Preface

The inspiration for this book, *DBT-JRF - Biotechnology Eligibility Test: Questions, Answers & Explanations*, arose from the noticeable lack of a comprehensive guide to support students in strategizing for entry-level biotechnology competitive examinations, particularly the DBT BET Exam. I firmly believe that this book not only fulfills that purpose but also serves as a valuable resource for other examinations such as GAT-B, IIT JAM, GATE, CSIR NET, ICMR, and various M.Sc./Ph.D. entrance tests.

Within these pages, you will find an extensive compilation of over 3000 meticulously sorted questions from the DBT-JRF Biotechnology Eligibility Tests conducted over the past 17 years (2008–2024). Each question is accompanied by detailed answers and explanations. The questions are systematically organized into fifteen broad chapters: Biochemistry, Cell Biology, Molecular Biology, Immunology, Plant Physiology, Animal Biology, Genetics, Environmental Biology, Plant Biotechnology, Animal Biotechnology & Recombinant DNA Technology, Microbial Biotechnology, Marine Biology, Bioinformatics & Computational Biology, Bio-techniques, and General Aptitude.

Each chapter begins with an analysis of the questions asked from the respective topic over the past 17 years. Additionally, questions within each chapter are categorized into sub-topics, a feature designed to help students prepare for the DBT-JRF BET in a structured and focused manner.

The answers and explanations provided for each question are the result of extensive research, consultation with standard biology textbooks, and my own expertise in the field. It is my sincere hope that this book achieves its primary goal: to elucidate the concepts underlying the questions asked in DBT-JRF BET examinations.

In striving for excellence, I have made every effort to ensure this book is as accurate and error-free as possible. However, I am mindful of the fact that it may still contain imperfections, as any human endeavor is bound to have. I warmly invite readers to share their feedback, constructive criticism, and suggestions to help improve this book for future editions. Your insights will be invaluable in refining this guide and making it even more effective for future aspirants.

Thank you for joining me on this educational journey.

Kailash Choudhary

Acknowledgement

At the outset, I express my deepest gratitude to the students of the Institute for Advanced Studies (IFAS), whose collective enthusiasm inspired me to compile solutions for the DBT-JRF Biotechnology Eligibility Test. Your curiosity and dedication to the subject have been the cornerstone of this endeavor.

I am profoundly thankful to Er. Radheshyam Choudhary, the visionary founding CEO of IfAS Edutech Pvt. Ltd. His invaluable guidance, sharp insights, and unwavering encouragement were pivotal in bringing this project to fruition.

My heartfelt thanks extend to Mr. Dadasaheb Sondge, COO of IFAS Publications, for granting me the opportunity to produce this book. I am particularly grateful to Mr. Pranshu Dwivedi and Mr. Lalji Kanoujia for their meticulous reviews and indispensable support in refining the book's structure and content. Their insights significantly enhanced the quality of this work.

Special recognition is due to Dr. Rakesh Kumawat and Mr. Vishal Bhujbal, whose diligent efforts in sorting and compiling questions by chapter and section were instrumental. Their precision in proofreading and verifying answers ensured the accuracy and reliability of the material presented.

My journey at IFAS has been immensely enriching. I am thankful to the entire team for fostering an environment that allowed me to enhance my teaching abilities and explore the nuances of creating a book of this nature.

This book stands as a testament to the power of teamwork, and I extend my heartfelt gratitude to the exceptional IFAS Publication team. Their dedication and creativity made the process of crafting this book both rewarding and enjoyable. A special thanks to Mr. Vikendra Metha for his artistic vision in designing an engaging cover page and informative text diagrams, and to Mr. Kuldeep Singh and his team for their meticulous attention to formatting and typesetting.

Finally, I wish to express my respect and appreciation to everyone who contributed significantly to this project but remains unnamed. Your hard work and dedication have not gone unnoticed, and this book is a product of your invaluable efforts.

Kailash Choudhary

About Exam

Department of Biotechnology, Ministry of Science and Technology, Government of India, invites application for award of "DBT-Junior Research Fellowship" (DBT-JRF) for pursuing research in frontier areas of Biotechnology and Life Sciences. The candidates will be selected through "Biotechnology Eligibility Test (BET)". Based on the performance in BET, two categories of merit list will be prepared (Category-I and Category-II). Government of India norms for reservation will be followed for selection.

