BATHGATE ACADEMY

NATIONAL 5 - CHEMISTRY

CHEMICAL CHANGES AND STRUCTURE

HOMEWORK
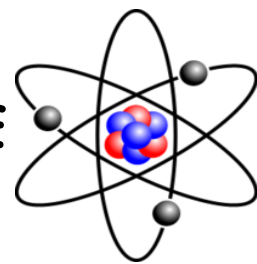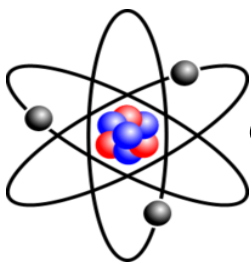
HOMEWORK	DEADLINE DATE	SCORE		TEACHER COMMENTS
1			(16)	Rates of reaction -
2			(10)	Rates of reaction -
3			(17)	Atomic Structure -
4			(15)	Atomic Structure -
5			(10)	Bonding related to properties -
6			(22)	Bonding related to properties –
7			(29)	Formulae and reaction quantities -
8			(40)	Formulae and reaction quantities -
9			(21)	Acids and Bases -
10			(25)	Acids and Bases -

HOMEWORK 1 - RATES OF REACTION

1) The speed of a reaction depends on the reaction conditions. Describe how each of the following affects the speed of a reaction using collision theory.

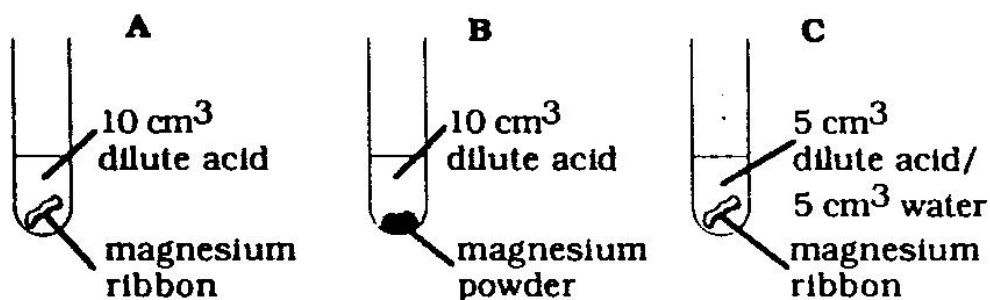(a) Decreasing the particle size of the reactants (increasing surface area of reactant(s)).

(2)

(b) Decreasing the concentration of the reactants

(2)

(c) Increasing the temperature of the reaction mixture

(2)

(2) (a) Three experiments were set up as shown. Each experiment is carried out at room temperature and the mass of magnesium is the same in each case.

State and explain any differences in the rate of reaction between:

(i)   Experiment A and B

(1)

(ii)   Experiment A and C

(1)

(b) Explain any difference in the reaction rate if experiment A was repeated at 50 ^{O}C.

(1)

(c) Catalysts are used in many industrial reactions.

    a. What does a catalyst do to the rate of a chemical reaction?

(1)

    b. Why can catalysts be used again and again?

(1)

    c. Explain the mechanism of how a catalytic converter in a car works (include in you answer; adsorption, desorption, heterogeneous)?

(2)

3) Research is being carried out into making chemicals that can be used to help relieve the side effects of chemotherapy.
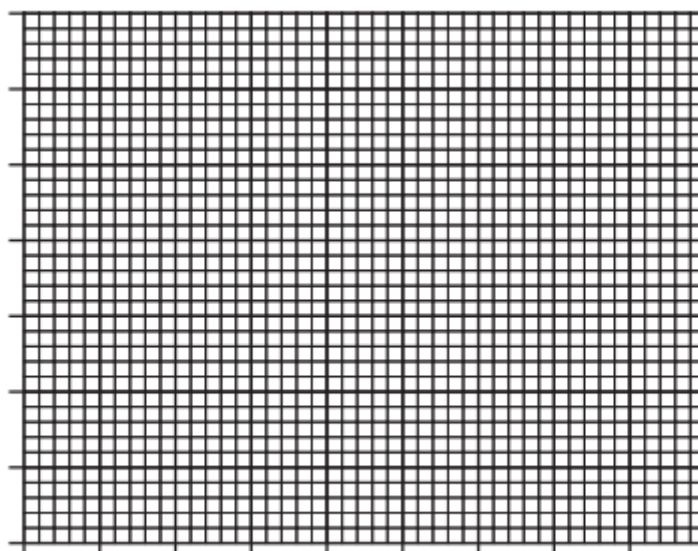
Part of the process is shown.   chemical **A** + hydrogen $\xrightarrow{\text{catalyst}}$ chemical **B**

The pressure was recorded from the moment the reaction started and the results are shown:

Time (min)	0	5	10	15	20	30	35	45
pressure (bar)	0	0·6	1·2	1·7	2·2	2·9	3·1	3·1

a) Describe the relationship between time and the pressure recorded.

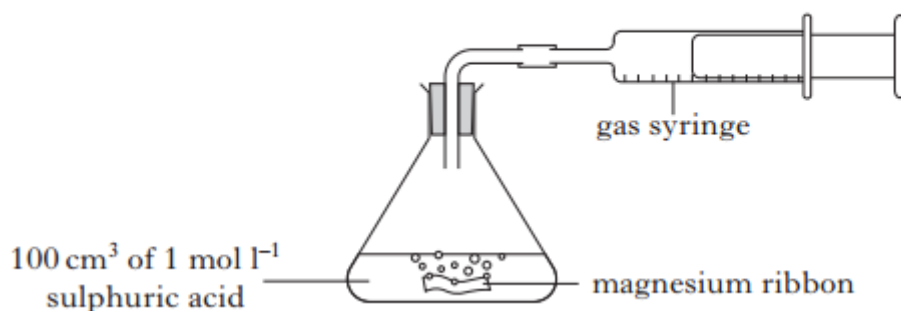(1)

b) Plot a line graph of the results shown above.

(2)

HOMEWORK 2 - RATES OF REACTION

Q1) Magnesium reacts with dilute sulphuric acid to produce salt and a gas.

Magnesium reacts with dilute sulphuric acid to produce a gas.

gas syringe

$100\,cm^3$ of 1 mol l^{-1}
sulphuric acid

magnesium ribbon

(a) A student tested the gas released from the reaction and identified it burned with a 'pop'. Name the gas produced in this reaction.

(1)

