CHLORINE AND ITS COMPOUNDS

MARKING SCHEME

1. i) Anhydrous calcium chloride

   ii) A white ppt is formed

   HCl gas forms Cl^- ions solution which react with silver ions to form silver chloride which is insoluble

   OR

   $HCl_{(aq)} + AgNo_{3(aq)} \longrightarrow HNO_{3(aq)} + AgCl_{(s)}$ ✓1mk

   White ppt ✓ ½

   $Cl^-_{(aq)} + Ag^+_{(aq)} \longrightarrow Agcl_{(s)}$

2.a) Potassium manganate VII (½)

   Manganese IV Oxide (½) ***Any two 1mk***

   Lead IV Oxide (½)

   b) It is a bleaching agent

3. a) Oxidizing agent

   b) $4HCl_{(aq)} + MnO_{2(s)} \longrightarrow MnCl_{2(aq)} + Cl_{2(g)} + 2H_2O_{(l)}$

4. a) $2OCl^-_{(aq)} \longrightarrow 2Cl_{(aq)} + 0_{2(g)}$ ✓1

   b) Time candle brightness✓1

   Colourless liquid (droplets) forms on walls✓1

   c) polypropene✓ ½

   Making ropes ✓ ½

   Polytetraflouroethene Tetraflouroethene✓ ½

Gas laws

1. *X*: $t_1 = 28.3$ sec RMM = ?
   Q_2: $t_2 = 20.0$ sec RMM = 32

$$T \propto \sqrt{MM} \checkmark$$

$$\frac{T_1}{T_2} = \sqrt{\frac{X}{32}}$$

$$\left(\frac{T_1}{T_2}\right)^2 = \frac{X}{32} \checkmark$$

$$\left(\frac{28.3}{T_2}\right)^2 = \frac{X}{32} \checkmark$$

$$X = \frac{28.3^2 \times 32}{400} \checkmark$$

$$X = 64 \checkmark$$

2. (a) *The rate of diffusion of a gas is inversely proportional to the square root of its density under the same conditions of temperature and pressure*

   (b) Rate of gas $V = \frac{1}{5} \times \frac{100cm}{10sec}$

$$= 2cm/sec \checkmark \tfrac{1}{2}$$

Rate of $W = \frac{10cm}{10sec}$

$$= 1cm/sec \checkmark \tfrac{1}{2}$$

$$\frac{RV}{RW} = \sqrt{\frac{MW}{MV}} \qquad = \frac{2}{1} \qquad = \sqrt{\frac{MW}{16}}$$

$$\left(\frac{2}{1}\right)^2 = \left(\sqrt{\frac{MW}{16}}\right)$$

$$\frac{4}{1} = \frac{MW}{16}; = \frac{4 \times 16}{1}$$

$$MW = 64$$

3. (a) *The volume of a fixed mass of a gas is directly proportional to its absolute temperature at constant Pressure* ✓

   (b) Apply combined gas law; $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$V_1 = 3.5 \times 10^{-2}\ m^3$ $V_2 = 2.8 \times 10^{-2} m^3$
$P_1 = 1.0 \times 10^5 Pa$ $P_2 = 1.0 \times 105Pa$
$T_1 = 291K$ $T_2 = ?$ ✓ ½

$$T_2 = \frac{P_2V_2T_1}{P_1V_1}$$

$$T_2 = \frac{1.0 \times 10^5 Pa \times 2.8 \times 10^{-2} m^3}{} \times 291K$$

$1.0 \times 10^5 Pa \times 3.5 \times 10^{-2} m^3$

$T_2 = 232.8k$ ✓

4. $\frac{TsO_2}{TO_2} = \frac{R.M.N.SO_2}{R.M.MO_2}$ ½

$SO_2 = 32 + (16 \times 2) = 64$ ½

$O_2 = (16 \times 2) = 32$ ½

$\frac{TsO_2}{50} = \sqrt{\frac{64}{32}}$ ½ $= 70.75$ ½

5. a) The rate of diffusion of a fixed mass of a gas is inversely proportional to the square root of it density at constant temperature and pressure

