① 22581 | 66301

MODEL ANSWER
GENERAL CHEMISTRY

Q.1 (a) Explain the terms (1 Mark each) **5**

i) Radioactivity: The phenomenon of emission of radiation owing to the spontaneous transformation or disintegration of the radionuclide is known as 'Radioactivity'. However, the term radioactivity is also used to express the physical quantity (activity or strength) of this phenomenon. The radioactivity of a preparation is the number of nuclear disintegrations or transformations per unit time.

ii) Antiseptic: A chemical agent which destroys or inhibits the growth of microorganisms (bacteria, fungi, protozoa, etc.) on living tissues. Antiseptics are applied to skin surfaces or mucous membranes for their anti-infective effects. This may be either bactericidal or bacteriostatic.

iii) Hypocalcemia: Hypocalcemia, a low blood calcium level, occurs when the concentration of free calcium ions in the blood falls below 4.0 mg/dL (dL = one tenth of a liter).

iv) Half life: Half-life ($t_{1/2}$) is the time required for a quantity to reduce to half its initial value.

v) Principal Quantum Number: The principal quantum number is the quantum number denoted by ***n***, which denotes the valence shell of the electron and its energy level. It take positive integer value, n = 1, 2, 3…..

vi) Sclerosing agent: It is a compound that acts by irritation of the veinous intimal epithelium; used in the treatment of varicose veins.

b) Answer the following (Any 5) **10**

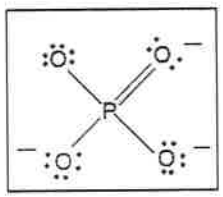
i) What are physiological functions of zinc?

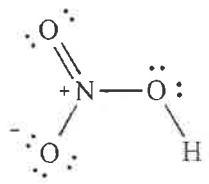
Zn^{+2} ion is widely distributed in the body. It is considered as an essential dietary mineral.

Physiological functions:

1. Biochemically zinc is associated with certain metalloenzymes like carbonic anhydrase, alcohol dehydrogenase, lactate dehydrogenase, aldolase, D-lactate cytochrome c reductase, carboxy peptidase, alkaline phosphatase etc
2. Zinc is essential for mechanism of action of all the above enzymes.
3. Zinc is also bound to RNA & helps in stabilizing secondary and tertiary structure.

ii) Draw Lewis structure for PO_4^{-3} and HNO_3





iii) Give ground state electronic configuration of Neon and Potassium.
Neon (10): $1s^2, 2s^2, 2p^6$
Potassium (19): $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$

iv) Explain phase transfer catalysis in brief.
Refer Modern Physical Organic Chemistry by Eric Anslyn p. no. 507

v) Enlist ionic composition of the body fluids. (0.25 Mark each)
Cations: Na^+, K^+, Ca^{++}, Mg^{++}
Anions: Cl^-, HPO_4^{-2}, HCO^{3-}, SO_4^{-2}

vi) Arrange the following compounds in increasing order of ~~inductive effect~~ s-character
~~iii > i > ii~~ → ~~Based on electronegativity~~
SF_6, PCl_5, CH_4, BeF_2

c) Match the following 5

Column A	Column B
i) HPO_4^{-2}	c) Principal intracellular anion
ii) Zinc oxide	b) Topical protective agent
iii) Roentgen	d) Radiation unit for X and γ rays
iv) NH_3	e) Triagonal pyramidal
v) Sodium potassium tartrate	a) Rochelle salt

Q.2

a) What is Kinetic isotope effect? Why kinetic isotopic studies are performed? How to express it, explain with suitable example? 4

Define Kinetic isotopic effect **(1 Mark)**

Why (1 Mark) An isotope effect is measured to determine if the bond at which the isotopic substitution is being made changes in some manner during the rate determining step. One piece of information that cannot be gained from a kinetic study is what bonds have been broken, formed, or rehybridized during the rate-determining step. Isotope effects can provide just this kind of information. Substituting one isotope for another at or near an atom at which bonds are breaking or rehybridizing typically leads to a change in the rate of the reaction. When the bonds being broken or formed involve those to hydrogen, the effect of replacing H with D often is relatively large and can be measured routinely. Isotope effects with other atoms have

We express (1 Mark) an isotope effect as a ratio of rate constants, where the numerator is the rate constant for the reaction with the natural abundance isotope, and the denominator is the rate constant for the re-action with the altered isotope.

