ZIAUDDIN UNIVERSITY EXAMINATION BOARD

RESOURCES FOR

"HSC-I CHEMISTRY"

ZUEB EXAMINATIONS 2021

PREFACE:

The ZUEB examination board acknowledges the serious problems encountered by the schools and colleges in smooth execution of the teaching and learning processes due to sudden and prolonged school closures during the covid-19 spread. The board also recognizes the health, psychological and financial issues encountered by students due to the spread of covid-19.

Considering all these problems and issues the ZUEB Board has developed these resources based on the condensed syllabus 2021 to facilitate students in learning the content through quality resource materials.

The schools and students could download these materials from www.zueb.pk to prepare their students for the high quality and standardized ZUEB examinations 2021.

The materials consist of examination syllabus with specific students learning outcomes per topic, Multiple Choice Questions (MCQs) to assess different thinking levels, Constructed Response Questions (CRQs) with possible answers, Extended Response Questions (ERQs) with possible answers and learning materials.
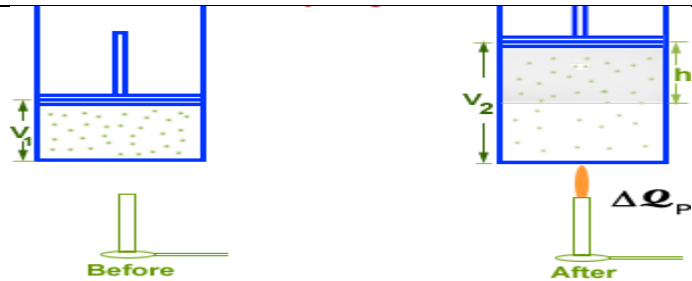
ACADEMIC UNIT ZUEB:

1. **Extended Response Questions (ERQs)**

HOW TO ATTEMPT ERQs:

- Write the answer to each Constructed Response Question/ERQs in the space given below it.
- Use black pen/pencil to write the responses. Do not use glue or pin on the paper.

SECTION C (LONG ANSWER QUESTIONS)

1. **What is a covalent bond? Explain the types of covalent bond and their characteristics?**

S#	ERQ	ANSWER	CL	DL
1.	Ethylene glycol is used as an antifreeze. Combustion of 6.38gm of ethylene glycol gives 9.06 gm of CO_2 and 5.58 gm of H_2O. Ethylene Glycol contains Carbon , Hydrogen and Oxygen find its empirical formula?	Mass of sample = 6.38gm Massof CO_2 = 9.06gm Massof H_2O = 5.58gm Empirical formula =? Elements present = C,H,O Solution Mass of Carbon = 1 mole mass of carbon x mass of CO_2/1 mole mass of CO_2 = 12x9.06/44 = 2.4709 gm. Mass of Hydrogen = 2 mole mass of Hydrogen x mass of H_2O /1 mole mass of H_2O = 2x 5.58 / 18 = 0.62gm. % of Carbon = Mass of C x100/Mass of Sample = 38.72% % of Hydrogen = Mass of H x100/Mass of Sample =9.717% % of Oxygen = 100 – (% of Carbon + % of Hydrogen) =51.56% Mole ratio of Carbon = % of C / At. Mass of C = 3.22 Mole ratio of Hydrogen = % of H / At. Mass of H = 9.71 Mole ratio of Oxygen = % of O/ At. Mass of O = 3.22 Simple ratio of Carbon = Mole ration of C / Least mole ratio = 1 Simple ratio of Hydrogen = Mole ration of H / Least mole ratio =3 Simple ratio of Oxygen = Mole ration of O / Least mole ratio =1 **Empirical Formula = CH3O**	K/A	M
2.	State the following?	***Isomorphism** Existence of different substances in one crystalline form is known as "ISOMORPHISM" ***Atomic crystal** Metal atoms are closely packed or held together by metallic bond called as atomic crystals In metals valence electron move freely in crystal lattice to form an electron cloud in which positive ions are immersed ❖ **Grahams law.** Graham's law is a quantitative relation between the density and rate of diffusion of gases. Statement: The rate of diffusion of a gas is inversely proportional to the square root of its density. $$r \; \alpha \; \frac{1}{\sqrt{d}}$$ *** Gay-Lussac Law** It states that: Gases react in the ratio of small whole numbers by volume under similar condition of temperature and pressure. The	K/A	M