(b) A student carried out the experiment. A graph of the results was plotted.
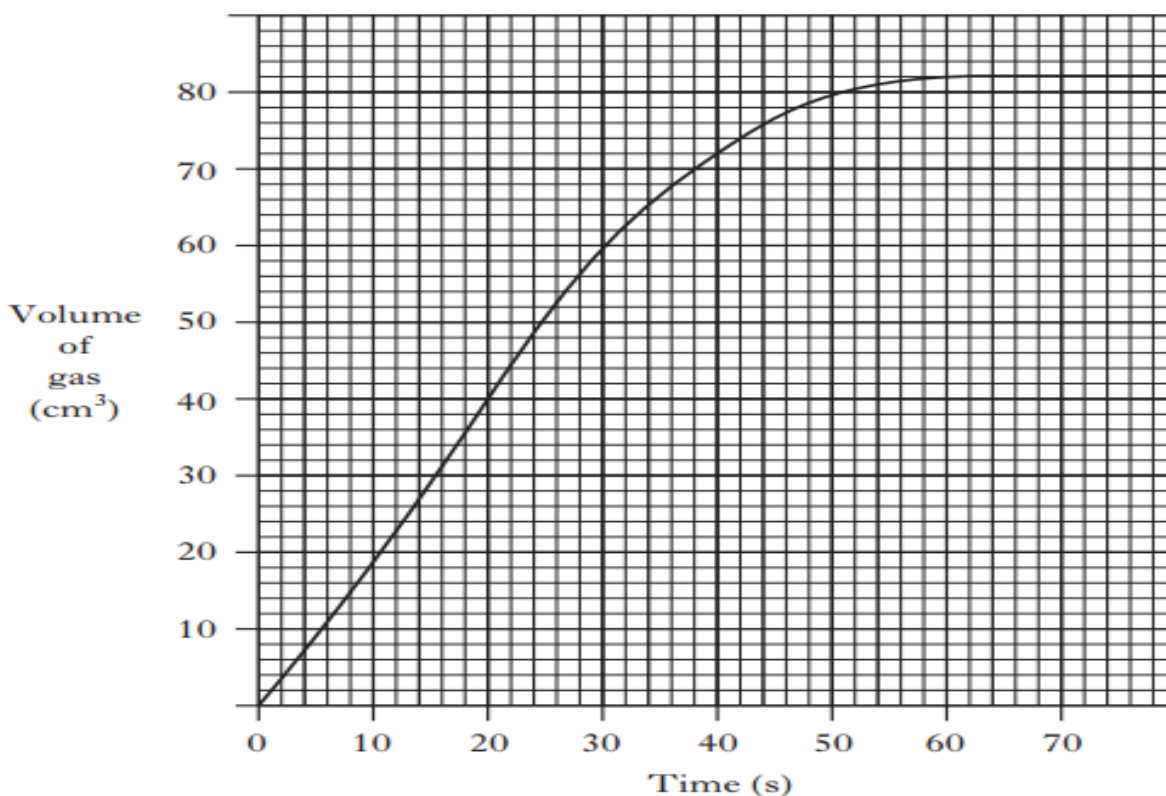
Calculate the rate of the reaction, in cm^3s^{-1}, for the first 40 seconds.

(1)

(c) What time did the reaction finish?

(1)

(d) The student repeated the experiment using *100 cm3* of *2 mol l-1 Sulphuric acid* solution and the *same mass* of *magnesium ribbon*. <u>How would this affect the rate of the reaction?</u>

(1)

(e) On the graph shown previously sketch the rate graph you would expect to see from the reaction discussed in question 1(d).   **(1)**

2) (a) The graph shows how the mass of reactants changes with time in a chemical reaction.
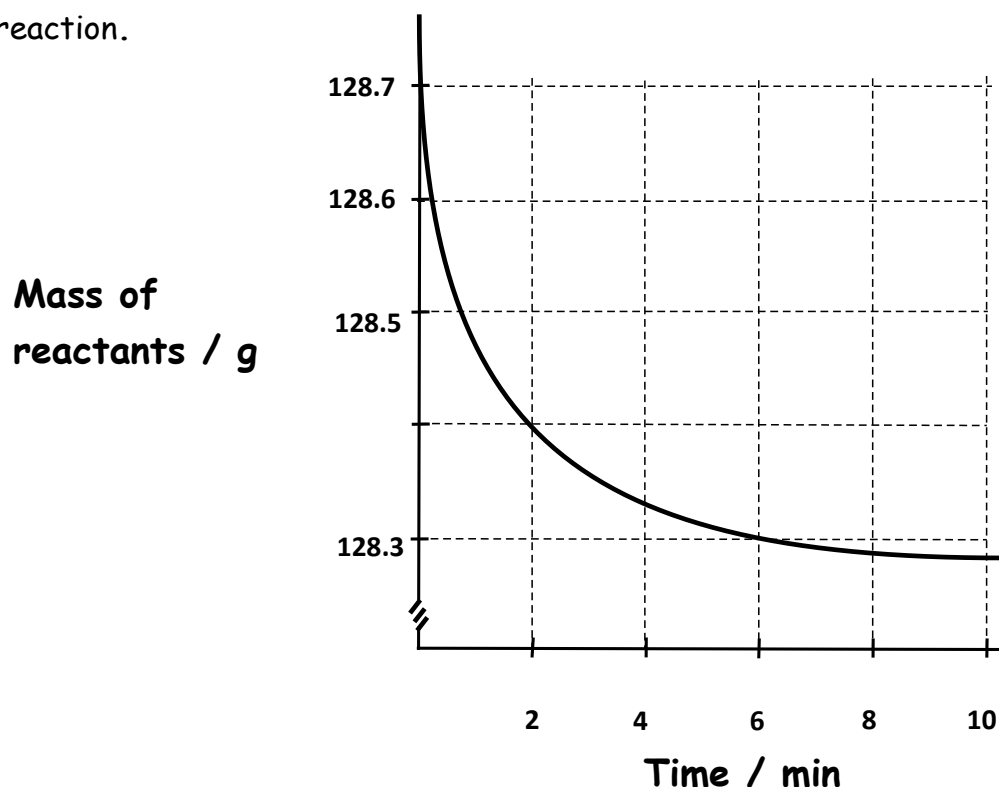
Calculate the average rate of reaction over each of the following

    0 to 2 minutes   *2 to 4 minutes*   *4 to 6 minutes*

                                                    periods.
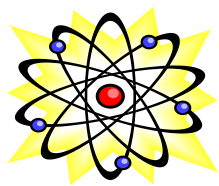
(3)

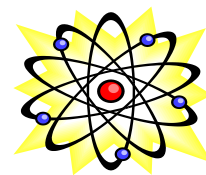b) What was the mass loss of the reactants between 2 minutes and 6 minutes?

(1)

c) Suggest why the mass loss is greatest at the start of the reaction.

HOMEWORK 3 - ATOMIC STRUCTURE

Atomic Structure Rule Box

1. The number of protons in the nucleus is called the **atomic** or **proton** number.

2. The number of **nucleons** (neutrons + protons) is called the **mass** number.

3. In a neutral atom, number of electrons = number of protons.

4. Isotopes of an element have the same number of protons in the nucleus but different numbers of neutrons.

Q1)   Elements are made up of atoms. An atom of an element is represented below.

- ● = protons
- ○ = neutrons
- ✗ = electrons
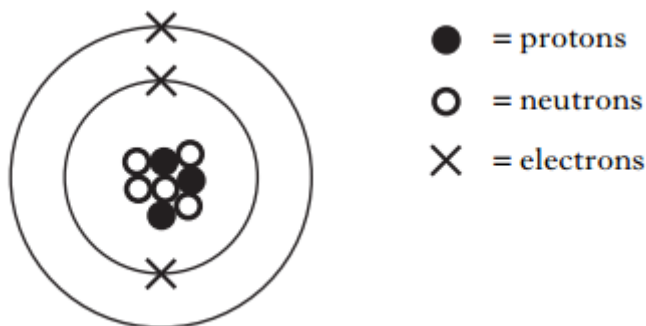
a) What name is given to the part of the atom which contains protons and neutrons?   (1)

b) Using the information in the diagram:

(i)   State the mass number of this atom;   (1)

(ii)   Explain why this atom is electrically neutral;   (1)

(iii)   Name the **group** of elements to which this atom belongs   (1)

2. An isotope of carbon contains 6 protons and 8 neutrons.

   a) What is its atomic number?   (1)

   b) What is its mass number?   (1)

   c) Write down the symbol for this isotope   (1)
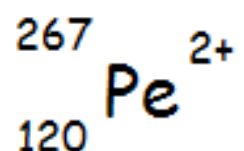
d) How many electrons would a neutral atom have?   (1)

3. Complete this table

Symbol	Number of protons	Number of neutrons	Number of electrons	Atomic number	Mass number
4 He 2	2	2			
12 C 6					
	6	8			
16 O 8					
	8				17
54 Fe 26					
		30		26	

                                                                                             (6)

(4) Which of the atoms in this table are isotopes of the same element?