b) $RHCl = \frac{30 \text{ cm}^3}{20 \text{ se}} = 1.5 \text{ cm}^3$ see

$\frac{RHCL}{RSO_2} = \frac{\sqrt{MSO_2}}{\sqrt{MHCL}}$

$\frac{(1.5)^2}{RSO_2} = \frac{\sqrt{64}}{\sqrt{36.5}}$

$(RSO_2)^2 = \frac{2.25 \times 36.5}{64}$

$RSO_2 = \sqrt{\frac{2.25 \times 36.5}{64}}$

1.133 cm/ sec

1.133 cm^3 ____________ 1 sec

$42 \text{ cm}^3 = \frac{42 \times 1}{1.133}$

= 37 sec

6. a) Boyles' law For a fixed mass of a gas, volume is inversely promotional to pressure at constant temperature

b)

c) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ √ ½ $V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2}$ √ ½

$\frac{250 \times 273 - 23}{273 + 127}$ √ ½

$= 156.5 \text{cm}^3$

7. a) RFM of $CaCO_3 = 40 + 12 + 48$

= 100kg. √½

∴ 100 kg of $CaCO_3 \equiv 22.4 dm^3$ of $CO_2(g)$

1000 kg " " ⟶ ?

$= \frac{22.4 \times 1000}{100}$ √1 $= 224 \text{ dm}^3$ √½

8. $T_1 = 23+273 = 296$ $T_2 = -25+273 = 248$

$V_1 = 200cm^3$ $V_2 = ?$

$P_1 = 740mmHg$ $P_2 = 780mmHg$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{740 \times 200}{296} \surd 1 = \frac{780x?}{248} \surd 1$$

$$\therefore x = \frac{740 \times 200 \times 248}{296 \times 780}$$

$= 158.974\ cm^3 \surd 1$ (penalize ½ mark for units)

9. $$\frac{Rk}{Rs} = \sqrt{\frac{Ms}{Mk}}$$

$$\therefore \frac{12}{7.2} = \sqrt{\frac{x}{16}} \surd ½$$

$$X = \frac{12^2}{7.2^2} \times 16 \surd ½$$

$= 44.464 \surd$

10. (a) When gases combine they do so in volume which bear a simple ratio to one another and to the product if gaseous under standard temperature and pressure $\surd 1$

11. a) Rate of diffusion is whereby proportional to molecular mass of a gas. $\surd 1$

b) $$\frac{T_{CO_2}}{T_{CO}} = \sqrt{\frac{M_{CO_2}}{M_{CO}}} \surd ½$$

$$\Rightarrow \frac{200}{T} = \sqrt{\frac{44}{28}} = \sqrt{\frac{44}{28}}\ \frac{11}{7} \surd ½$$

$$\Rightarrow \left(\frac{200}{T}\right)^2 = \frac{11}{7}$$

$$\Rightarrow \frac{T}{200} = \sqrt{\frac{7}{11}}$$

$\Rightarrow T = 200.0.79772 \surd ½ = 159.5$ Seconds. $\surd ½$

MOLE CONCEPT

MARKING SCHEME

1. a) Moles of Zinc used

$$Moles = \frac{Mass\ given}{Molar\ mass} = \frac{1.96g}{65.4} = 0.0299\ moles\ of\ Zn\ used \checkmark \tfrac{1}{2}$$

- Moles of Hydrochloric acid used.

$1000cm^3 \longrightarrow$ 0.2 moles Hcl

$\therefore$ $100cm^3 \longrightarrow$?

$$\frac{100\ x\ 0.2}{1000cm^3} \surd\tfrac{1}{2} = 0.02\ moles\ of\ Hcl\ acid\ used. \surd\tfrac{1}{2}$$

- Thus Zinc metal was in excess ✓ 1

b) If 65.4g of Zinc metal ✓ ½ $\longrightarrow$ 22.4 litres at S.T.P

$\therefore$ 1.96g of Zinc metal $\longrightarrow$?

$$= \frac{1.96g\ x\ 22.4 litres}{65.4g} \surd\tfrac{1}{2}$$

$$0.6713\ litres\ of\ H_2\ gas\ \checkmark \tfrac{1}{2}$$

$$or$$

$$671.3cm^3\ of\ H_2 gas$$

2. For Hydrogen, H_2, molar mass= 2g

2g $\longrightarrow$ 1mole ½

$\therefore$ 10g $\longrightarrow$?