Pattern of Exam

The medium of BET 2024 will be in English only. The pattern of question paper will comprise Multiple Choice Questions as given below-

Section A will comprise of 50 compulsory multiple-choice questions of 10+2 level in subjects: General Science, Mathematics, Chemistry, General Aptitude, Analytical, Quantitative Ability and General Biotechnology and each question carries Three (03) marks.

Section B will comprise of 150 multiple-choice questions of specific areas in Biotechnology. A candidate has to attempt 50 questions and each question carries Three (03) marks.

Section	Questions	Number of Questions to be attempted	Marks
A (General aptitude and Biotechnology)	50	50 (All compulsory)	3 x 50 = 150
Section B (Specialized areas of Biotechnology)	150	50 (Any 50 out of 150 questions)	3 x 50 = 150
Total	200	100	300

- There will be negative marking and for each incorrect response, 01 (one) mark will be deducted from the total marks. Un-answered/un-attempted will be given Zero (0) marks.
- Questions will be in the form of Multiple Choice Questions (MCQs).
- The exam is conducted online in Computer Based Test (CBT).
- Total Duration of exam: 3 Hours

Cut-off trends (Marks are out of 300)

Category -I

Category	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015
General	216	221	186	194	236	181	141	160	171	197
EWS	196	194	163	166	213	175	-	-	-	-
OBC	190	194	160	164	210	162	110	122	141	181
SC	166	169	150	150	186	154	95	100	126	148
ST	150	151	150	150	180	148	71	81	100	137
Differently Abled	152	151	150	150	180	152	48	66	97	84

Category -II

Category	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015
General	210	215	180	188	227	171	135	152	163	191
EWS	190	188	157	160	204	153	-	-	-	-
OBC	184	188	154	158	201	163	102	114	135	174
SC	160	163	145	144	177	144	89	93	117	141
ST	146	144	146	144	171	137	64	73	93	120
Differently Abled	146	146	144	144	171	133	38	58	68	66

NUMBER OF QUESTION ASKED IN DBT-BET EXAM (2008 to 2024)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Biochemistry	23	29	19	35	18	38	25	28	32	23	29	25	39	38	40	25	38
Cell Biology	13	09	10	16	13	19	14	09	07	13	12	09	15	05	10	19	07
Molecular Biology	25	20	19	10	25	12	23	25	05	24	24	20	24	20	16	14	09
Immunology	16	35	18	20	26	24	16	20	13	09	13	12	16	10	11	17	07
Plant Physiology	09	11	11	10	14	07	15	07	06	01	07	13	13	19	07	22	10
Animal Biology	16	20	18	06	15	20	16	13	11	10	03	09	03	14	09	10	10
Genetics	11	06	17	13	21	09	17	18	12	13	15	13	09	07	02	02	06
Environmental Biology	03	04	02	05	13	13	14	16	07	07	05	06	02	02	05	04	06
Plant Biotechnology	18	07	18	14	09	15	18	21	15	19	08	07	07	05	08	04	08
Animal Biotech & Recombinant DNA Tech	27	12	14	13	09	08	09	17	12	12	17	03	08	10	09	15	07
Microbial Biotechnology	15	21	23	18	27	11	15	19	20	10	16	11	20	30	24	21	31
Marine Biology	20	28	18	25	12	11	09	16	13	05	03	04	03	05	09	02	03
Bioinformatics & Computational Biology	20	25	23	10	11	11	15	10	06	15	13	15	05	15	14	16	10
Biotechniques	08	03	04	01	04	14	06	11	12	08	04	13	11	06	16	10	12
General Aptitude	-	-	-	-	-	-	16	18	08	04	09	12	11	14	20	19	36

CONTENTS

CHAPTER-1 BIOCHEMISTRY

1. Atom, Molecules and Bonds

(DBT-2008)

1. Which one of the following radioisotopes does not emit β rays?
   (1) ^{14}C (2) ^{3}H
   (3) ^{32}P (4) ^{125}I

(DBT-2008)

2. Which of the following statements is true regarding a secondary amide?
   (1) It can only participate in hydrogen bonding as a hydrogen bond donor
   (2) It can only participate in hydrogen bonding as a hydrogen bond acceptor
   (3) It can participate in hydrogen bonding both as a hydrogen bond donor and a hydrogen bond acceptor
   (4) It cannot participate in hydrogen bonding at all

(DBT-2011)