		pressure of a sample of gas at constant volume is directly proportional to its temperature in Kelvin.		
ii	**Calculate the density of SO₂ in g/dm³ at 25⁰C and 300torrpressure.**	Data : $T = 25^0C + 273 = 298$ K $P = 300$ torr $/760 = 0.394$ atm. Molecular mass of SO2 = 64gm $R = 0.0821$ atm.lit / mol k Density of SO2 = ? Solution : Formula = PV = nRT PV/ RT = Mass/Mol Mass PxMol mass/ RT = Mass/Vol **OR** PxMol Mass /RT = D $0.394 \times 64 / 0.0821 \times 298 =$ **1.033 g/dm^3**	**K/A**	**E**
iii(a)	**Write down the electronic configuration of**	$*$ $Fe^{+2}(Z = 26)$ No. of e=26-2=24 $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^4$ $*S^{-2}(Z=16)$ No. of e = 16 +2 = 18 $1s^2,2s^2,2p^6,3s^2,3p^6$	**K/A**	**E**
b)	**Write reasons * Water expands when cooled below4⁰C**	Because of breakage of Hydrogen Bonding	**K/A**	**E**
iv	**Dipole moment of CO₂ is zero while SO₂ has value of dipole moment**	because CO2 has linear symmetrical geometry while SO2 has angular geometry it is due to the presence of lone pairs in S	**K/A**	**E**
	Differentiate between the following.(any two) ***Continuous and Line spectrum**	<table><tr><td>CONTINEOUS</td><td>LINE</td></tr><tr><td>No line of demarcation</td><td>Line of demarcation</td></tr><tr><td>Source could be any white light</td><td>Specific gaseous source is used</td></tr><tr><td>Different colours are shown</td><td>Specific colored lines are shown</td></tr></table>	**K/A**	**E**
	Hydration and Hydrolysis	**Hydration** **Hydrolysis**		

					K/A	E
		Water reacts with compounds but it doesnot break bonding in water molecule	Water reacts with compounds but it break bonding in water molecule			
		No change in PH of solution	Change in PH happens			
		It is an exothermic process	It could be exothermic or endothermic process			
		Hydrogen bonding or Co- ordinate covalent type of bonding is involved	Ionic bonding is involved			
		Water of hydration could be removed after heating	No effect after heating			

Sigma and pi bond

	Sigma bond	Pi bond
1	It is formed by end-to-end overlapping of half-filled atomic orbitals.	It is formed by the sidewise overlapping of half-filled *p* obitals.
2	Overlapping takes place along the inter-nuclear axis.	Overlapping takes place perpendicular to the inter-nuclear axis.
3	The extent of overlapping is large and the bond formed is stronger.	The extent of overlapping is smaller and the bond formed is weaker.
4	There is free rotation around the sigma bond and so no geometrical isomerism is possible.	There is no free rotation about the pi bond and so geometrical isomerism possible.
5	Both *s* and *p* orbitals can participate in sigma bond formation.	Only *p* orbitals participate in the formation of pi bonds.

v

If 16ml of hydrogen diffuse in 30sec .what volume of SO₂ will diffuse in the same time (30sec) under similarconditions

Data :
Vol of H_2 = 16ml
Time of diffusion of Hydrogen = 30 sec
Time of diffusion of SO_2= 30 sec
Vol of SO_2 = ?
Mol mass of H_2 = 2gm
Mol mass of SO_2 = 64gm
Solution
Formula
$R_{H2} = V_{H2}/ t_{H2} = 16/30=0.533$
$R_{SO2} = V_{SO2}/ t_{SO2} = V_{SO2} / 30$
$$\frac{R_{H2}}{R_{SO2}}=\frac{\sqrt{M_{SO2}}}{\sqrt{M_{H2}}}$$
$0.533 \times 30/ V_{SO2} = \sqrt{64/2}$
$16 / V_{SO2} = 5.65$
$V_{SO2} = 16/5.65=$ **2.831 ml**

Explain Hybrid orbital model of Ethene.

