PART I - Chemistry

SECTION - I

Single Correct Choice Type

This Section contains **8 multiple choice questions**. Each question has four choices (A), (B) (C) and (D) out of which **ONLY ONE** is correct.

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1. The bond energy (in kcal mol^{-1}) of a $C-C$ single bond is approximately
   (A) 1 (B) 10 (C) 100 (D) 1000

1. **(C)** It is a fact. It is nearly 84 kcal mol^{-1}

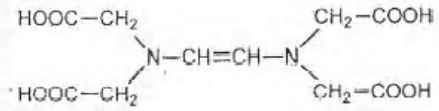
2. The species which by definition has ZERO standard molar enthalpy of formation at 298 K is
   (A) $Br_2(g)$ (B) Cl_2 (g) (C) H_2O (g) (D) CH_4 (g)

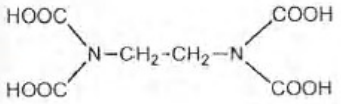
2. **(B)** $Cl_2(g)$ is gas in elemental state, Br_2 is not because it is liquid in elemental state.

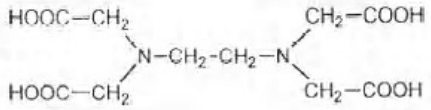
3. The ionization isomer of $[Cr(H_2O)_4\ Cl(NO_2)]Cl$ is
   (A) $[Cr(H_2O)_4(O_2N)]Cl_2$ (B) $[Cr(H_2O)_4Cl_2](NO_2)$
   (C) $[Cr(H_2O)_4Cl(ONO)]Cl$ (D) $[Cr(H_2O)_4Cl_2(NO_2)]H_2O$

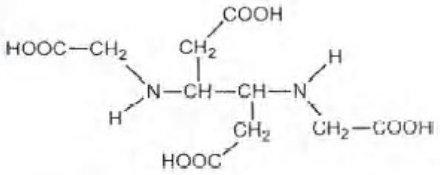
3. **(B)** $[Cr(H_2O)_4\ Cl(NO_2)]Cl$ and $[Cr(H_2O)_4Cl_2](NO_2)$ are ionization isomers.

4. The Correct structure of ethylenediaminetetraacetic acid (EDTA) is

(A) 

(B) 

(C) 

(D) 

4. **(C)** It is a fact

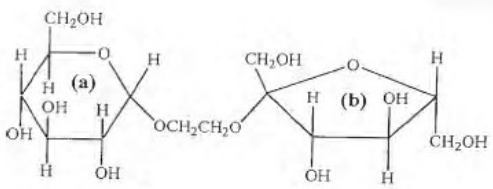
5. The synthesis of 3-octyne is achieved by adding a bromoalkane into a mixture of sodium amide and an alkyne. The bromoalkane and alkyne respectively are
   (A) $BrCH_2CH_2CH_2CH_2CH_3$ and $CH_3CH_2C\equiv CH$
   (B) $BrCH_2CH_2CH_3$ and $CH_3CH_2CH_2C\equiv CH$
   (C) $BrCH_2CH_2CH_2CH_2CH_3$ and $CH_3C\equiv CH$
   (D) $BrCH_2CH_2CH_2CH_3$ and $CH_3CH_2C\equiv CH$

5. **(D)** $CH_3-CH_2-C\equiv CH \xrightarrow{\text{Base}} CH_3-CH_2-C\equiv\bar{C}$

$CH_3-CH_2-C\equiv CH_3-CH_2-CH_2-CH_2Br$ (S_N2)

$CH_3-CH_2-C\equiv C-CH_2-CH_2-CH_2-CH_3$

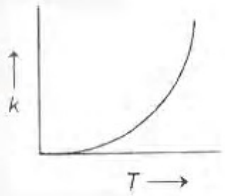
6. The correct statement about the following disaccharide is

