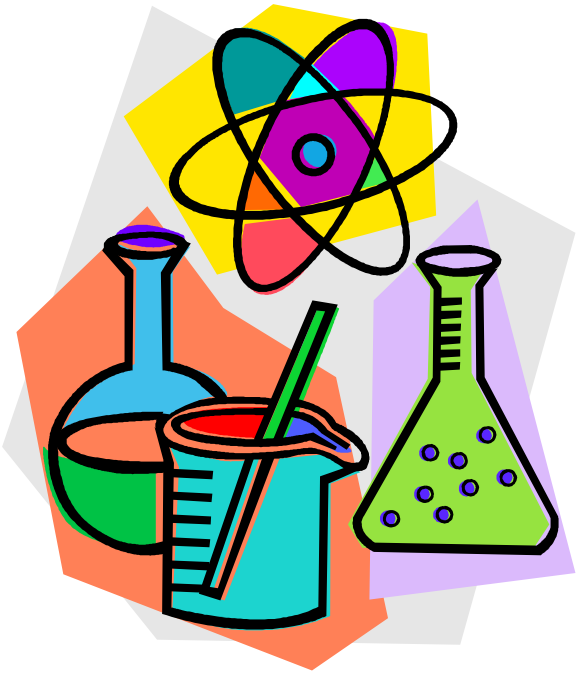
HEATHCOTE SCHOOL



A LEVEL CHEMISTRY

TRANSITION UNIT

Bridging the gap between GCSE and AS-Level

Name: _____

Secondary School _____

Contents ANSWERS

Task 1: # The structure of atoms

1 Complete the spaces to create a set of notes about the structure of atoms.

Atoms consist of a central nucleus containing protons and neutrons. The nucleus is small compared to the size of the whole atom. The nucleus is surrounded by electrons in energy levels (also called shells). Atoms have no electric charge because they contain the same number of protons and electrons.

Sub-atomic particle	Relative mass	Relative charge
Proton	1	+1
Neutron	1	0
Electron	Almost zero	-1

Protons and neutrons

Electrons in

Atomic number = number of protons.

Mass number = number of protons + number of neutrons.

mass number **19**

Symbol e.g. **F**

atomic number **9**

protons = 9

neutrons = 10

electrons = 9

Atoms of the same element have the same number of protons. It is the number of protons that determines what type of atom it is (e.g. all atoms with six protons are carbon atoms). Atoms of different elements have different numbers of protons. Isotopes are atoms of the same element. They contain the same number of protons but a different number of neutrons.

2 Complete the table about some atoms.

Atom	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
$^{23}_{11}Na$	11	23	11	12	11
Li	3	7	3	4	3
Ar	18	40	18	22	18
K	19	39	19	20	19
Al	13	27	13	14	13
Cl	17	35	17	18	17
$^{235}_{92}U$	92	235	92	143	92
$^{238}_{92}U$	92	238	92	146	92

Task 2: Atoms and ions

You will need to look at the Periodic Table to help you answer the following questions.

1 a Complete the table to show the electronic structure of the following ions.

Ion	F^-	Na^+	Al^{3+}	K^+	S^{2-}	H^+	O^{2-}	Ca^{2+}	Li^+	Mg^{2+}	Cl^-	Be^{2+}
Electronic structure	$[2,8]^-$	$[2,8]^+$	$[2,8]^{3+}$	$[2,8,8]^+$	$[2,8,8]^{2-}$	[0]+	$[2,8]^{2-}$	$[2,8,8]^{2+}$	$[2]^+$	$[2,8]^{2+}$	$[2,8,8]^-$	$[2]^{2+}$

b Complete the table below to show the electronic structure of some Group 0 elements (noble gases).Place the ions from part **a** into the correct row of the table.