Ethene consists of two sp^2-**hybridized** carbon atoms, which are sigma bonded to each other and to two

					K/A	E
					K/A	M

			K/A	M

hydrogen atoms each. The remaining p- orbitals become at right angle and parallelly overlap at the carbon form a pi bond, which gives **ethane**

1 sigma bond = Sp2 - Sp2 (between Carbon and carbon)
2 sigma bond = Sp2–s (between Carbon and Hydrogen)
1 Pi bond = 2 Pz -2 Pz   (un hybridized)

Orbital structure of ethene

Hybridization = Sp2
Geometry   = Trigonal
Bond angle = 120°
BONDLENGTH:
C=C bond length is 1.34A.
C-H bond length is 1.09A.

vi — **State First law of Thermodynamics also show that $q_p = \Delta H$**

STATEMENT

"Energy can neither be created nor destroyed but it can be changed from one form of energy to another form of energy"

In other words
"During any process total energy of system remains constant"

OR

"During any change the total energy of system and its surrounding remains constant .

MATHEMATICAL REPRESENTATION
according to the first law of thermodynamics:
Heat supplied = increase in internal energy +work done
$Q = \Delta E + W$
OR $Q = \Delta E + P \Delta V$

First law of thermodynamics at constant pressure
Heat supplied at constant pressure is also known as "ISOBARIC PROCESS". An isobaric process is one
In which no pressure change takes place during the supply of heat to system.
In order to understand an isobaric process consider a cylinder fitted with a frictionless piston, the piston is free to move. An ideal gas is enclosed in thecylinder.

K/A	D

Before   After

Let the internal energy of the system at initial state is E1, the temperature of system is T1,volume of gas is V1 and pressure isP.

If qp amount of heat is supplied to the system, its internal energy will increase from E1 to E2 and the temperature of system also rises from T1 toT2,

At the same time gas exerts some pressure on the piston, since the piston is free to move,it displaces

"**h**" the volume of gas increases from V1 to V2 . Due to increase in volume, pressureagaindecreases to its original value i.e.P1.

ACCORDING TO THE FIRST LAWOFTHERMODYNAMICS

$$Qp = \Delta E + work$$
$$Qp = \Delta E + P \Delta V$$
$$Qp = \Delta E + P \Delta V \qquad but (\Delta E = E2\text{-}E1)$$
$$Qp = E2\text{-}E1 + P (V2 – V1)$$
$$Qp = E2\text{-}E1 + PV2\text{-} PV1$$
$$Qp = E2 + PV2 – E1 – PV1$$
$$Qp = (E2 + PV2) – (E1 + PV1)$$

but
$$(E + PV = H)$$
(H= enthalpy)
therefore,
$$qP = \Delta H$$
OR
$$q\,p = \Delta E + P \Delta V = \Delta H$$

vii | **State Hesses law and Calculate the heat of formation of CH₃OH from the following data**

Data :

1. $C + 2H_2 + \frac{1}{2} O_2 \text{----------------} \to CH_3OH \qquad \Delta H = ?$

2. $C + O_2 \text{----------------} \to CO_2 \qquad \Delta H = -394 KJ/mol \qquad \Delta H = -394 KJ/mol$

3. $H_2 + \frac{1}{2} O_2 \text{---------} \to H_2O \qquad \Delta H = -286 KJ/mol \qquad \Delta H = -286 KJ/mol$

4. $CH_3OH + 3/2 O_2 \text{-------------} \to CO_2 + 2H_2O \quad \Delta H = -726 KJ/mol$

Multiply eq 3 by 2

5. $2H_2 + O_2 \text{---------} \to 2H_2O \qquad \Delta H = -572 KJ/mol$

Add eq 5 with 2

6. $C + 2O_2 + 2H_2 \text{-------} \to CO_2 + 2H_2O \quad \Delta H = -966 KJ/mol \Delta H =$

