

JEE Main 2020 Paper – Shift I – Chemistry

Date: 7th January 2020

Time: 09:30 am – 12:30 pm

Subject: Chemistry

1. The relative strength of inter-ionic/ intermolecular forces in the decreasing order is:

- a) ion-dipole > dipole-dipole > ion-ion
- b) dipole-dipole > ion-dipole > ion-ion
- c) ion-ion > ion-dipole > dipole-dipole
- d) ion-dipole > ion-ion > dipole-dipole

Answer: c

Solution:

Ion-ion interactions are stronger because they have stronger electrostatic forces of attraction whereas dipoles have partial charges and hence the electrostatic forces in their case would be relatively weak.

2. The oxidation number of K in K_2O , K_2O_2 and KO_2 respectively is:

- a) +0.5, +4, +1
- b) +2, +1, +0.5
- c) +1, +1, +1
- d) +0.5, +1, +2

Answer: c

Solution :

Alkali metals always possess a +1 oxidation state, whereas oxygen present in K_2O (oxide) is -2, and 1 in K_2O_2 (peroxide) is -1 and in KO_2 (superoxide) is -2.

3. At 35 °C the vapour pressure of CS_2 is 512 mm of Hg and that of acetone is 344 mm of Hg. A solution of CS_2 in acetone has a total vapour pressure of 600 mm of Hg. The false statement among the following is:

- a) CS_2 and acetone are less attracted to each other than themselves.
- b) Heat must be absorbed in order to produce the solution at 35 °C
- c) Raoult's law is not obeyed by this system
- d) A mixture of 100 mL CS_2 and 100 mL acetone has a volume less than 200 mL

Answer: d

Solution:

$$P_{\text{Total}} = P_T = P_A^\circ X_A + P_B^\circ X_B$$

The maximum value X_A can hold is 1, and hence the maximum value of P_T should come out to be 512 mm of Hg, which is less than the value of P_T observed (600 mm of Hg). Therefore, positive deviation from Raoult's law is observed. This implies that A-A interactions and B-B interactions are stronger than A-B interactions.

As we know, for a system not obeying Raoult's law and showing positive deviation,

$$\Delta V_{\text{mix}} > 0, \Delta H_{\text{mix}} > 0$$

4. The atomic radius of Ag is closest to:

- a) Ni
- c) Au
- b) Cu
- d) Hg

Answer: c

Solution:

Because of Lanthanide contraction, an increase in Z_{eff} is observed and so, the size of Au instead of being greater, as is expected, turns out to be similar to that of Ag.

5. The dipole moments of CCl_4 , CHCl_3 and CH_4 are in the order:

- a) $\text{CH}_4 > \text{CCl}_4 > \text{CHCl}_3$
- b) $\text{CHCl}_3 > \text{CCl}_4 > \text{CH}_4$
- c) $\text{CHCl}_3 > \text{CCl}_4 = \text{CH}_4$
- d) $\text{CCl}_4 = \text{CH}_4 > \text{CHCl}_3$

Answer: c

Solution:

All the three compounds possess a tetrahedral geometry. In both CCl_4 and CH_4 , $\mu_{\text{net}} = 0$, whereas in CHCl_3 , $\mu_{\text{net}} > 0$.

6. In comparison to the zeolite process for the removal of permanent hardness, the synthetic resins method is:

- a) Less efficient as it exchanges only anions
- b) More efficient as it can exchange only cations
- c) Less efficient as the resins cannot be generated
- d) More efficient as it can exchange both cations and anions

Answer: d

7. Amongst the following statements, which was not proposed by Dalton:

- a) Matter consists of indivisible atoms
- b) When gases combine or react in a chemical reaction, they do so in a simple ratio by volume provided all gases are maintained at the same temperature and pressure
- c) Chemical reactions involve reorganisation of atoms

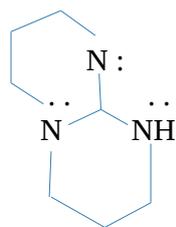
d) Atoms are neither created nor destroyed in a chemical reaction

Answer: b

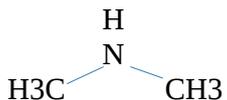
Solution:

When gases combine or react in a chemical reaction they do so in a simple ratio by volume provided all gases are maintained at the same temperature and pressure - Gay-Lussac's law.

