   1
d)   3-ethyl-2-methyl-hexane.   1

Q2.   Give the systematic name for the following:

a)

$CH_3CH_2CH_2CHCH_2CH_3$
           |
          CH_3

                                                                                                    1

b)

                                                                                                    1

Q3.   Give molecular formula for the following
a)   propane   1
b)   Butane   1
c)   An alkane containing 42 carbon atoms   1
d)   An alkane containing 26 hydrogen atoms.   1

Name the following structures.

a) CH_2-CH_2
     | |
     CH_2-CH_2

b)
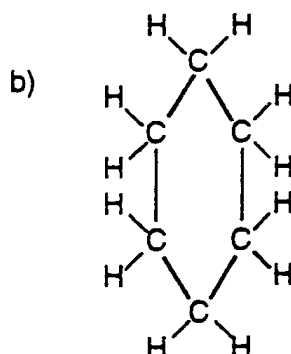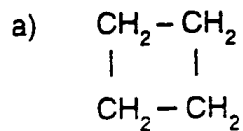
Draw the full structural formula of -

a) cyclopropane.   b)   cyclopentane.

20.   Draw the full structural formula of -

a) ethene.   b)   propene.   c)   pent–2–ene.

21.   Name the following alkenes

a)

b)

c) $CH_3CH_2CHCHCH_2CH_3$
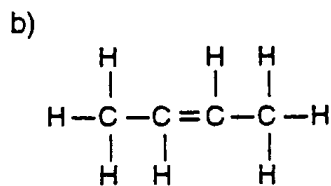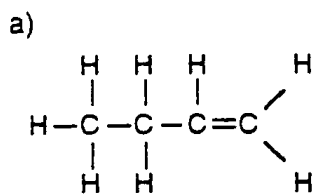
Exercise 13: Homologous Series

Q1.   Marks

a)   Name each of the following structures labelled A-F

A	B	C
H H H H │ │ │ │ H−C−C−C−C−H │ │ │ │ H H H H	H H │ │ C=C − C−H │ │ │ H CH₃H	H H │ │ H−C−C−H │ │ H−C−C−H │ │ H H
D	E	F
H H H H │ │ │ │ C=C−C−C−H │ │ │ H H H	H╲ ╱H H−C−C−H ╲ ╱ C ╱ ╲ H H	H H H │ │ │ H−C−C−C−H │ │ │ H CH₃H
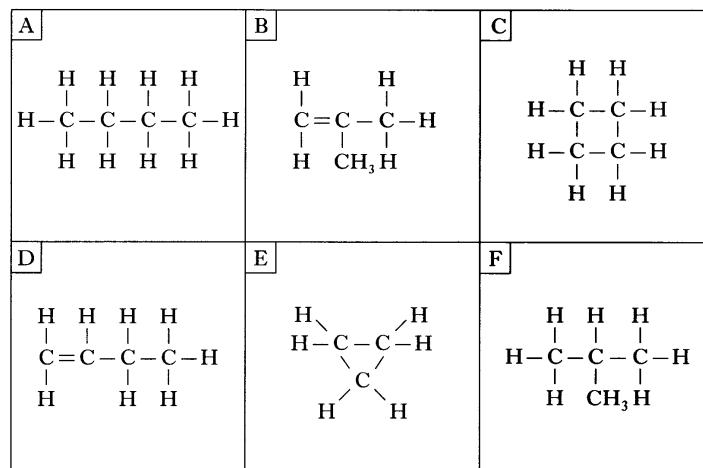
6

b)   Identify the box(es) which show hydrocarbons that would immediately decolourise   1
        bromine solution.

Q2.

Heptane can be cracked as shown.
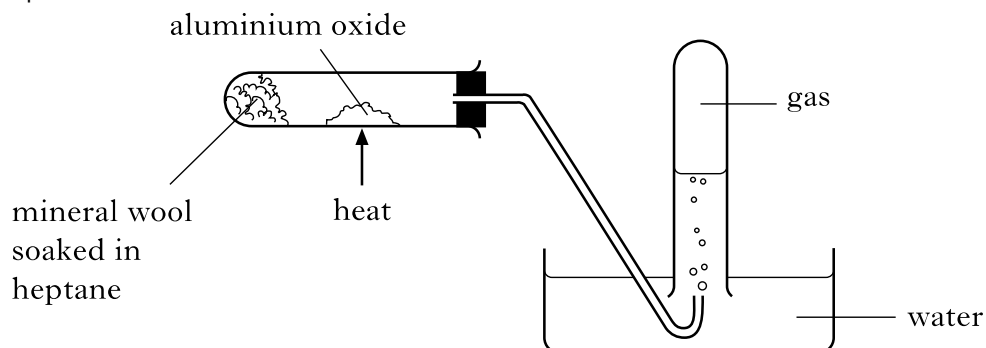
One of the reactions which takes place is:

$$C_7H_{16} \longrightarrow C_4H_{10} + C_3H_6$$
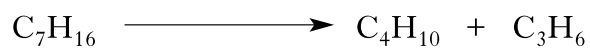
a)   Draw the full structural formula of C_4H_{10} 1

b)   The product C_3H_6 decolourises bromine solution quickly.

        Draw a structural formula for an isomer of C_3H_6, which would **not**
        decolourise bromine solution quickly.   1

Q3.   Marks

Ethylthioethane belongs to a homologous series of compounds called thioethers.

(a)   What is meant by a homologous series?   1

(b)   Ethylthioethane is formed when ethylthiol reacts with bromoethane as shown.

ethylthiol   bromoethane   ethylthioethane   hydrogen
                                                                    bromide
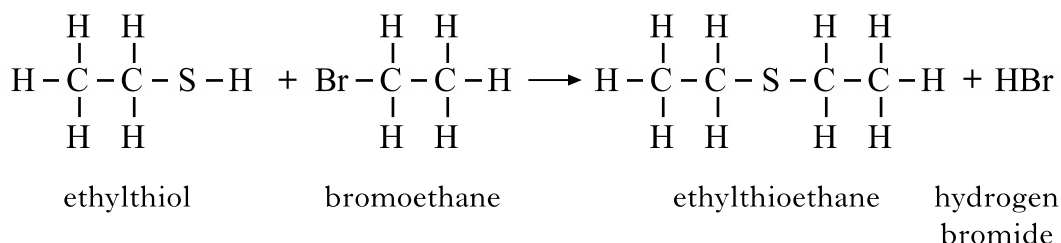
Draw the full structural formula for the thioether produced in the following reaction.