Element	**Electronic structure**	**Ions with the same electronic structure**
He	2	Li, Be
Ne	2,8	F, Na, Al, O, Mg
Ar	2,8,8	K, S, Ca, Cl

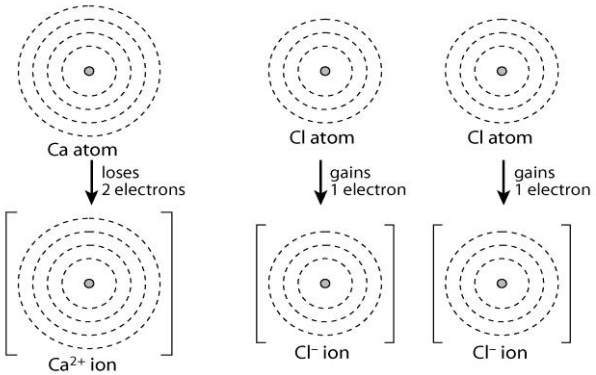
c i Complete the table with the ions from part **a**. Ions for Group 1 have been done for you. Do not include the H^+ ion.

Group	1	2	3	4	5	6	7	0
Ions	Li^+ Na^+ K^+	Be^{2+} Mg^{2+} Ca^{2+}	Al^{3+}			O^{2-} S^{2-}	F^- Cl^-	
Charge	+1	+2	+3			-2	-1	

ii Predict the charge that the following ions would have using the Periodic Table and your table.

strontium ions +2 iodide ions -1 rubidium ions +1

2 Calcium atoms react with chlorine atoms to form the ionic compound calcium chloride. Calcium atoms each lose two electrons to form calcium ions. Chlorine atoms each gain one electron to form chloride ions. This means that calcium atoms react with chlorine atoms in the ratio of one calcium atom for every two chlorine atoms. Complete the diagram to show the electronic structure of the calcium and chlorine atoms and the calcium and chloride ions. Answer in class



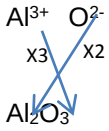
3 Complete the following table about some atoms and ions. The first row has been done for you.

Particle	**Atom or ion**	**Atomic number**	**Mass number**	**Number of protons**	**Number of neutrons**	**Number of electrons**	**Electronic structure**
$^{16}O^{2-}$	ion	8	16	8	8	10	$[2, 8]^{2-}$
^{31}P	atom	15	31	15	16	15	2,8,5
^{27}Al	atom	13	27	13	14	13	2,8,3
$^{27}Al^{3+}$	ion	13	27	13	14	10	$[2,8]^{3+}$
^{4}He	atom	2	4	2	4	2	2
$^{32}S^{2-}$	Ion	16	32	16	16	18	$[2, 8, 8]^{2-}$
$^{24}Mg^{2+}$	ion	12	24	12	12	10	$[2, 8]^{2+}$

Task 3: Writing formulas

Use the table of ions to write the formula of the following ionic compounds. Use the general rule of cross-multiply and then simplify where possible.

Eg: Aluminium oxide:



Positive ions				Negative ions			
aluminium	Al^{3+}	lead	Pb^{2+}	bromide	Br^{-}	oxide	O^{2-}
ammonium	NH_4^{+}	lithium	Li^{+}	carbonate	CO_3^{2-}	sulfate	SO_4^{2-}
barium	Ba^{2+}	magnesium	Mg^{2+}	chloride	Cl^{-}	sulfide	S^{2-}
calcium	Ca^{2+}	potassium	K^{+}	fluoride	F^{-}		
copper (II)	Cu^{2+}	silver	Ag^{+}	hydrogencarbonate	HCO_3^{-}		
hydrogen	H^{+}	sodium	Na^{+}	hydroxide	OH^{-}		
iron (II)	Fe^{2+}	zinc	Zn^{2+}	iodide	I^{-}		
iron (III)	Fe^{3+}			nitrate	NO_3^{-}		

1

a potassium iodide — KI

b sodium oxide — Na_2O

c aluminium bromide — $AlBr_3$

d magnesium chloride — $MgCl_2$

e silver oxide — Ag_2O

f iron (II) oxide — FeO

g iron (III) oxide — Fe_2O_3

h calcium sulfide — CaS

i copper (II) chloride — $CuCl_2$

j lithium fluoride — LiF

k barium chloride — $BaCl_2$

l lead sulfide — PbS

m zinc iodide — ZnI_2

2

a potassium sulfate — K_2SO_4

b magnesium sulfate — $MgSO_4$

c magnesium hydroxide — $Mg(OH)_2$

d copper (II) nitrate — $Cu(NO_3)_2$

e zinc carbonate — $ZnCO_3$

f potassium hydroxide — KOH

g sodium carbonate — Na_2CO_3

h aluminium hydroxide — $Al(OH)_3$

i ammonium hydroxide — NH_4OH

j ammonium chloride — NH_4Cl

k aluminium sulfate — $Al_2(SO_4)_3$

l iron (III) nitrate — $Fe(NO_3)_3$

m ammonium nitrate — NH_4NO_3

Task 4: Relative masses

Element		A_r
aluminium	Al	27
bromine	Br	80
calcium	Ca	40
carbon	C	12
chlorine	Cl	35.5
copper	Cu	63.5
fluorine	F	19

