JEE Main 2020 Paper

Date: 7th January 2020

Time: 09:30 am – 12:30 pm

Subject: Chemistry

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1. The relative strength of interionic/ intermolecular forces in 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. Oxidation number of potassium in K_2O, K_2O_2 and KO_2, respectively, is :
   a) $+2, +1$ and $+\frac{1}{2}$
   b) $+1, +2$ and $+4$
   c) $+1, +1$ and $+1$
   d) $+1, +4$ and $+2$

Answer: c

Solution:

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

3. At 35^0C, the vapour pressure of CS_2 is 512 mm Hg and that of acetone is 344 mm Hg. A solution of CS_2 in acetone has a total vapour pressure of 600 mm Hg. The false statement amongst the following is :
   a) CS_2 and acetone are less attracted to each other than to themselves
   b) heat must be absorbed in order to produce the solution at 35^0C
   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 $<$ 200 mL

Answer: d

Solution:

$P_{Total} = P_T = p_A^0 X_A + p_B^0 X_B$

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 that 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, $\Delta V_{mix} > 0$, $\Delta H_{mix} > 0$.

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4. The atomic radius of Ag is closest to :
   a) Ni
   b) Cu
   c) Au
   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 be similar to that of Ag.

5. The dipole moments of CCl_4, $CHCl_3$ and CH_4 are in the order:
   a) $CH_4 < CCl_4 < CHCl_3$
   b) $CHCl_3 < CH_4 = CCl_4$
   c) $CH_4 = CCl_4 < CHCl_3$
   d) $CCl_4 < CH_4 < CHCl_3$

Answer: c

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

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 exchanges only cations
   c) less efficient as the resins cannot be regenerated
   d) more efficient as it can exchange both cations as well as anions

Answer: d

7. Amongst the following statements, that which was not proposed by Dalton was :
   a) matter consists of indivisible atoms
   b) when gases combine or reproduced in a chemical reaction they do so in a simple ratio by volume provided all gases are at the same T & P.
   c) Chemical reactions involve reorganisation of atoms. These are neither created nor destroyed in a chemical reaction.
   d) all the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass.

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.

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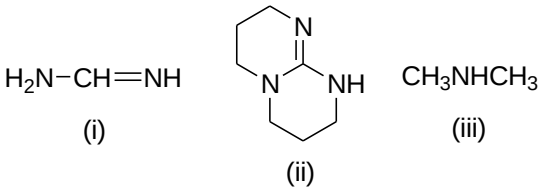
8. The increasing order of pK_b for the following compounds will be :



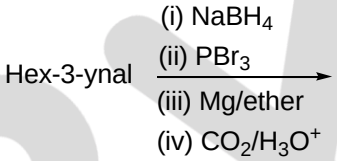
a) ii < iii < i
b) iii < i < ii
c) i < ii < iii
d) ii < i < iii

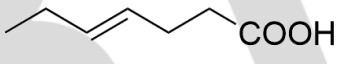
Answer: d

Solution:
Weaker the conjugate acid, stronger the base. (ii) 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 (i), the N is sp^2 hybridised and its electronegativity is higher as compared to the compound (iii) which is a 2^0 amine (sp^3 hybridised). So compound (ii) is more basic compared to compound (iii).

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

9. What is the product of the following reaction?



a)


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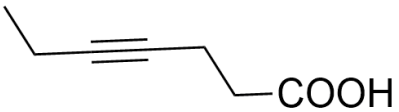

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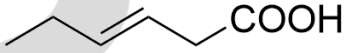

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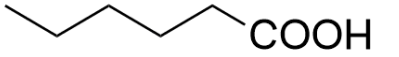
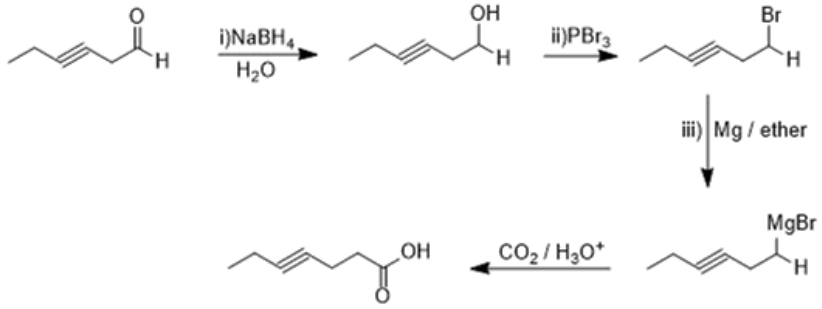


Answer: b

Solution:



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10. The number of orbitals associated with quantum number n=5, m_s=+½ is :
    a) 11
    b) 15
    c) 25
    d) 50

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) scrap iron and pig iron
    d) pig iron