For example, (1 Mark) when measuring isotope effects for reactions involving a substitution of hydrogen with deuterium, the isotope effect would be expressed as kH I k o. Measuring an isotope effect, therefore, typically requires us to run two kinetic analyses or to design a clever competition experiment.

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b) Answer the following (Any 2) 4

i) Give the uses of Talc and potassium permanganate.

Talc:

- Protective dusting powder
- Used to prevent irritation
- It has low adsorptive properties & is used as a filtering aid
- Used as lubricant in tablet manufacturing

Potassium permanganate: Antimicrobial agent

- Its oxidizing properties confer disinfectant and deodorizing properties.
- Also used as an astringent.
- Applied externally as solution in concentration 0.006-0.2% for antibacterial and antifungal effect.
- 0.1% solution used as cleansing application to ulcers or abscesses.
- 0.02% solution in water used as stomach wash in treatment of poisoning by morphine, opium & strychnine.

ii) What are expectorants? How do they act?

Refer Inorganic Pharmaceutical Chemistry by Chatwal p.no. 247

iii) Write a note on Antioxidants.

Refer Inorganic Pharmaceutical Chemistry by Chatwal p.no. 384

c) Fill in the blank: When emits $^{226}_{88}Ra$ **alpha (1 mark)** particle the atomic number decreases by **4 (0.5 Mark)** and mass number decreases by **2 (0.5 Mark)** of resulting nuclei $^{222}_{86}Rn$ **2**

d) Define hyponatremia. What are its causes? **2**

Hyponatremia: This is the condition of low serum level of sodium.

Causes: It may occurs due to

- Very high urine ions as in diabetes insipidus
- Metabolic acidosis in which sodium is excreted
- Addison's disease, where aldosterone level is lowered
- Diarrhoea, vomiting
- Kidney damage

Q.5 b)

~~Q.5~~ ~~a)~~ Classify catalysis. Write a note on specific acid catalysis or general base catalysis. **4**
Refer Modern Physical Organic Chemistry by Eric Anslyn

b) Classify gastrointestinal agents. Elaborate on saline cathartic with suitable example. **4**
Gastrointestinal agents: These are the agents which are used to treat gastrointestinal disorders.
Classification: (1 Mark)
1. Acidifying agents
2. Antacids
3. Protectives and adsorbents
4. Saline cathartics

Saline cathartics: Saline cathartics are the agents that quicken & increase evacuation from the bowels. They have mild purgative action. **(0.5 Marks)**

Ideal properties of saline cathartic: (0.5 Marks)
- It should be water soluble salts.
- It should be poorly absorbable

Mechanism of action: (1 mark)
Saline cathartics increases the osmotic load of intestine. To relieve this hypertonicity, body secretes additional fluid (absorbs large quantity of water) in gut. This increases bulk and thereby stimulates peristalsis.
Poorly absorbable cations like calcium, magnesium and anions like phosphate, sulphate, and tartrate are contributing to this effect.
Saline cathartics are taken with plenty of water. This helps in restricting excessive loss of body fluid & reduces nausea and vomiting.

Administration: (0.5 Marks)
By Oral route: suspension, tablet, powder
By rectal route: enema or suppository
Side effects: Relatively free from side effects when taken for brief period
Patients on low sodium diet should not use the sodium containing saline cathartics.
Examples: (0.5 marks)
1. Magnesium salts: Magnesium hydroxide, Magnesium sulphate
2. Tartrate salts: Sodium potassium tartrate, Sodium bitartrate
3. Sodium salts: Sodium phosphate.

c) Define Inductive effect and electronic configuration. **2**

05

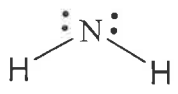
Inductive effect: An **inductive effect** is an electronic effect due to the polarisation of **σ bonds** within a molecule or ion. This is typically due to an electronegatvity difference between the atoms at either end of the bond.