Element		A_r
hydrogen	H	1
iodine	I	127
iron	Fe	56
magnesium	Mg	24
nitrogen	N	14
oxygen	O	16

Element		A_r
phosphorus	P	31
potassium	K	39
silver	Ag	108
sodium	Na	23
sulfur	S	32
zinc	Zn	65

1

a 58
b 80
c 213
d 100
e 94
f 53.5
g 400
h 162
i 132
j 249.5
k 286
l 396

2

a 55.2%
b 67.6%
c 48.0%
d 1.2%
e 21.2%
f 57.7%
g 16.1%
h 14.3%

Task 5: Balancing equations

Balance the following equations.

a $N_2 + 3H_2 \rightarrow 2NH_3$

b $2Ca + O_2 \rightarrow 2CaO$

c $Br_2 + 2KI \rightarrow 2KBr + I_2$

d $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

e $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

f $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

Task 6: Writing symbol equations from words

Write symbol equations for the following reactions taking place. You will first need to convert the names of the materials into formulae and then balance the equation.

1. Zinc metal reacts with copper sulphate solution to produce solid copper metal and zinc sulphate solution.
   $Zn + CuSO_4 \rightarrow Cu + ZnSO_4$

2. Solid calcium hydroxide reacts with solid ammonium chloride on heating to produce solid calcium chloride, steam and ammonia gas.
   $Ca(OH)_2 + 2NH_4Cl \rightarrow CaCl_2 + 2H_2O + 2NH_3$

3. When lead (II) nitrate is heated in a dry test tube lead (II) oxide, nitrogen dioxide gas and oxygen are produced.
   $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

4. Silicon tetrachloride reacts with water to produce solid silicon dioxide and hydrogen chloride gas.
   $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$

5. When octane (C_8H_{18}) vapour is burned with excess air in a car engine carbon dioxide and water vapour are produced.
   $C_8H_{18} + 12.5O_2 \rightarrow 8CO_2 + 9H_2O$ (accept multiples)

6. When rubidium reacts with water a solution of the hydroxide of the metal is produced as well as hydrogen gas.
   $2Rb + 2H_2O \rightarrow 2RbOH + H_2$

7. When strontium reacts with water a solution of the hydroxide of the metal is produced as well as hydrogen gas.
   $Sr + 2H_2O \rightarrow Sr(OH)_2 + H_2$

8. Sodium chloride reacts with concentrated sulfuric acid to produce sodium hydrogen sulphate and hydrogen chloride.
   $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

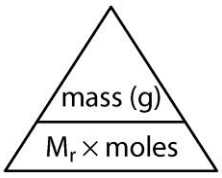
Task 7: Using moles

Element		A_r
aluminium	Al	27
bromine	Br	80
calcium	Ca	40
carbon	C	12
chlorine	Cl	35.5
copper	Cu	63.5
fluorine	F	19

Element		A_r
hydrogen	H	1
iodine	I	127
iron	Fe	56
magnesium	Mg	24
nitrogen	N	14
oxygen	O	16

Element		A_r
phosphorus	P	31
potassium	K	39
silver	Ag	108
sodium	Na	23
sulfur	S	32
zinc	Zn	65

$$\text{mass (g)} = M_r \times \text{moles}$$



1 Complete the blank parts of the following table.

Substance	Formula	M_r	Mass	Moles
carbon monoxide	CO	28	560 g	20
propane	C_3H_8	44	8.8 g	0.2
unknown solid	unknown	208	0.104 g	0.0005
methane	CH_4	16	6 kg	375
sodium carbonate	Na_2CO_3	106	265 g	2.5
unknown gas	unknown	40	0.1 g	0.0025

