JEE Main 2020 Paper

Date: 7th January 2020

Time: 02.30 PM – 05:30 PM

Subject: Chemistry

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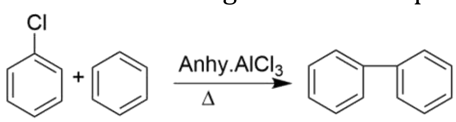
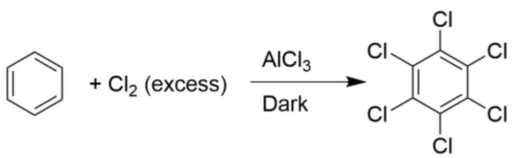
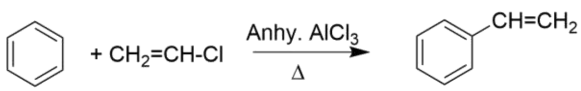
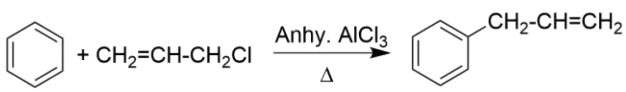
1. Which of the following reactions are possible?

A. 

B. 

C. 

D. 

a. A, B, C
b. B ,D
c. A, C, D
d. A, C

Answer: b

Solution:

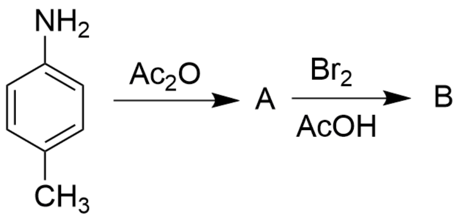
In aryl halides, due to the partial double bond character generated by chlorine, the aryl cation is not formed.

Vinyl halides do not give Friedel-Crafts reaction, because the intermediate that is generated (vinyl cation) is not stable.

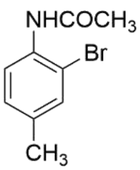
$$H_2C=\overset{+}{C}H$$

vinyl
cation

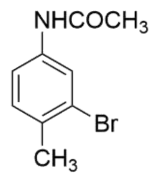
2. B in the given reaction is?



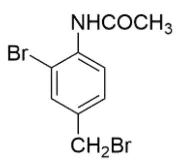
a.



b.



c.



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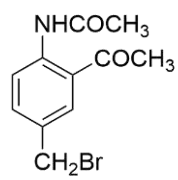
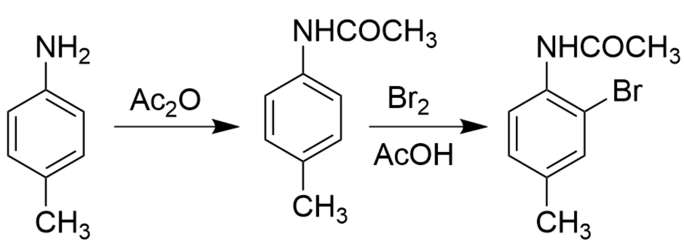


Answer: a

Solution:

During trisubstitution, the acetanilide group attached to the benzene ring is more electron donating than the methyl group attached, owing to +M effect, and therefore, the incoming electrophile would prefer ortho w.r.t the acetanilide group.



3. The correct statement about gluconic acid is:

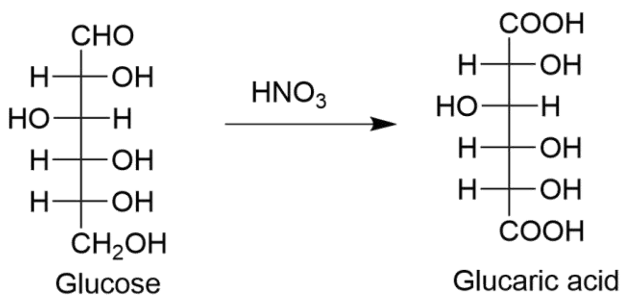
   a. It is prepared by oxidation of glucose with HNO_3
   b. It is obtained by partial oxidation of glucose
   c. It is a dicarboxylic acid
   d. It forms hemiacetal or acetal

