JEE MAIN July 2021

CHEMISTRY

25th July 2021 [SHIFT – 2]

QUESTION WITH SOLUTION

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SECTION –A

1. The ionic radii of F^- andO^{2-} respectively are 1.33 Å and 1.4Å, while the covalent radius of N is 0.74 Å.

The correct statement for the ionic radius of N^{3-} from the following is :

(1) It is bigger than F^- and N, but smaller than of O^{2-}

(2) It is smaller than O^{2-} and F^-, but bigger than of N

(3)It is bigger than O^{2-} and F^-

(4) It is smaller than F^- and N

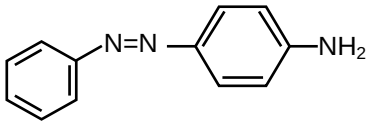
Sol. **(3)**

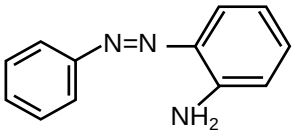
F^-, O^{2-} and N^{3-} all are isoelectronic species inwhich N^{3-} have least number of protons due to which it's size increases as least nuclear attractionis experienced by the outer shell electrons.

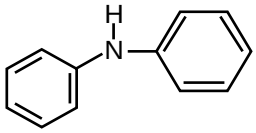
Size order $N^{3-} > O^{2-} > F^-$

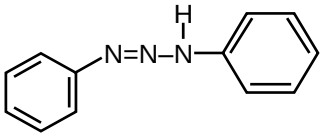
2. $C_6H_5NO_2 \xrightarrow{Sn+HCl}$ "A" $\xrightarrow[H^{\oplus}]{C_6H_5\overset{\oplus}{N}_2\overset{\ominus}{Cl}}$ P (Yellow coloured compund)

Consider the above reaction, the Product "P" is:

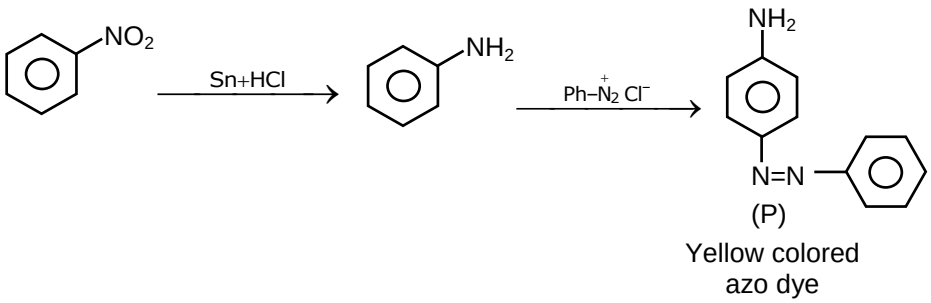
(1) 

(2) 

(3) 

(4) 

Sol. **(1)**

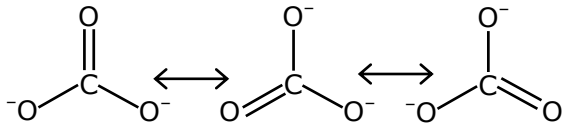


3. Identify the species having one π-bond and maximum number of canonical forms from the following :

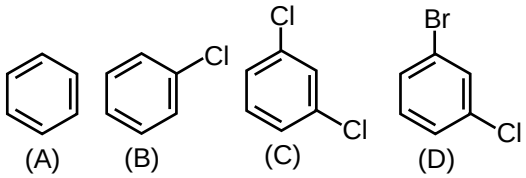
(1) CO_3^{2-} (2) O_2 (3) SO_2 (4) SO_3

Sol. **(1)**

Among SO_3, O_2, SO_2 and CO_3^{2-} only O_2 and CO_3^{2-} has only one π-bond



4. The correct decreasing order of densities of the following compounds is:



(1) (D) > (C) > (B) > (A)