K/A | D

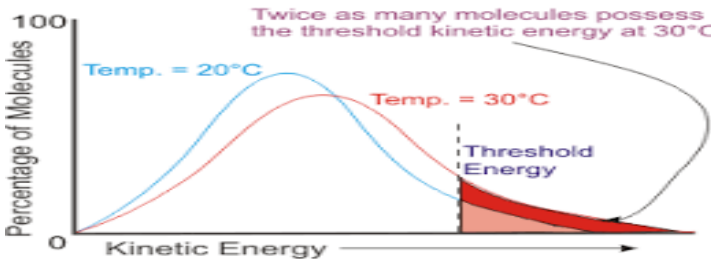|				
		- 966KJ/mol **Subtract eq 4 from 6** **7. C + 2H2 + ½ O2----------------□CH3OH ΔH = -240KJ /mol ΔH = -240KJ /mol**		
Viii	**State and Explain the law of Mass action . Derive the expression for the general reversible reaction given - m A + n B ↔ x C + y D**	**Law of mass action** According to the law of mass action. "The rate at which a substance reacts is directly proportional to its active mass " □ Rate [Reactant] The rate of reaction is directly proportional to the product of the active masses of reactants. Consider a general reversible reaction **A + B C + D** According to the law of mass action: **Rate of reaction [A][B]**	**K/ A**	**M**
ix	**Determination of equilibrium constant by using equilibrium law** **Derive expression for the frequency and wave number when the electron jumps from**	Consider a general reaction **aA + bB cC + dD** According to the law of mass action **Rate offorwardreaction [A]^a[B]^b** **Rate of forward reaction = Kf [A]^a[B]^b** Similarly, **Rate of backward reaction [C]^c[D]^d** **Rate of backward reaction = Kb [C]^c[D]^d** Where K_f = rate constant for forward reaction K_b = rate constant for backward reaction a, b, c, d = number of moles At equilibrium rate of forward reaction becomes equal to the rate of backward reaction, thus, **Rate of forward reaction = Rate of backward reaction** **Kf [A]^a[B]^b = Kb [C]^c[D]^d** **Kf / Kb = [C]^c[D]^d/[A]^a[B]^b** Let K_f/K_b =Kc **Kc = [C]^c[D]^d/[A]^a[B]^b** This is the expression of equilibrium constant where **c** represents concentration. The energy of electron = $-2\pi^2 Z^2 e^4 / n^2 h^2$ See from book page number 93-95	**K/ A**	**M**
3(a)			**K/**	**E**

			A

<table>
<tr><td>Explain the effects of surface area and Temperature on the rate of reaction.</td><td>

<u>Surface area of reactants</u>
- Greater the surface area, higher is the rate of reaction.
- For example finely divided calcium carbonate (marble) reacts more quickly with hydrochloric acid than calcium carbonate chips. It is due to the fact that powered calcium carbonate offers larger surface area to the reacting acid, so greater contact between individual particles is done and also the surface molecules reacts more quickly.

<u>Temperature</u>
- The rate of reaction increases with the rise of temperature. It can be explain by the fact that at higher temperature, a greater fraction of colliding molecules posse the necessary energy of activation.
- Generally an increase of every 10^oK in temperature doubles therate.
- As a result the no of effective collision is also double,hence rate isdoubled