   Answer: b

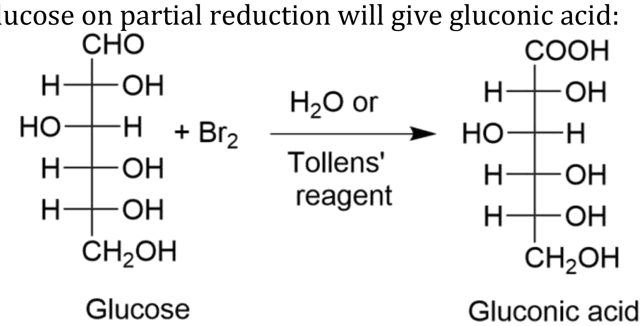
Solution:

The gluconic acid formed is a monocarboxylic acid which is formed during the partial oxidation of glucose

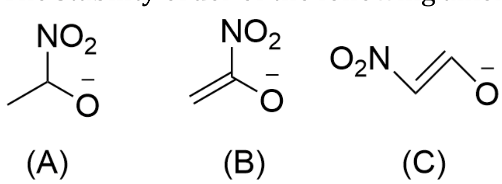
(a) Glucose on reaction with HNO_3 will give glucaric acid:



(b) Glucose on partial reduction will give gluconic acid:



4. The stability order of the following alkoxide ions are:

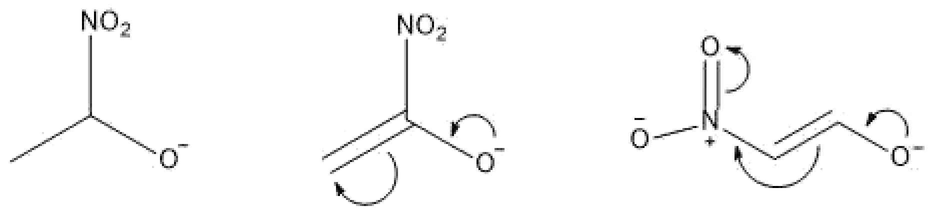


a. C > B > A
b. A > C > B
c. B > A > C
d. C > A > B

Answer: a

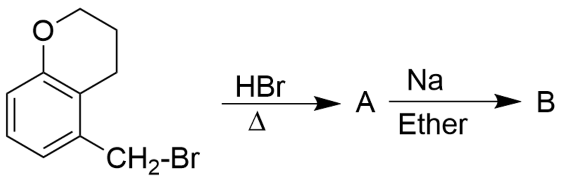
Solution:

Higher the delocalization of the negative charge, more will be the stability of the anion.



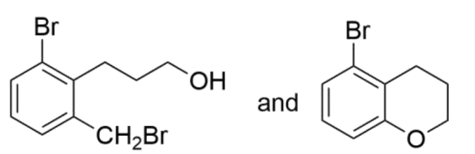
(A) The negative charge is stabilized only through –I effect exhibited by the – NO_2 group.
(B) The negative charge is stabilized by the delocalization of the double bond and the –I effect exhibited by the – NO_2 group.
(C) The negative charge is stabilized by extended conjugation.

5.



A and B are:

a.



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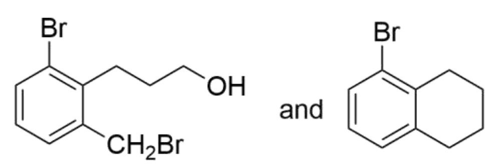
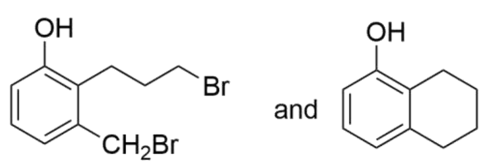
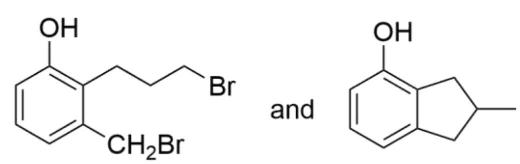


c.

