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JEE (Main)

PAPER-1 (B.E./B. TECH.)

2021

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 26 February, 2021 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: CHEMISTRY

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PART : CHEMISTRY

Single Choice Type

This section contains **20 Single choice questions.** Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

1. Identify the correct order of electron gain enthalpy of O, S, Se, Te.

(1) S > Se > Te > O (2) O > S > Se > Te (3) Te > Se > S > O (4) Se > S > O > Te

Ans. (1)

Sol.

Element	O	S	Se	Te	Po

Electron gain Enthalpy (kJ/Mol)	–141	–200	–195	–190	–174

Correct order of ΔH_{eg} = S > Se > Te > O

2. What is the correct order of Hybridisation of each carbon atom of following molecule ?

$CH_2 = C = CH - CH_3$

(1) sp^2, sp, sp^2 , sp^3 (2) sp, sp^2, sp^3 , sp (3) sp^3, sp, sp^2, sp^2 (4) sp^2, sp, sp^3 , sp

Ans. (1)

3. Which will emit low energy β^- ?

(1) ${}_1H^2$ (Deterium) (2) ${}_1H^1$ (Hydrogen) (3) ${}_1H^3$ (Tritium) (4) H^+ (Proton)

Ans. (3)

Sol. ${}_1H^3$ (Tritium) is radioactive

$\frac{n}{p}$ ratio is 2

Which is highly unstable so to reach stability range of $\frac{n}{p}$ 1 to 1.5, ${}_1H^3$ emit β^- particle

${}_1H^3 \longrightarrow {}_2He^3 + {}_{-1}e^0$

4. Match the column:

	Column-I		Column-II
(a)	NaOH	(i)	Solvay's process
(b)	Na_2CO_3	(ii)	Castner Kellner process
(c)	Ti	(iii)	Van arkel process
(d)	Cl_2	(iv)	Deacon's process

(1) a – ii, b – i, c – iii, d – iv (2) a – i, b – ii, c – iii, d – iv

(3) a – i, b – ii, c – iv, d – iii (4) a – iv, b – ii, c – iii, d – I

Ans. (1)

Sol.

	Column-I		Column-II
(a)	NaOH	(i)	Castner Kellner process
(b)	Na_2CO_3	(ii)	Solvay's process
(c)	Ti	(iii)	Van arkel process
(d)	Cl_2	(iv)	Deacon's process

5. When $FeCl_3$ dissolve in hot water, a colloidal solution is formed, charge develop on sol particle is :

(1) Positive charge (2) Negative charge

(3) Some time positive and some time negative charge (4) Neutral

Ans. (1)

Sol. $Fe(OH)_3$ sol prepared by the hydrolysis of $FeCl_3$ solution adsorbs Fe^{3+} and this is positively charged.

$FeCl_3 + 3H_2O \rightleftharpoons Fe(OH_3) + 3HCl$; $Fe(OH)_3 + FeCl_3 \rightarrow Fe(OH)_3$ Fe^{3+} : $3Cl^-$

Fixed part Diffused part.

Positive charge on colloidal sol is due to adsorption of Fe^{3+} ion (common ion between $Fe(OH)_3$ and $FeCl_3$).

6. Match the following:

	Column-I		Column-II
(a)	Siderite	(i)	Fe
(b)	Calamine	(ii)	Cu
(c)	Cryolite	(iii)	Al
(d)	Malachite	(iv)	Zn

(1) a – ii, b – i, c – iii, d – iv (2) a – i, b – ii, c – iii, d – iv

(3) a – i, b – ii, c – iv, d – iii (4) a – i, b – iv, c – iii, d – ii

Ans. (4)

Sol.

