O'LEVEL CHEMISTRY NATIONAL EXAMINATION PAPER 2020-2021

SECTION A: ATTEMPT ALL QUESTIONS (55 marks)

1) **Answer:**

a) **The balanced chemical equation for the thermal decomposition of $FeSO_4$:**

$$2FeSO_4(s) \xrightarrow{heat} Fe_2O_3(s) + SO_2(g) + SO_3(g)$$

b) **The colour changes from light green of $FeSO_4.7H_2O$ to white anhydrous of $FeSO_4$, for further decomposition brown solid of Fe_2O_3.**

2) **Answer:**

a) **The number of moles of NaOH contained in 100 cm^3 of solution** $= \frac{0.2x100}{1000} = 0.02$ **moles**

Or

n = MxV = 0.2 mol/dm^3 x 0.1dm^3 = 0.02 moles

b) **The mass of sodium sulfate crystals that are formed:**

Number of moles of Na_2SO_4 obtained $= \frac{0.02}{2} = 0.01\ mol$

Mm = 142g/mol

Mass of Na_2SO_4 = 0.01 x 142 = 1.42g

Or

$$H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$$

98g	80g	142g	36g
1 mole	2 moles	1 mole	2 moles

2 moles of NaOH $\longrightarrow$ **142 g of Na_2SO_4**

1 mole $\longrightarrow \frac{142g}{2moles}$

0.02moles of NaOH $\longrightarrow \frac{142gx\ 0.02moles}{2moles} = 1.42g$ **of Na_2SO_4**

Or

Mass of NaOH in 0.02 = 0.02 x 40 = 0.8g

$$H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$$

80g of NaOH $\longrightarrow$ **142 g of Na_2SO_4**

1 g of NaOH $\longrightarrow \frac{142gx0.8g}{80g} = 1.42g\ of\ Na_2SO_4$

3) **Answer:**

a) **Reagent: $Ba(NO_3)_2$ solution or $Pb(NO_3)_2$ solution**
Observation: The colourless solution of $Ba(NO_3)_2$ or $Pb(NO_3)_2$ turns to a white precipitate of $BaSO_4$ or $PbSO_4$

b) **Industrial and medical uses**

Industrial uses	Medical uses
✓ It is used to cut metals (oxyacetylene) ✓ Support combustion ✓ Preparation of nitric acid, sulphuric acid, sodium hydroxide ✓ Germination of seeds	✓ Used to give patients for inhaling in case of breathing problems

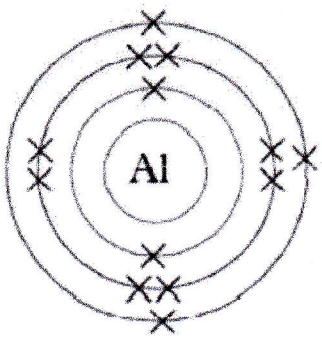
4) **Answer:**

a) **The ozone layer absorbs ultraviolet light of the sun to protect humans from those dangerous radiations.**

b) **The types of chemical substances that destroy the ozone layer:**
- ✓ **Chlorofluorocarbons organic substances emitted from the earth (CFCs)**
- ✓ **Free radicals containing F, Cl, Br**
- ✓ **NO, N_2O (N_xO)**

5) **Answer:**

a) **The structure of Aluminium atom:**



b) **Equation of reaction**

$2Al(s) + 3\ S(s) \longrightarrow Al_2S_3\ (s)$

6) **Answer:**

a) Na_2S

b) **Socio-economic importance:**
- ✓ **Sodium hydroxide used to produce soap**
- ✓ **Sodium is present in cryolite Na_3AlF_6 which is necessary during production of Aluminium in electrolysis.**
- ✓ **NaCl is used as common table salt**
- ✓ **Na_2CO_3 is used as baking powder, in preservation, in cleaning, …**

7) **Answer:**

a) **The equation or reaction:**

$Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$

b) **Effects of acidic rain to buildings and monuments:**

The H^+ ions in the acid reacts with CO_3^{2-} ions in calcium carbonate to produce H_2O and CO_2 gas, which means that the structure of the building keeps on being removed (destroyed)

Or

There is degradation of the building or monuments

8) **Answer:**

a) **Copper is preferred to be used in coating monetary coins because copper is not reactive with water and weak acids, so it resists corrosion for a long period.**

b) **Balanced chemical equation for the combustion of magnesium in oxygen gas:**

$2Mg(s) + O_2(g) \longrightarrow 2MgO\ (s)$

9) **Answer:**

a) **The litmus paper that changed its colour is the blue litmus paper**

b) **Uses of CO_2:**
- ✓ **It is put in fizzy soft drinks**
- ✓ **It is put in bread during the baking process**
- ✓ **It is used in fire extinguishers**
- ✓ **CO_2 is used in photosynthesis**