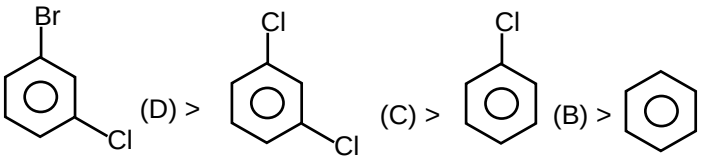
(2) (C) > (B) > (A) > (D)

(3) (C) > (D) > (A) > (B)

(4)(A) > (B) > (C) > (D)

Sol. **(1)**

The density order



5. In the following the correct bond order sequence is :

(1) $O_2^+ > O_2 > O_2^- > O_2^{2-}$

(2) $O_2 > O_2^- > O_2^{2-} > O_2^+$

(3) $O_2^{2-} > O_2^+ > O_2^- > O_2$

(4) $O_2^+ > O_2^- > O_2^{2-} > O_2$

Sol. **(1)**

$\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \sigma_{2p_z}^2$

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

Bond order of $O_2 \Rightarrow 2$

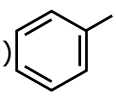
Bond order of $O_2^- \Rightarrow 1.5$

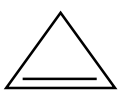
Bond order of $O_2^{2-} \Rightarrow 1$

Bond order of $O_2^+ \Rightarrow 2.5$

6. Which among the following is the strongest acid ?

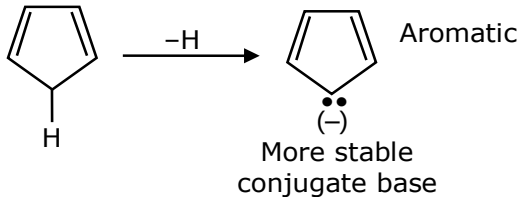
(1) 

(2) 

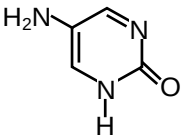
(3) 

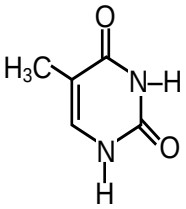
(4) $CH_3CH_2CH_2CH_3$

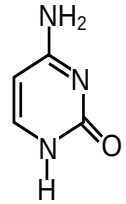
Sol. **(1)**

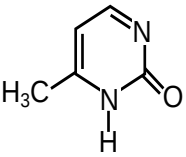


7. Which one of the following is correct structure of cytosine ?

(1) 

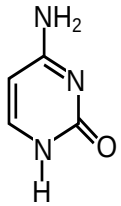
(2) 

(3) 

(4) 

Sol. **(3)**

The correct structure of cytosine



8. Match **List I** with **List II** :

List –I		**List – II**
Example of Colloids		**Classification**
(a) Cheese	(i)	dispersion of liquid in liquid
(b)Pumice stone	(ii)	dispersion of liquid in gas
(c)Hair cream	(iii)	dispersion of gas in solid
(d)Cloud	(iv)	dispersion of liquid in solid

Choose the most appropriate answer from the options given below:

(1) (a) – (iv), (b)-(iii), (c) – (i), (d)-(ii)

(2) (a) – (iv), (b)-(iii), (c) – (ii), (d)-(i)

(3) (a) – (iv), (b)-(i), (c) – (iii), (d)-(ii)

(4) (a) – (iii), (b)-(iv), (c) – (i), (d)-(ii)

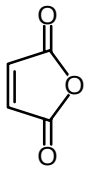
Sol. **(1)**

Cheese → liquid is solid

Pumice stone → gas in solid

Hair cream → liquid in liquid

Cloud → liquid in gas

9. 

