

JEE Main 2020 Paper

Date: 9th January 2020

Time: 09.30 AM – 12:30 PM

Subject: Chemistry

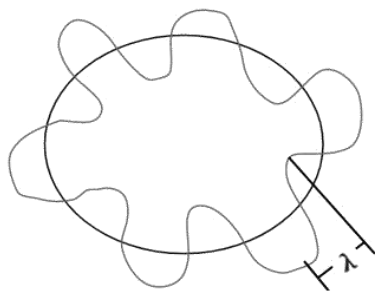
1. Determine the wavelength of electron in the 4th Bohr's orbit:
- | | |
|---------------|---------------|
| a. $4\pi a_0$ | b. $2\pi a_0$ |
| c. $8\pi a_0$ | d. $6\pi a_0$ |

Answer: c

Solution: $n=4$

$Z=1$

$\Lambda=?$



Circumference $(2\pi r) = n\lambda$

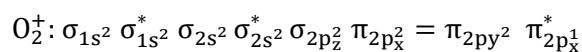
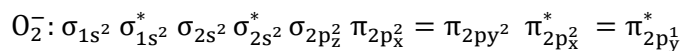
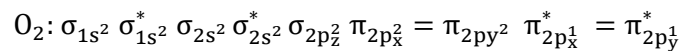
$$\frac{2\pi a_0 n^2}{z} = n\lambda$$

On solving, we get $8\pi a_0$

2. Which of the following species have one unpaired electron each?
- | | |
|-------------------|--------------------|
| a. O_2, O_2^- | b. O_2, O_2^+ |
| c. O_2^+, O_2^- | d. O_2, O_2^{2-} |

Answer: c

Solution:



5. The complex $\text{Cr}(\text{H}_2\text{O})_6\text{Cl}_n$, shows geometrical isomerism and also reacts with AgNO_3 solution. Given: The spin only magnetic moment = 3.8 B. M. What is the IUPAC name of the complex?
- Hexaaquachromium(III) chloride
 - Tetraaquadichloridochromium(III) chloride dihydrate
 - Hexaaquachromium(IV) chloride
 - Tetraaquadichloridochromium(IV) chloride dehydrate

Answer: b

Solution:

Spin only magnetic moment = 3.8 B. M. This implies, $\mu = \sqrt{n(n + 2)}$ B.M.

$(\sqrt{16} = 4)$ implies that $\sqrt{15}$ should be less than four.

This means, $n=3$ as $\sqrt{15} = \sqrt{3(3 + 2)}$

$\text{Cr} (24) = [\text{Ar}]4s^1 3d^5$

(g.s)

For 3 unpaired electrons, the oxidation state of Cr should be +3

Cr^{3+} can be attained if the complex has a structure that looks like: $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$

$[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$ has the IUPAC name : Tetraaquadichloridochromium(III) chloride dihydrate

6. The electronic configuration of bivalent Europium and trivalent Cerium, respectively is: (Atomic Number : Xe = 54, Ce = 58, Eu = 63)
- $[\text{Xe}]4f^7, [\text{Xe}]4f^1$
 - $[\text{Xe}]4f^7 6s^2, [\text{Xe}]4f^1$
 - $[\text{Xe}]4f^7 6s^2, [\text{Xe}]4f^1 5d^1 6s^2$
 - $[\text{Xe}]4f^7, [\text{Xe}]4f^1 5d^1 6s^2$

Answer: a

Solution:

$\text{Ce} (58): [\text{Xe}] 6s^2 4f^2$

(g.s)

$\text{Ce}^{3+}: [\text{Xe}]4f^1$

$\text{Eu}(63) : [\text{Xe}]6s^2 4f^7$

(g.s)

$\text{Eu}^{2+} : [\text{Xe}]4f^7$

9. The first Ionisation energy of Be is higher than that of Boron. Select the correct statements regarding this:

- (i) It is easier to extract electron from 2p orbital than 2s orbital
- (ii) Penetration power of 2s orbital is greater than 2p orbital
- (iii) Shielding of 2p electron by 2s electron
- (iv) Radius of Boron atom is larger than that of Be

a. (i), (ii), (iii), (iv)

b. (i), (iii), (iv)

c. (ii), (iii), (iv)

d. (i), (ii), (iii)

Answer: d

Solution:

Be (4): $1s^2 2s^2$

B (5): $1s^2 2s^2 2p^1$

The electron in $2p^1$ can easily be extracted.