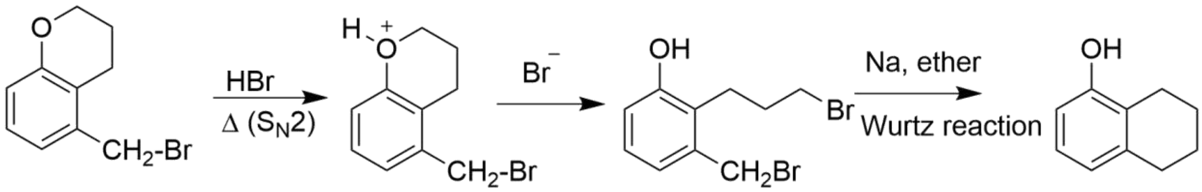


d.



Answer: c

Solution:

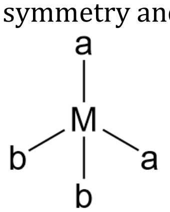


6. For the complex $[Ma_2b_2]$ if M is sp^3 or dsp^2 hybridized respectively then the total number of optical isomers respectively, are:

a. 1, 1
b. 2, 1
c. 0, 0
d. 1, 2

Answer: c

Solution:
Case 1: If M is sp^3 hybridized, the geometry will be tetrahedral. There will be a plane of symmetry and thus it does not show optical activity.



Case 2: If M is dsp^2 hybridized, the geometry will be square planar. Due to the presence of a plane of symmetry, it does not show optical activity.

7. The bond order and magnetic nature of CN^- respectively, are

a. 3, diamagnetic
b. 3, paramagnetic
c. 2.5, paramagnetic
d. 2.5, diamagnetic

Answer: a

Solution:

CN^- is a 14 electron system. The bond order and magnetism can be predicted using MOT.

The MOT electronic configuration of CN^- is:

$\sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*2}\pi_{2p_x}^2\pi_{2p_y}^2\sigma_{2p_z}^2$

Bond order $= \frac{1}{2} \times (N_{bonding} - N_{antibonding}) = 3$

As CN^- does not have any unpaired electrons, and hence it is diamagnetic.

8. Which of the following is incorrect?

a. $\Lambda_m^0 NaCl - \Lambda_m^0 NaBr = \Lambda_m^0 KCl - \Lambda_m^0 KBr$
b. $\Lambda_m^0 H_2O = \Lambda_m^0 HCl + \Lambda_m^0 NaOH - \Lambda_m^0 NaCl$
c. $\Lambda_m^0 NaI - \Lambda_m^0 NaBr = \Lambda_m^0 NaBr - \Lambda_m^0 KBr$
d. $\Lambda_m^0 NaCl - \Lambda_m^0 KCl = \Lambda_m^0 NaBr - \Lambda_m^0 KBr$

Answer: c

Solution:

$\Lambda_m^0 NaI - \Lambda_m^0 NaBr = \Lambda_m^0 NaBr - \Lambda_m^0 KBr$

$[\lambda_m^0 Na^+ + \lambda_m^0 I^-] - [\lambda_m^0 Na^+ + \lambda_m^0 Br^-] = [\lambda_m^0 Na^+ + \lambda_m^0 Br^-] - [\lambda_m^0 K^+ + \lambda_m^0 Br^-]$

$$\lambda_m^0 I^- - \lambda_m^0 Br^- \neq \lambda_m^0 Na^+ - \lambda_m^0 K^+$$

9. $NaOH + Cl_2 \rightarrow A + \text{Other products}$
Hot & conc.
$Ca(OH)_2 + Cl_2 \rightarrow B + \text{Other products}$
Cold & dil.
A and B respectively are:
a. $NaClO_3$, $Ca(OCl)_2$
b. $NaClO_3$, $Ca(ClO_3)_2$
c. NaCl, $Ca(ClO_3)_2$
d. NaClO, $Ca(ClO_3)_2$

