THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATION COUNCIL OF TANZANIA
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/2 **CHEMISTRY 2**

(For Both Private and School Candidates)

Duration: 3 Hour. **ANSWERS** **Year: 2025**

Instructions

1. This paper consists of a total of **six (6)** questions
2. Answer **five (5)** questions.
3. Each question carries **twenty (20)** marks.
4. Write your **Examination Number** on every page of your answer booklet(s).

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1. (a)

(i) From the initial concentrations and rates given in the table, find the rate law for the reaction.

Comparing Experiments 1 and 2:
\[X] constant, \[Y] doubles → rate doubles
Rate ∝ \[Y]^1

Comparing Experiments 2 and 3:
\[Y] constant, \[X] doubles → rate doubles
Rate ∝ \[X]^1

Therefore, rate law is:
Rate = k\[X]\[Y]

(ii) Calculate the rate constant with its units (Use data from experiment 1).
Rate = k\[X]\[Y]
$1.6 \times 10^{-5} = k(2.1 \times 10^{-6})(2.1 \times 10^{-6})$
$k = 1.6 \times 10^{-5} / (2.1 \times 10^{-6})^{2}$
$k = 1.6 \times 10^{-5} / 4.41 \times 10^{-12} = 3.63 \times 10^{6}$ $\text{mol}^{-1}\ \text{dm}^{3}\ \text{s}^{-1}$

(iii) Find the initial rate of the reaction when \[X] = 9.0×10^{-6} mol dm^{-3} and \[Y] = 1.0×10^{-6} mol dm^{-3}
Rate = k\[X]\[Y] = $3.63 \times 10^{6} \times 9.0 \times 10^{-6} \times 1.0 \times 10^{-6}$
Rate = 3.267×10^{-5} mol $\text{dm}^{-3}\ \text{s}^{-1}$

(b)
(i) To coat the object with copper, it should be connected to the cathode (negative terminal), since copper cations move to the cathode to be deposited.

(ii) What mass of copper will be deposited if a current of 0.22 A flows through the cell for 1.5 hours?

$Q = It = 0.22 \times 1.5 \times 3600 = 1188$ C
$n = Q / (nF) = 1188 / (2 \times 96500) = 6.16 \times 10^{-3}$ mol
$\text{Mass} = n \times M = 6.16 \times 10^{-3} \times 63.5 = 0.391$ g

2. (a)

Iron in the Haber process acts as a catalyst by providing a surface that adsorbs nitrogen and hydrogen gases, bringing them closer for reaction. Its properties include high melting point, ability to be finely divided for large surface area, durability under reaction conditions, and effectiveness in lowering activation energy.

(b)
Nylon-6,6 is made by condensation polymerization between hexamethylenediamine and adipic acid. Each molecule of diamine has two amino groups, and each adipic acid has two carboxylic acid groups. A

molecule of water is eliminated for each bond formed. The polymer chain grows as alternating units of the two monomers form amide bonds.

(c)
Styrene-butadiene rubber is prepared via addition polymerization:
$n(CH_2{=}CH–C_6H_5 + CH_2{=}CH–CH{=}CH_2) \rightarrow$ \[$–CH_2–CH(C_6H_5)–CH_2–CH{=}CH–CH_2–]_n$

(d)
Using vinyl chloride:
(i) Initiation: Formation of free radicals (e.g. benzoyl peroxide → 2R•)
(ii) Propagation: $R\bullet + CH_2{=}CHCl \rightarrow R–CH_2–CHCl\bullet$
Then: $R–CH_2–CHCl\bullet + CH_2{=}CHCl \rightarrow R–(CH_2–CHCl)_2\bullet$
(iii) Termination: Combination of two growing chains or disproportionation

3. (a)
Two factors to consider when selecting metal extraction method:

* Reactivity of the metal
* Cost and availability of the extraction process

(b)
Extraction of aluminium involves electrolysis of molten aluminium oxide (Al_2O_3) dissolved in cryolite. At the cathode, Al^{3+} gains electrons to form Al. At the anode, O^{2-} is oxidized to O_2 gas. High electricity input is required due to the stability of the oxide.

(c)
From the table: Electronegativity increases across the period due to increasing nuclear charge and decreasing atomic radius. Therefore, F has the highest electronegativity and Li the lowest in Period II.

