

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

# **JEE (Main) 2021**

## **Questions & Solutions**

Date : 25 February, 2021 (SHIFT-2) Time ; (3.00 pm to 6.00 pm)

Duration : 3 Hours | Max. Marks : 300

**SUBJECT : CHEMISTRY**

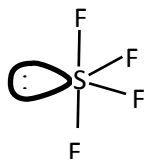
1. Which among the following species has unequal bond lengths ?

- (1)  $\text{BF}_4^-$  (2)  $\text{XeF}_4$  (3)  $\text{SF}_4$  (4)  $\text{SiF}_4$

Ans. (3)

Sol.  $\text{SF}_4$  see-saw structure

Axial bond length is more  
than equatorial bond length



2. Carbylamine test is used to detect the presence of primary amino group in an organic compound. Which of the following compound is formed when this test is performed with aniline?

- (1) (2)   
(3) (4)

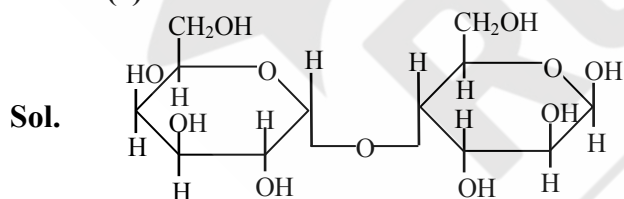
Ans. (4)

Sol.  $\text{PhNH}_2 \xrightarrow[\text{Carbyl amine test}]{\text{CHCl}_3, \text{KOH}} \text{Ph-NC}$

3. Which of the following is correct structure of  $\alpha$ -anomer of maltose ?

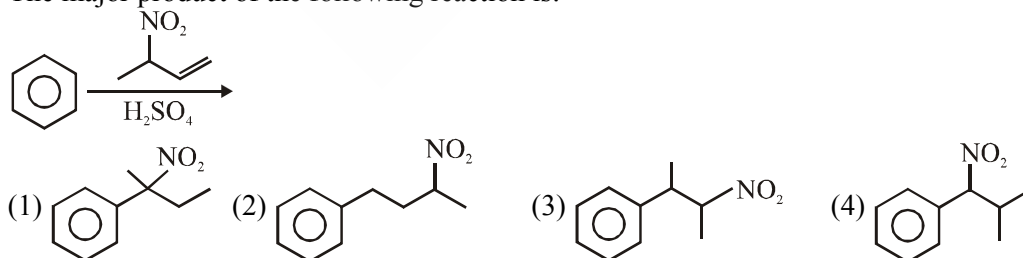
- (1) (2)   
(3) (4)

Ans. (4)



It is  $\alpha$ -anomer of maltose.

4. The major product of the following reaction is:

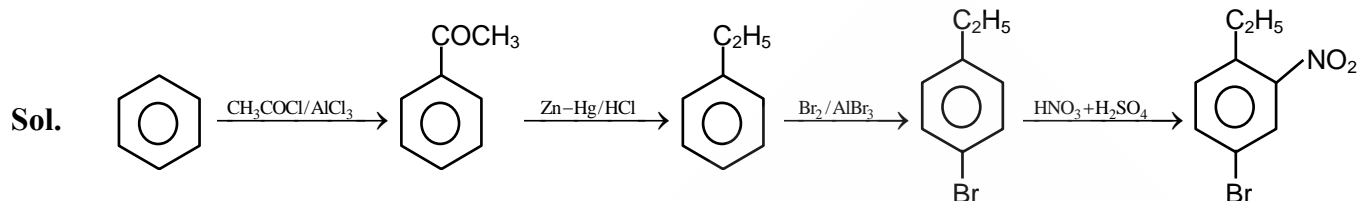


Ans. (3)

Sol.

5. The correct sequence of reagents used in the preparation of 4-bromo-2-nitroethyl benzene from benzene is :
- (1)  $\text{HNO}_3/\text{H}_2\text{SO}_4$ ,  $\text{Br}_2/\text{AlCl}_3$ ,  $\text{CH}_3\text{COCl}/\text{AlCl}_3$ ,  $\text{Zn-Hg}/\text{HCl}$
  - (2)  $\text{Br}_2/\text{AlBr}_3$ ,  $\text{CH}_3\text{COCl}/\text{AlCl}_3$ ,  $\text{HNO}_3/\text{H}_2\text{SO}_4$ ,  $\text{Zn}/\text{HCl}$
  - (3)  $\text{CH}_3\text{COCl}/\text{AlCl}_3$ ,  $\text{Br}_2/\text{AlBr}_3$ ,  $\text{HNO}_3/\text{H}_2\text{SO}_4$ ,  $\text{Zn}/\text{HCl}$
  - (4)  $\text{CH}_3\text{COCl}/\text{AlCl}_3$ ,  $\text{Zn-Hg}/\text{HCl}$ ,  $\text{Br}_2/\text{AlBr}_3$ ,  $\text{HNO}_3/\text{H}_2\text{SO}_4$