	Ore		Formula
(a)	Siderite	-	$FeCO_3$
(b)	Calamine	-	$ZnCO_3$
(c)	Cryolite	-	Na_3AlF_6
(d)	Malachite	-	$CuCO_3{\cdot}Cu(OH)_2$

7. Identify the correct combination of acidic oxides

(1) Na_2O, BaO (2) CaO, SiO_2 (3) B_2O_3, SiO_2 (4) B_2O_3, CaO

Ans. (3)

Sol. Acidic oxides = B_2O_3, SiO_2

Basic oxides = Na_2O, BaO, CaO

8. Match the following:

	Column-I (Molecule)		Column-II (Bond Order)
(a)	Ne_2	(i)	1
(b)	N_2	(ii)	2
(c)	F_2	(iii)	0
(d)	O_2	(iv)	3

(1) a – ii, b – i, c – iii, d – iv (2) a – iii, b – iv, c – i, d – ii

(3) a – i, b – ii, c – iv, d – iii (4) a – i, b – iv, c – iii, d – ii

Ans. (2)

Sol.

	Molecule		Bond Order
(a)	Ne_2	-	0
(b)	N_2	-	3
(c)	F_2	-	1
(d)	O_2	-	2

9. Which of the following statement is not true about calgon?

(1) It do not form ppt with Ca^{2+} ion in water.

(2) It is also known as Graham's salt.

(3) Calgon contain metal which is 2nd most abundant in the earth crust.

(4) Calgon is polymeric and water soluble.

Ans. (3)

Sol. (1) It keeps the Mg^{+2} & Ca^{2+} in solution.

$$Na_6P_6O_{18} \longrightarrow Na_4P_6O_{18}^{2-} + 2Na^+$$

$$M^{2+} + Na_4P_6O_{18}^{2-} \longrightarrow [Na_2MP_6O_{18}]^{2-} + 2Na^+$$

(2) Sodium hexametaphosphate is also known as Graham's salt.

(3) Fe is second most abundant metal in earth crust. Calgon does not contain it.

(4) Calgon is sodium hexametaphosphate ($Na_6P_6O_{18}$) or $(NaPO_3)_6$.

10. **Statement-I :** $Tl I_3$ is isomorphous with CsI_3 & oxidation number of Tl = +1

Statement-II : Tl has 14 f electrons

(1) Statement-I and Statement-II are true and Statement-II is correct explanation of Statement-I.

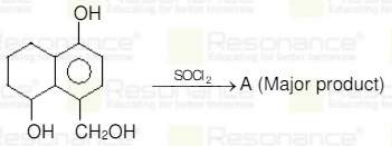
(2) Statement-I and Statement-II are true but Statement-II is not correct explanation of Statement-I.

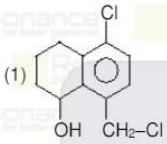
(3) Statement-I is true and Statement-II is false.

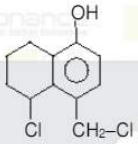
(4) Statement-I is false and Statement-II is true.

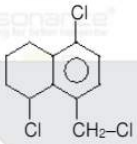
Ans. (2)

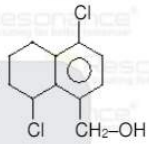
11. What is the major product of the given reaction ?



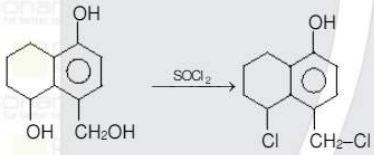
(1) 

(2) 

(3) 

(4) 

Ans. (2)

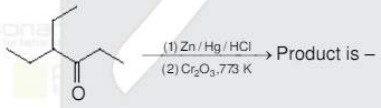
Sol. 

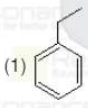
12. 2,4–DNP test is used for -

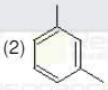
(1) Aldehyde (2) Alcohol (3) Aniline (4) Carboxylic acid

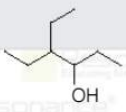
Ans. (1)

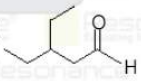
Sol. Carbonyl group (aldehyde & ketone) give positive test with 2,4-DNP.

13. 

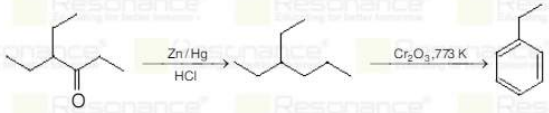
(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. 