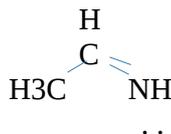
8. The increasing order of pK_b for the following compounds will be:



(i)



(ii)



(iii)

a) $i > ii > iii$

b) $iii > ii > i$

c) $ii > i > iii$

d) $i < iii < ii$

Answer: b

Solution:

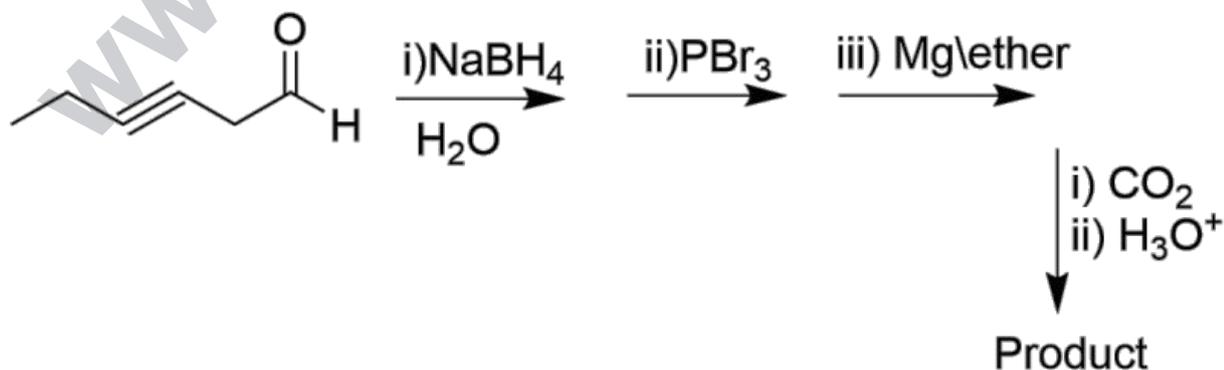
Weaker the conjugate acid, stronger the base. (i) is the most basic as it has a guanidine like structure. It has a high tendency of accepting a proton, giving rise to a very stable conjugate acid and hence, is a very strong base.

In compound (iii), the N is sp^2 hybridised and its electronegativity is higher as compared to the compound (ii) which is a 2° amine (sp^3 hybridised). So compound (ii) is more basic compared to compound (iii).

So the order of basicity is $i > ii > iii$ and thus the order of pK_b value will be $iii > ii > i$

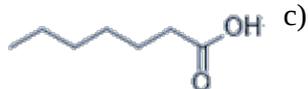
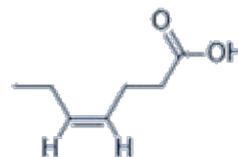
9. What is the product of the following reaction?

Solution :





b)

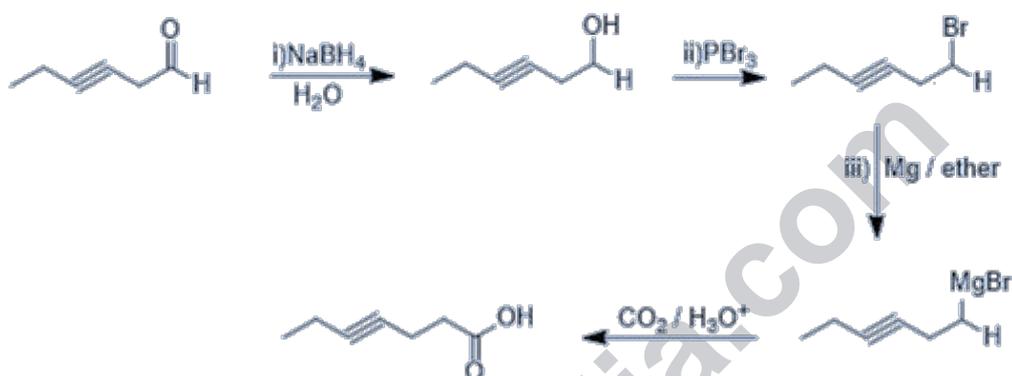


c)

d)



Solution :



10. The number of orbitals associated with quantum number $n=5$, $m_s = +1/2$ is:

- a) 50
- b) 16
- c) 25
- d) 30

Answer: c

Solution:

$n = 5$; $l = (n - 1) = 4$; hence the possible sub-shells for $n=5$ are: 5s, 5p, 5d, 5f and 5g.