The penetrating power is of the order: $s > p > d > f$

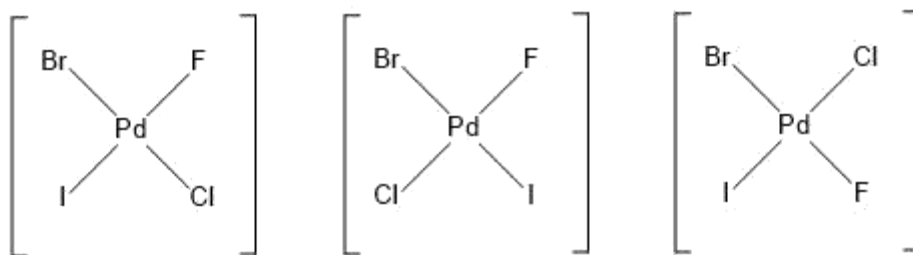
The shielding power order: $s > p > d > f$

As we move along the period, the size decreases, as Z_{eff} increases. Hence the radius of B is smaller than the radius of Be.

10. For $[\text{PdFClBrI}]^{2-}$, the number of geometrical Isomers = n. Determine the spin only magnetic moment and CFSE for $[\text{Fe}(\text{CN})_6]^{n-6}$ (Ignore pairing energy).
- 1.73 B.M., $-2\Delta_0$
 - 2.84 B.M., $-1.6\Delta_0$
 - 0, $-1.6\Delta_0$
 - 5.92 B.M., $-2.4\Delta_0$

Answer: a

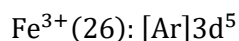
Solution:



Number of geometrical isomers (n) = 3

$$[\text{Fe}(\text{CN})_6]^{n-6} = [\text{Fe}(\text{CN})_6]^{3-6} = [\text{Fe}(\text{CN})_6]^{-3}$$

This implies, that Iron is in its +3 oxidation state.

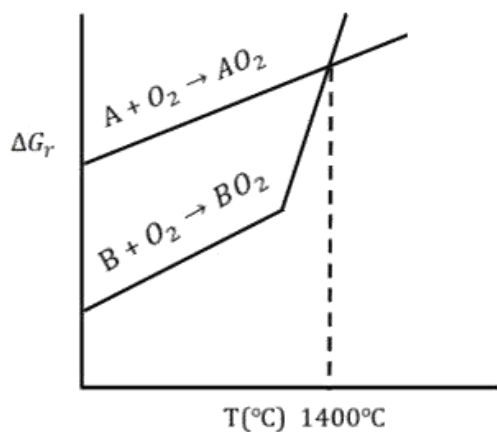


CN^- is a strong ligand in $[\text{Fe}(\text{CN})_6]^{-3}$ and causes pairing. Hence, according to CFT, the configuration will be $t_{2g}^5 e_g^0$.

Hence, there is only 1 unpaired electron, i.e, $n=1$ in $\sqrt{n(n+2)} = \sqrt{3} = 1.73 \text{ B.M}$

$$\begin{aligned} \text{CFSE} &= (-0.4 \times n_{t_{2g}} + 0.6 \times n_{e_g})\Delta_0 \\ &= (-0.4 \times 5 + 0.6 \times 0)\Delta_0 \\ &= -2\Delta_0 \end{aligned}$$

11. A can reduce BO_2 under which conditions?



- a. $> 1400^{\circ}\text{C}$
c. $> 1200^{\circ}\text{C}$

- b. $< 1400^{\circ}\text{C}$
d. $< 1200^{\circ}\text{C}$

Answer: a

Solution: In Ellingham's diagram, the line of the element that lies below can reduce the oxide of the element which lies above it. Therefore, for A to reduce BO_2 , the temperature when the line for element A is below that of BO_2 , according to the graph when $T > 1400^{\circ}\text{C}$.