Answer: a

Solution:

$6NaOH + 3Cl_2 \rightarrow 5NaCl + NaClO_3 + 3H_2O$
$2Ca(OH)_2 + Cl_2 \rightarrow Ca(OCl)_2 + CaCl_2 + H_2O$

10. There are two beakers (I) having pure volatile solvent and (II) having a volatile solvent and a non-volatile solute. If both the beakers are placed together in a closed container then:
a. Volume of solvent beaker will decrease and solution beaker will increase
b. Volume of solvent beaker will increase and solution beaker will also increase
c. Volume of solvent beaker will decrease and solution beaker will also decrease
d. Volume of solvent beaker will increase and solution beaker will decrease

Answer: a

Solution:

Consider beaker I contains the solvent and beaker 2 contains the solution. Let the vapour pressure of the beaker I be P^o and the vapour pressure of beaker II be P^s. According to Raoult's law, the vapour pressure of the solvent (P^o) is greater than the vapour pressure of the solution (P^s)

($P^o > P^s$)

Due to a higher vapour pressure, the solvent flows into the solution. So volume of beaker II would increase.

In a closed beaker, both the liquids on attaining equilibrium with the vapour phase will end up having the same vapour pressure. Beaker II attains equilibrium at a lower vapour pressure and so in its case, condensation will occur so as to negate the increased vapour pressure from beaker I, which results in an increase in its volume.

On the contrary, since particles are condensing from the vapour phase in beaker II, the vapour pressure will decrease. Since beaker I at equilibrium attains a higher vapour pressure, there, evaporation will be favoured more so as to compensate for the decreased vapour pressure, as mentioned in the previous statement.

11. Metal with low melting point containing impurities of high melting point can be purified by

a. Zone refining
b. Vapor phase refining
c. Distillation
d. Liquation

Answer: d

Solution:

Liquation is the process of refining a metal with a low melting point containing impurities of high melting point

12. Which of the following statements are correct?

I. On decomposition of H_2O_2, O_2 gas is released.
II. 2-ethylanthraquinol is used in the preparation of H_2O_2
III. On heating $KClO_3, Pb(NO_3)_2$ and $NaNO_3$, O_2 gas is released.
IV. In the preparation of sodium peroxoborate, H_2O_2 is treated with sodium metaborate.

a. I,II, IV
b. II, III, IV
c. I, II, III, IV
d. I, II, III

Answer: c

Solution:

Decomposition of H_2O_2 : $2H_2O_2(l) \rightarrow O_2(g) + 2H_2O(l)$

Industrially, H_2O_2 is prepared by the auto-oxidation of 2-alklylanthraquinols.

$2KClO_3 \xrightarrow{150-300^\circ C} 2KCl + 3O_2$

$2Pb(NO_3)_2 \xrightarrow{200-470^\circ C} 2PbO + 4NO_2 + O_2$

$2NaNO_3 \rightarrow 2NaNO_2 + O_2$

Synthesis of sodium perborate:

$Na_2B_4O_7 + 2NaOH + 4H_2O_2 \rightarrow 2NaBO_3 + 5H_2O$

13. Among the following, which is a redox reaction?

a. $N_2 + O_2 \xrightarrow{2000\text{ K}}$
b. Formation of O_3 from O_2
c. Reaction between NaOH and H_2SO_4
d. Reaction between $AgNO_3$ and NaCl

Answer: a

Solution:

$N_2 + O_2 \xrightarrow{2000\text{ K}} 2NO$: The oxidation state of N changes from 0 to +2, and the oxidation state of O changes from 0 to -2

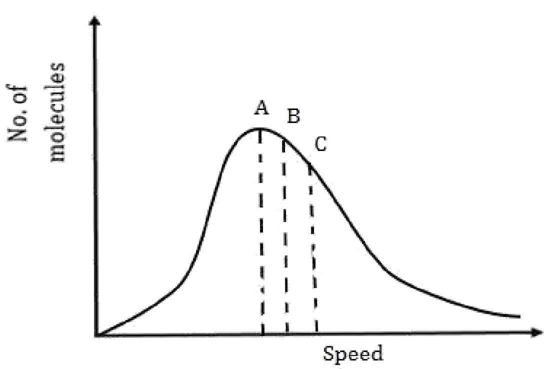
In all the remaining reactions, there is no change in oxidation states of the elements participating in the reaction.