Maleic anhydride

Maleic anhydride can be prepared by :

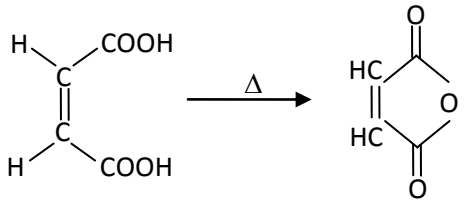
(1) Treating cis-but-2-enedioic acid with alcohol and acid

(2) Heating cis-but-2-enedioic acid

(3) Treating trans-but-2-enedioic acid with alcohol and acid

(4)Heating trans-but-2-enedioic acid

Sol. **(2)**



Cis but 2-enoic acid

10. Match **List-I** With **List II** : (Both having metallurgical terms)

List-I		**List-II**
(A) Concentration of Ag Ore	(i)	Reverberatory furance
(B) Blast furnace	(ii)	Pig iron
(C) Blister copper	(iii)	Leaching with dilute NaCN solution
(D) Froth floatation method	(iv)	Sulfide ores

Choose the correct answer from the options given below :

(1) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)

(2) (a) - (iv), (b) - (i), (c) - (iii), (d) - (ii)

(3) (a) - (iii), (b) - (iv), (c) - (i), (d) - (ii)

(4) (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)

Sol. **(4)**

(a) Concentration of Ag is performed by leaching with dilute NaCN solution

(b)Pig iron is formed in blast furnace

(c)Blister Cu is produced in Bessemer converter

(d)Froth floatation method is used for sulphide ores.

Note : During extraction of Cu reverberatory furnace is involved.

11. The spin only magnetic moments (in BM) for free Ti^{3+}, V^{2+} and Sc^{3+} ions respectively are (At.No. Sc : 21; Ti : 22; V : 23)

(1) 1.73, 3.87, 0 (2) 0, 3.87, 1.73

(3) 3.87, 1.73, 0 (4) 1.73, 0, 3.87

Sol. **(1)**

$\mu = \sqrt{n(n+2)}\,BM$

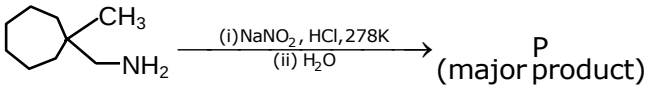
n = number of unpaired electrons

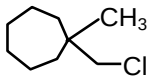
$Ti^{+3} = [Ar]3d^1$ n = 1 μ = 1.73 BM

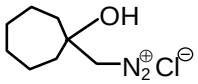
$V^{+2} = [Ar]3d^3$ n = 3 μ = 3.87 BM

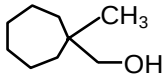
$Sc^{+3} = [Ar]3d^0 4s^0$ n = 0 μ = 0

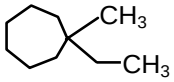
12. What is the major product "P" of the following reaction ?



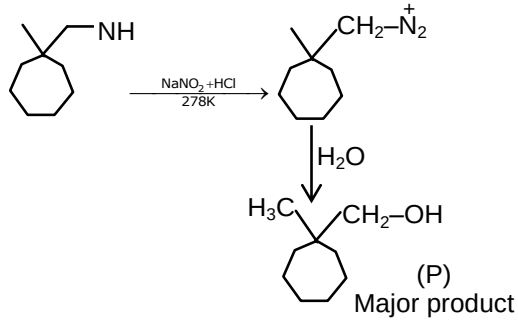
(1) 

(2) 

(3) 

(4) 

Sol. **(3)**



13. Which one of the following metals forms interstitial hydride easily ?

(1)Fe (2) Mn (3) Cr (4) Co

Sol. **(3)**

Elements of group 7, 8, 9 do not form hydrides thus Cr will only form hydride among the given elements (Fe, Mn, Co)

14. Match **List I** with **List II** :

	List – I elements		**List – II Properties**
(a)	Li	(i)	Poor water solubility of I^- salt
(b)	Na	(ii)	Most abundant element in cell fluid
(c)	K	(iii)	Bicarbonate salt used in fire extinguisher
(d)	Cs	(iv)	Carbonate salt decomposes easily on heating

Choose the correct answer from the options given below :

(1) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i) (2) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)

(3) (a)-(iv), (b)-(ii), (c)-(iii), (d)-(i) (3) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv)

Sol. **(1)**

(a) C_SI salt is poor water soluble due to it's lowhydration energy

(b) $NaHCO_3$ is used in fire extinguisher

(c) K is most abundant element in cell fluid

(d) Li_2CO_3 decomposes easily due to high covalentcharacter caused by small size Li^+ cation.