$$\frac{10g\ x 1mole}{2g} = 5\ moles\ of\ H_2\ gas\ \tfrac{1}{2}$$

For Nitrogen (IV) oxide gas, NO_2

Molar mass = 14 + 32 = 46g

1 mole of NO_2 $\longrightarrow$ 46g ✓ ½

$\therefore$ 5 moles of NO_2 $\longrightarrow$? √ ½

$$= \frac{5 moles\ x\ 46g}{1mole}$$

= 230g of NO_2 gas will occupy the same volume of 10g of H_2 gas

3. From the equation

$2NH_{3(g)} + CO_{2(g)} \longrightarrow (NH_2)_2CO_{(aq)} + H_2O_{(l)}$

Where;

2 moles of NH_3 $\longrightarrow$ 1mole of urea

2(14 + 3) (2 x 14) + (4 x 1) + (1 x 12) + (1 x 16)

2(17) 28 + 4 + 12 + 16

34g ✓ 1/2 → 60g

Hence; 34g of NH_3 ⟶ 1 mole of urea

∴ 340000g of NH_3 ⟶ ?

$$\frac{\overset{10000}{\cancel{340000}}g \times 1mole}{\cancel{34g}}$$ ✓ 1

= 10,000 moles of urea ✓1/2

4. RFM of NaOH = 40

Moles of NaOH = 8/40 = 0.2m ✓ 1/2mk

Moles of NaoH in $25cm^3$

$$\frac{25 x 0.2}{1000} = 0.005$$ ✓ 1/2

Mole ratio 1: 2

Moles of acid = $\frac{0.005}{2}$ ✓ 1/2

0.0025

$1m = \frac{1 x 0.245}{0.0025}$ ✓ 1

$= 98$ ✓ 1/2

5.

$CH_{4(g)}$	:	$O_{2(g)}$	:	$CO_{2(g)}$	
12.0 cm^3	:	24cm^3	:	36cm^3	(1mk)
1cm^3	:	2cm^3	:	3cm^3	
1vol	:	2vol	:	3vol	which is a small (simple) whole number

ratio according to Gay Lussac's law of combining volumes. (1mk)

6. 500cm^3 ≥ 4.9 g

1000cm^3 ≥ $\frac{1000}{500} \times 4.9g = 9.8g$ (1mk)

if 0.3 molar w.r.t $H^+_{(aq)}$ then $\frac{0.3}{3}$ molar w.r.t acid since it is a tribasic acid

$$0.1mols = 9.8g$$

$$1mol \equiv \frac{1}{0.1} \times 9.8 = 98g \qquad (1mk)$$

$$RMM\ of\ acid = 98 \qquad (\tfrac{1}{2}mk)$$

7.

$$24dm^3 = \frac{24}{1} \times 2.667g = 64.008g$$

(1mark)

$$Rmm\ of\ gas\ x = 64.008\ (no\ unuts)$$ (1mark)

8. Mass per litre of NaOH = 7.5 g x 1000 = 30gdm^3

Molarity of NaOH = 30/40 = 0.75 m (½)

Moles of NaOH reacted = 0.02 x 0.75 = 0.0015 moles

Moles of HCl used = 0.013 x 1 = 0.013 moles ½

Moles of NaOH that should have been used = 0.013 moles

Mass of NaOH reacted = 0.0015 x 40 = 0.06g (½)

Mass of NaOH required = 0.013 x 40 % = 0.52g (½)

% purity of NaOH = $\frac{0.56}{0.52}$ x 100 % = 11.54 %

9. a)

	N	**O**
Mass %	**30.4**	**69.6**
No of moles	$\frac{3.04}{14}$ **= 2.17**	$\frac{69.6}{16}$ **= 4.35**
Mole ration	$\frac{2.17}{2.17}$ **= 1**	$\frac{4.35}{2.17}$ **= 2**

