FORM SIX INTER-ISLAMIC MOCK EXAMINATION (2024)

CHEMISTRY 1

MARKING GUIDE:

01 (a) (i) Atom is the smallest particle of element which can take part in a chemical reaction; WHILE Element is a pure chemical substance which can not be splitted by any chemical means. (2 marks 1 mark @)

(ii) Given;

Mass (m) = 1.674×10^{-27} kg

Velocity (v) = 7000 ms^{-1} = 7 m/s

planks constant (h) = 6.63×10^{-34} J/s

Required to find, the wavelength (λ)

from, $\lambda = \frac{h}{mc}$ --- 01

$\lambda = \frac{6.63 \times 10^{-34}\ J/s}{1.674 \times 10^{-27}\ kg \times 7\ m/s}$ --- 01

$\lambda = 5.658 \times 10^{-8}$ m

$\therefore$ The wavelength is 5.658×10^{-8} m. ---- 01

(03 marks) Total

(b) (i) The deflected of α-particle rays were few compared to the α-rays penetrated.

(01 mark)

(ii) The rebound of α-particles on hitting the gold foil shows that there is a central mass which is very dense. Hence mass is located at the nucleus.

(01 mark)

(c) Given

^{63}Cu = 62.9

^{65}Cu = 64.9

RAM (Cu) = 63.55

Required to find; percentage abundance.

01(c) from

R.A.M = Σ (Relative isotopic mass x abundance).

$63.55 = 62.9x + 64.9y$ ... 00½

but $x + y = 1$

$y = 1 - x$

where x and y are % abundances.

$63.55 = 62.9x + 64.9(1-x)$

$63.55 = 62.9x + 64.9 - 64.9x$ --- 00½

$-1.35 = -2x$

$x = \frac{-1.35}{-2} = 0.675 \times 100\%$

$= 67.5\%$

For $y = 1 - x$ 00½

$= 1 - 0.675$ -----

$= 0.325 \times 100\% = 32.5\%$ --- 00½

Therefore, the % abundances for each isotope;

$\%\ ^{63}Cu = 67.5\%$

$\%\ ^{65}Cu = 32.5\%$.

∴ Percentage abundances of ^{63}Cu and ^{65}Cu are 67.5% and 32.5% respectively. --- 01

(03 marks)

02(a)(i) H_2O is liquid ~~to~~ due to the presence of intermolecular hydrogen bond whereas H_2S is a gas due to the absence of hydrogen bond (02 marks)

(b)(i) The presence of delocalized (resonance) π-electron system in CO_3^{2-} make equal bond length in a molecule (i.e 148nm). (01 mark)

(ii) The hybrid structure after hybridization is

(01 mark)

(c) Hybridization is the mixing up of orbitals having different energy level to obtain an hybrid energy of the same energy level. The mixing of orbital is done so as to increase the combining power of atom. (02 marks)

(i) PCl_5
(ii) C_2H_4
(iii) C_2H_2
(iv) CH_4

(4 marks, 1 mark @)

NOTE: Any corresponding correct molecule can be provided.

03 (a) (i) Origin of gas pressure is from collision between gas particle molecule and the wall of container (01½ marks)

(ii) Yes, this is because at any instant temperature molecules move with an independetly speed. (01½ marks)

(b) Rate of diffusion of tear gas = 10 units
Rate of diffusion of laughing gas = 20 unit
Molar mass of laughing gas = 44 g/mol
Required the molar mass of tear gas

from, Grahm's law (50m's)

$$\frac{R_A}{R_B} = \sqrt{\frac{M_{rB}}{M_{rA}}} \quad \text{---} \quad 01$$

ie $\frac{\text{Rate of tear gas}}{\text{Rate of laughing gas}} = \sqrt{\frac{\text{Molar mass of laughing}}{\text{Molar mass of tear}}}$ --- 01

$$\frac{10 \text{ units}}{20 \text{ units}} = \sqrt{\frac{44 \text{ g/mol}}{Mr}} \quad \text{---} \quad 01$$

$$Mr = 176 \text{ g/mol}$$ --- 01

∴ The molar mass of tear gas is 176 g/mol.