3. A bottle contains 1 mCi of L-Phenylalanine ^{14}C (uniformly labelled) in 2.0 ml of solution. Specific activity of the labelled amino acid is given as 150mCi/m mole. The concentration of L-Phenylalanine in the solution can be calculated as
   (1) 2.335×10^{-3} M (2) 3.335×10^{-3} M
   (3) 3.535×10^{-3} M (4) 2.535×10^{-3} M

(DBT-2011)

4. Water has a high dielectric constant value of 80. Because of its presence in biological systems compared with low dielectric solvents like hydrocarbons, it should
   (1) strengthen electrostatic interaction but weaken hydrophobic interactions
   (2) weaken electrostatic interaction but strengthen hydrophobic interactions
   (3) strengthen both electrostatic as well as hydrophobic interactions
   (4) weaken both electrostatic as well as hydrophobic interactions

(DBT-2012)

5. 6M Guanidium hydrochloride is known to denature a number of proteins. Such a high concentration is able to break down the non-covalent forces sustaining the structure of proteins by affecting
   (1) Electrostatic interactions only
   (2) Electrostatic and hydrophobic interactions
   (3) Intrapeptide hydrogen bonding only
   (4) Electrostatic, hydrophobic, and hydrogen bonding interactions.

(DBT-2014)

6. In the following options which has the most reduced form of carbon atom
   (1) R-CH_3 (2) R-COOH
   (3) R-CHO (4) R-CH_2OH

(DBT-2015)

7. If maltose and monosodium glutamate (MSG) are added to a vinegar and palmitic acid and shaken, the mixture will eventually separate into two phases of different density and polarity. Where will most of the sucrose and the MSG be located following phase separation?
   (1) Both will concentrate in the vinegar.
   (2) Both will concentrate in the oil
   (3) Maltose will concentrate in the oil and MSG will concentrate in the vinegar.
   (4) Maltose will concentrate in the vinegar and MSG will concentrate in the oil

(DBT-2015)

8. Water has a high dielectric constant of 80 in contrast with many non-polar solvents having very low dielectric constants. Due to this property the electrostatic interactions between various side-chains of amino acids in proteins after their transfer from non- polar solvent to water would:
   (1) decrease
   (2) Increase
   (3) Remain unaffected
   (4) Attain a value of zero

(DBT-2015)

9. Cells are broken to release the contents by using various enzymes. Which of the following combination is FALSE?
   (1) Lysozyme-bacteria (2) Cellulase - plant cell
   (3) Chitinase – fungus (4) Cellulase – bacteria

(DBT-2017)

10. The strength of the hydrogen bond represented by D-H...A (where D is the donor atom, H is the hydrogen atom and A is the acceptor atom) depends on
    (1) the D-H bond length and the nature of the D and A atoms.
    (2) the nature of the D and A atoms and the D...A distance.
    (3) the D...A distance and linearity of the angle DHA.
    (4) the H...A distance, linearity of the angle DHA and the nature of the atoms D & A.

(DBT-2017)

11. The van der Waals energy of a single water molecule is:
(1) 0 (2)-0.2 Kcal/mol
(3) -0.5 Kcal/mol (4) 0.2 Kcal/mol

(DBT-2018)

12. Phosphates, carboxylates, sulfonates are esters of phosphoric, carboxylic and sulfonic acids, respectively. Which one of the following statements is NOT true?
(1) The nucleophile attack occurs at acyl carbon in carbohydrates.
(2) The nucleophile attack occurs at the alkyl carbon in sulfonates.
(3) The nucleophile attack occurs at the oxygen or phosphorous in phosphates
(4) Sulfonates can be easily hydrolysed.

(DBT-2019)

13. Two charged molecules are at a distance 'r' from each other. Which one of the following is correct regarding the electrostatic interactions between them?
(1) The interaction energy is proportional to r-1 and the force is proportional to r-2
(2) The interaction energy is proportional to r and the force is proportional to r2
(3) The interaction energy is proportional to r2 and the force is proportional to r-3
(4) The interaction energy is proportional to r-3 and the force is proportional to r-2

(DBT-2019)

14. Thallium-208 has a half-life of 3.053 min. How long will a sample containing 120.0 µCi of Thallium-208 take to decay to 7.50 µCi?
(1) 6.11 min. (2) 9.36 min.
(3) 12.21 min. (4) 18.46 min.