2 How many moles are there in each of the following?

a 72 g of Mg moles = $\frac{\text{mass}}{M_r} = \frac{72}{24}$ = 3 moles

b 39 g of $Al(OH)_3$ 0.5 moles

c 1 tonne of NaCl 17 100 moles (3s.f)

d 20 mg of $Cu(NO_3)_2$ 0.000 107 moles (3s.f)

3 What is the mass of each of the following?

a 5 moles of Cl_2 mass = M_r × moles = 71 × 5 = 355 g

b 0.2 moles of Al_2O_3 20.4 g

c 0.01 moles of Ag 1.08 g

d 0.002 moles of $(NH_4)_2SO_4$ 0.264 g

e 0.3 moles of $Na_2CO_3.10H_2O$ 85.8 g

4 An experiment was carried out to find the M_r of vitamin C (ascorbic acid). It was found that 1 g contains 0.00568 moles of vitamin C molecules. Calculate the M_r of vitamin C.

1/0.00568

= 176 g (to 3sf)

Task 8: Reacting Mass calculations

Use A_r values given in task 7 for this exercise. Answer in the space provided. Show your working.

1 What mass of hydrogen is needed to react with 40 g of copper oxide?

$CuO + H_2 \rightarrow Cu + H_2O$

Moles CuO = 0.503, moles H_2= 0.503, **mass H_2 = 1.01 g.**

2 What mass of oxygen reacts with 192 g of magnesium?

$2\ Mg + O_2 \rightarrow 2\ MgO$

Moles Mg = 8, moles O2=4, mass O2 =128g

3 What mass of sulfur trioxide is formed from 96 g of sulfur dioxide?

$2\ SO_2 + O_2 \rightarrow 2\ SO_3$

Moles SO_2 = 1.5, moles SO_3 = 1.5, **mass SO_3 = 120 g**

4 What mass of carbon monoxide is needed to react with 480 g of iron oxide?

$Fe_2O_3 + 3\ CO \rightarrow 2\ Fe + 3\ CO_2$

Moles Fe_2O_3 = 3, moles CO = 9, **mass CO = 252 g**.

5 What mass of carbon dioxide is produced when 5.6 g of butene (C_4H_8) is burned?

$C_4H_8 + 6\ O_2 \rightarrow 4\ CO_2 + 4\ H_2O$

Moles C4H8 = 0.1, moles CO2 = 0.4, mass CO2=17.6g

6 What mass of oxygen is needed to react with 8.5 g of hydrogen sulfide (H_2S)?

$2\ H_2S + 3\ O_2 \rightarrow 2\ SO_2 + 2\ H_2O$

Moles H_2S = 0.25, moles O_2 = 0.375, **mass O_2 = 12 g**

7 The pollutant sulfur dioxide can removed from the air by reaction with calcium carbonate in the presence of oxygen. What mass of calcium carbonate is needed to remove 1 tonne of sulfur dioxide?

$2\ CaCO_3 + 2\ SO_2 + O_2 \rightarrow 2\ CaSO_4 + 2\ CO_2$

Moles SO_2 = 15 625, moles $CaCO_3$ = 15 625, mass $CaCO_3$ = 1 562 500 g (1 560 000 g to 3 sig. figs).

8 What mass of potassium oxide is formed when 7.8 g of potassium is burned in oxygen?

$4\ K + O_2 \rightarrow 2\ K_2O$

Moles K = 0.2, moles K_2O = 0.1, mass K_2O = 9.4 g.

9 What mass of oxygen is required to oxidise 34 g of ammonia (NH_3) to nitrogen monoxide (NO)?

$4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$

Moles NH_3 = 2, moles O_2 = 2.5, **mass O_2 = 80 g.**

10 5.00 g of hydrated sodium sulfate crystals ($Na_2SO_4.nH_2O$) gave 2.20 g of anhydrous sodium sulfate on heating to constant mass. Work out the relative formula mass (M_r) of the hydrated sodium sulfate and the value of *n*.

$Na_2SO_4.nH_2O \rightarrow Na_2SO_4 + n\ H_2O$

Moles Na_2SO_4 = 0.0155, moles $Na_2SO_4.nH_2O$ = 0.0155, M_r $Na_2SO_4.nH_2O$ = 322.7, ***n* = 10**.