                                                                                             (1)

(5) The symbol shown below represents an **ion** of a newly identified element (Burtonium), Pe.

$$^{267}_{120}Pe^{2+}$$

Which **two** statements are correct? The ion contains:

A) 267 neutrons

B) 120 electrons

C) 118 electrons

(2)

HOMEWORK 4 - ATOMIC STRUCTURE

Q1) Complete the missing values in the table…you will need a copy of the periodic table.

Element	Electrons	Protons	Neutrons
$^{19}_{9}F^{-}$		9	
$^{39}_{19}K^{+}$			20
$^{16}_{8}O^{2-}$	10		
$^{20}_{10}Ne$		10	
$^{27}_{13}Al^{3+}$			14
Ca^{2+}		20	20
$^{24}_{12}Mg^{2+}$	10		

(7)

Q2) A sample of the element Silver was shown to exist as a mixture of two isotopes: 48% Ag (107), 52% Ag (109)

a) What is meant by the term isotope

(1)

b) Complete the table for $_{47}^{107}Ag$

Isotope	Number of protons	Number of neutrons	Number of electrons
$_{47}^{107}Ag$			

(2)

The relative atomic mass of an element can be calculated using the formula:

$$\frac{(\text{mass of isotope A} \times \text{\% of isotope A}) + (\text{mass of isotope B} \times \text{\% of isotope B})}{100}$$
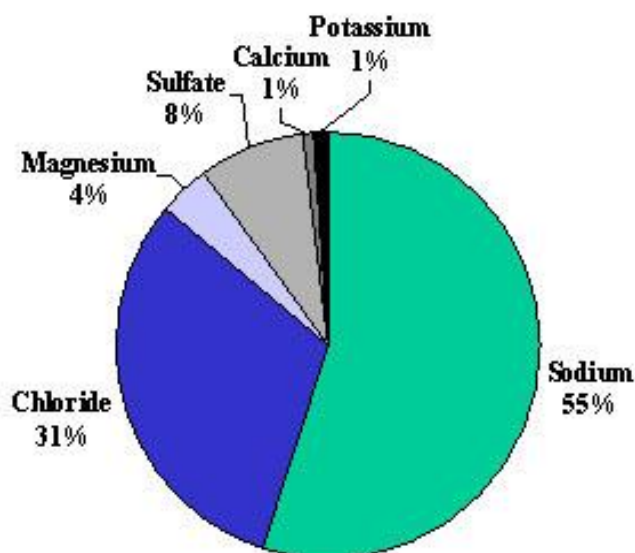
From the percentage abundance of each isotope of silver in the sample calculate the relative atomic mass for this sample of silver. [Show your working clearly]

(2)

d) Explain what is meant by an elements relative atomic mass.

(1)

3) (a) A water sample was taken from the river Almond in West Lothian. The percentage of ions identified in a sample of water are shown below.

A total of 2500 ions were collected from the 50cm^3 water sample. Calculate how many chloride ions make up part of the total ions collected.

(1)

(b) Four more 50cm^3 water samples were collected and analysed for their ion content. The results for the magnesium ion are shown below complete the table by calculating the average percentage obtained from the five samples.

50cm^3 of water from River Almond	% of magnesium in each sample
1	4
2	6.7
3	5.5
4	4.8
5	4.2
AVERAGE	

(1)

HOMEWORK 5 – BONDING RELATED TO PROPERTIES

Q1) What is the definition of a covalent bond?

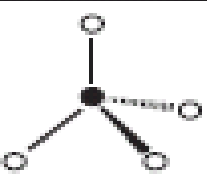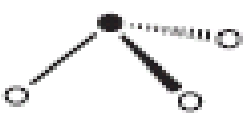(1)

Q2) Draw covalent bonding diagrams from the following:

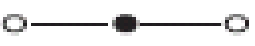a) Ammonia (NH_3).

(1)

b) Water (H_2O)

(1)

Q3) Using the table below name the shape the covalent molecules from question 1.

Tetrahedral	Pyramidal	Bent	Linear

Ammonia –

Water -   (2)

Q4) Which of the following elements are likely to have the formula X_2.

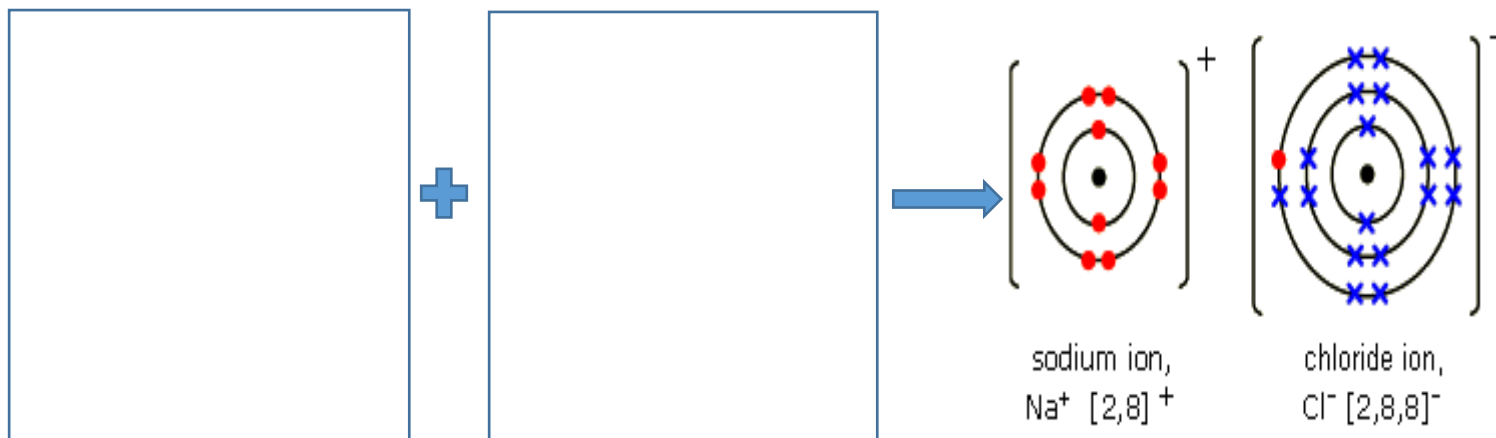A) Helium   B) Carbon   C) Chlorine   D) Magnesium

(1)

Q5) (a) What is the definition of an ionic bond.

(1)

(b) Complete the ionic bonding diagram (below) to show how the electron transfer occurred to form sodium chloride [electron arrangement and atomic diagrams for each required].

sodium ion,
Na$^+$ [2,8] $^+$

chloride ion,
Cl$^-$ [2,8,8]$^-$

(2)

(c) An unidentified solid, exhibits a very high melting point and boiling point. It can conduct electricity only when it is dissolved in water or melted to liquid. Electrolysis is the name of the process when this substance conducts.

chlorine
given off
as a gas

copper metal
deposited

copper(II)
chloride
solution
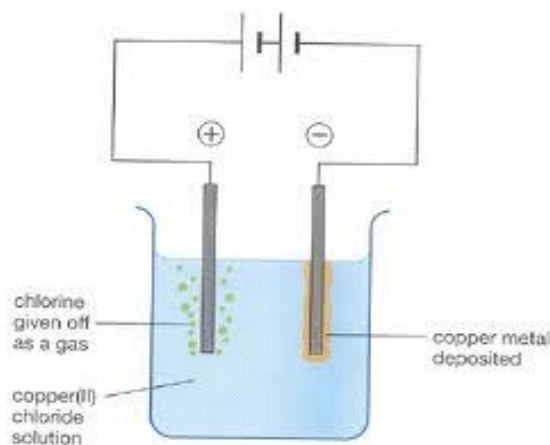
Which of the following is **not** correct regarding the conduction of the unidentified substance undergoing electrolysis.