(DBT-2019)

15. ^{14}C has a half-life of 5760 years; 100 mg of a sample of ^{14}C will completely disintegrate in:
(1) 23,040 years (2) 1440 years
(3) 11,520 years (4) infinite time

(DBT-2020)

16. If four atoms A, B, C, and D are connected linearly and there is rotation possible along bond BC, dihedral angle on this bond is described as
(1) the angle between AB and CD
(2) the angle formed between plane ABD and plane ACD
(3) the angle formed between plane ABC and plane BCD
(4) the angle between AC and BD

(DBT-2020)

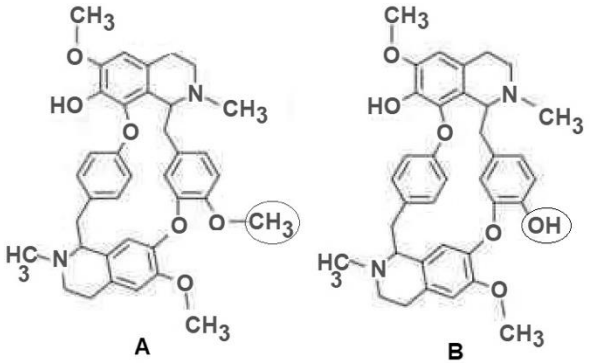
17. Which is the correct arrangement of the polarity of solvents?
(1) Water>DMSO>DMF>THF
(2) Water < DMSO > DMF <CH3CN
(3) Water > DMSO < DMF >CH3CN
(4) Water >DMSO >DMF >CH3CN

(DBT-2020)

18. Chlorine is assigned and atomic weight of 35.5. This is due to
(1) presence of half of proton
(2) none of the given options
(3) presence of isotopes
(4) presence of half a neutron

(DBT-2022)

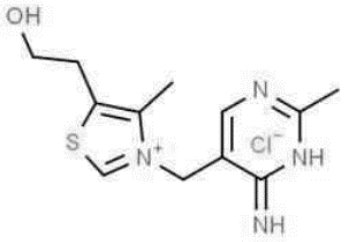
19. What, if any, is the difference between the molecular weights of molecule A (left) vs molecule B (right) ?



(1) Molecular weight of the two are identical
(2) Molecular weight of A is less by 20 Daltons
(3) Molecular weight of A is more by 14 Daltons
(4) Molecular weight of B is more by 2 Daltons

(DBT-2022)

20. What is the molecular formula for the structure given below?



(1) $C_{12}H_{17}ClN_4OS$ (2) $C_{10}H_{16}ClN_4OS$
(3) $C_{11}H_{16}ClN_4OS$ (4) $C_{13}H_{16}ClN_4OS$

(DBT-2022)

21. Arrange the following chemical bonds/interactions in the order of their strengths in vacuum - Hydrogen bond, Covalent bond, van der Waals attraction and Ionic bond:
(1) Covalent bond > Ionic bond > hydrogen bond > van der Waals attraction.
(2) Ionic bond > Covalent bond > hydrogen bond > van der Waals attraction.
(3) Covalent bond > Ionic bond > van der Waals attraction > hydrogen bond.
(4) Ionic bond > Covalent bond > van der Waals attraction > hydrogen bond.

(DBT-2024)

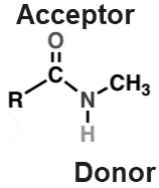
22. How many pi-bonds are present in cyano-benzene?
(1) 6 (2) 5
(3) 4 (4) 3

ANSWER & EXPLAINATION

1. Atom, Molecules and Bonds

1. **Correct Answer is (4):** Iodine-125 is a commonly used radionuclide with a half-life of 60 days, emitting gamma rays with a maximum energy of 0.035 MeV (Million Electron Volts). ^{14}C, ^{3}H and ^{32}P emit weak β rays.

2. **Correct Answer is (3):** Secondary amide is an amide in which the nitrogen atom is directly bonded to two carbon atoms: the carbonyl group carbon plus one other carbon For example peptide bond in protein.



It can participate in hydrogen bonding both as a hydrogen bond donor due to amide hydrogen and a hydrogen bond acceptor due to carbonyl oxygen.