Task 9: Yields and atom economy

$$\% \text{ yield} = \frac{\text{mass of product obtained}}{\text{maximum theoretical mass of product}} \times 100$$

$$\text{Atom economy} = \frac{Mr \text{ wanted product from equation}}{\text{total } Mr \text{ of products from equation}} \times 100$$

1 Balance the following equations.

a 2 SO_2 + O_2 → 2 SO_3

b $FeCl_3$ + 3 NaOH → $Fe(OH)_3$ + 3NaCl

c Na_2CO_3 + 2HCl → 2NaCl + CO_2 + H_2O

2 Calculate the percentage yield in each of the following reactions.

	Theoretical maximum mass of product	**Mass of product obtained**	**ans**
a	100 g	70 g	70%
b	4 g	2.5 g	62.5%
c	5 kg	1 kg	20%

3 Quicklime (calcium oxide, CaO) can be made by thermal decomposition of limestone (calcium carbonate, $CaCO_3$). **$CaCO_3$ → CaO + CO_2**

a Calculate the maximum theoretical mass of quicklime that can be made by heating 50 g of limestone (relative atomic masses: C = 12, O = 16, Ca = 40).

28 g

b In the reaction, only 26 g of quicklime was produced. Calculate the percentage yield.

92.9%

4 Calculate the atom economy in each of the following reactions.

	Mass of wanted product in equation	**Total mass of products in equation**	**ans**
a	71 g	100 g	71%
b	32 g	40 g	80%
c	56 g	56 g	100%

5 Aluminium is made by the electrolysis of aluminium oxide. Calculate the atom economy for the production of aluminium in this reaction. (relative atomic masses: O = 16, Al = 27)

2 Al_2O_3 → 4 Al + 3 O_2

52.9%

6 Hydrazine (N_2H_4) was used as the rocket fuel for the Apollo missions to the moon. It is made by the reaction of ammonia (NH_3) with sodium chlorate (NaOCl) (relative atomic masses: H = 1, N = 14, O = 16, Na = 23, Cl = 35.5).

ammonia	+	sodium chlorate	→	hydrazine	+	sodium chloride	+	water
2 NH_3	+	NaOCl	→	N_2H_4	+	NaCl	+	H_2O

a Calculate the maximum theoretical mass of hydrazine that can be made by reacting 340 g of ammonia with an excess of sodium chlorate.

320 g

b In the reaction, only 280 g of hydrazine was produced. Calculate the percentage yield.

87.5%

c Give **three** reasons why less than the maximum theoretical yield was produced.

Reaction's reversible, some NH_3 lost separating it from the reaction mixture, other reactions take place

.

d Calculate the atom economy for this way of making hydrazine.

29.5%

Task 10: Empirical and molecular formulae

Empirical formula is the simplest whole number ratio of elements. Divide the percentage or mass by the Mr of each element in the compound, divide by the smallest number and simplify to give a whole number ratio.

Element		A_r
aluminium	Al	27
bromine	Br	80
calcium	Ca	40
carbon	C	12
chlorine	Cl	35.5
copper	Cu	63.5
fluorine	F	19

Element		A_r
hydrogen	H	1
iodine	I	127
iron	Fe	56
lead	Pb	207
magnesium	Mg	24
nitrogen	N	14
oxygen	O	16

Element		A_r
phosphorus	P	31
potassium	K	39
silver	Ag	108
sodium	Na	23
sulfur	S	32
zinc	Zn	65

1 Copy and complete the table.

Empirical formula	M_r	Molecular formula
CH_2	42	C_3H_6
CH_2	70	C_5H_{10}
CH_2	56	C_4H_8
C_3H_8	44	C_3H_8
HO	34	H_2O_2
CH	78	C_6H_6

2 Find the empirical formula of each of the following substances using the data about composition by mass.

a H 5% F 95% HF

b Na 3.71 g O 1.29 g Na_2O

c Pb 90.7% O 9.3% Pb_3O_4

d C 60.0% H 13.3% O 26.7% C_3H_8O

3 3.53 g of iron reacts with chlorine to form 10.24 g of iron chloride. Find the empirical formula for the iron chloride. $FeCl_3$

4 Analysis of a compound consisting of carbon, hydrogen and oxygen showed it to contain 0.273 g C, 0.046 g H, and 0.182 g O. It has a relative formula mass (M_r) of 88.

a Calculate the empirical formula of the compound.