3 (c) Given:

Mass (m) = 0.2 g
Volume (V) = 30ml (0.03L)
Temperature (T) = 27°c (300k)
Pressure total (p_T) = 756mmHg (0.995atm)
Pressure of water (p_w) = 26mmHg (0.04atm)
Pressure of organic compound = $p_T - p_w$ -- 01
= (0.995 - 0.04)atm
= 0.96atm.

from $pV = nRT$

$pV = \frac{mRT}{M_r}$

$M_r = \frac{mRT}{pV}$ ---- 01

$= \frac{0.2g \times 0.0821 \times 300k}{0.96atm \times 0.03L}$

$= 170.9\ g/mol$ --- 01

∴ The molecular mass of compound is 170.9g/mol

04. (a) (i) The higher the degree of dissociation, the higher the boiling point elevation and vice versa. -- 01½

(ii) Consider

$A_bB_a \rightleftharpoons bA + aB$

1 — 0 0 Before
$1-\alpha$ — $b\alpha$ $a\alpha$ After — 00½

Total number of molecule after dissociation

$= 1 - \alpha + b\alpha + a\alpha$

$= 1 - \alpha + (b+a)\alpha$

but $b + a = N$

$= 1 - \alpha + N\alpha = 1 + \alpha(N-1)$.

from $i = \frac{\text{molecule after dissociation}}{\text{molecule before dissociation}}$ --- 00½

4 (a) (ii) $i = \frac{1 + \alpha(N-1)}{1}$

$\alpha = \frac{i-1}{N-1}$ hence shown. --- 0½

(b) Given:

Mass of solute (m_s) = 1g

Mass of solvent (m_{sv}) = 99g

Freezing point of solution (T_{soln}) = -0.604°C

Freezing point of solvent (T_{sv}) = 0°C

K_f of water 1.86 °Ckg/mol

Required to find degree of dissociation (α)

From, $\Delta T_f = i K_f m$. ---- 01

$\Delta T_f = i K_f \frac{n_s}{m_{sv}(kg)}$

$n_s = \frac{1g}{58.5 g/mol} = 0.017 mol$

Also $\Delta T_f = T_{sv} - T_{soln}$

$= 0°C - (-0.604°C)$

$= 0.604°C$ --- 01

$0.604°C = i\, 1.86 °Ckg/mol \times \frac{0.017 mol}{0.099 kg}$

$\frac{0.604°C}{0.319°C} = \frac{i\, 0.319°C}{0.319°C}$

$i = 1.89$

Then; $\alpha = \frac{i-1}{N-1}$ --- 01

$NaCl \longrightarrow Na^+ + Cl^-$

$N = 2$

$\alpha = \frac{1.89 - 1}{2-1}$

$= 0.89 = 89\%$ --- 01

∴ The degree of dissociation is 89%

04 (c) (i) Purification of sea water by reverse osmosis to get drinking water

(ii) Determination of molecular mass of dissolved Unknown solute.

(iii) To avoid freezing of water in a car radiator during winter period

(iv) Also used in Deicing to remove the frozen ice on the road.

(3 marks 1 @ any 3).

05 (a) (i) Sublimation energy — Is the energy needed to Convert solid atom to gaseous atom eg. $I_{(s)} \longrightarrow I_{(g)}$ S.E (1mark)

(ii) Dissociation energy - Is the energy needed to Convert the gaseous molecule to gaseous atom eg. $Cl_{2(g)} \longrightarrow 2Cl$ D.E (1 mark).