+ HBr

                                                                                                            1
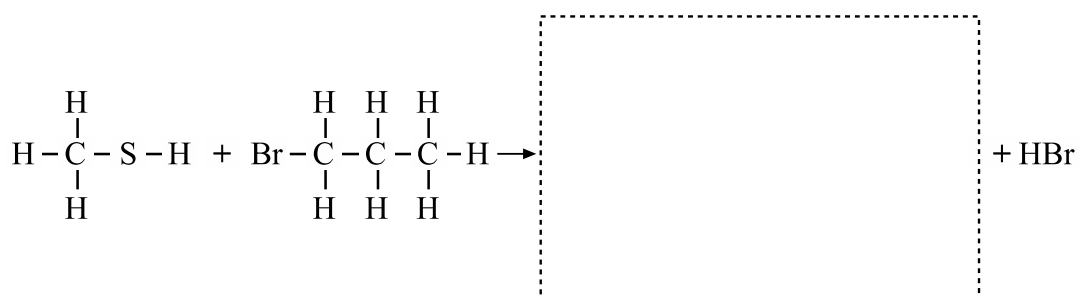
(c)   Ethylthioethane can also be formed by the reaction of ethylthiol with ethene.

ethylthiol   ethene   ethylthioethane
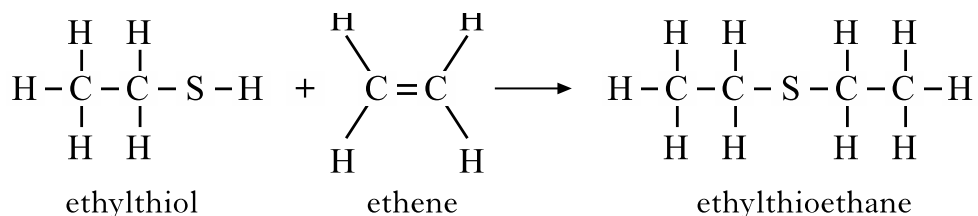
Suggest a name for the type of chemical reaction taking place.   1

Q4.   consider the following molecules:

A   B ,
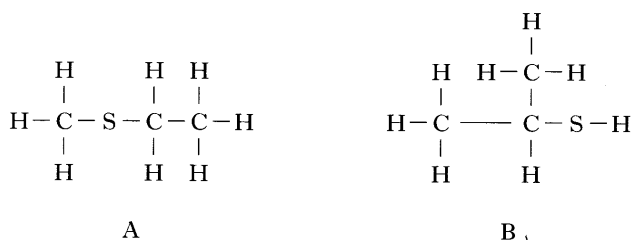
a)   Write the molecular formula for compound A   1
b)   Why can compound B be described as an **isomer** of compound A?   1

Q5.

Petrol contains the following molecule:

$$
\begin{array}{ccccc}
& H & & H & \\
& | & & | & \\
H & H-C-H & H-C-H & H & \\
| & | & | & | & \\
H-C & \!\!-\!\!-\!\! C & \!\!-\!\!-\!\! C & \!\!-\!\!-\!\! C-H \\
| & | & | & | \\
H & H & H & H \\
\end{array}
$$
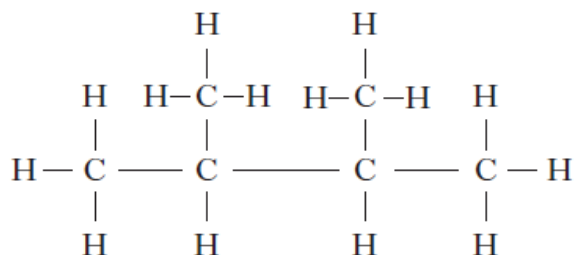
(a)   Name this molecule   1
(b)   Draw the full structural formula for 2,5,5-trimethylhept-1-ene   1

Q6.   Ethyne is the first member of a homologous series of compounds called the
      alkynes. All the alkynes contain 1 C to C triple bond

a)   Fill in the missing parts of the table.

Position in series	Name	Molecular Formula
1st	Ethyne	C_2H_2
2nd		C_3H_4
3rd	Butyne	

                                                                                       2

b)   Draw the full structural formula for ethyne.   1
c)   Deduce the **general formula** of the alkyne homologous series.   1

Exercise 14: Alcohols & Carboxylic Acids

Marks

Q1.   Draw full structural formulae for:

a)   Pentan-2-ol   1

b)   Hexan-1-ol   1

c)   An isomer of propan-1-ol   1

Q2.   Give the systematic name for the following:

a)
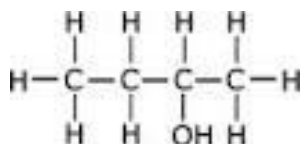
1

b)
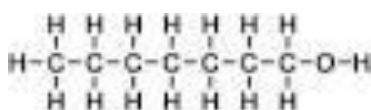
1

Q3.   Draw full structural formula for:
a)   methanoic acid   1
b)   Propanoic acid   1
c)   Heptanoic acid   1

Q4.   Name the following
a)
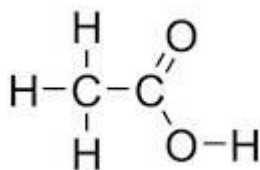
1

b)
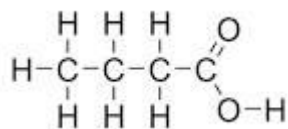
1

Exercise 15: Everyday Consumer Products

Marks

Q1.