½

E.F of compound is NO_2 **½**

If 22.4dm^3 of gas = 1 mole

Then 1 dm^3 of gas = 1/22.4 = 0.044 moles

If 0.044 moles of the gas = 4.11g
Then 1 mol of the gas = 1/0.044 x 4.11g = **<u>92.064g</u>**

OR

If 1 dm^3 of gas = 4.11g

Then 22.4dm^3 of gas = 22.4 x 4.11g
= 92.064g (½)

E.F.M of No_2 = 14 + 32 = 46

N= M.F. M = $\frac{92}{46}$ = 2

10. $2HCl_{(aq)} + Na_2CO_{3(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$ 1

Moles of Na_2 CO_3 reacting = $\frac{1}{2} \times \frac{20 \times 0.5}{1000} = 0.005\ moles$ ½

Moles of Na_2 CO_3 in 100cm^3 = $\frac{0.005 \times 100}{25}$ ½ = 0.02 moles ½

Mass of Na_2CO_3 in the mixture = 0.02x 10.6
= 2.12g. ½

11. RFM of Na_2SO_3 is 126 ✓ ½

Number of moles of Na_2SO_3 = $\frac{25.2}{126}$ = 0.2✓ ½

Number of moles of HCl = $\frac{700 \times 0.5}{1000}$ = 0.35✓ ½

Reacting ratio is 1:2 ∴0.2 moles of Na_2SO_3 require 0.4 mole of HCl
∴Reagent in excess is Na_2SO_3

12. i)

Concentration	Molarity	RFM
g/l = $\frac{9.42}{600} \times 1000$	$\frac{21.5 \times 0.207}{25}$	$\frac{15.7}{0.17802}$
= 15.7 g/l✓1	= 0.17802M✓1	= 88.192 ≈88✓1

ii) RCOOH = 88

R + 12 + 32 + 1 = 88

R = 88 – 45

R = 43✓1

13. a) Equation for the reaction

$2KOH_{(aq)} + H_2Y_{(aq)} \rightarrow K_2Y_{(aq)} + 2H_2O_{(l)}$

Mole ratio 2 : 1

Moles of KOH = $\frac{25}{1000} \ x \ 0.12$ ✓½

= 0.003 moles

∴ Moles of acid (H_2Y) = ½ x 0.003

= 0.0015 moles✓½

If $30cm^3$ contains 0.0015 moles

$100cm^3$ contains = $\frac{1000}{30} \ x \ 0.0015$ ✓½

= 0.05 moles/l (0.05M)

b) Molarity = $\frac{mass / l}{R.F.M}$

If $500cm^3$ contains 3.15g

$1000cm^3$ contains $\frac{1000}{500} \ x \ 3.15$✓½

= 6.30g/l

$0.05 = \frac{6.30}{R.F.M}$

∴ R.F.M = $\frac{6.30}{0.05}$ ✓½

R.F.M = 126✓½

14.(a) (i) RMM ZnSO4 = 65+32+64 = 161✓1

$moles \ of \ Zn = \frac{65}{165} = 0.4037 \ moles$ ✓1

(ii) Mass of water = 3.715 -2.08

= 1.635g✓1

RMM H_2O = 2 + 16 = 18

Moles of water = $\frac{1.635}{18} = 0.09083 \ moles.$

(iii) $ZnSO_4$ H_2O

mass: $\frac{2.08}{161}$ 0.09083✓ ½

0.01291

mole ratio : $\frac{0.01291}{0.1291}$ $\frac{0.09083}{0.01291}$ ✓ ½

1 7.035✓ ½

1 7

R = 7✓ ½

(b) (i) RMM $ZnSO_4.7H_2O$ = 161 + 7 x 18 = 287g✓ ½

287g ZnSO4.7H2O = 65g

= 0.015g

$$\frac{287\ x\ 0.015}{65} = 0.06623g$$

(ii) $Moles\ of\ ZnSO_4.7H_2O = \frac{0.06623}{287}$

= 0.0002308 moles

5cm3 = 0.0002308moles

1000cm3 =?