(b) Given;

(i) — $C + O_2 \longrightarrow CO_2$ $\Delta H_f = -393 KJ/mol$

(ii) — $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ $\Delta H_f = -286 KJ/mol$

(iii) — $CH_3COOH + 2O_2 \longrightarrow 2CO_2 + 2H_2O$ $\Delta H_c = -867 KJ/mol$

Required;

$2C_{(s)} + 2H_{2(g)} + O_{2(g)} \longrightarrow CH_3COOH_{(l)}$ $\Delta H_f = ?$ — 01

Soln:

Take eqn (iii) Reverse and add eqn (i) X2

$2CO_2 + 2H_2O \longrightarrow CH_3COOH + 2O_2$ $+867 KJ/mol$

$2C + 2O_2 \longrightarrow 2CO_2$ $X2(-393) KJ/mol$ — 01

$2C + 2H_2O \longrightarrow CH_3COOH$ $+81 KJ/mol$

Add eqn (ii) X2

$2C + 2H_2O \longrightarrow CH_3COOH$ $+81 KJ/mol$

$2H_2 + 2O_2 \longrightarrow 2H_2O$ $2 X -286 KJ/mol$ — 01

$\therefore 2C + 2H_2 + 2O_2 \longrightarrow CH_3COO$ $-491 KJ/mol$

$\therefore$ The enthalpy of formation of acetic acid is $-491 KJ/mol$ — 01

5 (c) Given;
Volume of acid (V_a) = $100cm^3$
Volume of base (V_b) = $100cm^3$
Change in temperature (ΔT) = 6.25k
Heat capacity of calorimeter (C) = 95 J/k
Specific heat capacity of mixture (c) = 4.2 J/gk
Required to calculate the enthalpy of neutralization ($\Delta H^{\ominus}_n$).

Soln:

From, $\Delta H^{\ominus}_n = \frac{\text{Heat evolved (H)}}{\text{no of moles of } H_2O}$ ... 01

Heat evolved (H) = $-[(m_w c_w \Delta T + m_c c_c \Delta T)]$

but $m_c c_c = C = 95 J/k$

Then, $H = -[(200cm^3 \times 1g/cm^3 \times 4.2 \times 6.25) + (95 \times 6.25)]$

$= -5842.75 J$ or $5.84 kJ$ --01

Consider

$HCl + KOH \longrightarrow KCl + H_2O$

Number of moles of HCl = M X Volume (dm^3)
$= 1M \times 0.1 dm^3$
$= 0.1$ mole. -- 01

from balanced equation 1 mole HCl ≡ 1 mole H_2O
0.1 mol HCl ≡ x
x = 0.1 mole = n H_2O.

Finally;

$\Delta H^{\ominus}_n = \frac{-5.84 kJ}{0.1 mole} = -58.4 kJ/mol$ -- 01

∴ The enthalpy of neutralization is $-58.4 kJ/mol$.

06 (a) (i) production of building and construction materials
(ii) Manufacturing of pigment, colourants and paints
(iii) Some are used as anti-acids eg $MgCO_3$ and $NaHCO_3$
(iv) Some are used in food industries eg $NaHCO_3$ used in bread making.

(02 marks any four @ 02 marks)

(b) It is called precipitation since it result into the formation of hydroxides which are insoluble in water. — 02

(c)(i) V — $CuCO_3$ — 01

Y — CuO — 01

(ii) X — CO_2 — 01

Z — NO_2 — 01

(iii) $CuCO_{3(s)} + 2HNO_{3(aq)} \longrightarrow Cu(NO_3)_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$ — 01

(iv) $2Cu(NO_3)_{2(s)} \longrightarrow 2CuO_{(s)} + 4NO_{2(g)} + O_{2(g)}$ — 01

07 (a) (i) Handling toxic chemical properly
(ii) Re-use chemical items
(iii) Do not throw chemical pp. away
(iv) Strictly law enforcement
(v) Provision of education
(vi) Do not dispose oils in the sink
(any 04 @ 1mark)

(b) (i) Deforestation
(ii) Overgrazing
(iii) Climate Change
(iv) occurance of fire
(v) Mono-crops cultivation
(any 03 @ 1mark)

(c) (i) Risk of skin Cancer
(ii) Global warming
(iii) Acidic rain
(iv) Risk of skin disease
(v) Increased risk of respiratory illness
(any 03 @ 1mark)

08 (a) (i) Reaction quotient - Is the ratio of the product of products of concentration to the product of concentration of reactant each raised to their stoichiometric coefficient when the reaction not attained equilibrium.