- ✓ It is used in extraction of Fe
- ✓ It is used in manufacture of carbonates

10) Answer:

a) Reagent: $AgNO_3$/ $Pb(NO_3)_2$
Observation: - white precipitated with NaCl
- No observable change with $NaNO_3$

b) Reagent: NH_3 solution
Observation: - white precipitate soluble in excess of ammonia with Zn^{2+}
- White precipitate insoluble in excess of ammonia with Al^{3+}

11) Answer:

a) $C_5H_{12}(g) + 8O_2(g) \longrightarrow 5CO_2(g) + 6H_2O(l)$
Or
$5C_5H_{12} + 11O_2 \longrightarrow 10CO + 12H_2O$

b) $C_3H_8(g) + 5O_2 \longrightarrow 3CO_2(g) + 4H_2O(l)$

12) Answer:

a) In the structure of Silicon dioxide, there is no free electrons available to carry electric charges

b) Two uses of diamond:
- ✓ To cut metals/ glasses
- ✓ Used as jewellery
- ✓ To make drilling devices

13) Answer:

Let the molar mass of gas X be M_x

$$\frac{Rate\ CO_2}{Rate\ x} = \sqrt{\frac{M_x}{44}}$$

$$\frac{102\ x\sqrt{44}}{83.3} = \sqrt{M_x}$$

$M_x = 65.93$ g/mol

14) Answer:

a) Two uses of strong acids:
- ✓ Strong acids are used during electrolysis of metals
- ✓ Strong acids are used in purification of metals
- ✓ H_2SO_4 is used to make fertilizers, dyes, paint
- ✓ HNO_3 is used to make TNT (trinitrotoluene)

b) A strong base dissociates completely to give OH^- ions in solution while weak base dissociates partially in solution.

SECTION B

15) Answer:

a) Time taken for Neon gas:

Let the rate be $\frac{1}{time}$, *then*

$$\frac{\frac{1}{243}}{\frac{1}{Neon\ time}} = \frac{\sqrt{20}}{\sqrt{131}}$$

$$\text{Neon time} = \frac{0.39}{0.00411} = 95.07\ seconds$$

Or

$$\frac{R_{Xe}}{R_{Ne}} = \frac{t_{Ne}}{t_{Xe}} = \sqrt{\frac{M_{Ne}}{M_{Xe}}}$$

$$\frac{t_{Ne}}{243} = \sqrt{\frac{20}{131}}$$

$$t_{Ne} = \sqrt{\frac{20x59049}{131}} = 95 \text{ sec}$$

b) i) How much faster NH_3 diffuses than HCl (percentage rate of NH_3 to the rate of HCl):

$$\frac{Rate\ NH_3}{Rate\ HCl} = \frac{\frac{1}{80}}{\frac{1}{117.2}} = 1.463 = 1.463x100 = 146.3\ \%.$$

Or

$$\frac{Rate\ NH_3}{Rate\ HCl} = \frac{t_{HCl}}{tNH_3} = \frac{117.2}{80} = 1.465$$

ii) The distance travelled by NH_3 gas in order that it meets HCl gas:

Let the distance covered by NH_3 be X,

Then the distance covered by HCl is 87-X

Time taken by NH_3 is the same as time taken by HCl in order to meet.

$$t_{NH_3} = t_{HCl}$$

$$t_{NH_3} = \frac{Distance\ covered\ by\ NH_3}{rate\ NH_3} = \frac{Distance\ covered\ by\ HCl}{rate\ HCl}$$

$$\frac{X}{1.463} = \frac{87-X}{1}$$

X = 51.677 dm

Or

Let X be the distance travelled by HCl and Y be distance travelled by NH_3

$$\begin{cases} x + y = 87\ (1) \\ 1.465x = y\ (2) \end{cases}$$

Equation (2) in (1), becomes

X + 1.465x = 87

2.465X = 87

X = 35.29

Y = 87 – 35.29 = 51.7 dm

Distance travelled by NH_3 = 51.7 dm

16) Answer:

a) The number of moles contained in 8.0 g of magnesium = $\frac{8}{24} = 0.333\ moles$

b) The maximum volume of sulphuric acid that reacted with all the 8.0g of magnesium

Number of moles H_2SO_4 used = 0.333 moles

Molarity = $\frac{Number\ of\ moles}{molarity} = \frac{0.333}{0.5} = 0.666\ litres$

c) The value of x in the equation:

The mass of $ZnSO_4$ in 1 mole = 161g/mol

The mass of 1 mole of $ZnSO_4$ x H_2O = $\frac{161x100}{56.09} = 287g/mol$

The mass of XH_2O = 287 = 161 = 126g/mol

The value of X = $\frac{126}{18} = 7$

Or

% of H_2O = 100 – 56.09 = 43.91

$ZnSO_4$	H_2O
$\frac{56.09}{161}$	$\frac{43.91}{18}$
$\frac{0.34824}{0.34824}$	$\frac{2.444}{0.34824}$
1	7