$$\frac{1000cm^3 \times 0.0002308\ moles}{5cm^3}$$

$$= 0.04616\ M$$

Nitrogen and its compounds

1. *(i) $4HN_3$ (g) + $5O_{2\ (g)}$ $4NO_{(g)}$ + $6H_2O_{(g)}$*
   (ii) Act as catalyst √
   (iii) $Zn(NH_3)_4^{\ 2+}$

2. *a) Platinum/ copper*

   b) Brown fumes √
   Hot rod m continues to glow red
   - NO formed reacts with oxygen to form NO_2 (brown flames)
   - Reaction highly exothermic

3. *a) Calcium hydroxide*
   b) $Ca(OH)_{2(g)}$ + $2NH_4CL_{(g)}$ ________ $2NH_{3(g)}$ + $CaCL_2$ + $2H_2O_{(L)}$

4. *(a) It neutralizes air to prevent violent combustion reaction from occurring.*
   (b) Its inert and have very low b.pt of -196°C
   **MAT*

5. *a) X is Nitrogen.* √1
   b) It is less dense than air. √½
   c) – In preservation of semen in artificial insemination. √1

6. *a) (i) Solution A contains Pb^{2+}(aq) ions* √½
   (ii) Solution B contains Al^{3+}(aq) ions. √½
   b) – A colourless liquid at cooler parts √1 *of test-tube is formed.*
   - A white reside remains in the test-tube. √1

7. *a) to expel air that is in the combustion tube so that oxygen in it does not react with hot copper√1*
   b)brown√ ½ copper metal will change to black√ ½
   c)nitrogen √1

8. *(a) To increase the surface area over which the reaction occurs hence increased rate of reaction.* √1 √1
   (b) NH_3 is basic and reacts with some moles of the acid hence reduction in concentration √1

9. *(a) (i) The solution changes from <u>green</u> √1 to <u>brown</u> √1 (1 mk)*
   (ii) A brown √1 precipitate is formed. (1 mk) 3
   (b) $Fe^{3+}_{(aq)}$ + $3OH^-_{(aq)}$ ⟶ $Fe(OH)_{3(s)}$ √1 (1 mk)

10. *(a) – Absorbs carbon (IV) oxide from√1 the air. (1 mk)*
    (b) 2 $Cu_{(s)}$ + O_2 ⟶ $2CuO_{(s)}$ √1 (1 mk) 3
    (c) Because it has the rare gases. √1 (1 mk)

ORGANIC 1

1.

(a) Only single bonds between carbon atoms 1 [1]
(b) (i) Water
Carbon dioxide [2]
(ii) No carbon or soot produced
No nitrogen oxides produced
No sulphur oxides produced
No carbon monoxide produced
[2]

Total [5]

2.

any two of: [2]

family of similar (organic) compounds /

with similar chemicalproperties /

presence of same functional group /

same general formula /

allow:compounds with a trend in physical properties

allow:difference of CH2between one member and another

[2]

3.

One general formula / same general formula;
differ by CH_2;
similar chemical properties;
gradual change in physical properties;
*Award **[1]** for any two from last three*

functional group: atom or group of atoms responsible for the characteristic reactions of the molecule / homologous series; 3

4.

(a) (i) boiling point increases as number of carbons increases / *OWTTE*;
increased surface area / greater Van der Waals' forces / increased M_r /

increased intermolecular forces / *OWTTE*; 2

(ii) exothermic / energy released / products have less energy than reactants; 1

(b) carbon dioxide; 2
water;
Accept formulas.

[5]

(a) (i) breaking down of molecules substances using heat [1]
(ii) substance which speeds up a reaction [1]
NOT: alters/changes rate of reaction
NOT: speeds up and slows down rate
(b) ethene/ethylene [1]
NOT: formula
(c) (i) paraffin [1]
(ii) 4000g/4kg [1]
(correct unit needed)
(iii) C_2H_4; H_2 [2]
(d) (i) two units polymerised with continuation bonds at either end and hydrogen atoms drawn [1]
ALLOW: _$CH_2CH_2CH_2CH_2$ _
ALLOW: _ [_CH_2CH_2 _] _ n
ALLOW: _ [_CH_2 _] _ n
(ii) addition (polymerisation) [1]

[Total 10m]

SULPHUR AND ITS COMPOUNDS

MARKING SCHEME

1. Barium carbonate reacts with dilute sulphuric (VI) acid to form the insoluble Barium sulphate ($BaSO_4$) which covers the reactant Barium carbonate preventing any contact between the acid and the carbonate salt. ✓ 1
Hence, the reaction is slow and stops after a very short time.