3. **Correct Answer is (2):**
Given: Specific activity of 1mmol=150 mCi
Thus,
1 mCi will have 1/150 mmol or 0.0066 x 10^{-3}M
2 ml shows 1 mCi, means 0.0066 x 10^{-3}M
1 ml will show 0.0066 x 10^{-3}M/2 = 0.0033 X 10^{-3}M
1000 ml will show 1000x 0.0033 X 10^{-3}M= 3.33×10^{-3}M

4. **Correct Answer is (2):** There is inverse relationship between dielectric constant (D) and strength of electrostatic interactions and direct relationship with hydrophobic interactions. Water has a high dielectric constant value of 80, thus it will decrease electrostatic interactions but will favour hydrophobic interactions.

5. **Correct Answer is (4):** Guanidinium chloride is a strong chaotrope and one of the strongest denaturants used in physiochemical studies of protein folding. At high concentrations of guanidinium chloride (e.g., 6 M), proteins lose their ordered structure, and they tend to become randomly coiled, i.e. they do not contain any residual structure. Guanidium hydrochloride affects hydrophobic interactions, electrostatic interactions, and hydrogen bonding.

6. **Correct Answer is (1):** The reduced state of a one-carbon fragment is defined by the number of C-X bonds that have been replaced by C-H bonds, where X = any electronegative element. The most reduced form of alkyl derivative is R-CH_3, the most oxidized form is R-COOH.

7. **Correct Answer is (1):** The simple rule is that "like dissolves like". Polar/ionic solvents dissolve polar/ionic solutes and non-polar solvents dissolve non-polar solutes. For example, MSG and maltose are both polar solute and vinegar is polar solvent and palmitic acid is non-polar solvent, thus both solute will concentrate in vinegar.

8. **Correct Answer is (1):** There is inverse relationship between dielectric constant (D) and strength of electrostatic interactions.

$$E= Kq_1q_2/r. D$$

Thus, when various side-chains of amino acids in proteins after their transfer from non- polar solvent (having low D) to water (D=80), electrostatic interactions will decrease.

9. **Correct Answer is (4):** Bacterial cell wall is composed of peptidoglycan which can be broken by lysozyme not by cellulase. Cellulase degrades cellulose which is present in cell wall of plants. Chitinase can degrade chitin present in cell wall of fungus.

10. **Correct Answer is (4):** Hydrogen bonds (D-H···A) are primarily electrostatic in nature and involve an interaction between a hydrogen attached to an electronegative atom (D-H) and another electronegative acceptor atom (A) that carries a lone pair of electrons. The strength of hydrogen bond depends on nature of donor and acceptor. The weak hydrogen bonds involve less polar X-H groups in proton donors, like C-H or P-H groups, or less polar acceptors, like the N2 molecule in the N2···HF. The distance between D-H is fixed, thus hydrogen bond strength depends on H..A distance, which may be variable, lesser the distance more is strength of hydrogen bond. The angle the bond forms is also important in determining the strength of the hydrogen bond. When DHA all are collinear (bond angle 1800), there is maximum strength, as bond angle decreases hydrogen bond strength decreases.

11. **Correct Answer is (1):** Inter-molecular van der Waals' forces assist for maintaining water in the liquid phase with hydrogen bonds. Single water molecule will not interact with any other molecule, thus van der Waals energy will be zero. The Single water molecule has two covalent bond not Vander wall interaction.

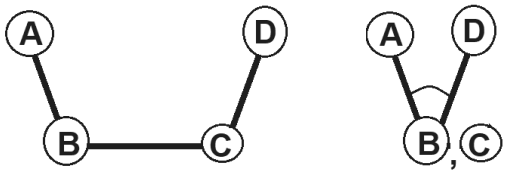
12. Correct Answer is (3): Statement 3 is false. The central atom of the phosphate groups carries a partial positive charge and is therefore capable of being attacked by nucleophilic agents. While phosphates do undergo nucleophilic substitution reactions, the nucleophile typically attacks the phosphorus atom, not the oxygen atoms. The oxygen atoms in phosphates are usually involved in resonance with the phosphorus atom, which makes them less likely to be the site of nucleophilic attack.

13. Correct Answer is (2):
The energy (E) in electrostatic interaction = F x r = Force between charges X distance between them.
$F= kq1q2/r^2$ X r
$E=kq1q2/r$
Thus, the interaction energy is inversely proportional to r and the force is inversely proportional to r^2.