For $T > 1400^{\circ}\text{C}$, $\Delta G_r < 0$ for $\text{A} + \text{BO}_2 \rightarrow \text{B} + \text{AO}_2$

12. $A \rightarrow B$; 700 K

$A \xrightarrow{c} B$; 500 K

Rate of the reaction in absence of catalyst at 700 K is same as in presence of catalyst at 500 K. If catalyst decreases the activation energy barrier by 30 kJ/mol, determine the activation energy in presence of catalyst. (Assume 'A' factor to be same in both cases)

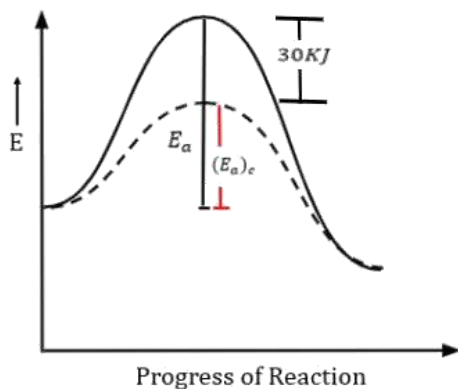
- a. 75 kJ
- b. 135 kJ
- c. 105 kJ
- d. 125 kJ

Answer: c

Solution:

$$K = Ae^{\left(-\frac{E_a}{RT}\right)}$$

$$K_{\text{catalyst}} = K_{\text{without catalyst}}$$



$$Ae^{\left(-\frac{(E_a)_c}{RT_{500k}}\right)} = Ae^{\left(-\frac{(E_a)}{RT_{700k}}\right)}$$

$$e^{\left(-\frac{(E_a)_c}{RT_{500k}}\right)} = e^{\left(-\frac{(E_a)}{RT_{700k}}\right)}$$

$$-\frac{(E_a)_c}{RT_{500k}} = -\frac{(E_a)}{RT_{700k}}$$

$$(E_a)_c = E_a - 30$$

$$-\frac{(E_a - 30)}{T_{500k}} = -\frac{(E_a)}{T_{700k}}$$

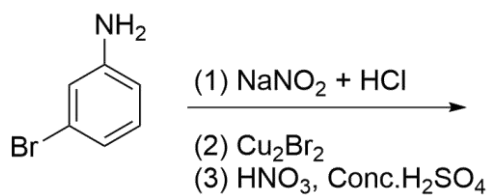
On Solving, $E_a = 105 \text{ kJmol}^{-1}$

13. A substance 'X' having low melting point, does not conduct electricity in both solid and liquid state. 'X' can be :
- a. Hg
 - b. SiC
 - c. ZnS
 - d. CCl₄

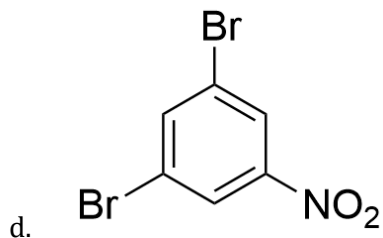
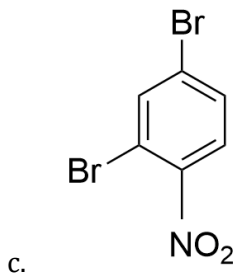
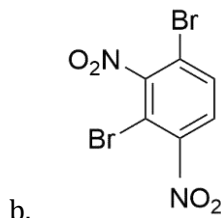
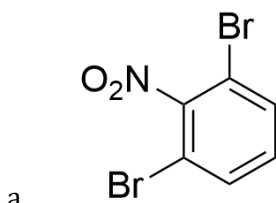
Answer: d

Solution: CCl₄ is non polar and does not conduct in either solid or liquid state.

14.