A) The substance can conduct when molten and in solution because the ions are free to move.

B) There are no chemical changes at the electrodes.

C) Electrons that are delocalised carry the current of electricity in the connecting wires.

D) Graphite rods can be used because they can conduct and are unreactive.
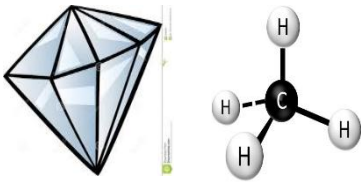
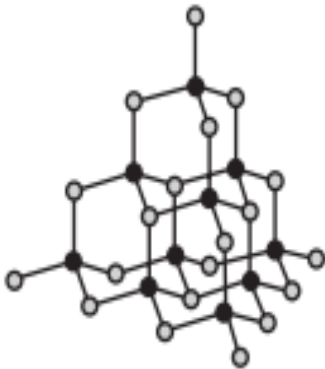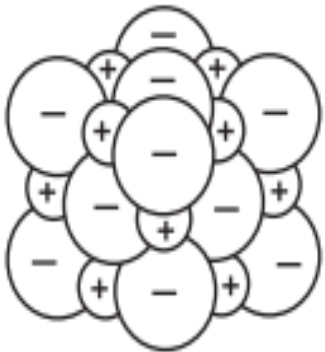# HOMEWORK 6 – BONDING RELATED TO PROPERTIES

Q1) Identify the bonding in each structure and describe some of the properties expected from that type of bonding. Give examples of substances that would exhibit that type of bonding also.
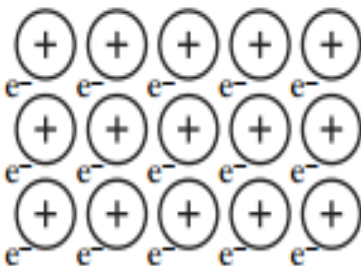
A

_____
_____
_____
_____
_____
_____
_____(2)

B

_____
_____
_____
_____
_____
_____(2)

C

_____
_____
_____
_____
_____
_____(2)

D

_____
_____
_____
_____

_____

_____(2)

Q2) Which **two** boxes show an electron arrangement of;

A	B	C
2,1	2,2	2,8,8
D 2,7	**E** 2,8,7	**F** 2,8,8,1
G 1	**H** 2,8,2	**I** 2,8,18,8

a) An element that reacts violently with water

b) An element in group 2

c) A noble gas

e) A halogen   **(4)**

Q3) Below is a list of substances and the properties exhibited because of their types of bonding.

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

Predict the bonding most likely to display the properties shown in the table;
    A)   D)
    B)   E)
    C)   F)

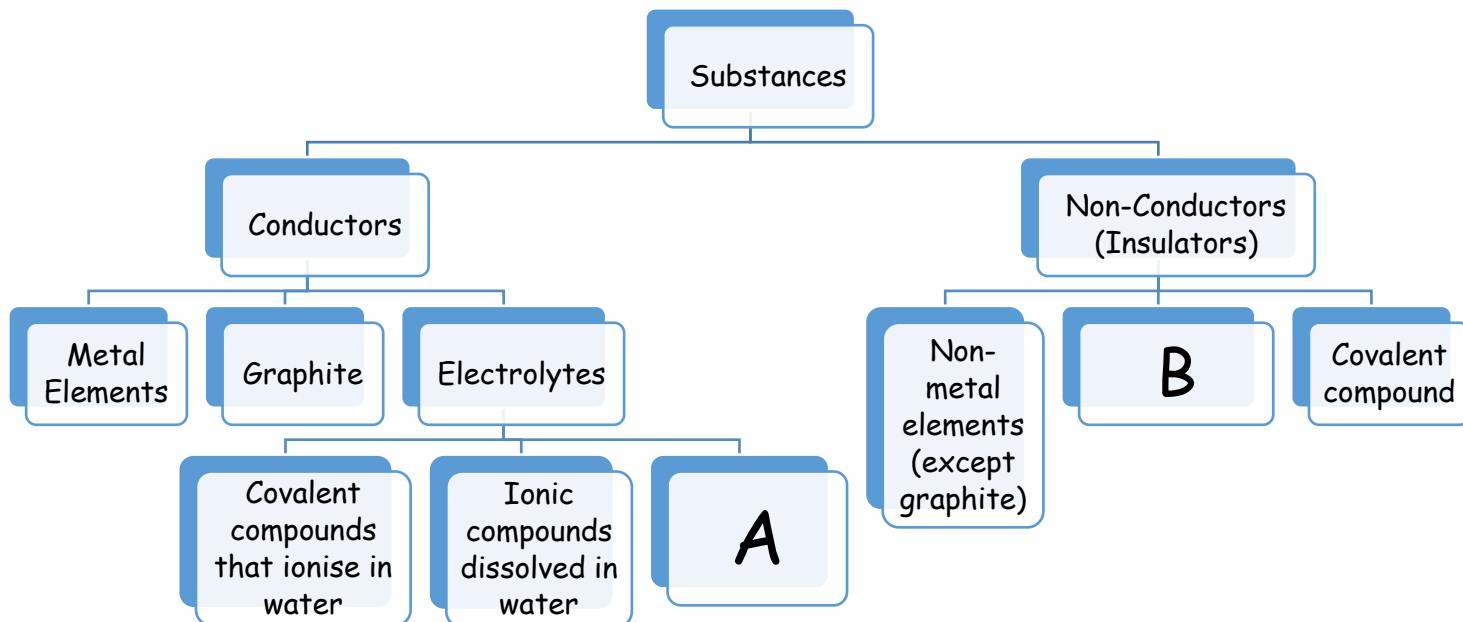   (6)

Q4) Below is a flow chart to describe categorise the bonding in substances. The student has left out important information about ionic bonding and the states it will and will not conduct. Help the student finish off their flow chart by identifying the following:

A)

B)

Substances

- **Conductors**
  - **Metal Elements**
  - **Graphite**
  - **Electrolytes**
    - Covalent compounds that ionise in water
    - Ionic compounds dissolved in water
    - **A**
- **Non-Conductors (Insulators)**
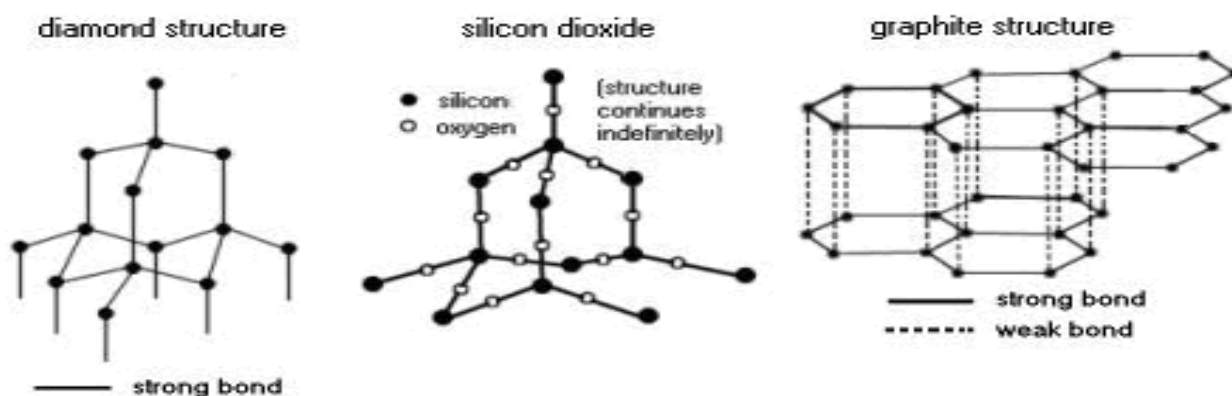 - Non-metal elements (except graphite)
  - **B**
  - Covalent compound