When a hippopotamus is seen out of water it looks as though it is bleeding. This is due to a red coloured secretion which protects the hippopotamus against sunburn caused by UVB radiation. Scientists have found that one of the active ingredients in this natural sunscreen is a chemical called hipposudoric acid.
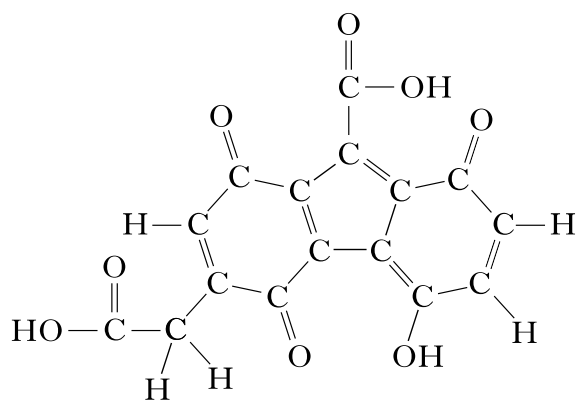
hipposudoric acid

a) Suggest a pH value for hipposudoric acid.   1

b) Hipposudoric acid contains both a hydroxyl group and a carboxyl group.   2
Draw the structure of **both** of these groups, clearly labeling which is which.

Q2. Butan-2-ol is a useful solvent.

a) Draw the full structural formula for butan-2-ol   1

b) Draw a full structural formula for an **isomer** of butan-2-ol   1

c) Give another use of alcohols   1

Q3.   An antibacterial hand gel contains two alkanols, ethanol and propan-2-ol.
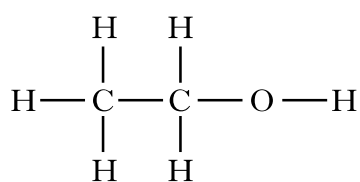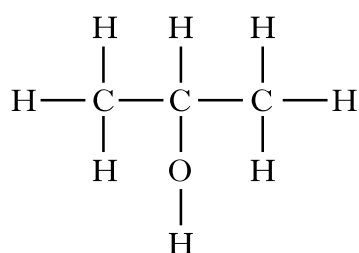
          ethanol   propan-2-ol

a)   When alkanols are oxidised alkanoic acids are produced.
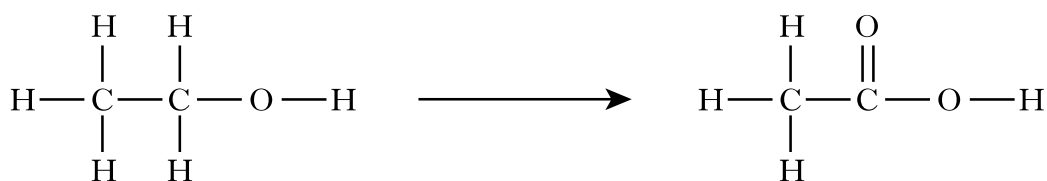
          ethanol   ethanoic acid

      Draw the full structural formula for the alkanoic acid produced when butanol is oxidised.
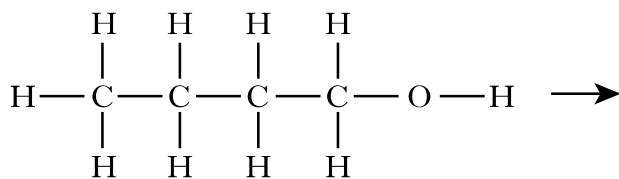
          butanol   butanoic acid   1

b)   Esters are produced when alkanols react with alkanoic acids.

      The table gives information on esters.

Alkanol	Alkanoic acid	Ester
methanol	ethanoic acid	methyl ethanoate
ethanol	propanoic acid	ethyl propanoate
propanol	methanoic acid	propyl methanoate
butanol	ethanoic acid	butyl ethanoate
pentanol	butanoic acid	**X**

      Suggest a name for X.   1

c)   Give a use for esters.   1
d)   Give the **molecular formula** for methanoic acid.   1

Exercise 16: Energy from Fuels

Q1.   Consider the following potential energy diagram.
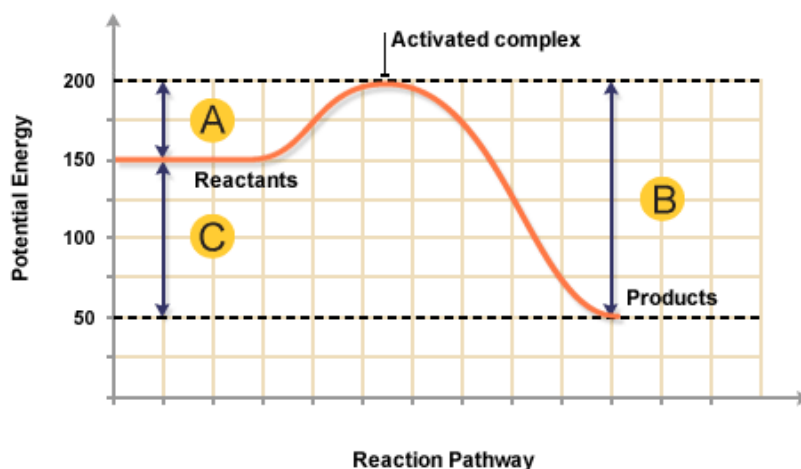
a)   Is the reaction exothermic or endothermic? Give a reason for your answer.   2

Q2.   Write balanced equations for the complete combustion of
a)   Ethanol, C_2H_6O 2
b)   Ethene, C_2H_4 2
c)   Butane, C_4H_{10} 2

Marks

Q3.   The alkanals are a homologous series of compounds that all contain the elements
      carbon, hydrogen and oxygen.
      The combustion of alkanals releases heat energy.

Name of alkanal	Heat energy released when one mole burns (kJ)
methanal	510
ethanal	1056
propanal	1624
butanal	2304

a)   Make a general statement linking the amount of heat energy released and the   1
      number of carbon atoms in the alkanal molecules.
b)   Predict the amount of heat energy released, when 1 mole of pentanal burns.   1

c)   What name is given to substances, such as alkanals, which release energy when   1
      burned?