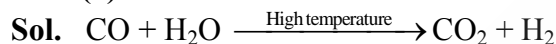
Ans. (4)



6. Water does not produce CO on reacting with:

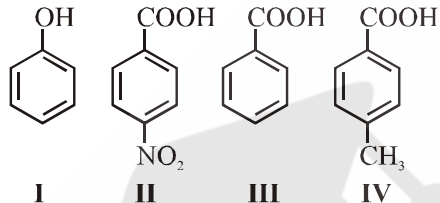
- (1)  $\text{CO}_2$
- (2) C
- (3)  $\text{CH}_4$
- (4)  $\text{C}_3\text{H}_8$

Ans. (1)



Reaction of steam on hydrocarbons or coke at high temperature in the presence of catalyst yield hydrogen and CO.

7. The correct order of acid character of the following compounds is :

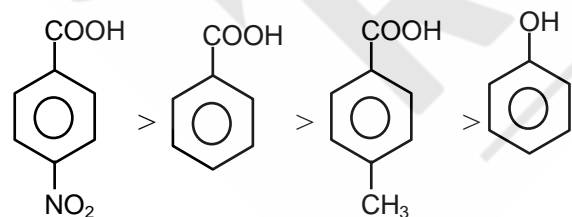


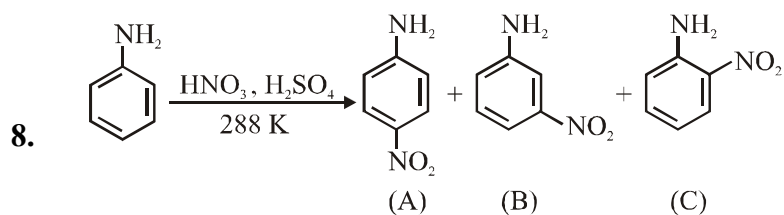
Options:

- (1) III > II > I > IV
- (2) IV > III > II > I
- (3) I > II > III > IV
- (4) II > III > IV > I

Ans. (4)

Sol. Carboxylic acid are more acidic than phenol. -I and -M group increases acidic strength.

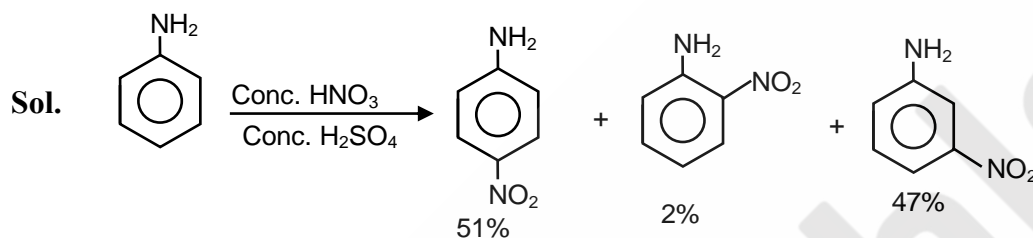




Correct statement about the given chemical reaction is :

- (1)  $-\ddot{N}H_2$  group is *ortho* and *para* directive, so product (B) is not possible.
- (2) Reaction is possible and compound (B) will be the major product.
- (3) The reaction will form sulphonated product instead of nitration.
- (4) Reaction is possible and compound (A) will be major product.

Ans. (4)



In acidic medium, aniline is converted into anilinium ion which is meta directing so meta product is formed in significant amount.

9. The correct order of bond dissociation enthalpy of halogens is :

- (1)  $Cl_2 > F_2 > Br_2 > I_2$
- (2)  $I_2 > Br_2 > Cl_2 > F_2$
- (3)  $Cl_2 > Br_2 > F_2 > I_2$
- (4)  $F_2 > Cl_2 > Br_2 > I_2$

Ans. (3)

Sol. Bond dissociation enthalpy of halogen is  $Cl_2 > Br_2 > F_2 > I_2$ .

10. Given below are two statements :

**Statement I :**

The pH of rain water is normally  $\sim 5.6$ .

**Statement II :**

If the pH of rain water drops below 5.6, it is called acid rain.