Answer: b

12. The theory that can completely/ properly explain the nature of bonding in [Ni(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 $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ is :
    a) Diamminechlorido(methanamine)platinum(II)chloride
    b) Bisammine(methanamine)chloridoplatinum(II) chloride
    c) Diammine(methanamine)chloridoplatinum(II)chloride
    d) Diamminechlorido(aminomethane)platinum(II)chloride

Answer: a

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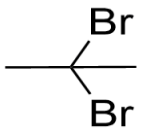
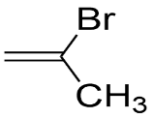
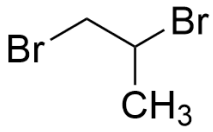
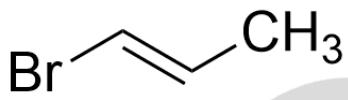
14. 1-methyl ethylene oxide when treated with an excess of HBr produces:

a) 

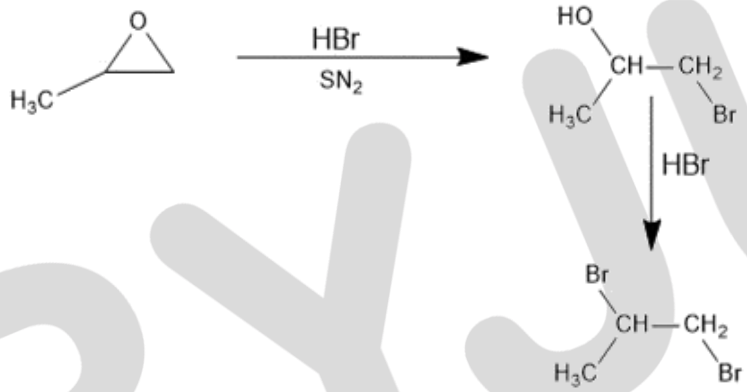
b) 

c) 

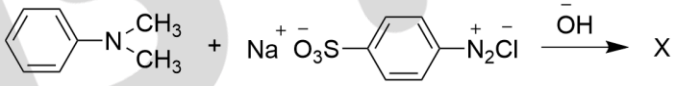
d) 

Answer: c

Solution:



15. Consider the following reaction:

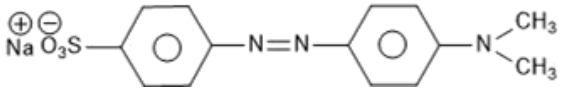


The product 'X' is used:

a) in protein estimation as an alternative to ninhydrin
b) as food grade colourant
c) in laboratory test for phenols
d) in acid-base titration as an indicator

Answer: d

Solution:



X formed is methyl orange.

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16. Match the following:

List I	List II
i) Riboflavin	p) Beri beri
ii) Thiamine	q) Scurvy
iii) Ascorbic acid	r) Cheliosis
iv) Pyridoxine	s) Convulsions

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

Answer: b

Solution:

Vitamins	Deficiency diseases
i) Riboflavin (Vitamin B_2)	Cheilosis
ii) Thiamine (Vitamin B_1)	Beri beri
iii) Ascorbic acid (Vitamin C)	Scurvy
iv) Pyridoxine (Vitamin B_6)	Convulsions

17. Given that the standard potential; (E^o) of Cu^{2+}/Cu and Cu^+/Cu are 0.34 V and 0.522 V respectively, the E^o of Cu^{2+}/Cu^+ is :

a) +0.158 V
b) -0.158 V
c) 0.182 V
d) -0.182 V

Answer: a

Solution:

$Cu^{2+} + 2e^- \rightarrow Cu \quad E^\circ = 0.340$ V

$Cu \rightarrow Cu^+ + e^- \quad E^\circ = -0.522$ V

$Cu^{2+} + e^- \rightarrow Cu^+ \quad E^\circ = ?$

Applying $\Delta G = -nFE^\circ$

We get,

$(-1 \times F \times E^\circ) = -2 \times F \times 0.340 + (-1 \times F \times -0.522)$

Solving, we get, $E^\circ = 0.158$ V

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18. A solution of m-chloroaniline, m-chlorophenol and m-chlorobenzoic acid in ethyl acetate was extracted initially with a saturated solution of $NaHCO_3$ to give fraction A. The left over organic phase was extracted with dil. NaOH solution to give fraction B. The final organic layer was labelled as fraction C. Fractions A, B and C, contain respectively:

a) m-chlorobenzoic acid, m-chlorophenol and m-chloroaniline
b) m-chlorophenol, m-chlorobenzoic acid and m-chloroaniline
c) m-chloroaniline, m-chlorobenzoic acid and m-chlorophenol
d) m-chlorobenzoic acid, m-chloroaniline and m-chlorophenol

Answer: a

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 fluorine, chlorine, bromine, and iodine, respectively, are:

a) -333, -325, -349 and -296
b) -333, -349, -325 and -296
c) -296, -325, -333 and -349
d) -349, -333, -325 and -296