15. Identify the process in which change in the oxidation state is five :

(1) $C_2O_4^{2-} \rightarrow 2CO_2$ (2) $CrO_4^{2-} \rightarrow Cr^{3+}$

(3) $Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$ (4) $MnO_4^- \rightarrow Mn^{2+}$

Sol. **(4)**

$\underset{(+7)}{MnO_4^-} \rightarrow \underset{(+2)}{Mn^{2+}}$ 5 e^- change

16. A reaction of benzonitrile with one equivalent CH_3MgBr followed by hydrolysis produces a yellow liquid "P". The compound "P" will give positive.

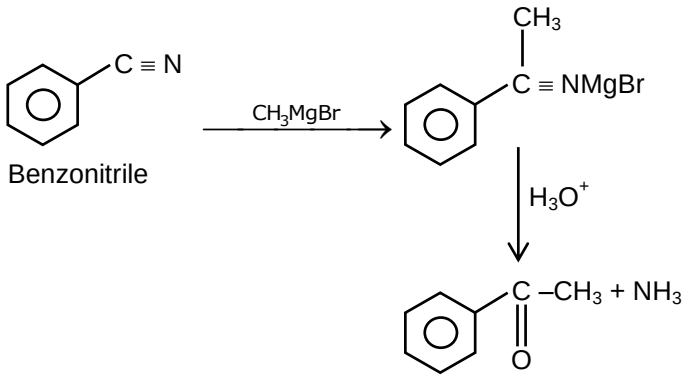
(1)Tollen's test

(2)Schiff's test

(3)Ninhydrin's test

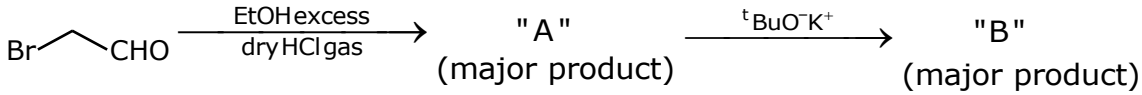
(4)Iodoform test

Sol. **(4)**



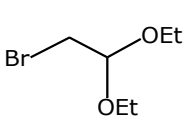
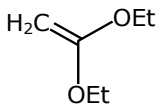
Benzonitrile

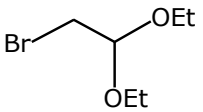
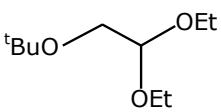
It is gives positive Iodoform test

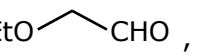
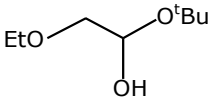
17. 

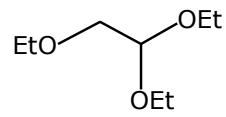
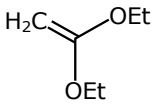
[Where Et ⇒ $-C_2H_5$ ^tBu ⇒ $(CH_3)_3C-$]

Consider the above reaction sequence, Product "A" and Product "B" formed respectively are :

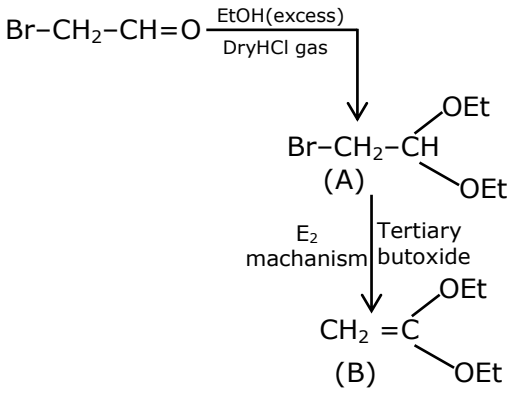
(1)  , 

(2)  , 

(3)  , 

(4)  , 

Sol. **(1)**



18. Given below are two statements :

Statement I : Chlorofluoro carbons breakdown by radiation in the visible energy region and release chlorine gas in the atmosphere which then reacts with stratospheric ozone.