$3O_2 \rightarrow 2O_3$

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ (Neutralisation reaction)

$AgNO_3 + NaCl \rightarrow NaNO_3 + AgCl$ (Double displacement)

14.



Select the correct options:

a. $A = C_{MPS}, B = C_{Average}, C = C_{RMS}$
b. $A = C_{Average}, B = C_{MPS}, C = C_{RMS}$
c. $A = C_{RMS}, B = C_{Average}, C = C_{MPS}$
d. $A = C_{Average}, B = C_{MPS}, C = C_{RMS}$

Answer: a

Solution:

$C_{RMS} = \sqrt{\frac{3RT}{M}}$

$C_{Average} = \sqrt{\frac{8RT}{\pi M}}$

$C_{MPS} = \sqrt{\frac{2RT}{M}}$

$\sqrt{3} > \sqrt{\frac{8}{\pi}} > \sqrt{2}$

$C_{RMS} > C_{Average} > C_{MPS}$

15. Which one of the following, among each pairs, will release maximum energy on gaining one electron? (A= F, Cl), (B= S, Se), (C= Li, Na)
    a. (A)= Cl, (B)= S, (C)= Li
    b. (A)= F, (B)= Se, (C)= Na
    c. (A)= F, (B)= S, (C)= Na
    d. (A)= Cl, (B)= Se, (C)= Li

Answer: a

Solution:

Element	First Electron gain enthalpy(kJ/mol)
Li	-60
Na	-53
F	-320
S	-200
Cl	-340
Se	-195

Despite F being more electronegative than Cl, due to the small size of F, Cl would have a more negative value of electron gain enthalpy because of inter-electronic repulsions.

As we go down group, the negative electron gain enthalpy decreases.

16. Which of the following statements are incorrect?
    a) Co^{3+} with strong field ligand forms a high magnetic moment complex.
    b) For Co^{3+}, if pairing energy (P)>Δ_o, then the complex formed will have t_{2g}^4, e_g^2 configuration
    c) For $[Co(en)_3]^{3+}$, $\lambda_{absorbed}$ is less than $\lambda_{absorbed}$ for $[CoF_6]^{3-}$
    d) If $\Delta_o = 18000\ cm^{-1}$ for Co^{3+}, then with same ligands for it $\Delta_t = 16000\ cm^{-1}$

    a. A, D
    c. A, B
    b. B, C
    d. A, B, C, D

Answer: a

Solution:

Co^{3+} has d^6 electronic configuration. In the presence of strong field ligand, $\Delta_o > P$. Thus the splitting occurs as: t_{2g}^6, e_g^0; so the magnetic moment is zero.

According to the spectrochemical series, en is a stronger ligand than F and therefore promotes pairing. This implies that the Δ_o of en is more than the Δ_o of F.

$$\Delta_o = \frac{hc}{\lambda_{abs}}$$

$$\Delta_t = \frac{4}{9}\Delta_o = 8000\ cm^{-1}$$

17. 0.6 g of urea on strong heating with NaOH evolves NH_3. The liberated NH_3 will react completely with which of the following HCl solutions?

a. 100 mL of 0.2 N HCl

b. 400 mL of 0.2 N HCl

c. 100 mL of 0.1 N HCl

d. 200 mL of 0.2 N HCl

Answer: a

Solution:

Moles of urea= $\left(\frac{0.6}{60}\right)$= 0.01

$$NH_2CONH_2 + 2NaOH \rightarrow Na_2CO_3 + 2NH_3$$

0.01 0.02

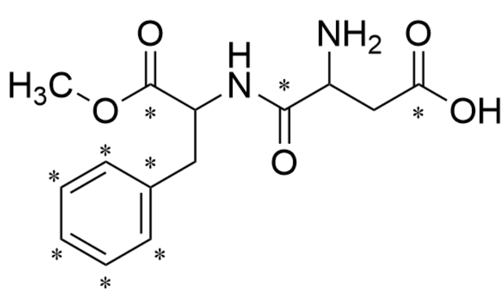
0.02 moles of NH_3 reacts with 0.02 moles of HCl.