The number of orbitals in each would be 1,3,5,7 and 9, respectively and summing them up gives the answer as 25.

11. The purest form of commercial iron is:

- a) Cast iron
- b) Wrought iron
- c) Pig iron
- d) None of these

Answer: b

12. The theory that can completely/ properly explain the nature of bonding in $[\text{Ni}(\text{CO})_4]$ is:

- a) Werner's theory
- b) Crystal Field Theory
- c) Molecular Orbital Theory
- d) Valence Bond Theory

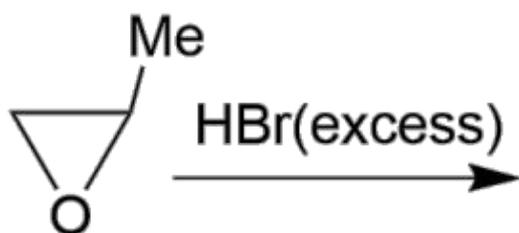
Answer: c

13. The IUPAC name of the complex $[\text{Pt}(\text{NH}_3)_2\text{Cl}(\text{NH}_2\text{CH}_3)]\text{Cl}$ is:

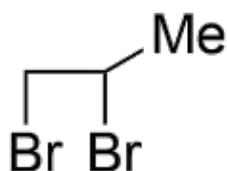
- a) Diamminechloridomethylamineplatinum(II) chloride
- b) Chloridomethanaminodiammineplatinum(II) chloride
- c) Diamminechloridomethylamineplatinate(II) chloride
- d) None of these

Answer: a

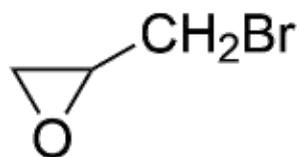
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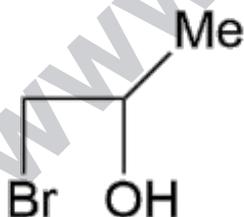
a)



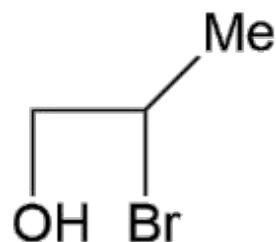
b)



c)

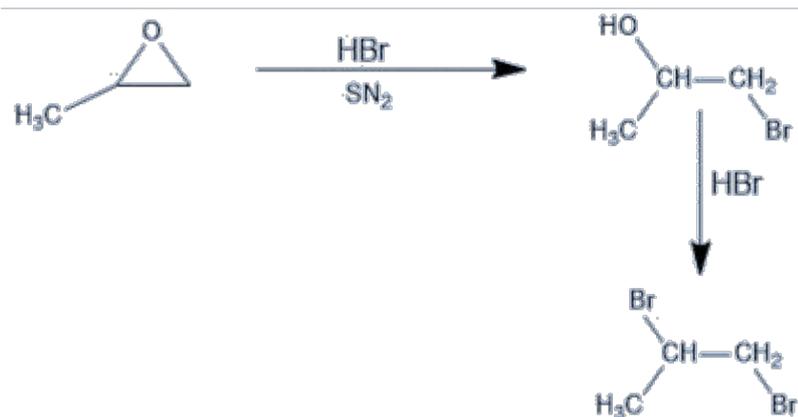


d)

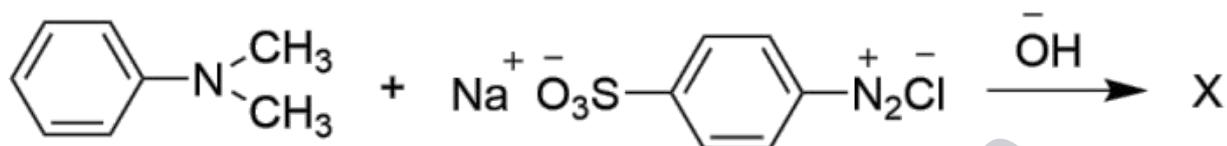


Answer: a

Solution :



15. Consider the following reaction:



The product X is used:

- In protein estimation as an alternative to Ninhydrin
- As a food grade colourant
- In laboratory test for phenols
- In acid-base titration as an indicator

Answer: d

Solution :



X formed is methyl orange.