14. Correct Answer is (3):
Disintegration constant (k) =
k = 0.693/Half life (t1/2)
k = 0.693/3.053=0.227
Substitute k into the equation below:
ln(No/N) = kt.
No = initial = 120 µCi
N = final = 7.50 µCi
k from above =0.227
Solve for time
ln (120/7.5) = 0.227 t
ln 16 = 0.227 t
2.77= 0.227 t
2.77/0.227 = time = 12.21 minute
Another way to solve is as follows
Half-life between 120 to 7.5 are 4:
$120 \overset{1}{\rightarrow} 60 \overset{2}{\rightarrow} 30 \overset{3}{\rightarrow} 15 \overset{4}{\rightarrow} 7.5$
After every 3.05 minutes it reduces to half, thus total duration will be 3.05 x 4= 12.20 minutes.

15. Correct Answer is (2): The half-life of radioisotope is duration in which it become half of original. But radioisotope will take infinite time to completely disintegrate as after every disintegration some amount will be there.

16. Correct Answer is (2): The standard IUPAC definition of a dihedral angle is illustrated in the figure below.

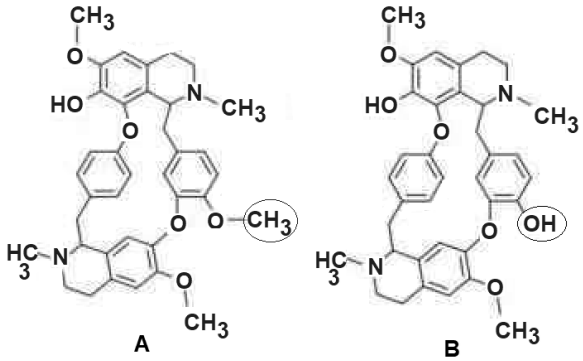


A, B, C and D illustrate the position of the 4 atoms used to define the dihedral angle. The rotation takes place around the central B-C bond. The view on the right is along the B-C bond with atom A placed at 12 o'clock. The rotation around the B-C bond is described by the A-B-D or A-C-D angle shown in the right image.

17. Correct Answer is (1): Polar solvent is a type of solvent that has large partial charges or dipole moments. The bonds between the atoms have very different but measurable electronegativities. A polar solvent can dissolve ions and other polar compounds. Water has a large difference in the electronegativity between the hydrogen and oxygen atoms, thus it is solvent with maximum polarity. Non-polar solvents are liquids or solvents that do not have a dipole moment.
As a result of this, the solvents are missing any partial positive or negative charges. The correct order of polarity of given solvents is as follows:
Water> acetonitrile (CH_3CN) > dimethylsulfoxide (DMSO) > dimethyl formamide (DMF) >tetrahydrofuran (THF)

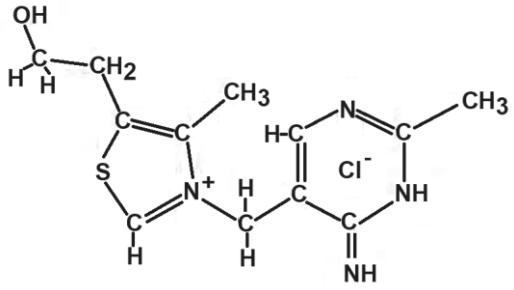
18. Correct Answer is (3): Atomic mass of chlorine is 35.5. It has two isotopes of atomic mass 35 and 37.
Chlorine – 35: A number of protons are 17 and the number of neutrons are 18. It happens in nature about 75 per cent of the time.
Chlorine – 37: A number of protons are 17 and the number of neutrons are 20. It happens in nature about 25 per cent of the time.
Atomic mass in an atom or group of an atom is the sum of the masses of protons, neutrons and electrons. For an element relative atomic mass is the average mass of the naturally occurring isotopes of that element relative to the mass of an atom of 12C.
Relative atomic mass = (75/100 x 35) + (25/100 x 37)
Relative atomic mass = 35.5 u.
Thus, the atomic mass of chlorine is taken as 35.5u

19. Correct Answer is (3): In diagram below differences between A and B have been highlighted by circle.



A has CH_3 (15 Dalton) group attached to oxygen atom and B as H (1 dalton) atom to oxygen atom, thus molecule A will be 14 dalton (15-1) heavier as compare to molecule B.

20. Correct Answer is (1): We can simply count the number of carbon, hydrogen, chlorine, nitrogen, oxygen and sulphur atoms in the above structure.