Moles of HCl in option a= $0.2 \times \frac{100}{1000} = 0.02$

21. Number of sp^2 hybrid carbon atoms in aspartame is ____.

Answer: 9

Solution:



The marked carbons are sp^2 hybridised.

22. 3 grams of acetic acid is mixed in 250 mL of 0.1 M HCl. This mixture is now diluted to 500 mL. 20 mL of this solution is now taken in another container. $\frac{1}{2}$ mL of 5 M NaOH is added to this. Find the pH of this solution. (log 3 = 0.4771, pK_a = 4.74).

Answer: 5.22

Solution:

mmole of acetic acid in 20 mL = 2

mmole of HCl in 20 mL = 1

mmole of NaOH = 2.5

$HCl + NaOH \rightarrow NaCl + H_2O$

1	2.5	-	-
-	1.5	1	1

CH_3COOH + NaOH (remaining) $\longrightarrow$ CH_3COONa + water

2	1.5	-	-
0.5	0	1.5	

$$pH = pK_a + \log\frac{1.5}{0.5} = 4.74 + \log 3 = 4.74 + 0.48 = 5.22$$

23. The flocculation value for As_2S_3 sol by HCl is 30 mmolL^{-1} . Calculate mass of H_2SO_4 required in grams for 250 mL sol is ____.

Answer: 0.3675 g

Solution:

For 1L sol 30 mmol of HCl is required

$\therefore$ For 1L sol 15 mmol of H_2SO_4 is required

For 250 mL of sol,

$\frac{15}{4} \times 98 \times 10^{-3}$ g of H_2SO_4= 0.3675 g

24. NaCl $\xrightarrow{K_2Cr_2O_7/Conc.H_2SO_4}$ (A) $\xrightarrow{NaOH}$ (B) $\xrightarrow{Dil.H_2SO_4,\ H_2O_2}$ (C)

Determine the total number of atoms in per unit formula of (A), (B) & (C).

Answer: 18

Solution:

$NaCl \xrightarrow{K_2Cr_2O_7/Conc.H_2SO_4} CrO_2Cl_2 \xrightarrow{NaOH} Na_2CrO_4 + NaCl$

$Na_2CrO_4 \xrightarrow{Dil.H_2SO_4} Na_2Cr_2O_7 \xrightarrow{Dil.H_2O_2} CrO_5$

$(A) = CrO_2Cl_2, (B) = Na_2CrO_4$ and $(C) = CrO_5$

25. Calculate the $\Delta H_f°$ (in kJ/mol) for $C_2H_6(g)$, if $\Delta H_c°$ [$C_{(graphite)}$] = −393.5 kJ/mol, $\Delta H_c°$ [$H_2(g)$] = −286 kJ/mol and $\Delta H_c°$ [$C_2H_6(g)$] = −1560 kJ/mol .

Answer: -85 kJ/mol

Solution:

$C_{(graphite)} + O_2(g) \rightarrow CO_2(g)\ \ \Delta H_c° = -393.5$ kJ/mol……………………………….(1)

$H_2(g) + 0.5O_2(g) \rightarrow H_2O(l)\ \ \ \Delta H_c° = -286$ kJ/mol …………………….......(2)

$C_2H_6(g) + 3.5O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)\ \Delta H_c° = -1560$ kJ/mol …. (3)

2 × (−393.5) + 3 × (−286) – (−1560) = −85 kJ/mol

By inverting (3) and multiplying (1) by 2 and (2) by 3 and adding, we get,

2 × (−393.5) + 3 × (−286) – (−1560) = −85 kJ/mol