4. (a)
(i) Common ion effect is the suppression of the solubility of a salt by the addition of another salt containing a common ion.
(ii) Solubility product (Ksp) is a constant for a sparingly soluble salt, representing the product of ion concentrations at equilibrium.
(iii) Factors affecting solubility:

* Presence of common ion
* pH of the solution
* Formation of complexes
* Temperature changes

(b)
Solubility of AgCl:
(i) In pure water:

Ksp = \[Ag$^+$]\[Cl$^-$] = s^2 → s = √Ksp = √(2 × 10^{-10}) = 1.41 × 10^{-5} mol dm^{-3}
(ii) In 0.1 M NaCl:
\[Cl$^-$] = 0.1
Ksp = \[Ag$^+$]\[Cl$^-$] → \[Ag$^+$] = Ksp / \[Cl$^-$] = 2 × 10^{-10} / 0.1 = 2 × 10^{-9} mol dm^{-3}

(c)
(i) When Na_2SO_4 and $Ca(NO_3)_2$ are mixed, $CaSO_4$ precipitates because $Ca^{2+} + SO_4^{2-} \rightarrow CaSO_4(s)$, and the solubility product is exceeded.
(ii)
\[Ca^{2+}] = 0.0125 M, \[SO_4^{2-}] = 0.0152 M
Q = \[Ca^{2+}]\[SO_4^{2-}] = 0.0125 × 0.0152 = 1.90 × 10^{-4}
Ksp = 9.1 × 10^{-6}
Since Q > Ksp, a precipitate will form.

5. (a)
(i) The partition coefficient (K) of solute G between pentan-1-ol and water:
Amount of solute extracted into pentan-1-ol = 1.5 g
Initial amount in aqueous = 4 g
Remaining in aqueous = 4 – 1.5 = 2.5 g
K = concentration in pentan-1-ol / concentration in water
\= (1.5 / 100) / (2.5 / 500) = 0.015 / 0.005 = 3

(ii) Mass of solute G remaining in aqueous after second shaking with 100 cm^3 pentan-1-ol:

Let x = amount remaining in aqueous after second shaking
Let y = extracted into pentan-1-ol
Total after first: 2.5 g
Use K = y / x × (Vwater/Vorganic) = 3 = y / x × (500/100) = y / x × 5
So y = 5x × 3 = 15x
But x + y = 2.5 → x + 15x = 2.5 → 16x = 2.5 → x = 0.156 g
Mass remaining in aqueous = 0.156 g

(b)
Z is volatile. Total mass = 26 g water + 7.5 g Z = 33.5 g
Use Dalton’s law of partial pressures:
P_total = 760 mmHg
P_water = 720 mmHg
P_Z = 760 – 720 = 40 mmHg
mole_water = 26 / 18 = 1.444 mol
mole_Z = n = ?
P_Z / P_total = n / (n + 1.444) → 40 / 760 = n / (n + 1.444)
Cross-multiplied: 40(n + 1.444) = 760n → 40n + 57.76 = 760n
720n = 57.76 → n = 0.0802 mol
Molar mass of Z = 7.5 / 0.0802 = 93.5 g/mol

(c)
Given: P_ethanol = 53.6 mmHg, P_phenol = 85.2 mmHg
x_ethanol = 0.45 → x_phenol = 0.55
Total P = (0.45)(53.6) + (0.55)(85.2) = 24.12 + 46.86 = 70.98 mmHg
Mole fraction of phenol in vapor:
P_phenol = 46.86
x_phenol(vapor) = 46.86 / 70.98 = 0.66

6. (a) IUPAC names:

(i) 2,3-dichlorobenzoic acid
(ii) Sodium 2,3-dichlorobenzoate
(iii) 2-methylbutanoic acid

(b) Order of increasing acidity:

(A) Toluic acid – weakest (electron-donating CH_3)
(D) $CHCl_2CH_2COOH$ – moderate inductive effect
(B) CCl_3COOH – strong electron withdrawing
(E) $ClCH_2CHClCOOH$ – stronger inductive effect than B
(C) Nitrobenzoic acid – strongest (resonance + induction)

So: $A < D < B < E < C$

(c) Arrange F-J in decreasing order of basic strength:

Basicity depends on availability of lone pair on N.

H (CH_3NH_2) > I (NH_3) > G (aniline) > J (4-nitroaniline) > F (2-nitroaniline)

Reason: Electron-donating CH_3 increases basicity. NO_2 reduces basicity via -I and -R effect. Aniline is less basic than ammonia due to delocalization.

(d) Equations:

(i) Butanone → propanoic acid:
$CH_3CH_2COCH_3$ + \[O] → CH_3CH_2COOH + CH_3COOH (via cleavage with hot acidified $KMnO_4$)

(ii) 1-chloropropane → propanoic acid:
$CH_3CH_2CH_2Cl$ + 2\[O] ($KMnO_4$ or $K_2Cr_2O_7$) → CH_3CH_2COOH

(iii) 1-propanol → propanoic acid:
$CH_3CH_2CH_2OH$ + 2\[O] → CH_3CH_2COOH + H_2O

(iv) Propanal → propanoic acid:
CH_3CH_2CHO + \[O] → CH_3CH_2COOH (using $K_2Cr_2O_7/H^+$)