16. Match:

List I	List II
i) Riboflavin	p) Beri
ii) Thiamine	q) Scurvy
iii) Ascorbic Acid	r) Cheilosis
iv) Pyridoxine	s) Convulsions

	i	ii	iii	iv
a)	s	q	p	r
b)	r	p	q	s

Solution:

m-chlorobenzoic acid being the most acidic can be separated by a weak base like NaHCO_3 and hence will be labelled fraction A.

m-chlorophenol is not as acidic as m-chlorobenzoic acid, and can be separated by a stronger base like NaOH , and hence can be labelled as fraction B.

m-chloroaniline being a base, does not react with either of the bases and hence would be labelled as fraction C.

19. The electron gain enthalpy in kJ/mol of F, Cl, Br, and I respectively are:

- a) -295, -324, -348, -333
- b) -348, -324, -333, -295
- c) -333, -348, -324, -295
- d) -348, -333, -295, -324

Answer: c

Solution:

$\text{Cl} > \text{F} > \text{Br} > \text{I}$

20. Consider the following reactions:

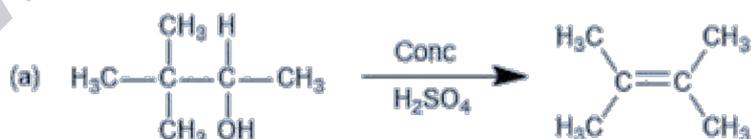


Which of these reactions will not produce Saytzeff product?

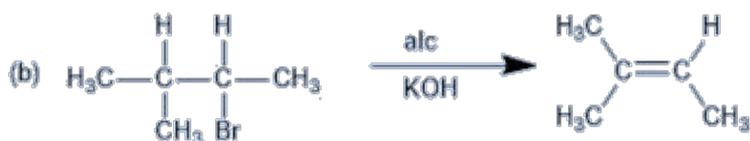
Answer: c

Solution :

a)



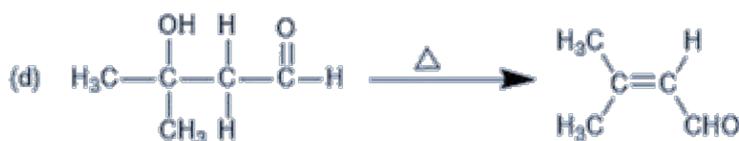
b)



c)



d)



21. Two solutions A and B each of 100 L was made by dissolving 4 g of NaOH and 9.8 g of H₂SO₄ in water respectively. The pH of the resulting solution obtained by mixing 40 L of Sol A and 10 L of Sol B is:

Answer: 10.6

Solution:

Molarity of NaOH (4 g in 100 L) = 10^{-3} M

Molarity of H₂SO₄ (9.8 g in 100 L) = 10^{-3} M

Equivalents of NaOH = $M \times V \times n_f = 10^{-3} \times 40 \times 1 = 0.04$

Equivalents of H₂SO₄ = $M \times V \times n_f = 10^{-3} \times 10 \times 2 = 0.02$

$M_{\text{NaOH}} \cdot V_{\text{NaOH}} \cdot (n_f)_{\text{NaOH}} - M_{\text{H}_2\text{SO}_4} \cdot V_{\text{H}_2\text{SO}_4} \cdot (n_f)_{\text{H}_2\text{SO}_4} = M \cdot V_{\text{total}}$