Answer: b

Solution:
Cl > F > Br > I

20. Consider the following reactions:

a) $(CH_3)_3CCH(OH)CH_3 \xrightarrow{Conc.H_2SO_4}$

b) $(CH_3)_2CHCH(Br)CH_3 \xrightarrow{Alc.KOH}$

c) $(CH_3)_2CHCH(Br)CH_3 \xrightarrow{(CH_3)_3\bar{O}\,K^+}$

d) $(CH_3)_2C(OH)-CH_2CHO \xrightarrow{\Delta}$

Which of these reaction(s) will not produce Saytzeff product?

a. b and d
b. d only
c. a, c and d
d. c only

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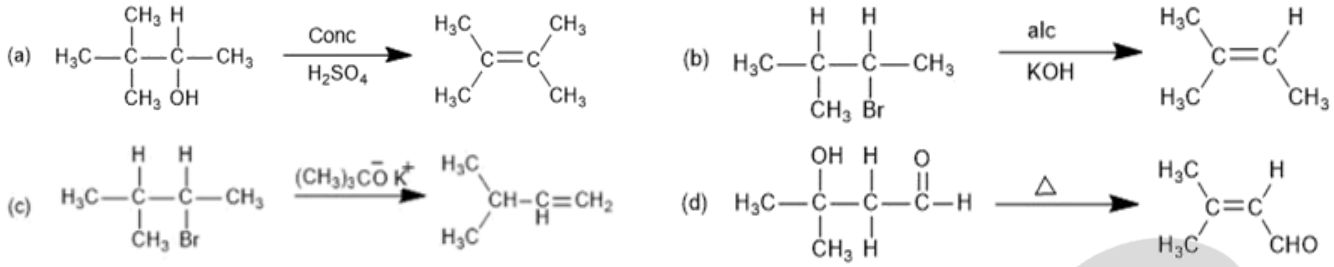
Answer: d

Solution:



21. Two solutions A and B each of 100 L was made by dissolving 4 g of NaOH and 9.8 g of H_2SO_4 in water, respectively. The pH of the resulting solution obtained from mixing 40 L of Solution A and 10 L of Solution B is:

Answer: 10.6

Solution:

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

Molarity of H_2SO_4 (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 H_2SO_4= $M \times V \times n_f = 10^{-3} \times 10 \times 2 = 0.02$

$$M_{NaOH}.V_{NaOH}.(n_f)_{NaOH} - M_{H_2SO_4}.V_{H_2SO_4}.(n_f)_{H_2SO_4} = M.V_{total}$$

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

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

pOH= -log M

=4 – 2log2

=3.4

pH= 14 -3.4 = 10.6

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22. During the nuclear explosion, one of the products is ^{90}Sr with half of 6.93 years. If 1 μg of ^{90}Sr 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

Answer: 23.03

Solution:
All nuclear processes follow first order kinetics, and hence

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

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

$t = \frac{2.303}{\lambda}\left(\frac{\log(a_0)}{a_t}\right)$

$t = \frac{2.303}{0.1}\left(\frac{\log(a_0)}{0.1a_0}\right)$

On solving, t= 23.03 years

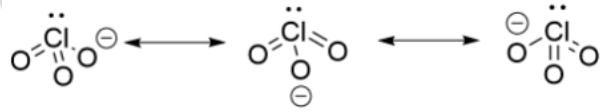
23. Chlorine reacts with hot and concentrated NaOH and produces compounds (X) and (Y). Compound (X) gives white precipitate with silver nitrate solution. The average bond order between Cl and O atoms in (Y) is

Answer: 1.67

Solution:

$Cl_2 + NaOH$ (hot) $\longrightarrow$ $NaCl + NaClO_3 + H_2O$ (X)

(X) $\xrightarrow{AgNO_3}$ AgCl (White)



$$\text{Bond order} = \frac{\text{Total no of bonds}}{\text{Total resonating structures}} = \frac{5}{3} = 1.67$$

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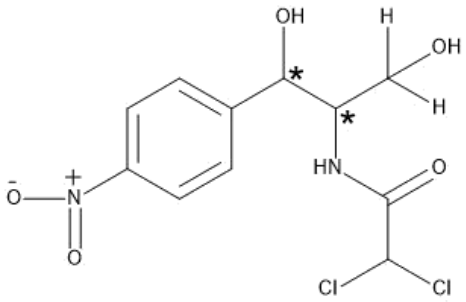
24. The number of chiral carbons in chloramphenicol is:

Answer: 2

Solution:



25. For the reaction $A_{(l)} \rightarrow 2B_{(g)}$

$\Delta U = 2.1$ kcal, $\Delta S = 20$ calK^{-1} at 300 K, Hence ΔG in kcal is

Answer: -2.7

Solution:

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

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

$= 3300$ cal

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

$\Delta G = 3300 - (300 \times 20) = -2.7$ kcal

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