In the light of the above statements, choose the correct answer from the options given below:

- (1) Statement I is true but Statement II is false.
- (2) Both Statement I and Statement II are false.
- (3) Statement I is false but Statement II is true.
- (4) Both Statement I and Statement II are true.

Ans. (4)

Sol. Both statement (I) and (II) are true.

Normal rain water has a pH of 5.6 due to the presence of  $H^+$  ion formed by the reaction of rain water with  $CO_2$  present in the atmosphere. When the pH of the rain water drops below 5.6, it is called acid rain.

11. The major components of German Silver are :

- (1) Ge, Cu and Ag
- (2) Zn, Ni and Ag
- (3) Cu, Zn and Ni
- (4) Cu, Zn and Ag

Ans. (3)

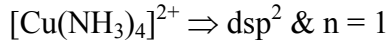
Sol. Cu 25 – 30%, Zn 25 – 30%, Ni 40 – 50%

12. In which of the following order the given complex ions are arranged correctly with respect to their decreasing spin only magnetic moment ?

- (i)  $[\text{FeF}_6]^{3-}$  (ii)  $[\text{Co}(\text{NH}_3)_6]^{3+}$   
 (iii)  $[\text{NiCl}_4]^{2-}$  (iv)  $[\text{Cu}(\text{NH}_3)_4]^{2+}$   
 (1) (i) > (iii) > (iv) > (ii)  
 (2) (ii) > (iii) > (i) > (iv)  
 (3) (iii) > (iv) > (ii) > (i)  
 (4) (ii) > (i) > (iii) > (iv)

Ans. (1)

Sol.  $[\text{FeF}_6]^{3-} \Rightarrow sp^3d^2$  &  $n = 5$ ;  $[\text{Co}(\text{NH}_3)_6]^{3+} \Rightarrow d^2sp^3$  &  $n = 0$  ;  $[\text{NiCl}_4]^{2-} \Rightarrow sp^3$  &  $n = 2$



13. Which of the following compound is added to the sodium extract before addition of silver nitrate for testing of halogens?

- (1) Nitric acid (2) Ammonia  
 (3) Hydrochloric acid (4) Sodium hydroxide

Ans. (1)

Sol. In lassaingne test for the detection, the sodium fusion extract is first boiled with concentrated nitric acid.

14. Which one of the following statements is FALSE for hydrophilic sols ?

- (1) Their viscosity is of the order of that of  $\text{H}_2\text{O}$ .  
 (2) The sols cannot be easily coagulated.  
 (3) They do not require electrolytes for stability.  
 (4) These sols are reversible in nature.

Ans. (1)

Sol. Theory

15. The solubility of  $\text{Ca}(\text{OH})_2$  in water is :

[Given : The solubility product of  $\text{Ca}(\text{OH})_2$  in water =  $5.5 \times 10^{-6}$ ]

- (1)  $1.77 \times 10^{-6}$  (2)  $1.11 \times 10^{-6}$   
 (3)  $1.11 \times 10^{-2}$  (4)  $1.77 \times 10^{-2}$

Ans. (3)

Sol. For  $\text{Ca}(\text{OH})_2$

$$K_{sp} = 4s^3$$

$$5.5 \times 10^{-6} = 4s^3$$

$$s = \sqrt[3]{\frac{5.5}{4} \times 10^{-6}} = 1.11 \times 10^{-2} \text{ M}$$

16. Given below are two statements :

**Statement I :**

The identification of  $\text{Ni}^{2+}$  is carried out by dimethyl glyoxime in the presence of  $\text{NH}_4\text{OH}$ .

**Statement II :**

The dimethyl glyoxime is a bidentate neutral ligand.

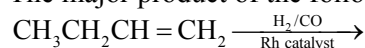
In the light of the above statements, choose the correct answer from the options given below:

- (1) Statement I is false but Statement II is true.
- (2) Both Statement I and Statement II are false.
- (3) Statement I is true but Statement II is false.
- (4) Both Statement I and Statement II are true.

**Ans. (4) (NTA Answer 3)**

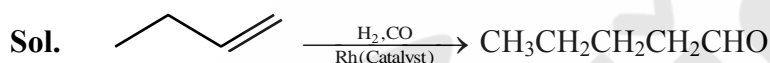
**Sol.** Both statements are correct.

17. The major product of the following reaction is:



- (1)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}-\text{CHO}$
- (2)  $\text{CH}_3\text{CH}_2\underset{\text{CHO}}{\text{C}}=\text{CH}_2$
- (3)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$
- (4)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$

**Ans. (3)**



It is oxo process.