$10^{-3} \times 40 \times 1 - 10^{-3} \times 10 \times 2 = M \cdot 50$

$M = 4 \times 10^{-4}$

pOH = $-\log M$

= $4 - 2\log 2$

= 3.4

pH = $14 - 3.4 = 10.6$

22. During the nuclear explosion, one of the products ⁹⁰Sr was absorbed in the bones of a newly born baby in place of Ca. How much time in years is required to reduce it by 90% if it is not lost

metabolically? ($t_{1/2} = 6.93$ years)

Answer: 23.03

Solution:

All nuclear processes follow first order kinetics, and hence hence

$$t_{1/2} = \frac{0.693}{\lambda}$$

$$\lambda = 0.1 \text{ (year)}^{-1}$$

$$t = 2.303$$

$$\frac{\log \{a_0\}}{\lambda} - \frac{\log \{a_t\}}{\lambda}$$

$$t = 2.303$$

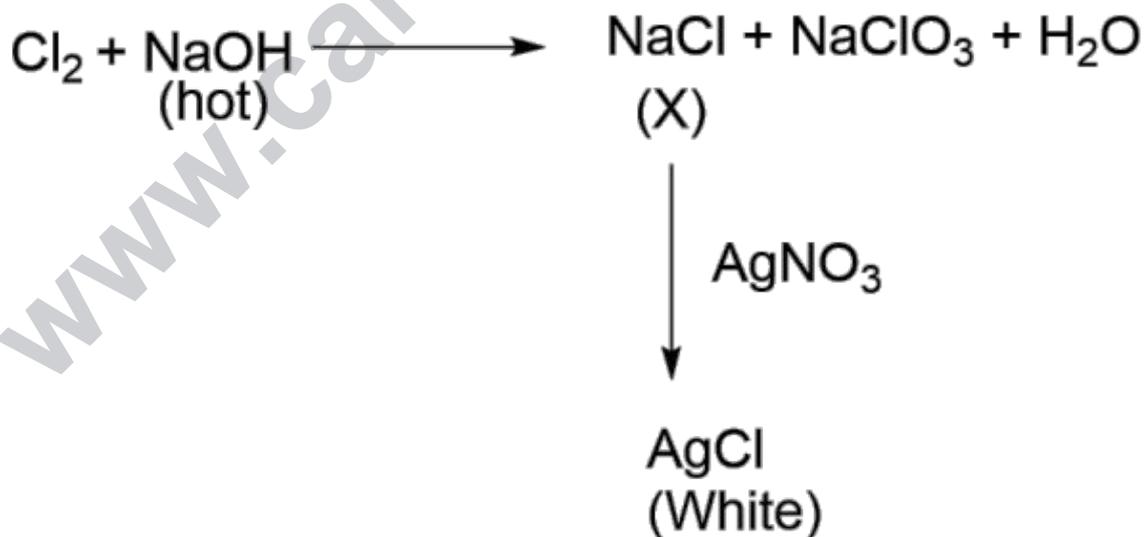
$$\frac{\log \{a_0\}}{\lambda} - \frac{\log \{0.1a_0\}}{\lambda}$$

On solving, $t = 23.03$ years

23. Chlorine reacts with hot and conc. NaOH and produces compounds X and Y. Compound X gives a white precipitate with AgNO₃ soln. The average bond order between Cl and O atoms in Y is?

Answer: 1.67

Solution:



$$\text{Bond order} = \frac{\text{Total number of bonds}}{\text{Total reasoning structures}} = \frac{\text{---}}{3} = 1.67$$

24. The number of chiral carbons in chloramphenicol is:

Answer: 2

Solution:



25. The reaction $A(l) \rightarrow 2B(g)$

$\Delta U = 2.1 \text{ kcal}$, $\Delta S = 20 \text{ cal/K}$ at 300 K, find ΔG in kcal.

Answer: -2.7

Solution:

$$\Delta H = \Delta U + \Delta n_g RT$$

$$\Delta H = 2100 + (2 \times 2 \times 300) \quad (R = 2 \text{ calK}^{-1} \text{ mol}^{-1})$$

$$= 3300 \text{ cal}$$

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G = 3300 - (300 \times 20) = -2700 \text{ cal} = -2.7 \text{ kcal}$$