(ii) Irreversible reaction - Is the reaction which proceed only one direction.

(iii) Dynamic equilibrium - Is the condition for equilibrium reaction when the rate of forward and backward reaction is not equal to zero.

(03 marks @ 1mark)

(b) Given;

$[Ag^+] = 0.4M$

$[Fe^{2+}] = 0.2M$

$[Fe^{3+}] = 0.6M$

then $Q_c = \dfrac{[Fe^{3+}]}{[Ag^+][Fe^{2+}]}$ — 01/2

$= \dfrac{(0.6M)}{(0.4M)(0.2M}$ — 01/2

$= 7.5\,M^{-1}$

since $Q_c > K_c$ the net change is to the left — 01/2

then,

$Ag_{(s)} + Fe^{3+}_{(aq)} \rightleftharpoons Ag^+_{(aq)} + Fe^{2+}_{(aq)}$

Initial	0.6M	0.4M	0.4	0.2
At eq.	0.6M−x	0.4M−x	0.4M+x	0.2M+x — 01/2

$K_c' = \dfrac{1}{K_c}$

$= \dfrac{[Ag^+][Fe^{2+}]}{[Fe^{3+}]}$ — 01/2

$\dfrac{1}{5.96} = \dfrac{(0.4+x)(0.2+x)}{0.6-x.}$

08. (b) $0.478 + 3.576x = 0.6 - x$ — 00½

$5.96x^2 + 4.576x - 0.122 = 0$

$x = 0.03M$

Equilibrium Concentration,

$[Ag^+] = 0.2 + 0.03 = 0.23M$

$[Fe^{2+}] = 0.4 + 0.03 = 0.43M$ } 01

$[Fe^{3+}] = 0.6 - 0.03 = 0.57M$

(c) (i) Yes, because there is excess formation of products than reactants at equilibrium — 01½

(ii) Colour will change from blue to pink on cooling ie more $[Co(H_2O)_6]^{2+}$ will be formed. — 02

(iii) By adding Concentrated hydrochloric acid — 01½

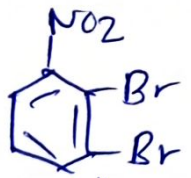
(d) (i) The gas produced is ammonia — 01

(ii) Catalyst — 01

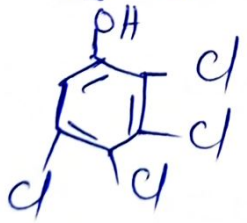
(iii) – Temperature
– Catalyst
– Pressure
(01 mark any two @ 00½ marks).

09 (a) (i) Aromatic
(ii) Not aromatic
(iii) Not aromatic
(iv) Not aromatic
(4 marks @ 1 mark)

(b) (i)



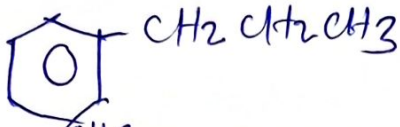
(ii)

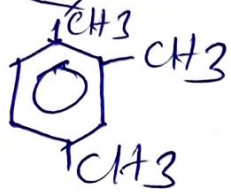


(4 marks @ 2 marks)

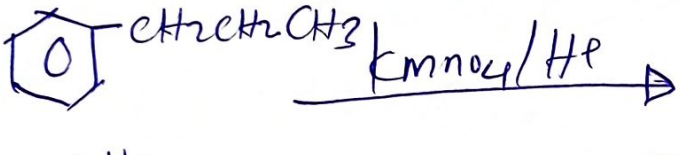
(C) (i) • Activators
– Increase the reactivity of benzene ring towards electrophilic substitution reaction (i.e makes ortho and para position more nucleophilic) (01 mark)