Q4.   A value for the enthalpy of combustion of butan-2-ol, C_4H_9OH, can be
determined experimentally using the apparatus shown
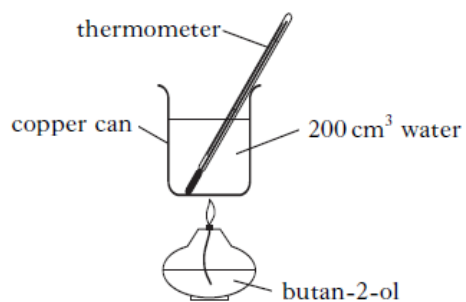
Mass of butan-2-ol burned   = $1 \cdot 0$ g
Temperature rise of water   = $40 \,°C$

a)   Use the results shown to calculate the enthalpy of combustion of butan-2-ol.   3
b)   The enthalpy given in the data booklet is much greater. Suggest a reason for the   1
difference in result when calculated experimentally.

Exercise 17: Mixed Unit 2 Questions

Q1.   The alkanols are a family of compounds containing a hydroxyl group.

a)   What name is given to a family of compounds, such as the alkanols, which follow a
        general formula and have similar chemical properties?   1

b)   Draw the hydroxyl functional group   1

c)   Ethanol can be used as a fuel.
   i)   What is meant by the term 'fuel'?   1
   ii) Give one advantage of using ethanol as a fuel over petrol   1
   iii) The enthalpy of combustion of ethanol can be determined experimentally using the
        apparatus shown below:

Mass of burner at start (g)	3.46
Mass of burner at end (g)	2.18
Temp. of water at start (°C)	22
Temp of water at end (°C)	38
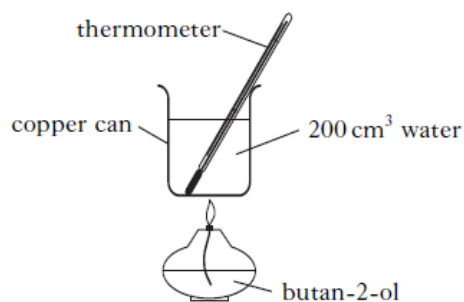
        Use the information above to calculate the enthalpy of combustion of ethanol   3

Q2.   Draw the following compounds:

a)   Cyclopentane
b)   Hex-2-ene
c)   3-methyl heptane
d)   Butanoic acid
e)   Hexan-3-ol   5

Q3.   Name the following:
       (a) $CH_3\ CH_2\ CH= CH\ CH_2\ CH_3$ (b) $CH_3\ CH_2\ CH_2\ CH= CH_2$
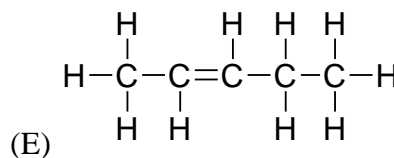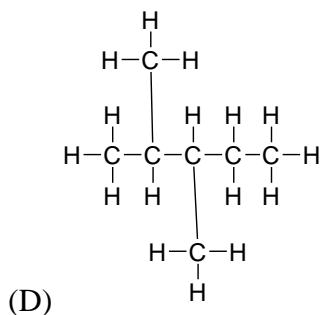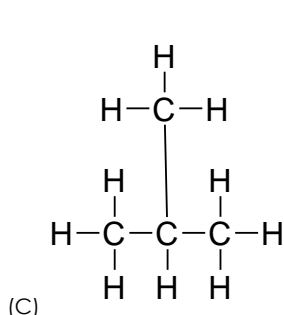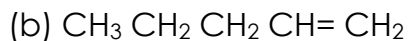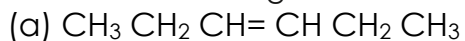
(C)   (D)   (E)   5
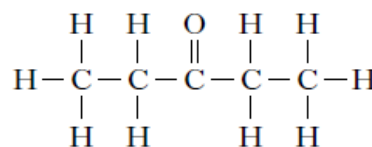
Q4.   Chemicals in food provide flavour and smell.

       Ketones are responsible for the flavour of blue cheese. Two examples of ketones are
       shown below
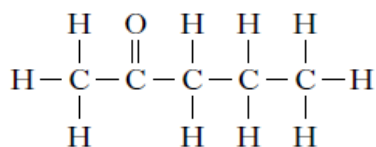
       pentan-2-one   pentan-3-one

a)   Draw the full structural formula for hexan-3-one.   1
b)   Information about the boiling points of 4 ketones is shown in the table below:

Ketone	Boiling point (°C)
C_3H_6O	56
C_4H_8O	80
$C_5H_{10}O$	102
$C_6H_{12}O$	127

i)   State the relationship between the number of carbon atoms and the boiling point   1
ii)   Predict the boiling point of $C_7H_{14}O$.   1

Exercise 18: Ionic Equations

Marks

Q1. For each of the following reactions, give
    i) A word equation
    ii) A balanced chemical equation
    iii) An ionic equation

a) Sodium reacting with oxygen   3

b) Zinc (valency 2) reacting with oxygen   3

c) Potassium reacting with water   3

d) Calcium reacting with water   3

Q2. For the following reactions, give:
    i) a word equation
    ii) a balanced chemical equation
    iii) an ionic equation
    iv) identify the spectator ions

a) Nickel (valency 2) reacting with hydrochloric acid   4

b) Calcium with sulphuric acid   4

Marks

Q1. Write REDOX equations for the following reactions

a) Zn and Mg

b) Al and Fe(II)

c) Sn and Pb

d) Ca and Ni

e) Li and Zn

 f) Au and Mg

g) Cu and Al

h) K and Na

i) Bromine and potassium

j)Nickel and chlorine   10

Exercise 20: Percentage Composition

Calculate the percentage, by mass, of:

a) carbon in methane, CH_4

b) calcium in calcium carbonate, $CaCO_3$

c) oxygen in water, H_2O

d) nitrogen in ammonia, NH_3

e) sulphur in sulphur dioxide, SO_2

f) magnesium in magnesium nitride, Mg_3N_2

g) nitrogen in ammonium phosphate, $(NH_4)_3PO_4$

h) oxygen in calcium nitrate, $Ca(NO_3)_2$

i) hydrogen in ammonium carbonate, $(NH_4)_2CO_3$

j) phosphorus in magnesium phosphate, $Mg_3(PO_4)_2$

Exercise 21: Metals

Q1. Most metals react with oxygen in the air when they are heated

a) Write a word equation to show the reaction of potassium with oxygen 1

b) Convert your word equation to a formula equation 1

c) Balance this equation. 1

Q2. A, B and C are all metals. Metal A reacts with dilute hydrochloric acid but not water. Metal B reacts with neither water nor dilute acid. Metal C reacts with both water and dilute acid.