</td><td>K/ A</td><td>E</td></tr>
</table>

| **b)** | **What effect on the position of equilibrium** | $CaCO_3 \leftrightarrow CaO + CO_2$ **$\Delta H = + 176$ KJ/mol , does each of the following changes have**
∗ **Adding $CaCO_3$** - reaction will move to forward direction
∗ **Decrease the volume of container** - reaction will move to backward direction
∗ **Raising the temperature -** reaction will move to forward direction
∗ **Removing CO_2 –** reaction will move to forward direction | K/ A | E |
| | **Derive the formula for the radius of nth orbit of hydrogen** | 1. **CONCEPT OF CONSTANT ENERGY**
Energy of an electron is constant in one of its allowed orbits. As long as an electron remains in its orbit, it neither absorbs nor radiatesenergy.
2. **STATIONARYSTATES** | | |

c)	atom by using Bohr's atomic model. From book Page no. 90-91 **OR** Write down postulates of Bohrs atomic model	Electrons revolve around the nucleus of atom in circular orbits in which energy of electrons is constant. These circular paths are known as "energy levels" or "stationary states" **3. EMISSION OFENERGY** If an electron jumps form higher energy level to a lower energy level, it radiates a definite amount of energy. **4. ABSORPTION OFENERGY** If an electron jumps from lower energy level to a higher energy level, it absorbs a definite amount of energy. **5. ENERGYCHANGES** Energy released or absorbed by an electron is equal to the difference of energy of two energy levels. Let an electron jumps from a higher energy level E_2 to a lower energy level E_1.The energy is emitted in the form of light . Amount of energy released is given by: $\Delta E = E_2 - E_1$ **$E_2 - E_1 = V$** Where **h** = Planck's consrant(6.6256×10^{-34} j.s) **V** = Frequency of radiant light **6. ANGULAR MOMENTUM OFELECTRON** Angular momentum of an electron in an energy level is given by: **$m v r = nh / 2\pi$** **Where n = 1, 2, 3, ……….** **m = mass of electron** **V = velocity of electron** **r = radius of orbit** **OR** Only those energy levels or orbits are possible for which angular momentum of electron isan integral multiple of**h /2 π.**	**K/A**	**M**
	Write the postulates of electron pair repulsion theory. Explain the shape of the NH_3 or H_2O on the basis of electron pair repulsion theory.	**Following are the main points of electron pair repulsion theory:(any 4)** • There are two types of electron pairs surrounding the central atom. Bond pair. And Lone pair. • These bond pairs are known as active set of electrons. • These electron pairs (bond pairs or lone pairs) repel each other. • Due to repulsion, electron pairs of central atom try to be as far as possible. Hence, they arrange themselves in space in such a manner that the force of repulsion	**K/A**	**D**

between them is minimized.
- The force of repulsion between lone pairs and bond pairs is not the same. The order of repulsion is as follows:

lone pair-lone pair>lone pair-bond pair>bond pair-bond pair.
- Pi-electron pairs are not considered as an active set of electrons.
- The shape of molecule depends upon total number of electron pairs surrounding the central atom.

SHAPE OF NH3 BY E.P.R THEORY

Central atom = **Nitrogen**
Surrounding atom = **Hydrogen**
At. Number of Nitrogen = **7**
Number of electron = **7**

Ground state Electronic configuration = $1s^2$, **$2s^2$, $2px^1$, $2py^1$,**

$2Pz^1$ Number of valence electron = **3 unpaired electron with one lone**

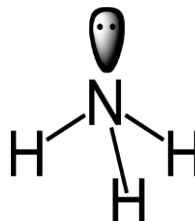**pair** Number of bond pairs = **3 bond pairs with one lone pair**

BOND FORMATION

Nitrogen utilizes three unpaired electrons to form bond
with s- electron of hydrogen while lone pair remain as it is
and it takes part in geometry prediction
Its structure is Tetrahedral with bond angles of 107°.
Geometry : Tetrahedral (with one lone pair)

Bond angle : $107^o.$

SHAPE OF H2O BY E.P.R THEORY

Central atom = **Oxygen**
Surrounding atom = **Hydrogen**
At. Number of Oxygen = **8**
Number of electron = **8**