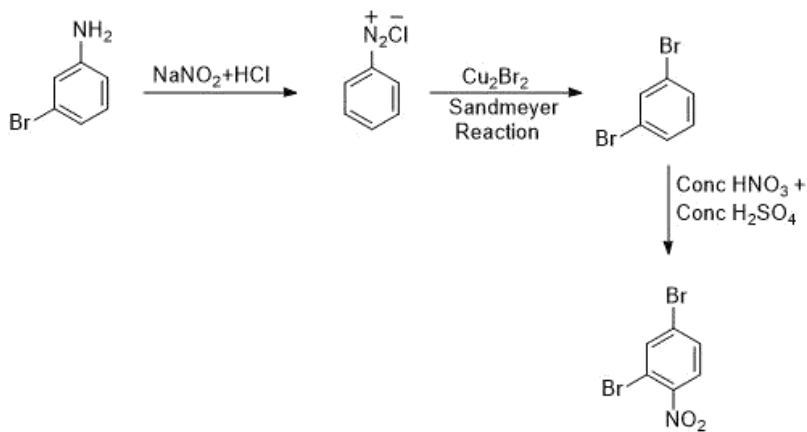


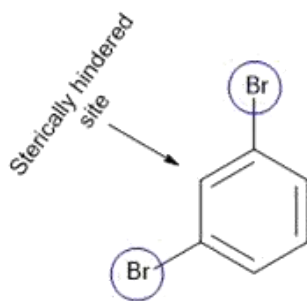
The major product for above sequence of reaction is:



Answer: c

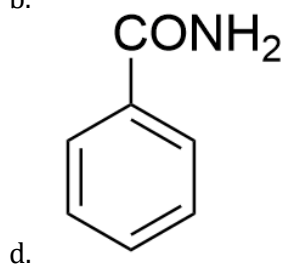
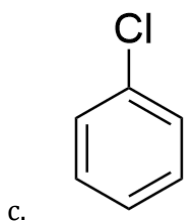
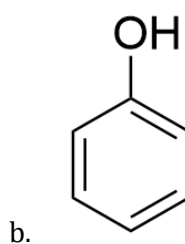
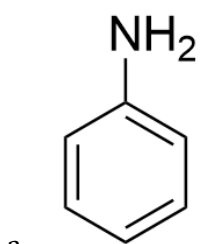
Solution:





Hence, major product formed is that of option b.

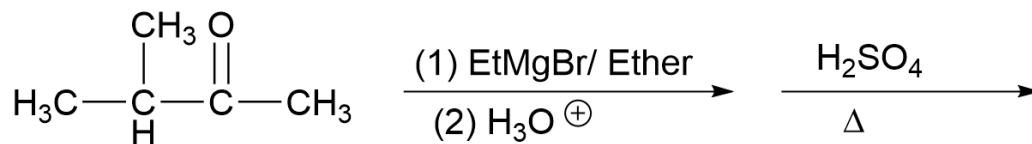
15. Which of the following can give the highest yield in Friedel-Craft's reaction?



Answer: b

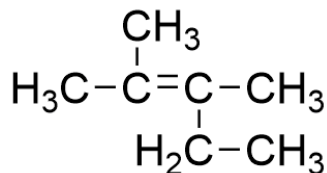
Solution: Out of the four options given, only aniline and phenol show strong +R effects, but as we know, aniline is a Lewis base and can react with a Lewis acid that is added during the reaction. Hence, Phenol gives the highest yield in Friedel-Craft's reaction.

16.

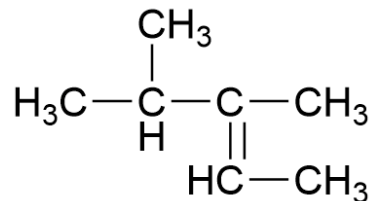


What will be the major product?

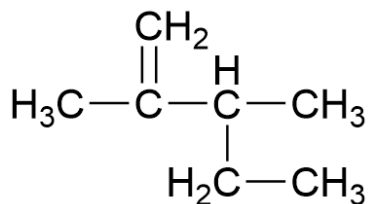
a.



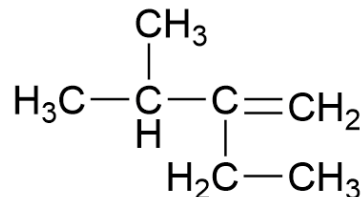
c.



b.

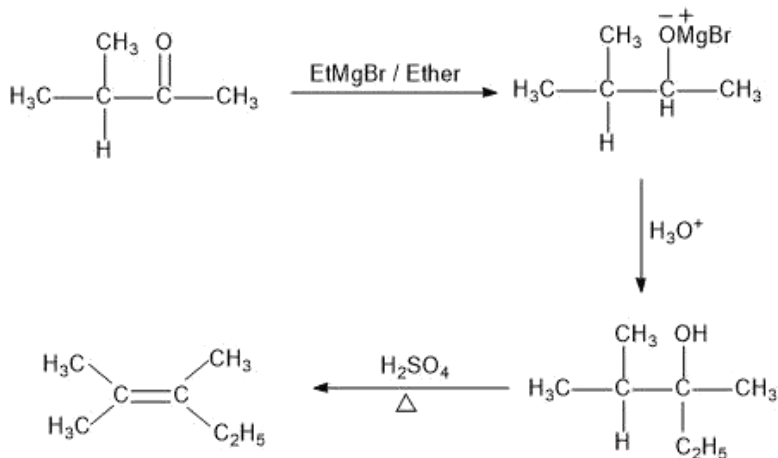


d.