(2)

Q5) Which of the following covalent network structures can unusually conduct and why can this structure conduct electricity?

diamond structure   silicon dioxide   graphite structure

silicon   (structure continues indefinitely)
oxygen

strong bond
weak bond

strong bond

(2)

HOMEWORK 7 – FORMULA AND REACTION QUANTITIES

Q1) Write chemical formula for the following compounds (the ones with prefixes e.g. di, tri… then it is telling you the formula!):

a) sodium oxide

b) barium bromide

c) magnesium nitride

d) carbon fluoride

e) nitrogen hydride

f) Dinitrogen tetraoxide

(6)

Q2) Write the ionic formula for the following compounds [simple group ions and Roman numerals]

a) lithium nitrate

b) calcium chromate

c) potassium phosphate

d) silver (I) iodide
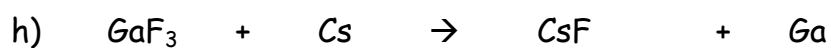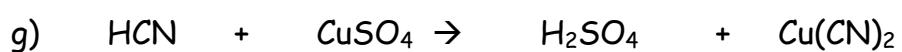
e) zinc (II) hydroxide

f) iron (III) sulphate

g) aluminium Oxide

h) magnesium chloride

i) aluminium fluoride

(9)

Q3)   Balance the following equations:

a) Na_3PO_4 + KOH → $NaOH$ + K_3PO_4

b) MgF_2 + Li_2CO_3 → $MgCO_3$ + LiF

c) P_4 + O_2 → P_2O_3

d) $RbNO_3$ + BeF_2 → $Be(NO_3)_2$ + RbF

e) $AgNO_3$ + Cu → $Cu(NO_3)_2$ + Ag

f) CF_4 + Br_2 → CBr_4 + F_2

g) HCN + $CuSO_4$ → H_2SO_4 + $Cu(CN)_2$

h) GaF_3 + Cs → CsF + Ga

(i) N_2 + H_2 → NH_3

(9)
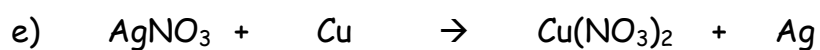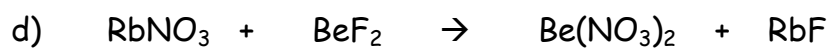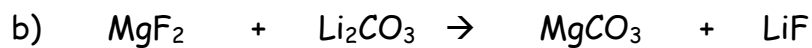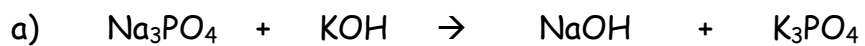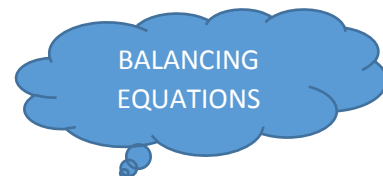
Q4)

A section of a covalent network compound is shown below.

● = silicon

○ = oxygen

Write the formula for this covalent network compound.

_____

(1)

Q5) Using page 6 of your National 5 Chemistry Data Booklet identify the flame colours when the following ions burn.

Potassium –

Strontium –

Copper –

Barium -   **(4)**

Nota bene (N.B.) "note well" Identify the metals on the periodic table and keep a mental note that they are **group 1, 2** and **transition metal ions**. In addition, N.B. that those **metal ions** are **positive** because they **lose electrons**. Flick your eyes up to the conveniently placed **electron arrangement** belonging to atoms of those elements.

Electron A...   Main Group Elements

Generally Cov. Bond molecules + network

2,8,8

Key

Forms both positive and negative group ions. H⁺ and OH⁻ for example

| Atomic Number |
| Name of Element |
| Symbol |
| Electron arrangement |

MONATOMIC GASES

Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 0
						2 Helium He 2
1 Hydrogen H 1						
3 Lithium Li 2,1	4 Beryllium Be 2,2	5 Boron B 2,3	6 Carbon C 2,4	7 Nitrogen N 2,5	8 Oxygen O 2,6	9 Fluorine F 2,7	10 Neon Ne 2,8
11 Sodium Na 2,8,1	12 Magnesium Mg 2,8,2	13 Aluminium Al 2,8,3	15 Phosphorus P 2,8,5	16 Sulfur S 2,8,6	17 Chlorine Cl 2,8,7	2,8,8
19 Potassium K 2,8,8,1	20 Calcium Ca 2,8,8,2	31 Gallium Ga 2,8,18,3	32 Germanium Ge 2,8,18,4	33 Arsenic As 2,8,18,5	34 Selenium Se 2,8,18,6	35 Bromine Br 2,8,18,7	36 Krypton Kr 2,8,18,8

+ 2⁺ 3⁺

14 ... C 2,8,4

- 2⁻ 3⁻

FORM NEGATIVE IONS

HOMEWORK 8 – FORMULA AND REACTION QUANTITIES

Q1) Calculate the Gram Formula Mass (GFM) of the following:

COMPOUND	FORMULA MASS
$AgNO_2$	
$NiSO_3$	
$Ca_3(PO_4)_2$	
$HgSO_4$	

COMPOUND	FORMULA MASS
$ZnCl_2$	
K_3PO_4	
$Al_2(SO_4)_3$	
$MgCrO_4$	

(8)

Q2) Using page 8 of your data book data booklet organise the following under the two different headings.

Calcium bromide   Aluminium Phosphate   **Lead(ii) Iodide**
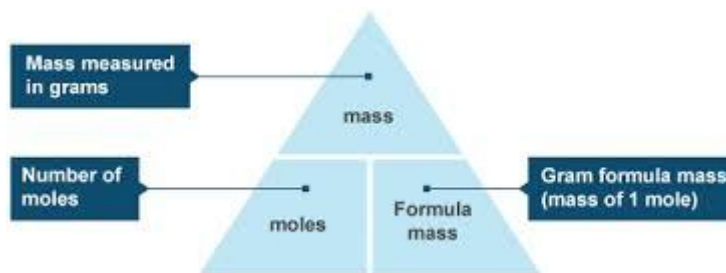
Nickel hydroxide   Tin(ii) Sulphate   Barium hydroxide

Silver sulphate   **Calcium Carbonate**

Soluble	Insoluble

| | |
| | |

(8)

Q3) (a) How many moles of barium chloride, $BaCl_2$, are present in 4.166g of the salt?

(1)

(b) What is the mass of 1.2 mol of sodium hydroxide, $NaOH$?

(1)

(c) What is the mass of 0.2 mol of copper(ii) chloride, $CuCl_2$?

(1)

(d) How many moles of nitric acid, HNO_3, are present in 94.5g of the pure substance?

(1)

(e) What is the mass of 0.025 mol of iron(iii) oxide, Fe_2O_3?

(1)

(f) How many moles of silver(i) nitrate, $AgNO_3$, are present in 6.796g of the substance?

(1)

(g) The balanced equation shown below:

$$CaO \quad + \quad 2HCl \quad \rightarrow \quad CaCl_2 \quad + \quad H_2O$$

MOLE RATIO

According to this balanced equation, the mass of calcium chloride that 0.2 mol of calcium oxide will produce is

A) 22.2g   B) 111g   C) 11.2g   D) 37.5g   **(1)**

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

(4) (a) Calculate the no. of moles present in 50cm^3 of 0.05 molar HCl.

(1)

(b) Calculate the concentration of a glucose solution, given that 0.2 moles of glucose are dissolved in water and made up to 250 cm^3 of solution.