Ground state Electronic configuration = $1s^2$, **$2s^2$, $2px^2$, $2py^1$,**

$2Pz^1$ Number
of valence electrons= **two unpaired electrons with two lone pair**
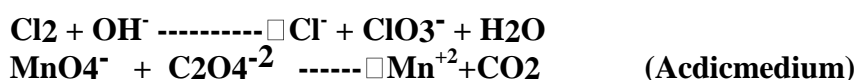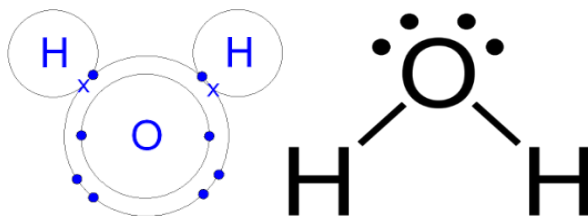Number
of bond pair = **two bond pairs with two lone pair**

Bond making:
Oxygen utilizes its two unpaired electrons to form bond with
s- electrons of Hydrogen.The other two lone pairs are

Balance the

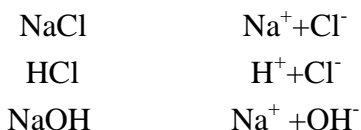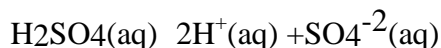|				
	given equations by ION electron method.	involved in geometry prediction , Due to reduced angle in H2O, angular or bent structure is formed. Which is tetrahedral in nature with bond angle 104.5^0 Geometry : tetrahedral with two lone pair also called angular Angle : 104.5^0 **Cl2 + OH⁻ ----------▢Cl⁻ + ClO3⁻ + H2O** **MnO4⁻ + C2O4⁻² ------▢Mn⁺²+CO2** **(Acdicmedium)** Steps involved Split the equations Balancing oxygen and Hydrogen Adding charges Balancing charges Adding two equations	**K/A**	**D**
4(a)	**Explain Arrhenius theory of ionization in detail. Arrhenius theory of ionization consists of the following postulates.(any six points)**	1. The substance called electrolytes are believed to contain electrically charged particles called ions. These charges are positive for H^+ ion or ions derived from metals and negative for the ions derived from non-metals. Number of electrical charges carried by an ion is equal to the valency of corresponding atom. 2. Molecules of electrolytes (acids, bases and salts) dissociate into oppositely chargedions ondissolution in water,e.g. NaCl $Na^+ + Cl^-$ HCl $H^+ + Cl^-$ NaOH $Na^+ + OH^-$ 3. The number of positive and negative charges on the ions must be equal so that the solution as a whole remains neutral. 4. In solution, the ions are in a state of disorderly or random motion. Upon colliding they may combine to give unionized molecules. Thus ionization is a reversible process in which the solution contains ions of electrolyte together with unionized molecules. H2SO4(aq) $2H^+$(aq) $+SO4^{-2}$(aq) 5. The extent of ionization or the degree of ionization depends upon the nature of electrolyte. Strong electrolytes such as HCl etc. ionize completely in water. Weak	**K/A**	**M**

		electrolytes such as acetic acid (CH3COOH) ionize only slightly.		
		6. Ionization is not affected by electric current.		
		7. When electric current is passed through an electrolytic solution, charges move towards their respective electrodes, i.e. cations towards cathode and anions towards anode .When these ionsreached their respective electrodes, they change into neutral species by the gain or loss of electrons.		
		8. Degree of dissociation = no of molecules ionize / total number of molecules The dissociation of electrolyte depend upon - <u>Nature of electrolyte:</u> Strong electrolytes 100% ionize and weak electrolytes does not ionize completely - <u>Degree of dilution :</u> More dilution more ionization - <u>Temperature :</u> High temperature more ionization		

		9. The electrical conductivity depends upon:
		   - The number of ions present in the solution
		   - Speed of ions		

b)	**what are cathode rays? Give the properties of cathode rays and conclusion drawn about the structure of the atom from this experiment.**	Cathode rays were discovered by crooks tube experiment these are the negative charged rays emerge from cathodic side consist of electrons. **PROPERTIES OF CATHODE RAYS** **1.** Cathode rays travel in straight line that's why it produces shadow **2.** These rays deflected in electric field towards positive site means these are negatively charged **3.** These rays deflected in magnetic field towards north pole **4.** They produce mechanical pressure from fast moving electron, which can move a paddle wheel means these are material particles. **5.** These rays have e/m ratio same as of electron so we can say these rays are consist of electron **6.** These rays are as fast as speed of light **7.** Nature of rays remain same it does not depend on gas filled init. **CONCLUSION** Different discharge tube with different electrodes were tried. All the experiments gave the same value of charge to mass ratio this shows that electrons could be produced from any kind of matter and hence perhaps were constituent of all matter. **OR**	**K/ A**	**M**