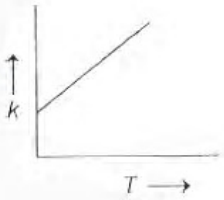


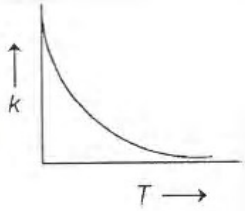
(A) Ring **(a)** is pyranose with α-glycosidic link
(B) Ring **(a)** is furanose with α-glycosidic link
(C) Ring **(b)** is furanose with α-glycosidic link
(D) Ring **(b)** is pyranose with α-glycosidic link

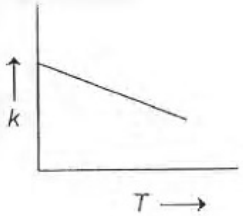
6. **(A)** A is a pyranose ring and is 'D' form so glucoside is α.

7. Plots showing the variation of the rate constant (k) with temperature (T) are given below. The plot that follows Arrhenius equation is

(A) 

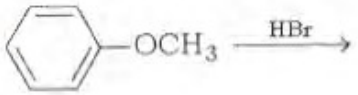
(B) 

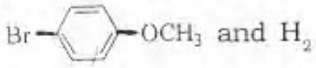
(C) 

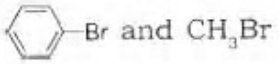
(D) 

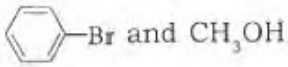
7. **(A)** $K = A \cdot e^{-Ea/RT} = \dfrac{A}{e}$

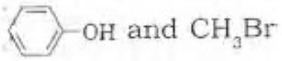
If 'T' is zero, $K \to 0$

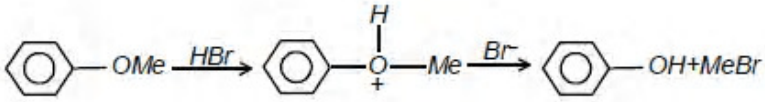
8. In the reaction  the products are

(A) 

(B) 

(C) 

(D) 

8. **(D)** 

SECTION - II
Multiple Correct Choice Type

This section contains 5 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE OR MORE may be correct.

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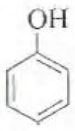
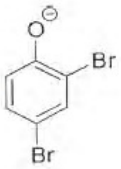
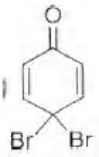
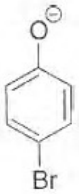
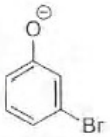
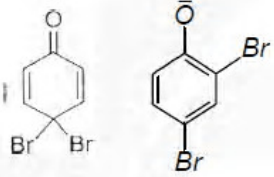
9. In the reaction  $\xrightarrow{NaOH(aq)/Br_2}$ the intermediate(s) is (are)

(A)  (B)  (C)  (D) 

9. **(AC)** 

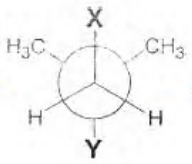
10. The reagent(s) used for softening the temporary hardness of water is (are)
(A) $Ca_3(PO_4)_2$ (B) $Ca(OH)_2$ (C) Na_2CO_3 (D) $NaOCl$

10. **(BC)** $Na_2CO_3 + Ca(HCO_3)_2 \rightarrow CaCO_3 + NaHCO_3$
$Ca(OH)_2 \rightarrow CaO + H_2O$
$CaO + Ca(HCO_3)_2 \rightarrow 2CaCO_3 + H_2O$

11. Aqueous solutions of HNO_3, KOH, CH_3COOH, and CH_3COONa of identical concentrations are provided. The pair(s) of solutions which form a buffer upon mixing is (are)
(A) HNO_3 and CH_3COOH (B) KOH and CH_3COONa
(C) HNO_3 and CH_3COONa (D) CH_3COOH and CH_3COONa

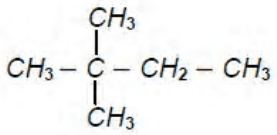
11. **(CD)** $CH_3\overset{O}{\overset{\|}{C}}ONa + HNO_3 \rightarrow CH_3 - \overset{O}{\overset{\|}{C}} - OH + NaNO_3$

CH_3COOH and $CH_3 - \overset{O}{\overset{\|}{C}}ONa$.