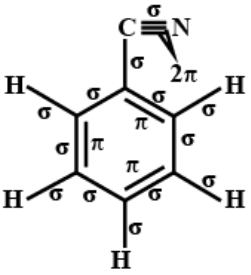


It comes out to be $C_{12}H_{17}CIN_4OS$

21. Correct Answer is (2): The bond strength mostly depends on the charges present on each ion and the distance between them. The correct order of bond strength in vacuum is ionic bond > Covalent bond > hydrogen bond > van der Waals attraction.

The reason is simple because the ionic bonds are formed due to electrostatic attraction between the two atoms hence, they are definitely the strongest ones. They are formed by complete transfer of electrons. Next comes the covalent bond because they are formed by the overlapping of orbitals of two atoms hence, it is also the strong one but not as strong as an ionic bond. Then comes the hydrogen bond because the bond is formed when a high electronegative atom like oxygen, nitrogen or fluorine generally are present in hydrogen atom which has a partial positive charge and hence to neutralise that hydrogen bond is formed. It is formed by the partial electrostatic attraction between the hydrogen and other atoms with lone pairs of electrons. At last is Van der Waals interaction which is due to the virtue of the number of electrons present in an atom and its size. These forces are the sum of attractive and repulsive electrical forces between atoms and molecules. Hence, it is the weakest interaction force.

22. Correct Answer is (2): Cyano-benzene, also known as benzonitrile, has a molecular structure represented as C_6H_5CN. It has a single aromatic ring with a cyano group (C≡N) attached. The number of pi-bonds in cyano-benzene is 5 and sigma bonds are 13.



2. Acid, Base, pH, Buffer and Solutions

1. Correct Answer is (1):

$$pH = pK_a + log\frac{[\text{Tricene base}]}{[\text{Tricine acid}]}$$

$$7.5 = 8.15 + log\frac{[\text{Tricene base}]}{[\text{Tricine acid}]}$$

$$7.5 - 8.15 = log\frac{[\text{Tricene base}]}{[\text{Tricine acid}]}$$

$$-0.65 = log\frac{[\text{Tricene base}]}{[\text{Tricine acid}]}$$

$$antilog\ -0.65 = \frac{[\text{Tricene base}]}{[\text{Tricine acid}]}$$

$$\frac{[\text{Tricene base}]}{[\text{Tricine acid}]} = \frac{[1]}{[4.47]}$$

Total Tricene will be Base form + acid form
= 1+ 4.47=5.57

Tricene base form will be $\frac{1.7}{5.57} \times 0.05 = 0.009\ M$

Tricene acid form will be $\frac{4.47}{5.57} \times 0.05 = 0.041\ M$

The ability of a buffer to resist changes in pH is referred to as the 'buffer capacity." The buffer capacity can be defined as the number of moles per liter of H^+ or OH^- required to cause a given change in pH (for eg. 1 unit)

An expression for instantaneous buffer capacity, *β,* can be represented as

$$\beta = 2.3\ \frac{[A^-][HA]}{[A^-] + [HA]}$$

$$\beta = 2.3\ \frac{[0.009][0.041]}{[0.009] + [0.041]}$$

$$\beta = \frac{0.0008487}{0.05} = 0.017\ M$$

2. Correct Answer is (1):

The Ka of acetic acid (HOAc) is 1.70 x 10^{-5}

Thus pKa will be = - log Ka

= - log 1.70 x 10^{-5}

= 4.77

$$pH = pK_a + log\frac{[\text{OAc}-]}{[\text{HOAc}]}$$

$$5 = 4.77 + log\frac{[\text{OAc}-]}{[\text{HOAc}]}$$

$$0.23 = log\frac{[\text{OAc}-]}{[\text{HOAc}]}$$

$$Antilog\ 0.23 = \frac{[\text{OAc}-]}{[\text{HOAc}]} = \frac{1.7}{1}$$

The molar ratio (1.7 : 1) of OAc^- and HOAc in 0.2 M acetate buffer will give you

OAc- = $\frac{1.7}{2.7}$ x 0.2 = 0.126 M

HOAc = $\frac{1}{2.7}$ x 0.2 = 0.074 M

3. Correct Answer is (2):

At the equivalence point, the number of moles H^+ added equals the number of moles OH^- present.