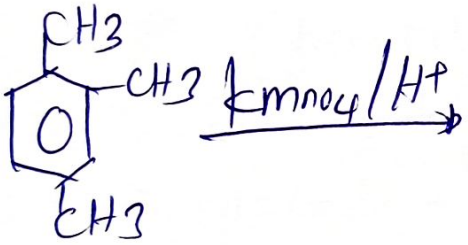
• Deactivators
– Decrease reactivity of benzene ring towards electrophiliz substitution reaction (i.e makes only meta position more nucleophiliz). (01 mark)

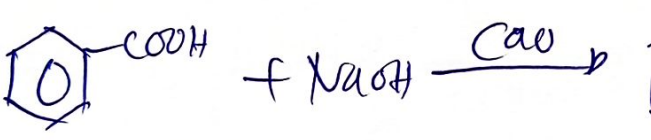
(ii) P =  (01 mark)

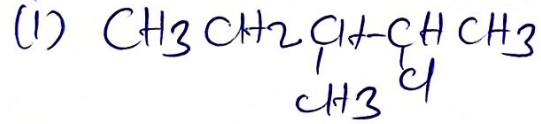
Q =  (01 mark)

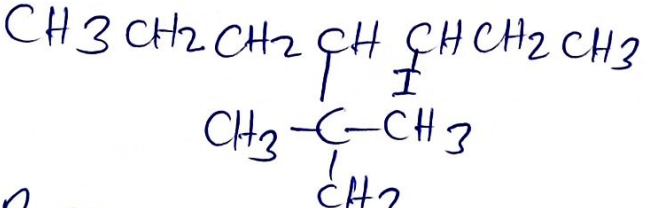
Reactions

 (01 mark)

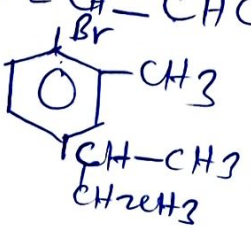
 (01 mark)

 (01 mark)

10 (a) (i) 

(ii) 

(iii) $BrCH_2CH=CHCH_2Br$

(iv) 

(04 marks 1 mark @)

10 (b) Description:

Compound X is Unsaturated hydrocarbon with internal triple bond.

Prpared structure: $CH_3CH_2C\equiv C-CH_3$. – 02

Reactions involved;

(i) $CH_3CH_2C\equiv C-CH_3 + 2Cl_2 \rightarrow CH_3CH_2\underset{Cl}{\overset{Cl}{C}}-\underset{Cl}{\overset{Cl}{C}}-CH_3$ – 01

(ii) $CH_3CH_2C\equiv CCH_3 + 2Br_2 \xrightarrow{H_2O} CH_3CH_2\underset{Br}{\overset{Br}{C}}-\underset{Br}{\overset{Br}{C}}-CH_3$ – 01

(iii) $CH_3CH_2C\equiv C-CH_3 + AgNO_3 \xrightarrow{NH_3}$ No reaction. (Since lack terminal hydrogen). – 01

(c) The two isomers are:

(i) $CH_3-(CH_2)_7-\underset{Br}{\overset{Br}{C}}=CH_2$ — 01

(ii) $CH_3-(CH_2)_7-CH=CHBr$ — 01

Chemical reactions

$CH_3(CH_2)_7-\underset{Br}{\overset{Br}{C}}=CH_2 \xrightarrow{NaNH_2} CH_3(CH_2)_7C\equiv CH + NaBr + NH_3$ 01½

$CH_3(CH_2)_7CH=CHBr \xrightarrow{NaNH_2} CH_3(CH_2)_7C\equiv CH + NaBr + NH_3$ 01½

$CH_3-(CH_2)_7-\underset{Br}{CH}-CH_2Br \xrightarrow[CH_3CH_2OH]{KOH} CH_3(CH_2)_7CH=CHBr +$

$CH_3(CH_2)_7\underset{Br}{\overset{Br}{C}}=CH_2 + KBr + H_2O$ 01½