$BaCO_{3(s)} + H_2SO_{4(aq)} \longrightarrow BaSO_{4(s)} + CO_{2(g)} + H_2O_{)(l)}$
Insoluble

2. The dye is oxidized to a new product with chlorine (1mk) but oxygen is removed to form an unstable product which gradually gets re-oxidized by atmospheric oxygen on exposure for sometime to air (1mk) in the case of Sulphur (IV) oxide.

3. (a) Dehydrating agent (1mk)
(b) Oxidizing agent (1mk)

4. 1 – Compressed hot air, in
2 – Molten froth of Sulphur water mixture, out
3 – Superheated water – in

5. a) i) Dehydration (½)
ii) Oxidation (½)
b) $Cu_{(s)} + 2H_2SO_{4(l)} \longrightarrow CuSo_{4(aq)} + SO_{2(g)} + 2H_2O_{(l)}$ (1)

6. (a) Mass of acid = $\frac{75}{100} \times 1.84 \times 1000$ = 1380g in 1000cm^3

Morality = $\frac{1380}{98}$ = 14 .08m ½

(b)Moles of dilute acid = 0.25 x 1 = 0.25x 1 ½ = 0.25 moles.
 ½ ½

Volume = $\frac{0.25}{14.08} \times 1000$ ½ = 17. 756cm^3 ½
Penalize ½ for wrong units

7. It reacts with ammonia ½ gas to form ammonium sulphate. ½
(b) Quick time / Ca O

(b) $SO_3(g) + H_2SO_4(l) \longrightarrow H_2S_2O_7(l)$ 1

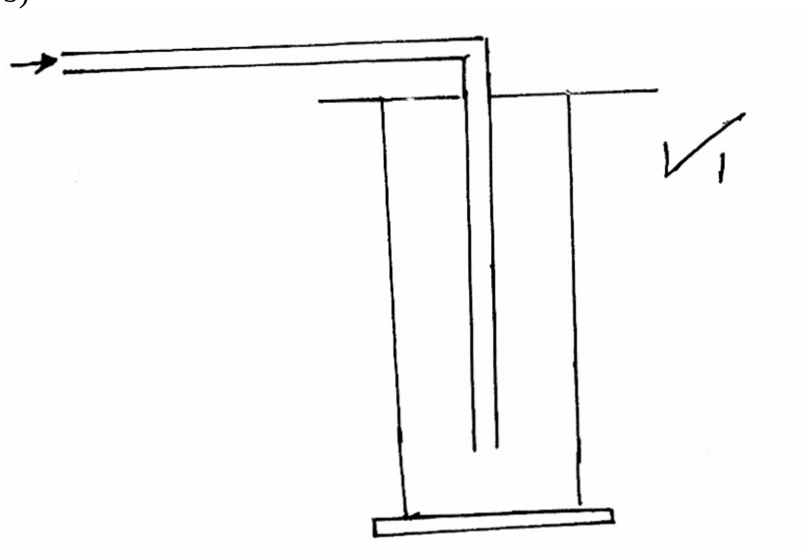
(c) Vanadium (v) Oxide $V_2\ O_5$ 1

9.	a) $3H_2S_{(g)} + H_2SO_{4(l)}$ $4H_2O_{(l)} + 4S_{(s)}$ ✓ b) H_2S ✓ ½reducing agent ; Sulphur in H_2S oxidized from -2 to 0 (zero c) $Pb(C_2H_3O_2)_{2(aq)} + H^2S_{(g)} \longrightarrow PbS_{(s)} + 2C^2H_4O_{2(aq)}$

9. a) Hydrogen chloride✓1

Sulphur (IV) oxide✓1

b)



25. a) Frasch process✓1

b) Hot compressed air✓1

c) Monoclinic / prismatic sulphur / beta sulphur✓½

Rhombic / octahedral sulphur / alpha sulphur✓½