	Define radioactivity? Write down the names of the radioactive rays along with their properties	All the elements having atomic number greater than 82 emit invisible radiation all the time. The phenomenon of emission of these powerful rays is called "**Natural Radioactivity**" and the element that emits such rays is called "**Radio Active Elements**".			

OR

Spontaneous emission of radiation from radio active elements is called radioactivity

TYPES OF RAYS OBSERVED:

There are three types of rays emitted from radioactive substance
- Alpha rays (move to –ve site of electric field
- Beta rays (move to +ve site of electricfield)
- Gamma Rays go straight

- **Alpharays**	**Beta rays**	**Gamma rays**
Positively charged	Negatively charged	neutral
Helium particles	Electrons	Only radiations
Deflect to negative site	Deflect to positive site	Go straight undeflected
Size is bigger speed is slow	Size smaller than alpha so high speed than alpha	Speed equals to speed of light

Panetrating power is low cannot pass through solids	Power to penetrate into metals not solids	Greater power of penetration through solids
Ionizing power of air is high	Ionize gases to less extent	Weak ionizer of gases
Produce fluorescence	Can produce floresce nce in	Produce feeble fluorescence

K/A   M

	some substances		
Can used in artificial radioactivity		In medical use for cancer therapy	

c)

4.6 gm of Ethylalcohol and 6.0 gm of acetic acid were kept at constant temperature until equilibirium was established 2.0gm of acetic acid remained unused .* Calculate Kc for the reaction

After calculating Kc Calculate the equilibirium concentration of CH₃COOC₂H₅ when 1.66 moles of CH₃COOH react with 2.17 moles of C₂H₅OH

$$CH_3COOH + CH_3CH_2OH \xrightarrow[\text{esterification reaction}]{H^+} CH_3COOCH_2CH_3 + H_2O$$

acetic acid   ethyl alcohol   ethyl acetate ester

$$CH_3COOH + CH_3CH_2OH \xrightarrow[\text{esterification reaction}]{H^+} CH_3COOCH_2CH_3 + H_2O$$

acetic acid   ethyl alcohol   ethyl acetate ester

Initial 6.0/60 4.6/46   Nil   Nil

moles0.1   0.1   Nil   Nil

Moles At Equilibrium

0.1-x   0.1-x   x   x

During the reaction 2 gms of acetic acid were left which is 2/60= 0.033 moles Or   0.1-x = 0.033   or   x = 0.1 – 0.033 =0.067

At equilibrium

0.033   0.033   0.067   0.067

Formula : Kc = [CH3COOC2H5] [H2O]/ [CH3COOH] [CH3CH2OH]]

        = 0.067 x 0.067 / 0.033 x 0.033 = 4

Kc =4

*Data

Kc =4

K/ A

M

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$$CH_3COOH + CH_3CH_2OH \xrightarrow[\text{esterification reaction}]{H^+} CH_3COOCH_2CH_3 + H_2O$$

acetic acid   ethyl alcohol   ethyl acetate ester

Initial moles 1.66   2.17   Nil   Nil
AtEq.   1.66-x   2.17-x   x   x

Formula : $K_c = [CH_3COOC_2H_5] [H_2O] / [CH_3COOH] [CH_3CH_2OH]$

$\qquad 4 = x \cdot x / (1.66-x)(2.17-x)$

Use quadratic equation to get value of x

For quadratic eq. a= 3 , b= -15.32 , c = 14.408

X =3.86   and   x =1.24

Correct answer is 1.24

$[CH_3COOC_2H_5]$ = 1.24 moles