a) Put the metals in order of reactivity, the most reactive first. 1

b) Use the reactivity series in the databook to give possible names for metals A, B and C. 1

Q3. Consider the following electrochemical cell.
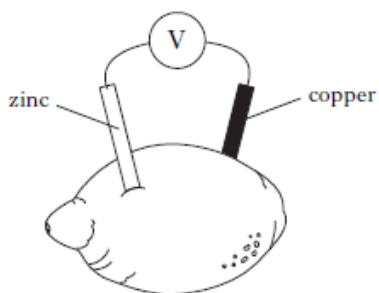
a) In which direction would the electrons flow? 1

b) Which metal is being:
i)oxidised
ii)reduced? 1

c) Write ion-electron equations to show the oxidation and reduction reactions 2

d) Combine these equations to give an overall **redox** equation 1

e) Which metal could replace zinc to produce a higher voltage? 1

Q4. The equation for a reaction is:

$Pb^{2+}(aq) + 2NO_3^-(aq) + 2Na^+(aq) + 2I^-(aq) \rightarrow Pb^{2+}(I^-)_2(s) + 2Na^+(aq) + 2NO_3^-(aq)$
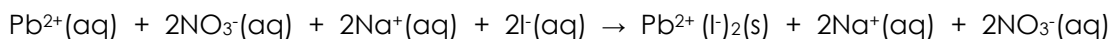
Identify the spectator ions in the equation above. 1
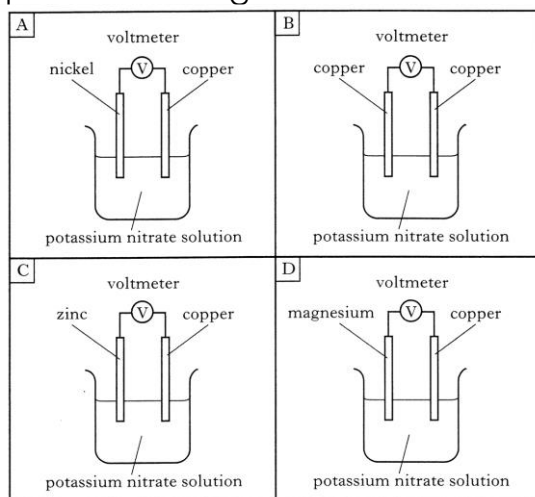
Q5.

Ammonia and nitric acid react together to form ammonium nitrate, NH_4NO_3.

Calculate the percentage by mass of nitrogen in ammonium nitrate.

Show your working clearly.

3

Q6.   Electricity can be produced using an electrochemical cell.

a)   Identify the arrangement which would not produce any electricity   1

b)   Identify the arrangement which would produce the largest voltage   1

c)   What is the purpose of the potassium nitrate solution in the above set ups?   1

d)   Give the overall redox equation for the reaction happening in experiment A   2

Exercise 22: Plastics

Q1. Polypropene is a very common thermoplastic. It is used to make fibres for carpets and clothing; car bumpers, buckets and pipes.

a) Draw the structure of Polypropene by showing 3 monomer units joined together.   1

b) What type of polymerization is used to produce polypropene?   1

Q2. Consider the following polymer:
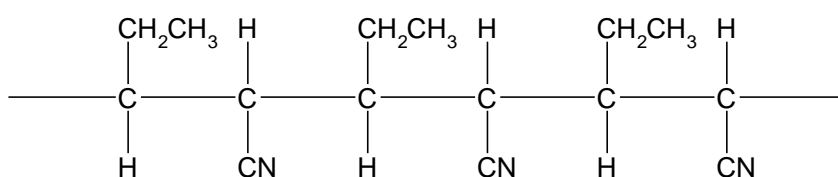
a) Identify the <u>repeating unit</u>   1

b) Identify the <u>monomer</u>   1

Q3. Redraw the following polymer into your jotter
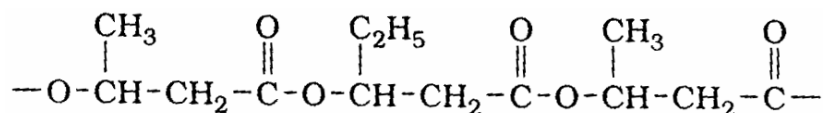
a) Circle the ester link   1

b) Draw the structure of the repeating units   1

c) Draw the structure of the monomers   1

d) Is this a condensation or addition polymer? Give a reason for your choice.   2

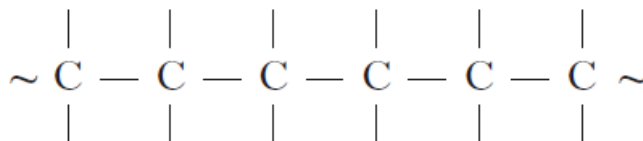**7.** Polystyrene is made from the monomer, styrene. The systematic name for styrene is phenylethene.

$$CH = CH_2$$
$$|$$
$$C_6H_5$$
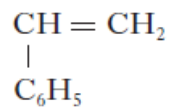
Styrene (phenylethene)

(*a*) The monomer used to form polystyrene is shown.

Which part of the structure of styrene allows the polymer to form?

_____

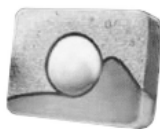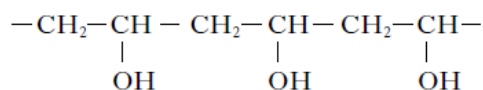(*b*) Complete the diagram to show how three styrene molecules join to form part of the polymer chain.

$$\sim C - C - C - C - C - C \sim$$

3

(*c*) Give another name for polystyrene.