12. In the Newman projection for 2,2-dimethylbutane 

X and *Y* can respectively be

(A) *H* and *H* (B) *H* and C_2H_5 (C) C_2H_5 and *H* (D) CH_3 and CH_3

12. **(D)** 

13. Among the following, the intensive property is (properties are)
(A) Molar conductivity (B) electromotive force
(C) resistance (D) heat capacity

13. **(AB)** resistance and heat capacity both depend on mass.

SECTION - III
Paragraph Type

This section contains 2 paragraphs. Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which ONLY ONE is correct.

Paragraph for questions 14 to 15

The concentration of potassium ions inside a biological cell is at least twenty times higher than the outside. The resulting potential difference across the cell is important in several processes such as transmission of nerve impulses and maintaining the ion balance. A simple model for such a concentration cell involving a metal *M* is :
M(s)| M^+(aq; 0.05 molar)|| M^+(aq; 1 molar)| *M*(s)
For the above electrolytic cell the magnitude of the cell potential $|E_{cell}| = 70$ mV.

14. For the above cell
(A) $E_{cell} < 0; \Delta G > 0$ (B) $E_{cell} > 0; \Delta G < 0$
(C) $E_{cell} < 0; \Delta G^\circ > 0$ (D) $E_{cell} > 0; \Delta G^\circ < 0$

14. **(B)** The reaction should be spontaneous and hence $\Delta G < 0$.

15. If the 0.05 molar solution of M^+ is replaced by a 0.0025 molar M^+ solution, then the magnitude of the cell potential would be
(A) 35 mV (B) 70 mV (C) 140 mV (D) 700 mV

15. **(C)** $0.070 = Emf^\circ - \frac{.06}{1}\log .05$

$$x = Emf^\circ - \frac{.06}{1}\log .0025$$

$$\frac{.070}{x} = \frac{\log .05}{\log .0025} = \frac{-1.3}{-2.6}$$

$x = .07 \times 2 \times 10^3 = 140$

Paragraph for questions 16 to 18

Copper is the most noble of first row transition metals and occurs in small deposits in several countries. Ores of copper include chalcanthite($CuSO_4.5H_2O$), atacamite ($Cu_2Cl(OH)_3$), cuprite (Cu_2O), copper glance (Cu_2S) and malachite ($Cu_2(OH)_2CO_3$). However, 80% of the world copper production comes from the ore chalcopyrite ($CuFeS_2$). The extraction of copper from chalcopyrite involves partial roasting, removal of iron and self-reduction.

16. Partial roasting of chalcopyrite produces
(A) Cu_2S and FeO (B) Cu_2O and FeO
(C) CuS and Fe_2O_3 (D) Cu_2O and Fe_2O_3

16. **(A)** Partial roasting of $CuFeS_2$ gives Cu_2S and FeO. Iron is preferentially oxidised.

17. Iron is removed from chalcopyrite as
(A) FeO (B) FeS (C) Fe_2O_3 (D) $FeSiO_3$

17. **(D)** $FeO + SiO_2 \rightarrow FeSiO_3\downarrow$

18. In self-reduction, the reducing species is
(A) S (B) O^{2-} (C) S^{2-} (D) SO_2

18. **(C)** $Cu_2S + 2Cu_2O \rightarrow 6Cu + SO_2$

SECTION - IV (Integer Type)

This section contains TEN questions. The answer to each question is a single digit integer ranging from 0 to 9. The correct digit below the question number in the ORS is to be bubbled.