OR

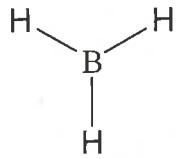
The **inductive effect** is an experimentally observable **effect** of the transmission of charge through a chain of atoms in a molecule, resulting in a permanent dipole in a bond. (1 mark)

Electronic Configuration: The **electron configuration** is the distribution of electrons of an atom or molecule (or other physical structure) in atomic or molecular orbitals. For example, the electron configuration of the Neon atom is $1s^2\ 2s^2\ 2p^6$. (1 mark)

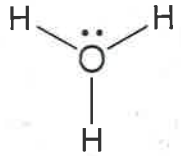
d) Calculate the formal charge on central atom (Any 2) **2**



(i)



(ii)



(iii)

i) $5 - [2 + 4] = -1$
ii) $3 - [3 + 0] = 0$
iii) $6 - [3 + 2] = +1$

Q.4 **a)** Complete the following table on the basis of hybridization concept. (0.5 Mark each) **4**

Molecule	Hybridized state of underlined atom	Bond angle
$\underline{P}Cl_5$	sp3d	90° & 120°
$\underline{C}H_3\text{-}\underline{C}H_3$	sp3	109°28'
$\underline{Al}Cl_3$	sp2	120°
$\underline{C}O_2$	sp	180°

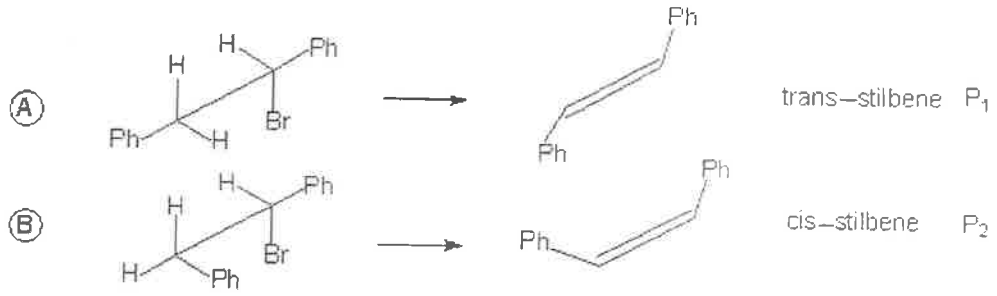
b) Give mechanism of action of following agents ~~(Any 4)~~ **4**

i. **Zinc peroxide:** Antimicrobial agent by oxidation mechanism
ii. **Silver nitrate:** Antimicrobial agent by protein precipitation mechanism
iii. **Titanium dioxide:** Topical protective act by blocking the pores & forming protective layer on the surface of skin or tissue. It removes moisture thereby decreases the mechanical friction & irritation
~~iv. **Sodium hypochlorite:** Antimicrobial agent by halogenation i.e. hypochlorite ion exerts their antimicrobial activity by chlorination of peptide linkage of protein molecule.~~
v. **Povidone iodine:** Antimicrobial agent by oxidation mechanism

c) State and explain the Curtin-Hammet principle. **2**

This principle states that the Ratio of products is determined by the Relative heights of the highest energy barriers leading to the different products, and is not significantly influenced by the relative energies of any isomers, conformers, or intermediates formed prior to the highest energy transition states.

This principle is applicable when the barrier interconverting the different starting points is much lower than the barriers to form products.