X = 7

Or

% composition of $ZnSO_4 = \frac{161x100}{161+18x} \Leftrightarrow X = 7$

d) i) Little OH^- solution

$Zn^{2+}(aq) + 2OH^-(aq) \longrightarrow Zn(OH)_2(s)$

ii) Excess of OH^- solution

$Zn^{2+}(aq) + 4OH^-(aq) \longrightarrow Zn(OH)_4^{2-}(aq)$

17) Answer:

a) Chemical equation of reaction between Aluminium and water

$2Al(s) + 3H_2O(g) \longrightarrow Al_2O_3(s) + 3H_2(g)$

b) Aluminium metal is used to make overhead electrical cables on streets because aluminium is a good conductor of electricity and resists corrosion of water and acids.

c) Aluminium reacts with Cl_2 according to the equation:

$2Al(s) + 3Cl_2(g) \longrightarrow 2AlCl_3(s)$

i) Mass of $AlCl_3$:

Number of moles of Al $= \frac{5.4}{27} = 0.2\ moles$

Mm of $AlCl_3$ = 133.5g/mol

The mass of $AlCl_3$ produced = 0.2 x 133.5 = 26.7g

Or

54g $of\ Al \longrightarrow$ 267 g of $AlCl_3$

1 g of Al $\longrightarrow \frac{267}{54}$

5.4 g of Al $\longrightarrow \frac{267x5.4}{54} = 26.7g$

ii) Volume of Cl_2

Number of moles of $Cl_2 = \frac{0.2x3}{2} = 0.3\ moles$

Volume of Cl_2 = 0.3 x 24 = 7.2 dm^3

Or

$2Al(s) + 3Cl_2(g) \longrightarrow 2AlCl_3(s)$

54g 3x24 = 72dm^3

54g $of\ Al \longrightarrow$ 72 dm^3 of Cl_2

1 g of Al $\longrightarrow \frac{72}{54}$

5.4 g of Al $\longrightarrow \frac{72\ x5.4}{54} = 7.2\ dm^3$

18) Answer:

a) The equation of reaction:

$Ag_2O(s) + H_2(g) \longrightarrow 2Ag(s) + H_2O(l)$

b) Explanation:

Hydrogen is more reactive than silver or in other words zinc is more reactive than hydrogen.

c) CaO absorbs water vapour which is mixed with the liberated gas.

d) i) Downward displacement of air or upward delivery

ii) Reagent: Burning splint

Observation: The gas burns with pop sound.

e) Equation:

$ZnO(s) + C(s) \longrightarrow Zn(s) + CO(g)$

Or

$2ZnO + C \longrightarrow 2Zn + CO_2$

19) Answer:

a) i) Anode: $Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$
ii) Cathode: $Cu^{2+} + 2e^- \longrightarrow Cu(s)$

b) Observable changes:
The volume of the anode keeps on reducing while the volume of the cathode keeps on increasing as the reactions of electrolysis go on with time.

c) Electrons move from the anode to the cathode in the external circuit.

d) To purify copper during its extraction process

e) At anode: release of O_2, anode keeps same size, Reaction: $4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$
At cathode: no change (brown cathode)
In electrolyte: there is decolorization.

SECTION C: Attempt only One question in this section (15 marks)

20) Answer:

a) The colorless color of the solution turns to pink.

b) The number of moles of NaOH in 24.16ml = 0.1048 x $\frac{24.16}{1000} = 0.00253\ moles$

c) Since the ratio is 1: 1
Number of moles of HCl = 0.00253 moles

d) The number of moles of HCl (0.17 mole/litre) in 20.0ml= 0.17 x $\frac{20}{1000} = 0.0034\ moles$

e) The number of moles of K_2CO_3 present in 0.048g sample
$n = \frac{m}{Mm} = \frac{0.048}{138} = 0.0003478$

21) Answer:

a) Names of the compounds:
i) 4-methylpent-2-ene
ii) butan-2-ol

b) 2 physical properties of alcohols:
- ✓ Alcohols have higher boiling points than alkanes
- ✓ Alcohols are soluble in water

c) i) $CH_3CH_2CH_2OH + \frac{9}{2}O_2 \longrightarrow 3CO_2 + 4H_2O$
ii) $CH_3CH_2OH \xrightarrow{K_2Cr_2O_7/H^+} CH_3CHO \xrightarrow{K_2Cr_2O_7/H^+} CH_3COOH$

d) Two uses of alcohols:
- ✓ Used as disinfectants
- ✓ Used as antifreeze in car engines

e) Two health hazards caused by drinking too much alcohol:
- ✓ Drinking too much alcohol can cause liver damage to humans (hepatitis) which is difficult to cure.
- ✓ Drinking too much alcohol can result in domestic violence and destruction of property thus causing poverty in families and despair.

f) Alcohols require many steps which are involved in order to obtain quantities of it, which means that the process is expensive.
Alkanes can be distilled easily after minutes
Alcohols produce soot