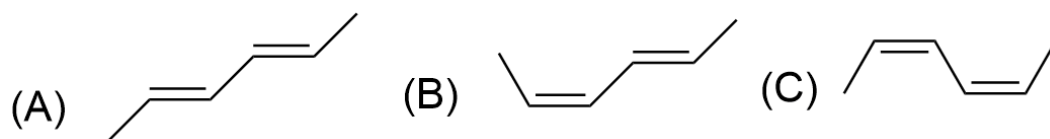


Answer: a

Solution:



17. Which of the following is the correct order for heat of combustion?



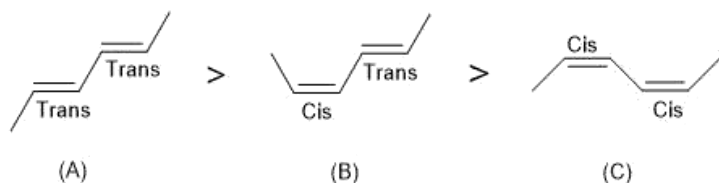
- a. $C > B > A$
c. $A > B > C$

- b. $B > A > C$
d. $C > A > B$

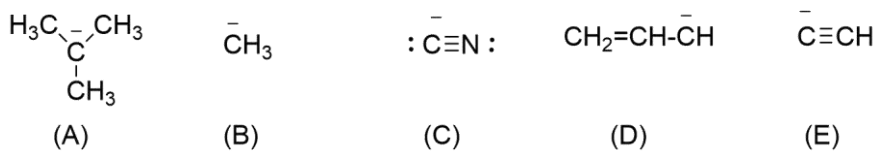
Answer: c

Solution: Heat of combustion $\propto \frac{1}{\text{stability}}$

The trans-isomer is more stable than the cis-isomer. More the number of trans forms in a structure, higher the stability.



18. Write the correct order of basicity:



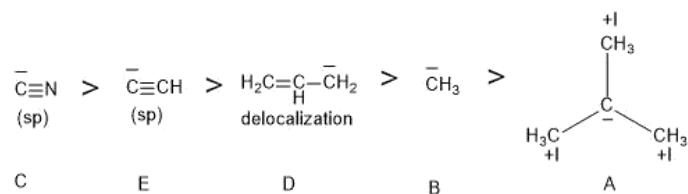
- a. $A > B > D > E > C$
c. $A > B > E > D > C$

- b. $B > A > D > C > E$
c. $C > E > D > B > A$

Answer: a

Solution: As we know weaker the conjugate base, stronger the acid.

The order of stability of conjugate base:



Hence, the order of basicity or acidic strength is:

$A > B > D > E > C$

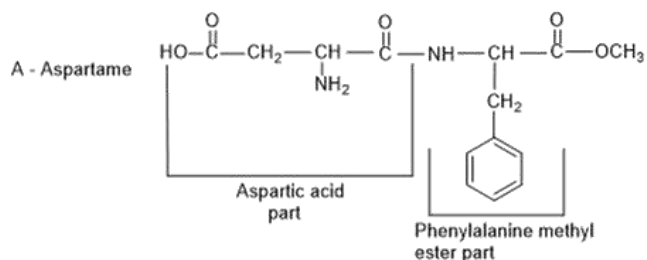
19. A, B, C, and D are four artificial sweeteners.
- (i) A & D give positive test with ninhydrin.
 - (ii) C form precipitate with AgNO_3 in the lassaigne extract of the sugar.
 - (iii) B & D give positive test with sodium nitroprusside.