14. **Column–I** **Column–II**

Disaccharide **Monomeric unit**

(i) Sucrose (P) α-D-Glucose + α-D-Glucose

(ii) Maltose (Q) α-D-Glucose + β-D-Fructose

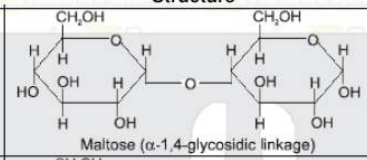
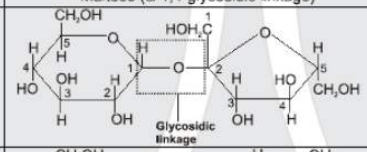
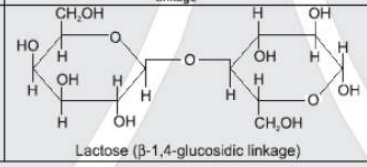
(iii) Lactose (R) β-D-Galactose + β-D-Glucose

(1) (i) – Q , (ii) – P, (iii) – R (2) (i) – R , (ii) – Q, (iii) – P

(3) (i) – Q , (ii) – R, (iii) – P (4) (i) – P , (ii) – Q, (iii) – R

Ans. (1)

Sol.

Disaccharide	Structure	Monomeric unit linkage
Maltose	 Maltose (α-1,4-glycosidic linkage)	α-D (+) Glucose + α-D(+) Glucose (α-1, 4-glycosidic linkage)
Sucrose		α-D-glucose + β-D-fructose (α-1,β-2 glycosidic linkage)
Lactose	 Lactose (β-1,4-glucosidic linkage)	β-D(+) Glucose + β-D (+) galactose (β-1,4- glycosidic linkage)

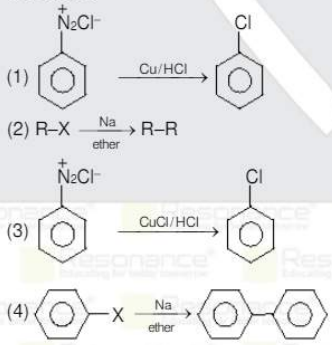
15. **Column–I** **Column–II**

(P) Wurtz reaction

(Q) Gattermann reaction

(R) Fittig reaction

(S) Sandmeyer's reaction



(1) (P) – 2 , (Q) – 1, (R) – 4, (S) – 3 (2) (P) – 3 , (Q) – 4, (R) – 1, (S) – 2

(3) (P) – 1 , (Q) – 4, (R) – 3, (S) – 2 (4) (P) – 2 , (Q) – 4, (R) – 3, (S) – 1

Ans. (1)

Sol. From theory.

16. (A) N,N–Dimethyl aniline (B) N–Methyl aniline

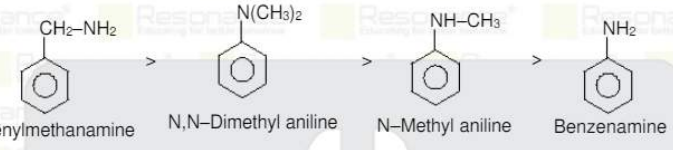
(C) Benzenamine (D) Phenylmethanamine

Correct order of basic strength is :

(1) D > C > B > A (2) D > A > B > C (3) A > D > B > C (4) A > B > C > D

Ans. (2)

Sol. **Basic strength order is**



17. Seliwanoff's test and Xanthoproteic test are respectively used for the identification of :

(1) Proteins, Ketose (2) Ketose, Proteins (3) Aldose, Ketose (4) Ketose, Aldose

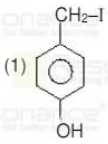
Ans. (2)

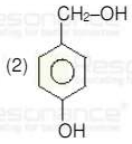
Sol.

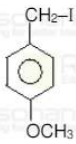
Test	Reagent	Observations	Reason	Test Given By
Seliwanoff's Test	0.5% **Resorcinol in conc. HCl** and heat for 5 minutes.	**Fiery red colour** or Coloured solution.	Complex formation.	**Fructose gives fiery red solution** but glucose, maltose and sucrose gives brown/violet coloured solutions. (Difference between fructose and glucose)

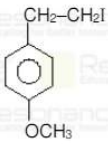
Xanthoproteic test is used to detect a presence of protein.

18. 