C_2H_4O

b Calculate the molecular formula of the compound.

$C_4H_8O_2$

Task 11: Titration calculations

TRIPLE/

FURTHER SCIENCE

n = Number of moles
c = Concentration (in mol l^{-1})
v = Volume (in litres)

1 Sodium hydroxide and hydrochloric acid react together according to the equation:

$$NaOH + HCl \rightarrow NaCl + H_2O$$

In a titration between sodium hydroxide solution and hydrochloric acid 25.0 cm^3 of 0.2 mol/dm^3 sodium hydroxide solution is neutralised by 27.75 cm^3 of hydrochloric acid.

Use the information to calculate the concentration of the hydrochloric acid in mol/dm^3. Give your answer to 2 decimal places. *(3 marks)*

0.18 mol/dm^3 *(3 marks)*

2 Potassium hydroxide and hydrochloric acid react together according to the equation:

$$KOH + HCl \rightarrow KCl + H_2O$$

In a titration between potassium hydroxide solution and hydrochloric acid 10.0 cm^3 of 0.1 mol/dm^3 potassium hydroxide solution is neutralised by 0.12 mol/dm^3 hydrochloric acid.

Use the information to calculate the volume of hydrochloric acid needed to exactly neutralise the potassium hydroxide solution. Give your answer to 2 decimal places. *(3 marks)*

8.33 cm^3 *(3 marks)*

3 Potassium hydroxide and nitric acid react together according to the equation:

$$KOH + HNO_3 \rightarrow KNO_3 + H_2O$$

In a titration between potassium hydroxide solution and nitric acid 25.0 cm^3 of 0.25 mol/dm^3 potassium hydroxide solution is neutralised by 0.2 mol/dm^3 nitric acid.

Use the information to calculate the volume of nitric acid needed to exactly neutralise the potassium hydroxide solution. Give your answer to 2 decimal places. *(3 marks)*

31.25 cm^3 *(3 marks)*

Task 12: Different types of structures

Complete the table about substances with each of the types of structures shown.

Type of structure	**Simple molecular**	**Ionic**	**Giant covalent**	**Metallic**
Description of the structure	Many separate molecules. Each molecule is made from atoms joined by covalent bonds. There are weak forces between the molecules.	Many positive and negative ions. There are strong electrostatic attractions between the positive and negative ions.	A regular, giant network of atoms joined by covalent bonds.	A regular, giant structure of positive metal ions surrounded by delocalised outer shell electrons.
Type of bonding	**Covalent**	**Ionic**	**Covalent**	**Metallic**
Melting and boiling points (with reason)	Low – weak forces between molecules	High – strong attraction between positive and negative ions	Very high – many covalent bonds need to be broken	High – strong attraction between positive metal ions and delocalised electrons
Electrical conductivity (with reason)	Do not conduct – molecules are neutral	Conducts when molten or dissolved as ions can move. Does not conduct when solid as ions cannot move around.	Graphite conducts as it has delocalised electrons. Others do not as they do not have delocalised electrons. **Exception: Graphite**	Conduct as they have delocalised electrons.
Which type of substances have this structure	Some non-metal elements and compounds containing non-metals	Compounds containing metals and non-metals	Diamond, graphite and silicon dioxide	Metals

Task 13: Alkanes and formulae

1 **a** Compounds of hydrogen and carbon only. *(1 mark)*

b Covalent bond. *(1 mark)*

c Hydrocarbons containing C–C bonds and C–H bonds only. *(1 mark)*

d They only have single carbon to carbon bonds. *(1 mark)*

2 **a** Propane molecules have three carbon atoms and eight hydrogen atoms. *(2 marks)*

b The bonds between the atoms. *(1 mark)*

3 **a** One from: they take part in similar chemical reactions; the molecular formula for each successive member differs by CH_2. *(1 mark)*

b C_nH_{2n+2} *(1 mark)*

c C_8H_{18} *(1 mark)*

d C_9H_{20} *(1 mark)*

4 **a** Single covalent bonds. *(1 mark)*

b C_4H_{10} *(1 mark)*

c It shows the bonds present between the atoms in the molecule. *(1 mark)*

5 **a** CH_4, C_2H_6, C_3H_8 *(3 marks)*

b Displayed formulae for the alkanes in part a. (*3 marks*)