Correct option is :

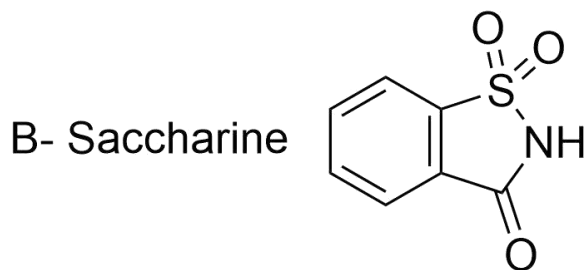
- a. A – Saccharine, B – Aspartame, C – Sucralose, D – Alitame
- b. A – Aspartame, B – Saccharine, C – Sucralose, D – Alitame
- c. A – Saccharine, B – Aspartame, C – Alitame, D – Sucralose
- d. A – Aspartame, B – Sucralose, C – Saccharine, D – Alitame

Answer: b

Solution:

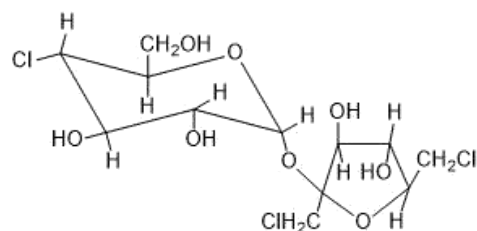


It has a free amine group and hence reacts with ninhydrin to give a purple colour known as Ruhemann's purple.

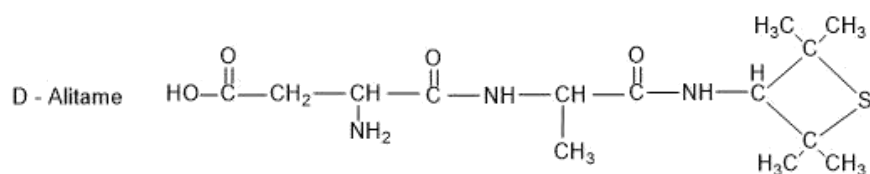


It has Sulphur, therefore, it will give a positive test with sodium nitroprusside.

C - Sucralose



It has chlorine and hence it forms a precipitate with AgNO_3 in the Lassaigne's extract of the sugar.

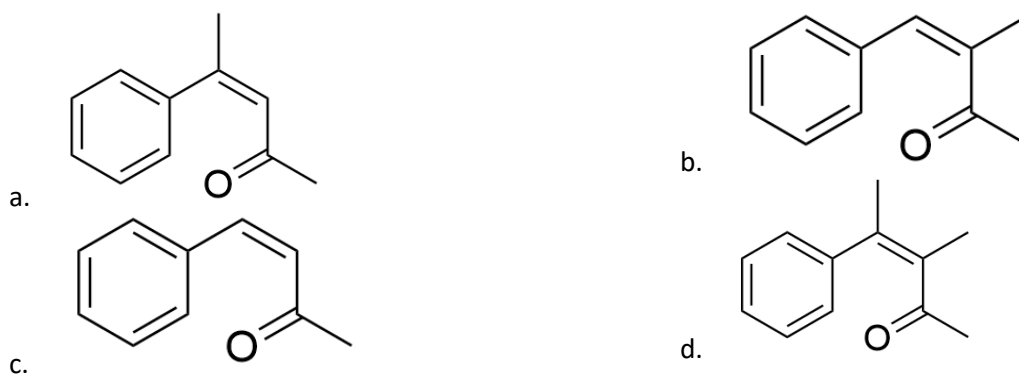


It has a free amine group and hence reacts with ninhydrin to give purple colour known as Ruhemann's purple. Also, it has Sulphur, therefore, it will give positive test with sodium nitroprusside.

20.

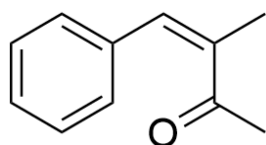


Predict the compound (P) on the basis of above sequence of the reactions, where compound (P) gives positive Iodoform test:

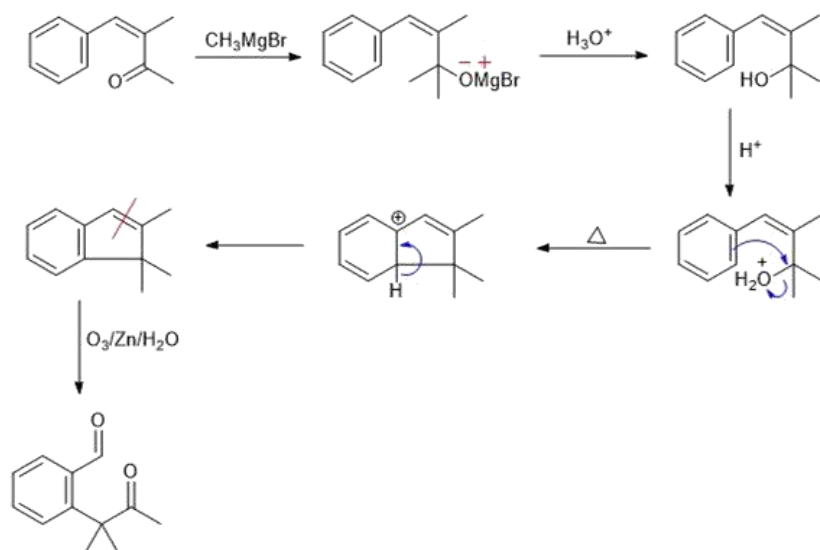


Answer: b

Solution:



is a methyl ketone, which gives positive Iodoform test.



21. Given a solution of HNO_3 of density 1.4 g/mL and $63\% \frac{\text{w}}{\text{w}}$. Determine molarity of HNO_3 solution.

Answer: 14.00

Solution: $\% \frac{\text{w}}{\text{w}} = 63\%$

$$\rho = 1.4 \text{ g/mL}$$

$$M = \frac{\left(\% \frac{\text{w}}{\text{w}} \times \rho \times 10\right)}{\text{MM}}$$

$$M = \frac{(63 \times 1.4 \times 10)}{63}$$

$$M = 14 \text{ mol/L}$$

22. Determine the degree of hardness in terms of ppm of CaCO_3 of 10^{-3} molar MgSO_4 (aq).

Answer: 100.00

Solution:

Hardness of water is measured in ppm in terms CaCO_3 .

$$n_{\text{CaCO}_3} = n_{\text{MgSO}_4}$$

ppm is the parts (in grams) present per million i.e, 10^6

1000 mL has 10^{-3} moles of MgSO_4 .

Grams of CaCO_3 in 1000 mL = $10^{-3} \times 100$ grams

$$\text{Grams of } \text{CaCO}_3 \text{ in 1 mL} = \frac{10^{-3} \times 100}{1000 \text{ mL}} \text{ grams}$$

$$\text{Hardness} = \frac{10^{-3} \times 100}{1000 \text{ mL}} \times 10^6 = 100$$

23. Determine the amount of NaCl to be dissolved in 600 g of H_2O to decrease the freezing point by 0.2°C . Given : k_f of $\text{H}_2\text{O} = 2 \text{ K m}^{-1}$

Answer: 1.76

Solution: NaCl is strong electrolyte and gives 2 ions in the solution. This implies, $i=2$.

$$\text{Molality} = \frac{w \times 1000}{58.5 \times 600}$$

$$\Delta T_f = 0.2^\circ\text{C}$$

$$\Delta T_f = i \times k_f \times m$$

On solving we get,

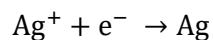
$$w = 1.76 \text{ grams}$$

24. On passing a particular amount of electricity in AgNO_3 solution, 108 g of Ag is deposited. What will be the volume of $\text{O}_2(\text{g})$ in litres liberated at 1 bar, 273 K by the same quantity of electricity?

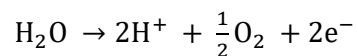
Answer: 5.68

Solution: On applying Faraday's 1st law,

Moles of Ag deposited = $108/108 = 1$ mol.



1 Faraday is required to deposit 1 mole of Ag.



$\frac{1}{2}$ moles of O_2 are deposited by 2 F of charge.

This implies, 1 F will deposit $\frac{1}{4}$ moles of O_2

Using $PV = nRT$

$P = 1$ bar

$T = 273$ K

$R = 0.0823$ Lbar $\text{mol}^{-1}\text{K}^{-1}$

On solving we get,

$V = 5.68$ L

25. Find percentage nitrogen by mass in Histamine?

Answer: 37.84

Solution:

Molecular mass of Histamine = 111

In Histamine, 3 Nitrogens are present (42g)

The percentage of Nitrogen by mass in Histamine = $\frac{42}{111} \times 100 = 37.84\%$