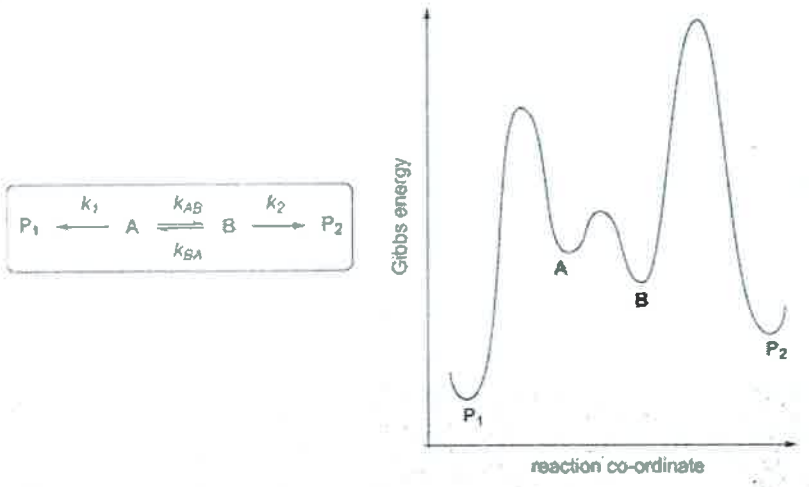
- A and B are conformational isomers.
- Under elimination conditions A leads to trans-stilbene while B leads to cis-stilbene.
- The compound exists as a mixture of the two conformational isomers A and B, among others and therefore elimination leads to a mixture of the two stereoisomers P1 and P2.
- The question is which is the major product?
- Normally the more stable comformer should lead to the major product
- But according to Curtin Hammett Principle,
- "The product proportion does not depend on the ground state population of the two conformational isomers, but depends on the transition state energies of the two processes."
- That is the more stable conformational isomer does not necessarily lead to the major product.
- The major product is the one that has less activation energy barrier.
- Conformation B has more steric problems. Due to the interactions of the two phenyl rings has a higher energy barrier and thus leads to the minor product.

Mathematically the Principle can be explained as follows.

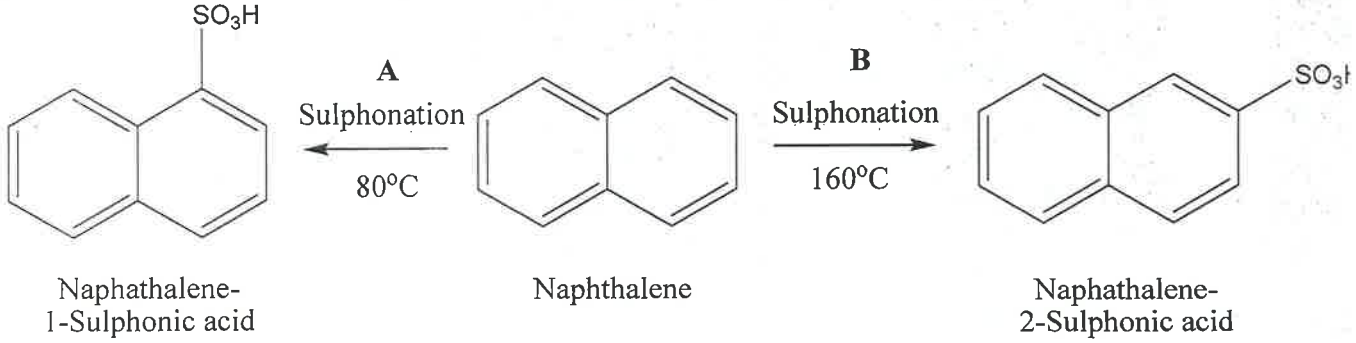
$$\frac{P_1}{P_2} = \frac{k_1 [A][X]}{k_2 [B][X]} = \frac{k_1 [A]}{k_2 [B]} \qquad \frac{[B]}{[A]} = K$$

K is the equlibrium constant

P1 / P2 is the product proportion, k1and k2 are the rate constants of the two processes and K is the equilibrium constant for the equilibrium between the two isomers. [x] is the concentration of all other species.



d) In the following reaction of Sulphonation of naphthalene, identify which is kinetically controlled and which is thermodynamically controlled product. **2**



Reaction A: Sulphonation at 80°C is kinetically controlled
Reaction B: Sulphonation at 160°C is thermodynamically controlled

Q.5 **a) State true or false. (Any 4)** **4**

i) Electronegativity is related to ionization energy and electron affinity. **TRUE**
ii) Bond angle of $AlCl_3$ is 180° by hybridization theory. **FALSE**
iii) Red colour in electrostatic potential surface indicate electronegative region. **TRUE**
iv) H_2C=CHCl behaves as nonpolar molecule. **FALSE**

b) What is catalysis? Give its principle and elaborate on covalent catalysis. **4**
Refer Modern Physical Organic Chemistry by Eric Anslyn

c) Define antidote. Classify them based on mechanism of action with suitable example. **2**