Statement II : Atmospheric ozone reacts with nitric oxide to give nitrogen and oxygen gases, which add to the atmosphere.

For the above statements choose the correct answer from the options given below :

(1)Both statement I and II are correct

(2)Both statement I and II are false

(3)Statement I is correct but statement II is false

(4)Statement I is incorrect but statement II is true

Sol. **(2)**

CFCs are broken down by powerful UV radiationand releases chlorine free radical which reacts withozone and start chain reaction.

$$CF_2Cl_{2(g)} \xrightarrow{UV} \dot{C}l_{(g)} + \dot{C}F_2Cl_{(g)}$$

$$\dot{C}l_{(g)} + O_{3(g)} \rightarrow \dot{C}lO_{(g)} + O_{2(g)}$$

$$\dot{C}lO_{(g)} + O_{(g)} \rightarrow \dot{C}l_{(g)} + O_{2(g)}$$

Statement (2)

Atmosphere ozone reacts with nitric oxide toproduce nitrogen dioxide and oxygen.

$$NO_{(g)} + O_{3(g)} \rightarrow NO_{2(g)} + O_{2(g)}$$

19. A biodegradable polyamide can be made from:

(1)Hexamethylene diamine and adipic acid

(2)Styrene and caproic acid

(3)Glycine and aminocaproic acid

(4)Glycine and isoprene

Sol. **(3)**

A biodegradable polyamide nylon-2-Nylon-6 inmade from glycine and amino caproic acid

20. Which one of the following metal complexes is most stable?

(1)$[Co(en)(NH_3)_4]Cl_2$ (2)$[Co(en)_3]Cl_2$

(3) $[Co(NH_3)_6]Cl_2$ (4)$[Co(en)_2(NH_3)_2]Cl_2$

Sol. **(2)**

Complex $[Co(en)_3]Cl_2$ is most stable complexamong the given complex compounds because more number of chelate rings are present in thiscomplex as compare to others.

(1) $[Co(en)\ (NH_3)_4]Cl_2$ 1 chelate ring

(2) $[Co(en)_3]Cl_2$ 3 chelate ring

(3) $[Co(en)_2(NH_3)_2]Cl_2$ 2 chelate ring

(4) $[Co(NH_3)_6]Cl_2$ 0 chelate ring

SECTION –B

1. Number of electrons present in 4f orbital of Ho^{3+} ion is _____.

(Given Atomic No. of Ho = 67)

Sol. **(10)**

Ho = $[Xe]4f^{11}6s^2$

Ho^{3+}= $[Xe]\ 4f^{10}$

So number of e^- present 4f is 10.

2. Assuming that $Ba(OH)_2$ is completely ionised in aqueous solution under the given conditions the concentration of H_3O^+ ions in 0.005 M aqueous solution of $Ba(OH)_2$ at 298K is_____$\times 10^{-12}$ mol L^{-1}. (Nearest integer)

Sol. **(1)**

$Ba(OH)_2 \rightarrow Ba^{+2} + 2OH^- \rightarrow 2 \times 0.005 = 0.01 = 10^{-2}$

At 298 K : in aq. solution $[H3O^+]\ [OH^-] = 10^{-14}$

$$[H_3O^+] = \frac{10^{-14}}{10^{-2}} = 10^{-12}$$

$[H_3O^+] = 1 \times 10^{-12}$ M

3. An accelerated electron has a speed of 5×10^6 $ms^{-1}$with an uncertainty of 0.02%. The uncertainty in finding its location while in motion is $x \times 10^{-9}$ m. The value of x is_____. (Nearest integer)

[Use mass of electron = 9.1×10^{-31} kg, h = 6.63×10^{-34} Js, $\pi = 3.14$]

Sol. **(58)**

$$\Delta v = \frac{0.02}{100} \times 5 \times 10^6 = 10^3 m/s$$

According to Heisenberg uncertainty principle

$$\Delta x.\Delta v = \frac{h}{4\pi m}$$

$$x \times 10^{-9} \times 10^3 = \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31}}$$