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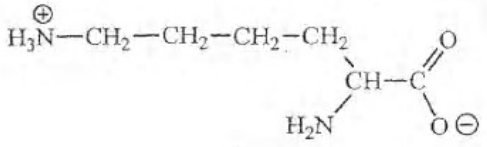
19. The number of neutrons emitted when $^{235}_{92}U$ undergoes controlled nuclear fission to $^{142}_{54}Xe$ and $^{90}_{38}Sr$ is :

19. **(3)** $^{235}_{92}U \rightarrow {}^{142}_{54}Xe + {}^{90}_{38}Sr + {}_0n^1$

$235 = 232 + x$

$x = 3.$

20. The total number of basic groups in the following form of lysine is



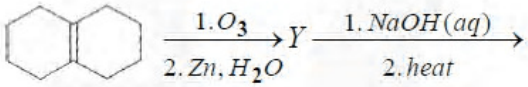
20. **(2)** $-\overset{\overset{O}{\|}}{C}-\bar{O}$ is Conjugate base, $-NH_2$ is basic, NH_3^+ is acidic

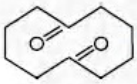
Total no. is 2.

21. The total number of cyclic isomers possible for a hydrocarbon with the molecular formula C_4H_6 is.

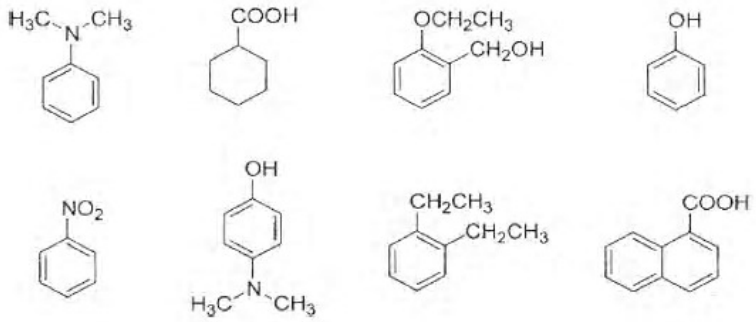
21. **(5)** 

22. In the scheme given below, the total number of intramolecular aldol condensation production formed from '*Y*' is



22. **(1)**  Since it is symmetrical only one aldol product is possible.

23. Amongst the following, the total number of compounds soluble in aqueous *NaOH* is



23. **(4)** *COOH* group and *OH* group reacts with *NaOH*.

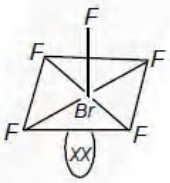
24. Amongst the following, the total number of compounds whose aqueous solution turns red litmus paper blue is

KCN	K_2SO_4	$(NH_4)_2C_2O_4$	*NaCl*	$Zn(NO_3)_2$
$FeCl_3$	K_2CO_3	NH_4NO_3	*LiCN*	

24. **(3)** *KCN* K_2CO_3 and *LiCN* They are the salts of weak acid and strong base.

25. Based on VSEPR theory, the number of 90 degree *F-B-F* angles in BrF_5 is

25. **(0)**



Due to *LP-BP* repulsion the bond angle decreases, axial angle no longer remains 90°. Other angles also suffer distortion.

26. The value of *n* in the molecular formula $Be_nAl_2Si_6O_{18}$ is

26. **(3)** $2n + 2 \times 3 + 6 \times (4) + 18 (-2) = 0$ $2n = 6$ $n = 3$

27. A student performs a titration with different burettes and finds titre values of 25.2 mL, 25.25 mL, and 25.0 mL. The number of significant figures in the average titre value is

27. **(3)** As per rules

28. The concentration of *R* in the reaction $R \rightarrow P$ was measured as a function of time and the following data is obtained :

[R] (molar)	1.0	0.75	0.40	0.10
t(min.)	0.0	0.05	0.12	0.18

The order of the reaction is

28. **(0)** (.25 / .05) = 5 again (0.35 / 0.07) = 5
rate remain constant irrespective of change of concentration.