6. Poly(ethenol) is one of the substances used to cover dishwasher tablets.

A section of the poly(ethenol) polymer is shown.

$$-CH_2-CH - CH_2-CH-CH_2-CH-$$
$$| \qquad\qquad | \qquad\qquad |$$
$$OH \qquad\quad OH \qquad\quad OH$$

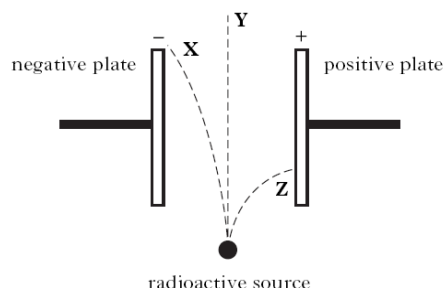(*a*) Name the functional group present in this polymer.

_____

2

(*b*) Draw the structure of the repeating unit for this polymer.

Exercise 23: Nuclear Chemistry

Q1.   The diagram shows the paths of alpha, beta and gamma radiations as they pass through an electric field.

a)   Which line in the table correctly identifies the types of radiation that follow paths **X**, **Y** and **Z**?
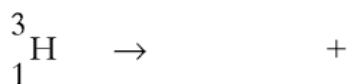
	Path X	Path Y	Path Z
A	gamma	beta	alpha
B	beta	gamma	alpha
C	beta	alpha	gamma
D	alpha	gamma	beta

1

Q2.   Tritium, ^3H, is an isotope of hydrogen. It is formed in the upper atmosphere when nitrogen atoms capture neutrons from cosmic rays.

$$^{14}_{7}N \ + \ ^{1}_{0}n \ \rightarrow \ ^{12}_{6}C \ + \ ^{3}_{1}H$$
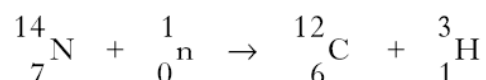
Tritium atoms then decay by beta-emission.

$$^{3}_{1}H \quad \rightarrow \qquad \qquad +$$

a)   Complete the equation to show the beta decay of tritium atoms.   1

b)   The concentration of tritium atoms in fallen rainwater is found to decrease over time. The age of any product made with water can be estimated by measuring the concentration of tritium atoms.

In a bottle of wine, the concentration of tritium atoms was found to be ⅛ of the concentration found in rain.

Given that the half-life of tritium is 12.3 years, how old is the wine?   1

Q3.   Many granite rocks contain radioactive elements which decay to release
       radon gas. The gas is an alpha emitter with a half-life of 55s and contributes
       to background radiation.

a)   Write a balanced nuclear equation for the alpha decay of radon-220.   1

b)   A sample of radon has a count rate of 80 counts min^{-1}.
       How long will it take for the count rate to fall to 5 counts min^{-1}?   1

Q4.   Phosphorus-32 and strontium-89 are two radioisotopes used to study how far
       mosquitoes travel.

a)   Strontium-89 decays by emission of a beta particle.
       Complete the nuclear equation for the decay of strontium-89.
                                                                                           1

b)   In an experiment, 10 g of strontium-89 chloride was added to a sugar solution used
       to feed mosquitoes.
       The strontium-89 chloride solution was fed to the mosquitoes in a laboratory at 20
       °C. When the mosquitoes were released, the outdoor temperature was found to be
       35 °C.
       What effect would the increase in temperature have on the half-life of the
       strontium-89?
                                                                                           1

c)   A mosquito fed on a solution containing phosphorus-32 is released.
       Phosphorus-32 has a half-life of 14 days.
       When the mosquito is recaptured 28 days later, what fraction of the phosphorus-32
       will remain?   1

Q5 The element iodine has only one isotope that is stable. Several of the radioactive
    isotopes of iodine have medical uses. Iodine-131, for example, is used in the study
    of the thyroid gland and it decays by beta emission.

a) Give the balanced nuclear equation for the beta decay of iodine-131.   1

b) The graph shows how the mass of iodine-131 changes over time.
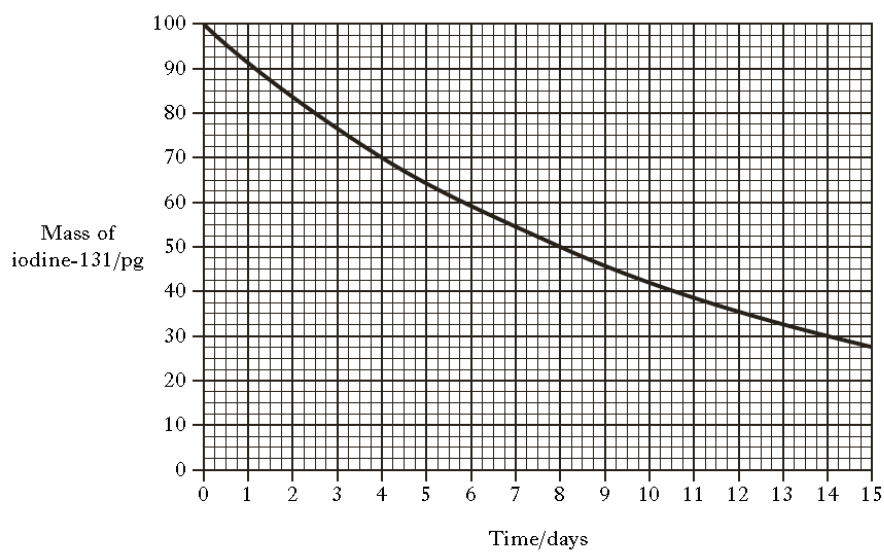
What is the half life of iodine-131?   1

Exercise 24: Mixed Unit 3 Questions

Q1.   Zinc displaces copper from copper(II) sulphate solution.
        The equation for the reaction is:

$$Zn(s) + Cu^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow Zn^{2+}(aq) + SO_4^{2-}(aq) + Cu(s)$$

a)   Identify the spectator ion(s) in the above equation.   1

b)   Write the ion-electron equation for the **oxidation** step in this reaction.   1
        You may wish to use the data booklet to help you.