$X \times 10^{-9} \times 10^3 = 0.058 \times 10^{-3}$

$$x = \frac{0.058 \times 10^{-6}}{10^{-9}} = 58$$

4. For a chemical reaction A $\rightarrow$ B, it was found that concentration of B is increased by 0.2 mol L^{-1} in 30 min. The average rate of the reaction is _____ $\times 10^{-1}$ mol L^{-1} h^{-1}. (Nearest integer)

Sol. **(4)**

A $\rightarrow$ B

t = 0 0

t = 30 min 0.2M

$$\text{Av. Rate of reaction} = -\frac{\Delta[A]}{\Delta t} = \frac{\Delta[B]}{\Delta t} = \frac{(0.2-0)}{\frac{1}{2}}$$

$= 0.4 = 4 \times 10^{-1}$ mol / L $\times$ hr

5. When 3.00 g of a substance 'X' is dissolved in 100 g of CCl_4, it raises the boiling point by 0.60 K. The molar mass of the substance 'X' is_____ g mol^{-1}. (Nearest integer).

[Given K_b for CCl_4 is 5.0 K kg mol^{-1}]

Sol. **(250)**

$\Delta T_b = K_b \times$ molality

$$0.60 = 5 \times \left(\frac{3/M}{100/1000}\right)$$

M = 250

6. The number of significant figures in 0.00340 is _____.

Sol. **(3)**

Number of significant figures = 3

7. An LPG cylinder contains gas at a pressure of 300 kPa at 27°C. The cylinder can withstand the pressure of 1.2×10^6 Pa. The room in which the cylinder is kept catches fire. The minimum temperature at which the bursting of cylinder will take place is_____°C. (Nearest integer)

Sol. **(927)**

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow \frac{300 \times 10^3}{300} = \frac{1.2 \times 10^6}{T_2}$$

$\Rightarrow$ $T_2 = 1200$ K

$T_2 = 927$°C

8. 0.8 g of an organic compound was analysed by Kjeldahl's method for the estimation of nitrogen. If the percentage of nitrogen in the compound was found to be 42%, then _____ mL of 1 M H_2SO_4 would have been neutralized by the ammonia evolved during the analysis.

Sol. **(12)**

Organic compound : 0.8 gm

$$\text{wt. of N} = \left(\frac{42}{100} \times 0.8\right)\text{gm}$$

$$\text{mole of N} = \frac{42 \times 0.8}{100 \times 14} = \frac{2.4}{100}\text{mol}$$

moles of $NH_3 = \frac{2.4}{100}$

$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2 SO_4$

$\frac{2.4}{100}$ mole $\quad \frac{1.2}{100}$ mole

For H_2SO_4 $\quad \frac{1.2}{100} = 1 \times V(\ell)$

$\Rightarrow V_{H_2SO_4} = \frac{1.2}{100}\ell = 12m\ell$

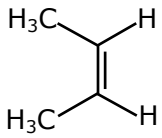
9. A system does 200J of work and at the same time absorbs 150 J of heat. The magnitude of the change in internal energy is _____J. (Nearest integer)

Sol. **(50)**

w = –200 J, q = +150 : $\Delta U = q + w$

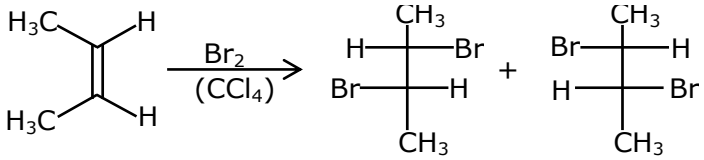
$\Delta U = 150 - 200 = -50$ J

magnitude = 50 J = $|\Delta U|$

10.  + $Br_2 \xrightarrow{CCl_4}$ Product "P"

Consider the above chemical reaction. The total number of stereoisomers possible for product 'P' is _____.

Sol. **(2)**



The total number of products possible = 2

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