Definition: An antidote is an agent that counteracts a poison **(0.5 Mark)**

Classification based on mechanism of action:

i) Physiological antidote: Counteract the effect of poison by producing other effects e.g. Sodium nitrite **(0.5 Mark)**

ii) Chemical antidote: Counteract the effect of poison by changing chemical nature of poison e.g. Sodium thiosulphate **(0.5 Mark)**

iii) Mechanical antidote: Counteract the effect of poison by preventing absorption of poison into the body e.g. Activated Charcoal **(0.5 Mark)**

d) Define buffer capacity and buffer action. Enlist different physiological buffers that maintain physiological acid base balance. **2**

Buffer capacity: It is defined as the number of gram equivalents of strong acid or strong alkali necessary to produce a pH change of 1 unit in 1 liter of the solution. **(0.5 Mark)**

$$\beta = dx / dpH$$

It is a measure of the resistance of a buffer solution on addition of acid or alkali.

Buffer action: The resistance of a solution to changes in pH upon addition of small amounts of acid or alkali is termed as buffer action. **(0.5 Mark)**

Physiological buffers: (1 mark)

The major buffer systems of the body which helps in maintaining acid-base balance are:

i) Bicarbonate – carbonic acid buffer (HCO_3^- / H_2CO_3) found in plasma and kidney

ii) Phosphate buffer (HPO_4^{-2} / $H_2PO_4^-$) found in cells and kidney

iii) Haemoglobin (Hb) buffer system found in erythrocytes

Q.6 Answer the following (Any 6) **12**

i) Calculate rate constant and half-life for first order reaction, if 90% of substance reacted within 10 min.

Given: t = 10 min

A = 100 – 90 = 10

A_0 = 100

k = ?

$t_{1/2}$ = ?

Formula:

$k = 2.303 / t \log (A_0/A)$

$k = 2.303 / 10 \log (100/10)$

$k = 0.2303 \log 10$

$k = 0.2303 \times 1$

$k = 0.2303\ min^{-1}$ (1 mark)

$t_{1/2} = 0.693 / k$
$t_{1/2} = 0.693 / 0.2303$
$t_{1/2}$ = 3 min (1 mark)

ii) Write a note on electrolyte replacement therapy.

iii) What is the role of copper in metabolism? (Any 4 role)

1. It has a role in Haemoglobin formation. It may help in absorption of Fe or in mobilisation of stored iron.
2. It is important in oxidative phosphorylation (ATP production by cellular respiration) as it is a constituent of cytochrome oxidase which is involved in electron transport mechanism.
3. It is associated with the formation of elastin which is present in blood vessels
4. It is a component of tyrosinase, an enzyme which converts tyrosine to the black pigment, melanin
5. Other enzymes associated with copper are

- Amine oxidase – Causes oxidation of amines
- Ascorbate oxidase – Causes oxidation of ascorbic acid
- Galactose oxidase – causes oxidation of galactose
- Dopamine hydroxylase

iv) Discuss the biological effect of radiation.

v) Give any four clinical application of I-131.

1. Sodium iodide (I-131) solution & capsules: Given orally, for diagnosis and treatment of thyroid disorders like hyperthyroidism and thyroid cancer (Thyrocarcinoma)
2. Iodinated (I-131) human serum albumin: Given intravenously, for blood volume & cardiovascular studies.
3. Iodinated (I-131) human serum albumin: Used for scanning of brain, liver and lungs
4. Sodium iodo-hippurate (I-131) Injection: Used to investigate renal functions
5. Sodium Rose Bengal (I-131): Used in eye drops to stain conjuctival and corneal cells & thereby identify damage to the eye.

vi) The half-life of Zn-71 is 2.4 minutes. If a patient had 100g at the beginning, how many grams would be left over after 7.2 minutes has elapsed?

Given: $A_0 = 100g$
$t = 7.2$ min
$t_{1/2} = 2.4$ min
$A = ?$

10

Formula:

$\log A = \log A_0 - 0.301\ (t / t_{1/2})$

$\log A = \log 100 - 0.301\ (7.2/ 2.4)$

$\log A = 2 - 0.301\ (3)$

$= 2 - 0.903$

$\log A = 1.097$

$A = \text{Antilog}\ (1.097)$

$A = 12.50\ g$

Answer: 12.5g will leave after 7.2 minutes

vii) Draw the reaction coordinate diagram two step exothermic reaction.