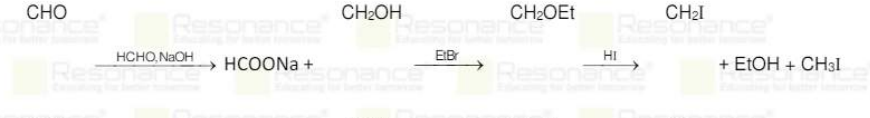
(1) 

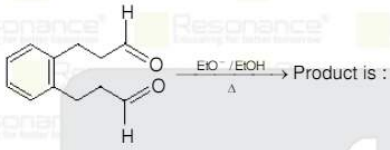
(2) 

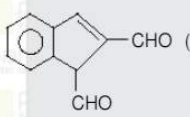
(3) 

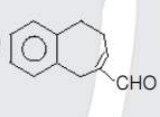
(4) 

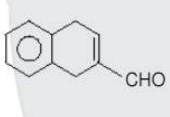
Ans. (1)

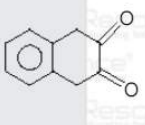
Sol. 

19. 

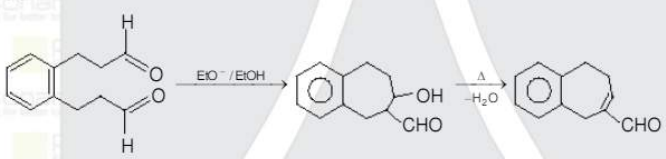
(1) 

(2) 

(3) 

(4) 

Ans. (2)

Sol. 

20. Which of the following give positive test with ceric ammonium nitrate and $CHCl_3$+KOH respectively.

(1) Amine and phenol (2) Phenol and amine

(3) Alcohol and amine (4) Amine and alcohol

Ans. (3)

Sol. Alcohols give positive test with Ceric ammonium nitrate & 1º amines give positive test with $CHCl_3 + KOH$ i.e. carbylamine test.

Numerical Value Type

This section contains **10 Numerical value type questions.**

21. Find total number of possible stereoisomers of $[Co(OX)_2Br(NH_3)]$

Ans. (3)

Sol.

Trans Cis [d + ℓ]

22. Find average bond energy of S–F in SF_6 [in kJ/mole] using following data **[PC-I-XI-TDS-T]**

$\Delta H_f^\circ(SF_6, g) = -1100$ kJ/mole, $\Delta H_f^\circ(S, g) = 285$ kJ/mole, $\Delta H_f^\circ(F, g) = 80$ kJ/mole

[Report your answer to nearest possible integer]

Ans. (311)

Sol. $SF_6(g) \longrightarrow S(g) + 6F(g)$

$$\Delta H^\circ_{reaction} = 6(BE_{S-F}) = \Delta H_f^\circ(S, g) + 6\Delta H_f^\circ(F, g) - \Delta H_f^\circ(SF_6, g)$$

$$= 285 + 6 \times 80 - (-1100)$$

$$= 1865$$

$$BE_{S-F} = \left(\frac{1865}{6}\right) = 310.83 \text{ kJ/mol} \approx 311 \text{ kJ/mol}$$

23. $Zn(s)\left|Zn^{+2}_{(0.1\,M)}(aq)\right|\left|Ag^{+}_{(0.01\,M)}(aq)\right|Ag(s)$

Given $E^\circ_{Zn^{2+}|Zn} = -0.76$ V, $E^\circ_{Ag^+|Ag} = 0.80$ V

Determine E_{cell}, if your answer is $x \times 10^{-2}$ V then determine value of 'x'.

Ans. (147)

Sol. Anode (oxidation) : $Zn(s) \longrightarrow Zn^{+2}(aq) + 2e^-$

Cathode (reduction) : $2Ag^+(aq) + 2e^- \longrightarrow 2Ag(s)$

Overall reaction $Zn(s) + 2Ag^+(aq) \longrightarrow Zn^{+2}(aq) + 2Ag(s)$

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{2}\log\frac{[Zn^{+2}]}{[Ag^+]^2}$$

$$= (0.76 + 0.8) - \frac{0.059}{2}\log\frac{0.1}{(0.01)^2}$$

$= 1.56 - \frac{0.059}{2}\log 10^3$

$= 1.56 - \frac{0.059}{2} \times 3$

$= 1.56 - 0.09$

$= 1.47$

$= 147 \times 10^{-2}$ V **Ans. 147**

24. Determine mass of $NaNO_3$ (in gram) in 50 ml solution in which Na^+ conc. is 70 mg/ml. (Report your answer to nearest integer).