c)   The reaction can also be carried out in a cell:
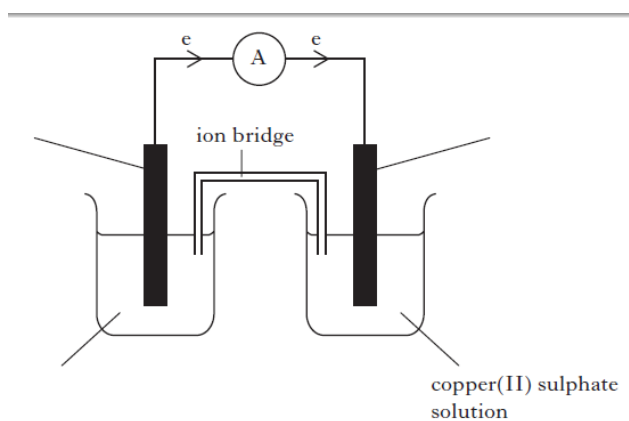
i)   Complete the 3 labels on the diagram
                                                                                              1
ii)   What is the purpose of the ion bridge?   1

Q2.   Polyvinyldichloride (PVDC) is a plastic used in food packaging.
        The structure of part of a PVDC molecule is shown.
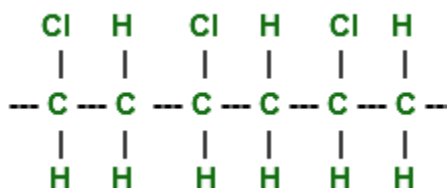
a)   Draw the **full** structural formula for the monomer used to make PVDC   1
b)   Name a toxic gas produced when PVDC burns.   1

Q3   Calculate the percentage by mass of:

a)   calcium in calcium carbonate, $CaCO_3$
                                                                                              3

b)   nitrogen in ammonium phosphate, $(NH_4)_3PO_4$
                                                                                              3

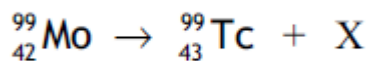Q4.   Catalysts can be used in industrial processes. The flow diagram below shows the production of ammonia
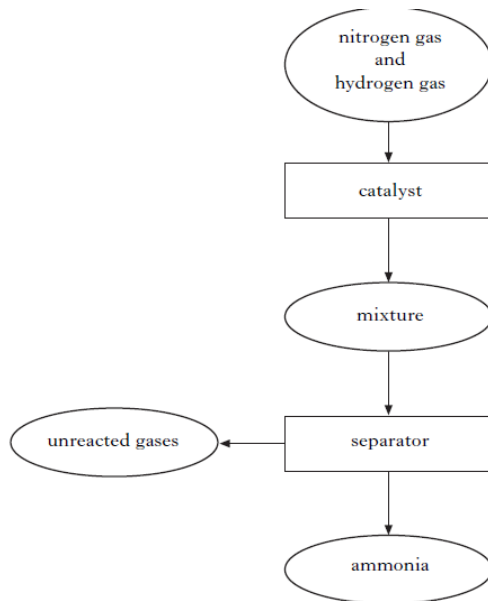
a)   Name the process used to produce ammonia   1

c)   Name the catalyst used
                                                                                                  1

d)   Other than to speed up a chemical reaction, give another reason why a catalyst may be
      used.   1

e)   Give a balanced chemical equation for the production of ammonia.   2

Q5.   Which particle will be formed when an atom of $^{211}_{83}Bi$ emits an

      a-particle and the decay product then emits a β-particle?
                                                                                                  1

Q6.   Technetium-99 is used in medicine to detect tissue damage.
      It is a gamma-emitting radioisotope and is injected into the body.

a)   The half life of technetium-99 is 6 hours. How much of a 2g sample would be left after
      12 hours?   1

b)   Technetium-99 is formed when molybdenum-99 decays.
      The decay equation is:

      $$^{99}_{42}Mo \rightarrow {}^{99}_{43}Tc + X$$

      Identify X.   1

Q1.

The little pen-tailed tree shrew, found in the jungles of West Malaysia, feeds on nectar from the Bertam palm tree. This nectar contains glucose which ferments, producing solutions of up to 3·8% alcohol. Therefore, the tree shrew regularly drinks a solution which is equivalent to a man drinking 9 units of alcohol per day. It seems that the tree shrew never gets drunk because it is able to breakdown the alcohol much quicker than humans can.

$$\text{Volume of alcohol solution} = \frac{\text{units of alcohol} \times 1\cdot25}{\%\ \text{of alcohol}}$$

Use information in the passage above to calculate the volume of alcohol solution the tree shrew drinks each day. 1

Q2. Some indicators can have different colours when in solutions of different pH values. The tables give information about two indicators, bromothymol blue and methyl orange.

Bromothymol blue	
Colour	pH
yellow	below 6·0
blue	above 7·6

Methyl orange	
Colour	pH
red	below 3·1
yellow	above 4·4

The pH of three solutions was investigated using both indicators.
The results are shown below.

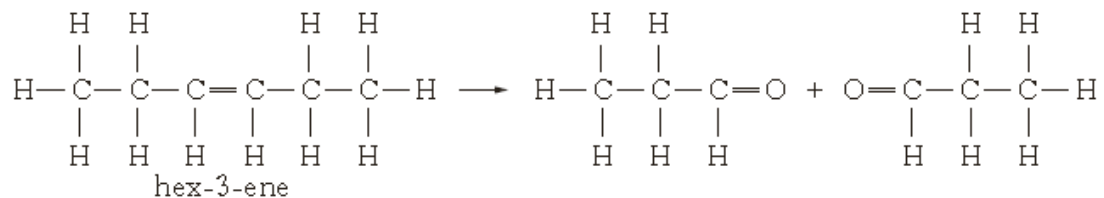| Substance	Colour with bromothymol blue	Colour with methyl orange
A	yellow	red
B	yellow	yellow
C	blue	yellow

a) Which solution is alkaline? 1

b) Suggest a pH for solution B. 1

Q3. Alkenes can undergo different reactions.
In ozonolysis an alkene reacts with ozone forming two molecules. The ozonolysis of hex-3-ene is shown.