(1)

(c) Calculate the concentration of a solution of calcium hydroxide given that it contains 1.48g of Calcium hydroxide in 800 cm^3 of solution.
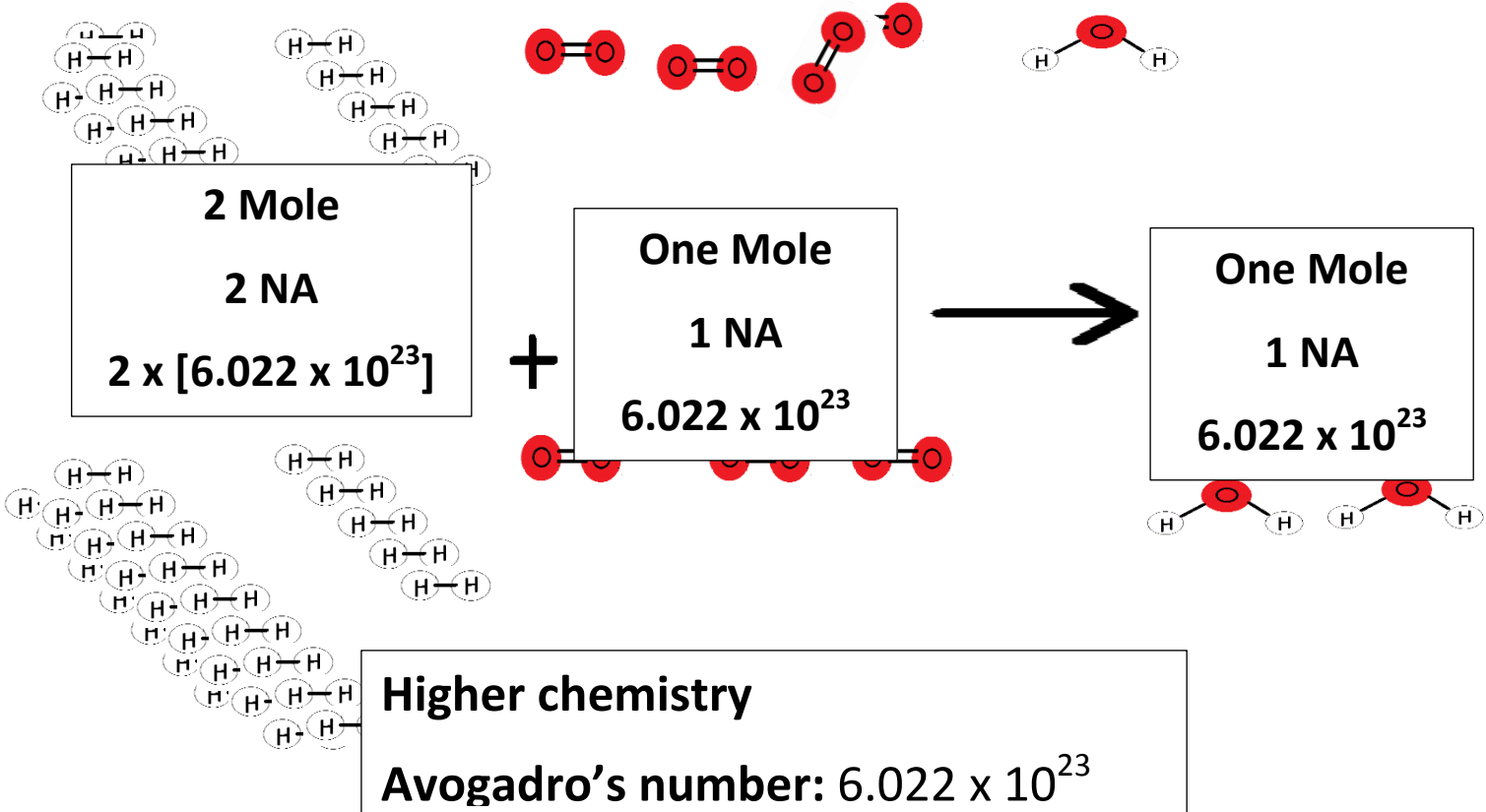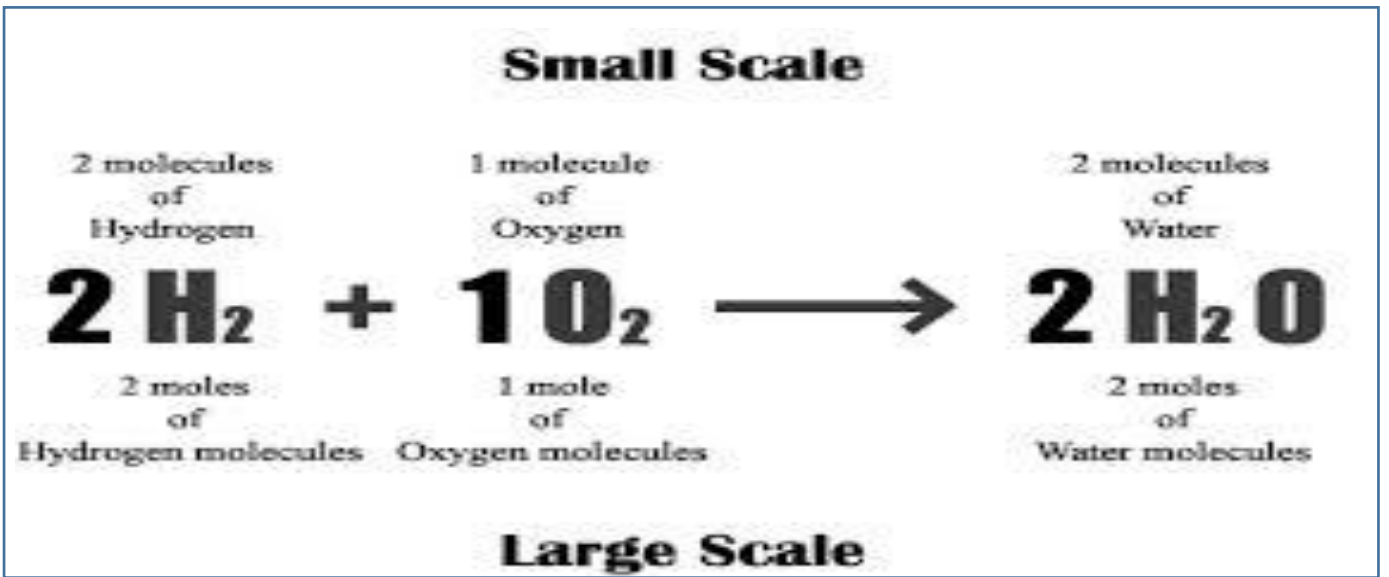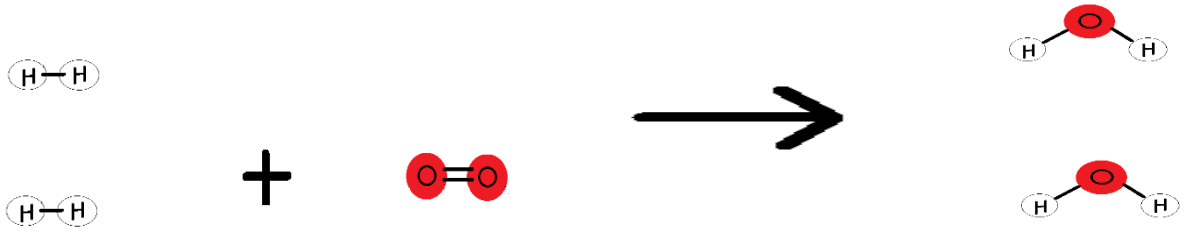
(1)

(d) Calculate the volume of solution produced if 22.5g of Oxalic acid $(COOH)_2$, is used to make a solution with concentration 0.5 mol L^{-1}.

(1)

(e) A 330 cm3 can of "Fizz Alive" has a carbohydrate concentration of 0.01 mol/l.

Calculate the number of moles of carbohydrate in the can of "Fizz Alive".