6 **a** Four carbon atoms, 10 hydrogen atoms. *(1 mark)*

b C_4H_{10} (*1 mark*)

c Two from: it follows the general formula for the alkanes, it only has single carbon to carbon bonds, it is a hydrocarbon. (*2 marks*)

Task 14: Products from fuels

1 **a** Carbon dioxide. *(1 mark)*

b Water. *(1 mark)*

2 Carbon dioxide. *(1 mark)*

3 **a** Carbon and hydrogen. *(2 marks)*

b Carbon dioxide and water. *(2 marks)*

c Oxygen. *(1 mark)*

d paraffin wax + oxygen → carbon dioxide + water *(2 marks)*

4 **a** Carbon (soot). *(1 mark)*

b Carbon monoxide. *(1 mark)*

5 **a** Sulfur dioxide. *(1 mark)*

b Nitrogen. *(1 mark)*

6 **a** $C_3H_8 + \mathbf{5}O_2 \rightarrow \mathbf{3}CO_2 + \mathbf{4}H_2O$ *(1 mark)*

b $C_3H_8 + \mathbf{3½}O_2 \rightarrow \mathbf{3}CO + \mathbf{4}H_2O$ *(1 mark)*

c $C_3H_8 + \mathbf{3}O_2 \rightarrow C + 2CO + \mathbf{4}H_2O$ *(1 mark)*

d $½N_2 + O_2 \rightarrow NO_2$ *(1 mark)*

Task 15: Fractional distillation and cracking

1 Use the words from the word box to complete these sentences.

boiling	distillation	fractions	fuel	gas	oil	vapour

The different fractions in crude oil can be separated by fractional distillation. The different fractions have different boiling points. The crude oil is turned into a gas. It travels up a fractionating column, where different fractions cool down, and the vapour turns back into a liquid. Different fractions have different uses. For example, petrol is used as a fuel for cars.

The table below shows how many barrels of different fractions of crude oil are produced in a day at an oil refinery.

Fraction	**LPG**	**petrol**	**naphtha**	**paraffin**	**diesel**
Number of barrels you produce	100	500	300	700	800
Number of barrels you can sell	100	700	300	500	800

2 Which fraction can you sell more of than you produce each day? *(1 mark)*

3 Some barrels are left over and not sold each day. Which fraction is this? *(1 mark)*

4 Write a paragraph to explain what you do with the leftover barrels. Use the following words in your answer: cracked, alkanes, alkenes, fuels, plastics. *(7 marks)*

Extension

5 Explain why cracking is useful by considering supply and demand issues. *(3 marks)*

Answers (Q2-5)

2 Petrol. *(1 mark)*

3 Paraffin. *(1 mark)*

4 Paraffin is cracked, by passing vaporised paraffin over hot catalyst, producing shorter alkanes, used as fuels, and alkenes, used to make plastics. *(7 marks)*

5 Demand for petrol is greater than supply, supply of paraffin is greater than demand, surplus paraffin is cracked to make up for petrol shortfall. *(3 marks)*

Pre-Knowledge Topics Answers to problems

Q1.1a) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6 4s^2$ b) $1s^2\ 2s^2\ 2p^6 3s^2 3p^1$ c) $1s^2\ 2s^2\ 2p^6 3s^2 3p^4$ d) $1s^2\ 2s^2\ 2p^6 3s^2 3p^5$

e) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6$ f) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^6 4s^2$ g) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^3 4s^2$

h) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^8 4s^2$ i) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^{10}\ 4s^1$ j) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^{10} 4s^2$

k) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 4s^2\ 3d^{10}\ 4p^3$

Q1.2a) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6$ b) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6$ c) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^{10}$

d) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6$ e) $1s^2\ 2s^2\ 2p^6 3s^2 3p^6\ 3d^7$

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Q2.1 a) +4 b) +6 c) +5 d) +4 e) +3 f) +5 g) +7 h) +6 i) +4

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Q3.1 They must be ionised / turned into ions

Q3.2 The ions are all given the same amount of kinetic energy, as KE = ½ mv^2 the lighter ions will have greater speed / heavier ions will have less speed.