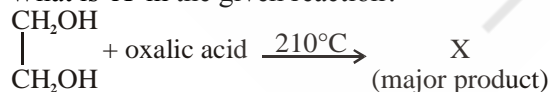
18. The method used for the purification of Indium is :

- (1) van Arkel method
- (2) liquation
- (3) zone refining
- (4) vapour phase refining

**Ans. (3)**

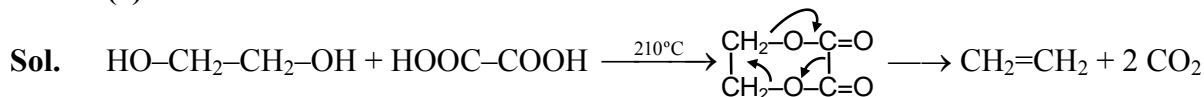
**Sol.** Theory

19. What is 'X' in the given reaction?



- (1)  $\text{CH}_2=\text{CH}_2$
- (2)  $\text{CH}(\text{OH})-\text{CH}_2$
- (3)  $\text{CHO}-\text{CHO}$
- (4)  $\text{CH}_2\text{OH}-\text{CHO}$

**Ans. (1)**



20. Given below are two statements :

**Statement-I** :  $\alpha$  and  $\beta$  forms of sulphur can change reversibly between themselves with slow heating or slow cooling.

**Statement-II** : At room temperature the stable crystalline form of sulphur is monoclinic sulphur.

In the light of the above statements, choose the correct answer from the options given below:

- (1) Statement I is false but Statement II is true.
- (2) Both Statement I and Statement II are true.
- (3) Statement I is true but Statement II is false.
- (4) Both Statement I and Statement II are false.

Ans. (3)

Sol. Theory

### Numerical

1. If a compound AB dissociates to the extent of 75% in an aqueous solution, the molality of the solution which shows a 2.5 K rise in the boiling point of the solution is \_\_\_\_\_ molal. (Rounded-off to the nearest integer) [ $K_b = 0.52 \text{ K kg mol}^{-1}$ ]

Ans. 3

Sol.  $\Delta T_b = i m K_b$

$$2.5 = (1 + (2 - 1) \times 0.75) \times m \times 0.52$$

$$2.5 = 1.75 \times m \times 0.52$$

$$m = \frac{2.5}{1.75 \times 0.52} = 2.747$$

2. The number of compound/s given below which contain/s  $-\text{COOH}$  group is \_\_\_\_\_.

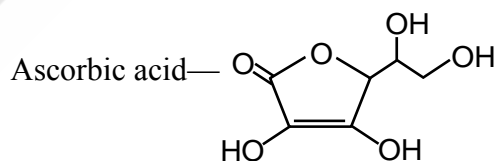
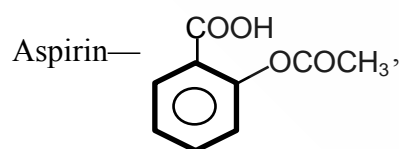
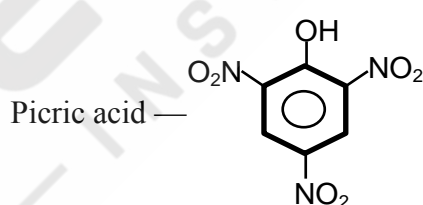
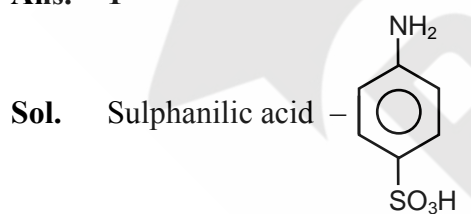
(A) Sulphanilic acid

(B) Picric acid

(C) Aspirin

(D) Ascorbic acid

Ans. 1



3. The rate constant of a reaction increases by five times on increase in temperature from  $27^\circ\text{C}$  to  $52^\circ\text{C}$ . The value of activation energy in  $\text{kJ mol}^{-1}$  is \_\_\_\_\_ (Rounded-off to the nearest integer) [ $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ ]

Ans. 52

Sol.  $\log_{10} \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[ \frac{1}{T_1} - \frac{1}{T_2} \right]$

$$\log_{10} 5 = \frac{E_a}{2.303 \times 8.314} \left[ \frac{1}{300} - \frac{1}{325} \right]$$

$$0.693 = \frac{E_a}{2.303 \times 8.314} \times \frac{25}{300 \times 325}$$

$$E_a = 51.74 \text{ kJ/mole}$$

4. Among the following, number of metal/s which can be used as electrodes in the photoelectric cell is \_\_\_\_\_ (Integer answer)