Mole ratio Questions

Small Scale

2 molecules of Hydrogen	1 molecule of Oxygen	2 molecules of Water
$2H_2$	$+$ $1O_2$	$\longrightarrow$ $2H_2O$
2 moles of Hydrogen molecules	1 mole of Oxygen molecules	2 moles of Water molecules

Large Scale

| **2 Mole** **2 NA** $2 \times [6.022 \times 10^{23}]$	$+$	**One Mole** **1 NA** 6.022×10^{23}	$\longrightarrow$	**One Mole** **1 NA** 6.022×10^{23}

Higher chemistry

Avogadro's number: 6.022×10^{23}

Q5) (a) Calculate the mass of hydrogen produced when 4.9g of magnesium reacts with an excess of dilute sulphuric acid.

$$Mg \ + \ H_2SO_4 \longrightarrow MgSO_4 \ + \ H_2$$

(2)

(b) Urea reacts with water, breaking down to form carbon dioxide and ammonia. Calculate the mass of ammonia produced, in grams, when 90g of urea breaks down.

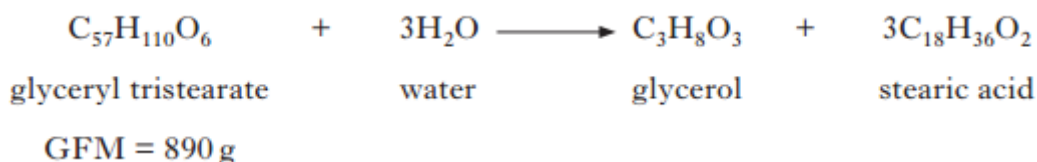$$H_2NCONH_2 \ + \ H_2O \longrightarrow CO_2 \ + \ 2NH_3$$
urea
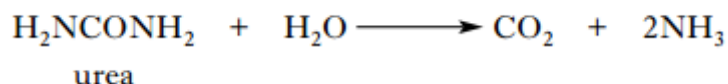
(2)

(c) The neutralisation reaction shown below was carried out in the laboratory. The chemist used 1g of calcium carbonate and reacted it with excess dilute hydrochloric acid. Calculate the mass of carbon dioxide produced.

$$CaCO_3(s) \ + \ 2HCl(aq) \ \rightarrow \ CaCl_2(aq) \ + \ CO_2(g) \ + \ H_2O(\ell)$$
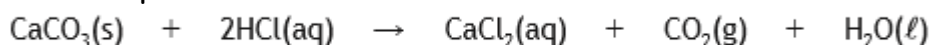
(2)

(d) The equation below shows the breakdown of glyceryl tristearate to form glycerol and stearic acid. Calculate the mass of stearic acid produced from 8.9g of glyceryl tristearate.

$$C_{57}H_{110}O_6 \ + \ 3H_2O \longrightarrow C_3H_8O_3 \ + \ 3C_{18}H_{36}O_2$$
glyceryl tristearate   water   glycerol   stearic acid
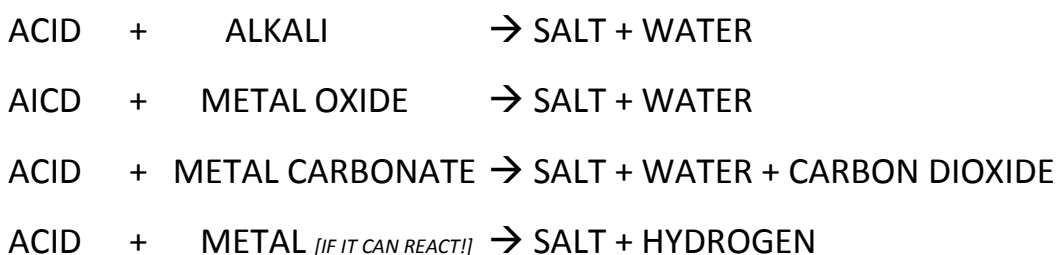
GFM = 890 g

(3)

(e) Ammonium sulphate is a commonly used fertiliser. It can be produced by the reaction between ammonium carbonate and calcium sulphate. What mass of ammonium carbonate, $(NH_4)_2CO_3$, would be needed to make 13·2 kg of ammonium sulphate, $(NH_4)_2SO_4$?

$$(NH_4)_2CO_3(aq) \ + \ CaSO_4(aq) \longrightarrow (NH_4)_2SO_4(aq) \ + \ CaCO_3(s)$$

(3)

HOMEWORK 9 – ACIDS AND BASES

Remember:

ACID	+	ALKALI	→ SALT + WATER
AICD	+	METAL OXIDE	→ SALT + WATER
ACID	+	METAL CARBONATE	→ SALT + WATER + CARBON DIOXIDE
ACID	+	METAL *[IF IT CAN REACT!]*	→ SALT + HYDROGEN

Dissociation of water molecules (small number do this and is why water can carry a short current)

Name of acid	Name of Salt
Sulfuric	Sulfate
Nitric	Nitrate
Hydrochloric	Chloride

Acidic Solution   Neutral Solution   Alkaline Solution
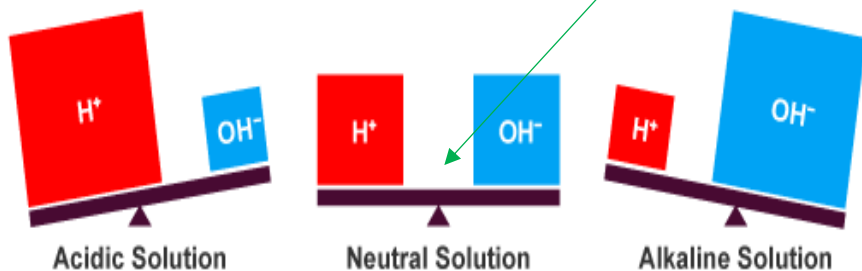
(Q1) (a) Water is a neutral solution. Write the equation that represents the equilibrium present in water.

(1)

(b) In a solution of pH 5, what can we say about the relative concentration of hydrogen ions and hydroxide ions?

`   **(1)**

(c) An oxide dissolves in water to give a solution of pH 9. Is this likely to be a metal oxide or a non-metal oxide? Explain your answer.

(2)

(d) Calculate the mass of sodium nitrate required to prepare 250cm^3 of 0.1 mol l^{-1} solution

(2)

(e) What will be the concentration of 200cm^3 of a solution containing: 4.8g of LiOH

(2)

Q2) Complete the following neutralisation reactions:

(a)   Sodium hydroxide + sulphuric acid →

(b)   Potassium oxide + nitric acid →

(c)   Calcium carbonate + hydrochloric acid →

(d)   → magnesium chloride + water + carbon dioxide

(e)   → Aluminium sulphate + hydrogen   **(5)**

(Q3) The essential elements for plant growth are nitrogen, phosphorus and potassium. A student was asked to prepare a dry sample of a compound which contained two of these elements. The student was given access to laboratory equipment and the following chemicals.

Chemical	Formula
ammonium hydroxide	NH_4OH
magnesium nitrate	$Mg(NO_3)_2$
nitric acid	HNO_3
phosphoric acid	H_3PO_4
potassium carbonate	K_2CO_3
potassium hydroxide	KOH
sodium hydroxide	$NaOH$
sulfuric acid	H_2SO_4
water	H_2O

Using your knowledge of chemistry, comment on how the student could prepare their dry sample. You may wish to use the data booklet to help you.

Q4) Which of the following could be classified as both an alkali and a base?