Molecular weight of NaOH is 40 g/mol

Means 40 g will have 1 mole of NaOH

1 g of NaOH will have 1/40 mole

8 g of NaOH will have 8/40 mole = 1/5 = 0.2 moles

To neutralize 0.2 moles of NaOH we need 0.2 moles of HCl

Given HCl is 0.05 N means 0.05 moles per 1000 mL

(As acidity of HCl is 1 so normality and molarity will be same)

For 0.2 Mole we will need 0.05 x 4

i.e. we need 4000 mL of 0.05 N HCl

4. Correct Answer is (3):

Given: C_1 = 0.1 M V_1 = *x* mL

C_2 = 5 mM (5 X 10^{-3} M) V_2 = 10 mL

We can apply dilution formula $C_1V_1=C_2V_2$

0.1 M X V_1 = 5 X 10^{-3} M X 10 mL

V_1 = 0.5 mL

Answer is asked in microliters so 0.5 mL will be 500 µL.

5. Correct Answer is (2):

$$pH = pK_a + log\frac{[Deprotnated\ form]}{[Protonated\ form]}$$

$$5.7 = 4.7 + log\frac{[Deprotnated\ form]}{[Protonated\ form]}$$

$$Antilog\ 1 = \frac{[Deprotnated\ form]}{[Protonated\ form]} = \frac{[10]}{[1]}$$

Total acid = Deprotonated + Protonated form = 10 + 1=11

% of protonated form = $\frac{Protonated\ form}{Total\ amount} \times 100 = \frac{1}{11} \times 100$

Degree of protonation = 9.09%

6. Correct Answer is (1):

The equation for pH is as follows:

$$pH=-\log[H^+]$$

$$pH=-\log(10^{-8}) = 8$$

We get pH equal to 8. But this is not correct because an acidic solution cannot have pH greater than 7.

This is case of very dilute solution of acid so we have to take into account H^+ provided by acid as well as by water. It may be noted that in very dilute acidic solution when H^+ concentrations from acid and water are comparable, the concentration of H^+ from water cannot be neglected.

Therefore, Total $[H^+]$ = $[H^+]$ obtained from HCl +$[H^+]$ obtained from H_2O

Since HCl is a strong acid and is completely ionized = $[H^+]HCl=1.0\times10^{-8}$

The concentration of H^+ from ionization is equal to the $[OH^-]$ from water

= $[H^+]H_2O=[OH^-]H_2O$ = x

= $[H^+]$ total = $1.0 \times 10^{-8} + x$

But, $[H^+][OH^-] = 1.0 \times 10^{-14}$

$(1.0 \times 10^{-8} + x)(x) = 1.0 \times 10^{-14}$

$x^2 + 10 - 8x - 10 - 14=0$

Solving for x, we get $x = 9.5 \times 10^{-8}$

Therefore, $[H^+] = 1.0 \times 10^{-8} + 9.5 \times 10^{-8}$

$= 10.5 \times 10^{-8} = 1.05 \times 10^{-7}$

$pH= -\log[H^+]$

$= -\log(1.05\times10^{-7}) = 6.959$

So, pH of 10^{-8} M HC will be slightly less than 7 (6.959).

7. Correct Answer is (1):

Molecular weight of protein is 10 kDa = 10000 Da

If we take 10000 g it will be 1 mole of protein

1 g will have 1/10000 moles

250 µg will have 250 x 10^{-6}/10000 moles

= 250 x 10^{-10} moles

1 mole contain 6.022 x 10^{23} molecules

Thus, 250 x 10^{-10} moles will have

250 x 10^{-10} x 6.022 x 10^{23} molecules

250 x 6.022 x 10^{13} molecules

1505.5 x 10^{13} molecules

1.505 x 10^{16} molecules

8. Correct Answer is (3):

For 1000 mL of 1M NaCl we need 58.5 g NaCl

For 1000 mL of 10 mM NaCl

We need 58.5 x 10 X 10^{-3} g NaCl = 0.585 g

For 10 mL of 10 mM NaCl we need 100 times lesser amount = 0.585 g/100= 0.00585 g

9. Correct Answer is (4): In homogenous suspension components are uniformly distributed throughout the mixture as we see in boiling a mixture of butter, water and eggs due to presence of lecithin. If the eggs are omitted, then the butter and the water separate out due to absence of lecithin.

Lecithins found in egg yolks are mixtures of glycerophospholipids which act like emulsifier. The lecithin coats the butter droplets, keeping them separate from each other.

10. Correct Answer is (1):

Molecular weight of protein is 25 kDa = 25000 D