(A) Li (B) Na (C) Rb (D) Cs

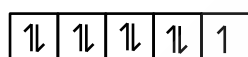
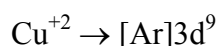
Ans. 1

Sol. 1 (Cs)

5. The spin only magnetic moment of a divalent ion in aqueous solution (atomic number 29) is \_\_\_\_\_ BM.

Ans. 2

Sol.  $Z = 29$  [Cu element]



3d

No of unpaired electron = 1

$$\text{Magnetic moment } \mu = \sqrt{n(n+2)} \text{ BM}$$

$$= \sqrt{1 \times 3} \text{ BM} = 1.732 \text{ BM}$$

6. Electromagnetic radiation of wavelength 663 nm is just sufficient to ionise the atom of metal A. The ionization energy of metal A in  $\text{kJ mol}^{-1}$  is \_\_\_\_\_. (Rounded-off to the nearest integer)

$$[h = 6.63 \times 10^{-34} \text{ Js}, c = 3.00 \times 10^8 \text{ ms}^{-1},$$

$$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}]$$

Ans. 181 (NTA Answer 180)

$$\text{Sol. } E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34})(3 \times 10^8)}{(663 \times 10^{-9})} \times \frac{6.02 \times 10^{23}}{1000}$$

$$= \frac{6.62 \times 3 \times 6.02}{66.3} \times 1000 \frac{\text{kJ}}{\text{mole}}$$

$$= 180.6 \text{ kJ/mole}$$



7. Consider titration of NaOH solution versus 1.25M oxalic acid solution. At the end point following burette readings were obtained.

- (i) 4.5 mL (ii) 4.5 mL  
(iii) 4.4 mL (iv) 4.4 mL  
(v) 4.4 mL

If the volume of oxalic acid taken was 10.0 mL then the molarity of the NaOH solution is \_\_\_\_\_ M.  
(Rounded-off to the nearest integer)

**Ans. 6**

**Sol.** meq. of NaOH = meq. of  $H_2C_2O_4$

$$M \times 1 \times 4.4 = 1.25 \times 2 \times 10$$

$$M = 5.68 \text{ M}$$

8. Five moles of an ideal gas at 293 K is expanded isothermally from an initial pressure of 2.1 MPa to 1.3 MPa against at constant external pressure 4.3 MPa. The heat transferred in this process is \_\_\_\_\_  $\text{kJmol}^{-1}$ .  
(Rounded-off to the nearest integer) [Use  $R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$ ]

**Ans. 15**

**Sol.**  $W = -P_{\text{ext}} (\Delta V) = -4.3 \times 10^6 \left( \frac{5 \times 8.314 \times 293}{1.3 \times 10^6} - \frac{5 \times 8.314 \times 293}{2.1 \times 10^6} \right)$

$$Q = -w = 15347 \text{ J} = 15.347 \text{ kJ}$$

9. Copper reduces  $\text{NO}_3^-$  into NO and  $\text{NO}_2$  depending upon the concentration of  $\text{HNO}_3$  in solution. (Assuming fixed  $[\text{Cu}^{2+}]$  and  $P_{\text{NO}} = P_{\text{NO}_2}$ ), the  $\text{HNO}_3$  concentration at which the thermodynamic tendency for reduction of  $\text{NO}_3^-$  into NO and  $\text{NO}_2$  by copper is same is  $10^x \text{ M}$ . The value of  $2x$  is \_\_\_\_\_. (Rounded-off to the nearest integer)

[Given,  $E_{\text{Cu}^{2+}/\text{Cu}}^\circ = 0.34 \text{ V}$ ,  $E_{\text{NO}_3^-/\text{NO}}^\circ = 0.96 \text{ V}$ ,  $E_{\text{NO}_3^-/\text{NO}_2}^\circ = 0.79 \text{ V}$  and at 298 K,  $\frac{RT}{F} (2.303) = 0.059$ ]

**Ans. 1**

**Sol.**

10. The unit cell of copper corresponds to a face centered cube of edge length  $3.596 \text{ \AA}$  with one copper atom at each lattice point. The calculated density of copper in  $\text{kg/m}^3$  is \_\_\_\_\_.

[Molar mass of Cu :  $63.54 \text{ g}$  ; Avogadro Number =  $6.022 \times 10^{23}$ ]

**Ans. 9084 (NTA Answer 9077)**

**Sol.**  $d = \frac{Z \times \text{At. Mass}}{a^3 \times N_A} = \frac{4 \times 63.54}{(3.596 \times 10^{-8})^3 \times 6.022 \times 10^{23}} = 9.08384 \text{ g/cm}^3$   
 $= 9083.84 \text{ kg/m}^3$