A) copper(ii) oxide   B) nitrogen dioxide   C) sulphur dioxide   D) sodium oxide   **(1)**

Q5) The grid shows some ions:

A	B	C
Al^{3+}	Cl^-	Li^+
D	**E**	**F**
H^+	Br^-	OH^-

(a) Identify the ion present in all alkali solutions   **(1)**

(b) Identify the ion present in all acid solutions   **(1)**

(c) Identify the **two** ions which combine to form an insoluble compound   **(1)**

Q6) A student made some statements about the effect of adding water to an acidic solution.

A	The pH of the solution will stay the same.
B	The acidity of the solution will decrease.
C	The pH of the solution will fall.
D	The acidity of the solution will increase.
E	The solution will become less concentrated.

Identify the **two** correct statements.

A
B
C
D
E

HOMEWORK 10 – ACIDS AND BASES

Clamp stand
Burette
Titration flask
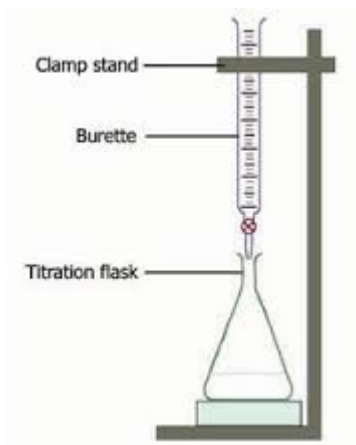
$$\boxed{p \ v \ c \ = \ p \ v \ c}$$

p = power of acid (no of H^+/OH^- in formula)

v = volume (litres)

c = concentration (mol/l)

Clamp stand
Burette
Titration flask
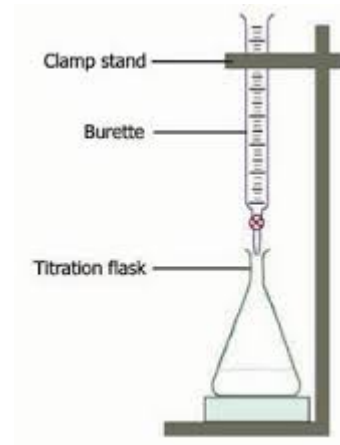
1. What volume of potassium hydroxide solution (concentration 2mol/l) is required to neutralise 50 cm^3 sulphuric acid (concentration 1 mol/l).

(2)

2. What volume of nitric acid (concentration 0.5 mol/l) is required to neutralise 25 cm^3 sodium hydroxide solution (concentration 4mol/l).

(2)

3. If 25 cm^3 hydrochloric acid is neutralised by 50 cm^3 sodium hydroxide solution (concentration 2 mol/l), what is the concentration of the acid?

(2)

4. If 100 cm^3 of nitric acid is neutralised by 30.3 cm^3 sodium hydroxide (concentration 1 mol/l), what is the concentration of the acid?

(2)

Q5) What is meant by a spectator ion?

(1)

Q6) What is meant by an ion equation?

(1)

Q7) Write the ion equation for the reaction of any acid with any alkali

(1)

Q8) Write the ion equation for the reaction of any acid with a solution of a metal carbonate.

(1)

Q9) For each of the following reactions,
    (i)   write a balanced equation, and
    (ii)   remove the spectator ions to write the ion equation.

- **the reaction of potassium hydroxide solution with dilute hydrochloric acid**

(2)

- **the reaction of lithium hydroxide solution with dilute sulphuric acid**
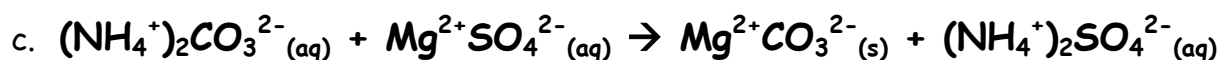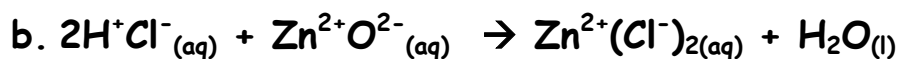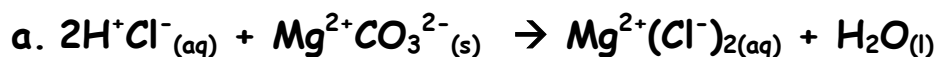
(2)

- **the reaction of lithium carbonate solution with dilute sulphuric acid**

(2)

- **the reaction of potassium carbonate solution with dilute nitric acid**

Q10) Name the spectator ions in the following reactions?

a. $2H^+Cl^-_{(aq)} + Mg^{2+}CO_3^{2-}_{(s)} \rightarrow Mg^{2+}(Cl^-)_{2(aq)} + H_2O_{(l)}$

b. $2H^+Cl^-_{(aq)} + Zn^{2+}O^{2-}_{(aq)} \rightarrow Zn^{2+}(Cl^-)_{2(aq)} + H_2O_{(l)}$

c. $(NH_4^+)_2CO_3^{2-}_{(aq)} + Mg^{2+}SO_4^{2-}_{(aq)} \rightarrow Mg^{2+}CO_3^{2-}_{(s)} + (NH_4^+)_2SO_4^{2-}_{(aq)}$

(3)

(Q11) Electronegativity is a measure of the attraction that an atom has for the bonded electrons. The chart below shows the electronegativity values for some elements in the periodic table.

Skill Q
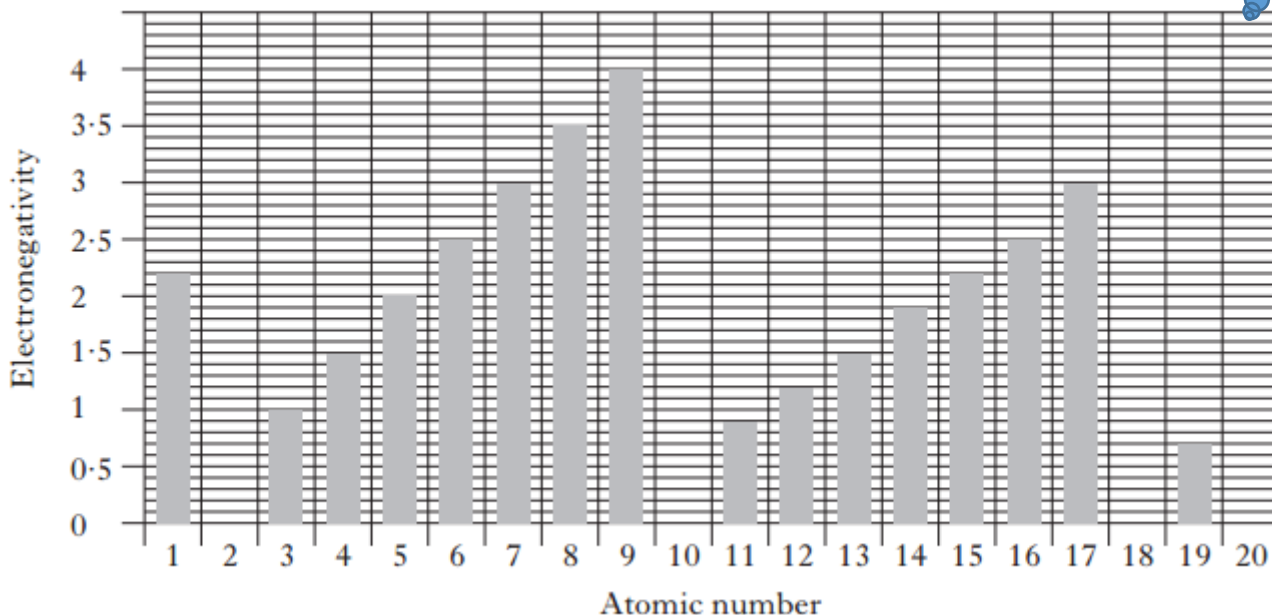
(a) Describe what happens to the elctronegativity values going across a period in the periodic table.

(1)

(b) Draw a bar on the chart to predict the electronegativity value for the element calcium, atomic number 20. (1)