Ans. (13)

Sol. $[Na^+] = \frac{\frac{70\times10^{-3}}{23}}{\frac{1}{1000}} = \frac{70}{23}$ M

Also, $[Na^+] = [NaNO_3] = \frac{70}{23}$ M

Millimoles of $NaNO_3 = \frac{70}{23} \times 50$

moles of $NaNO_3 = \frac{70}{23} \times 50 \times 10^{-3}$

mass of $NaNO_3$(g) $= \frac{70}{23} \times 50 \times 10^{-3} \times 85 = 12.93$ g **Ans. 13**

25. When thiosulphate react with $KMnO_4$ in weakly basic medium, then product obtained is 'A'. Find the oxidation state of sulphur in product A.

Ans. (6)

Sol. $S_2O_3^{2-} + MnO_4^- \xrightarrow[(\text{Weakely Basic})]{OH^-} \underset{(A)}{SO_4^{2-}}(aq) + MnO_2$

So oxidation state of sulphur in product A is +6.

Ans. 6

26. Given a 10 g mass particle with velocity 90 m/sec. Given uncertainty in velocity is 5% then determine, uncertainty in momentum of particle. If your answer is $x \times 10^{-33}$ $\frac{kg \times m}{s}$, then determine value of x.

Ans. (1)

Sol. From Heisenberg's principle of uncertainty

$$(\Delta x)\,(\Delta p) = \frac{h}{4\pi} \qquad \text{(SI unit)}$$

$$(\Delta P = m\Delta V)$$

$$\Delta x \times \frac{10}{1000} \times 90 \times \frac{5}{100} = \frac{6.62\times10^{-34}}{4\times\frac{22}{7}}$$

Or $\Delta x = 1.17 \times 10^{-33}\ \frac{kg\times m}{s}$

Or $= x \times 10^{-33}\ \frac{kg\times m}{s}$ **Ans. 1**

27. Find pH of 0.1 M $CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-COONH_4$ solution.

Given $pK_b(NH_3) = 4.75$ & $pK_a\left(CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-COOH\right) = 5.23$

[Report your answer to nearest integer].

Ans. (7)

Sol. It is salt of WAWB

$$pH = 7 + \frac{1}{2}pK_a - \frac{1}{2}pK_b$$

$$= 7 + \frac{5.23}{2} - \frac{4.75}{2}$$

$$= 7 + 2.615 - 2.375$$

pH = 7.24 **Ans. 7**

28. What is the ratio of octahedral voids & number of lattice points in a FCC crystal structure ?

Ans. (1)

Sol. For FCC unit cell Z = 4

TV = [Z]2 and OV = Z

So, no. of octahedral void in FCC lattice = 4.

So, ratio of octahedral voids & number of lattice points in a FCC crystal structure = 1.

29. 12.2 gram of benzoic acid (M_w = 122) in 100 gram water decrease freezing point upto –0.93ºC.

$K_f = 1.86\ \frac{k.kg}{mole}$

If there is 100% polymerization, the number of molecules of benzoic acid in associated sate is

Ans. (2)

Sol. $\Delta T_f = i\,k_f\,m$

$$0.93 = i \times 1.86 \left\{\frac{12.2\times1000}{122\times100}\right\}$$

i = 0.5

There for benzoic acid associated as dimer.

30. Fraction of molecules crossing activation energy barrier = e^{-x}. Determine 'x'.
(E_a = 80.3 kJ/mole, T = 700 K, R = 8.314 J/mole-K)
[Report your answer to nearest integer]

Ans. 14

Sol. Fraction of molecules crossing activation energy barrier $= e^{\frac{E_a}{RT}}$

$$= e^{\frac{80.3\times10^3}{8.314\times700}}$$

$$= e^{13.8}$$

So $x = 13.8$