Q3.3 a) 121.855 b) 67.796 c) 107.973 d) 204.41 e) 87.710 / 87.7102

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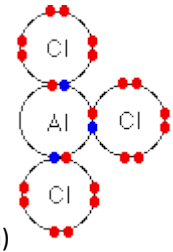
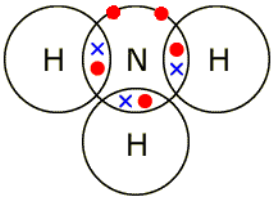
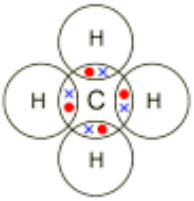
Q4.1



a) 120°



b) 107°



c) 109.5°

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Q5a. $2H_2 + 0_2 \rightarrow 2\ H_20$

b. $S_8 + 1202 \rightarrow 8SO_3$

c. $2HgO \rightarrow 2Hg + 0_2$

d. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

e. $2Na + 2H_20 \rightarrow 2NaOH + H_2$

f. $C_{10}H_{16} + 8Cl_2 \rightarrow 10C + 16HCl$

g. $2Fe + 302 \rightarrow 2Fe_2O_3$

h. $C_6H_{12}O_6 + 602 \rightarrow 6\ CO_2 + 6\ H_20$

i. $Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_20$

j. $2Al + 3\ FeO \rightarrow Al_2O_3 + 3Fe$

Q6.1 a) 85.2/284 = 0.3 moles b) 73.56/122.6 = 0.6 moles c) 249.5/249.5 = 1.0 moles

d) 0.125 x 212.8 = 26.6g e) 2Mg : 2O or 1:1 ratio 2.4g of Mg = 0.1moles so we need 0.1 moles of oxygen (O_2): 0.1 x 32 = 3.2g

7.1 a) 9.53g/95.3 = 0.1 moles, in 100cm^3 or 0.1dm^3 in 1dm^3 0.1moles/0.1dm^3 = 1.0 mol dm^{-3}

b) 13.284g/331.2 = 0.04 moles, in 2dm^3 in 1dm^3 0.04moles /2dm^3 = 0.02 mol dm^{-3}

c) 100cm^3 of 0.1 mol dm^{-3} = 0.01 moles added to a total volume of 2 dm^3 = 0.01moles/2dm^3 = 0.005 mol dm^{-3}

d) in 1dm^3 of 1 mol dm^{-3} silver nitrate, 1 mole of Ag = 107.9g in 0.1dm^3 = 107.9 x 0.1 = 10.79g

e) 0.0526 x 79.7 = 42.0274g

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8.1

$Ba(NO_3)_2$: Na_2SO_4

1 : 1 ratio

12.5cm^3 of $Ba(NO_3)_2$ = 0.0125dm^3

0.15 moldm^{-3} x 0.0125dm^3 = 0.001875 moles

same number of moles of sodium sulfate needed, which has a concentration of 0.25 mol dm^{-3}

0.001875 moles / 0.25 mol dm^{-3} = 0.0075 dm^3 or 7.5cm^3

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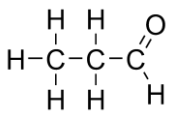
9.1 1-chlorobutane

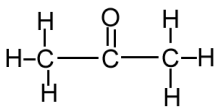
Add butan-1-ol to concentrated HCl and shake

9.2 react ethene with hydrogen gas at high temperature and pressure with a nickel catalyst

The reaction is similar in that it releases hydrogen but different as it proceeds much slower than in water

9.3 propanal propanone





The carbon atom joined to oxygen in propanal has a hydrogen attached to it, it does not in propanone.

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10.1 An acid is a proton donor

10.2 Ammonia can accept a proton, to become NH_4^+

10.3 ethanoic acid has not fully dissociated, it has not released all of its hydrogen ions into the solution.

$CH_3COOH \leftrightharpoons CH_3COO^- + H^+$
Mostly this Very few of these

10.4 pH = -log [0.01] = 2 The pH = 2