Draw the products formed by the ozonolysis of hex-2-ene.
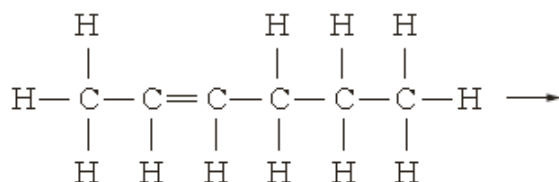
1

Q4. The table below shows the relationship between the percentage of ethanol and the density of alcoholic drinks.

| Percentage of ethanol (%)	40	50	60	70	80
Density of alcoholic drink (g/cm^3)	0·928	0·907	0·886	0·865	0·844

a) Write a general statement describing how the percentage of ethanol affects the density of the alcoholic drink.

1

b) The density of a particular brand of alcoholic drink is 0·970 g/cm³.
Predict the percentage of ethanol in this alcoholic drink.

1

Q5.

Some household cleaners contain the chemical limonene which gives them a lemon smell. The structure of limonene is shown below.
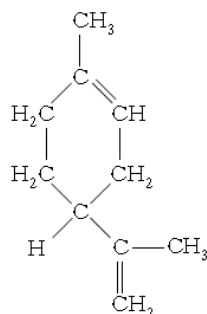

Using bromine solution, a student carried out titrations to determine the concentration of limonene in a household cleaner.

$0.50 \, mol \, l^{-1}$ bromine solution (orange/red)

Flask

$20.0 \, cm^3$ household cleaner (colourless)
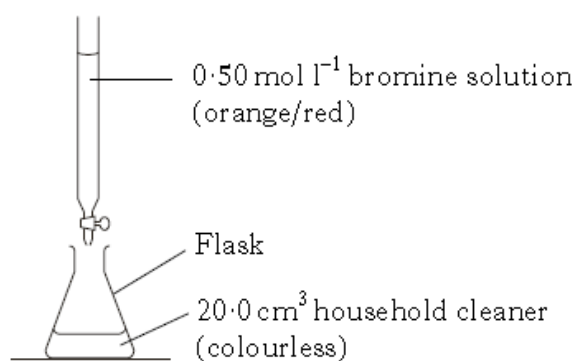
Titration	Initial burette reading (cm^3)	Final burette reading (cm^3)	Titre (cm^3)
1	0·5	17·1	16·6
2	0·2	16·3	16·1
3	0·1	16·0	15·9

(a) What average volume should be used in calculating the concentration of limonene? 1

(b) The equation for the reaction between limonene and bromine solution is shown.

$$C_{10}H_{16}(aq) \; + \; 2Br_2(aq) \longrightarrow C_{10}H_{16}Br_4(aq)$$
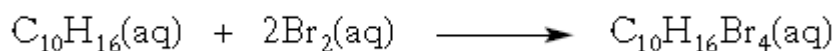
3

Calculate the concentration of limonene in the household cleaner in mol l⁻¹.

Exercise 26: Open Ended Questions

Each of the following questions is worth 3 marks. They require you to use your knowledge of chemistry and apply it to a new situation. Marks are awarded as follows:

3 marks: The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.

2 marks: The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood.

1 mark: The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.

0 mark: the student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of relevant chemistry principle. This mark would also be given if the candidate merely restates the chemistry given in the question.

1. The periodic table groups together elements with similar properties. In most periodic tables hydrogen is placed at the top of group 1, but in some it is placed at the top of group 7.

   Using your knowledge of chemistry, comment on the reasons for hydrogen being placed either above group 1 or group 7.

2. A mass spectrometer is a machine used by scientists to find out information about the isotopes that elements have. Part of the process involves atoms of elements being turned into positive ions.

   Using your knowledge of chemistry, comment on whether the positive ions produced would be bigger, smaller or the same size as the atoms from which they were made.

3. Many different hydrocarbon compounds exist. A student was give 3 bottles labelled A, B and C and told that 1 bottle contained hexane, another cyclohexane, and the third hex-1-ene.

   Using your knowledge of chemistry describe how you would correctly identify the contents of each bottle.

4. Aspirin is widely used as a medicine. Its structure is shown below:
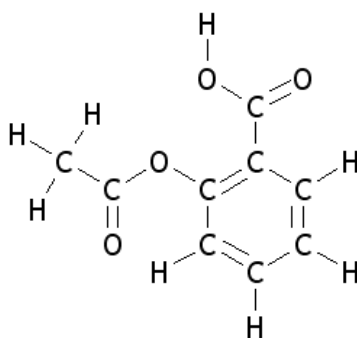
   Using your knowledge of chemistry, comment on what physical and chemical properties you would expect aspirin to demonstrate.

5. The labels have dropped off three bottles containing organic compounds. The chemistry technician has asked a National 5 chemistry class to identify these compounds.

   Using your knowledge of chemistry, comment on how would the class could identify the alcohol, alkene and carboxylic acid.

6. Esters, alcohols and carboxylic acids are widely used in everyday life. A student was give 3 bottles labelled A, B and C and told that 1 bottle contained an ester, another contained an alcohol, and the third a carboxylic acid.

   Using your knowledge of chemistry describe how you would correctly identify the contents of each bottle.

7. Dentists use an amalgam (an alloy of mercury silver and tin) for fillings. A person with an amalgam filling touched a steel fork against it while eating and felt a sharp pain. The dentist said this was caused by an electric current produced, and would have been more painful had they touched it with aluminium foil.

   Use your knowledge of chemistry to comment on why this is the case.

8. 'Mag Wheels' were a popular type of alloy wheel fitted to sports cars in the 1950s and 60s. the wheels were made using an alloy of magnesium, and they were preferred to steel wheels by manufacturers of racing cars and road-going sports cars. Today, most of these cars have aluminium alloy wheels.

   Using your knowledge of chemistry, comment on why manufacturers may have used 'Mag Wheels' instead of steel ones on sports cars, and why today an aluminium alloy might be used instead.