JEE Main September 2020

Question Paper With Text Solution

5 September| Shift-1

CHEMISTRY

MATRIX

JEE Main & Advanced | XI-XII Foundation| VI-X Pre-Foundation

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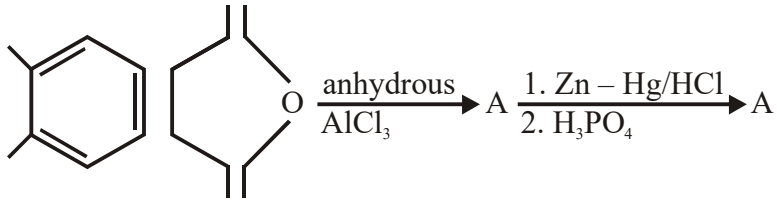
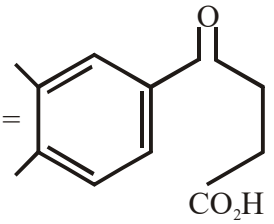
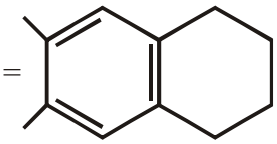
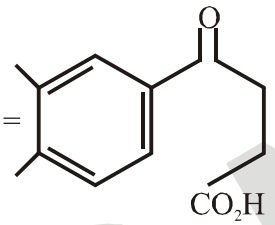
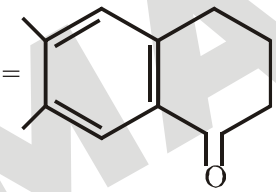
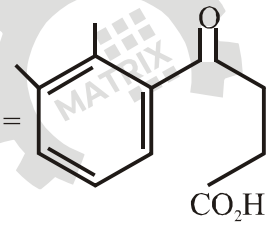
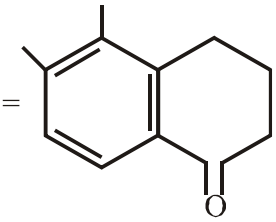
JEE MAIN SEP 2020 | 5 SEP SHIFT-1

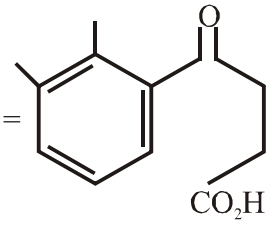
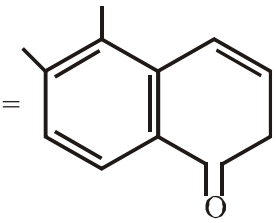
1. In the following reaction sequence the major products A and B are :



(1) A =  ; B = 

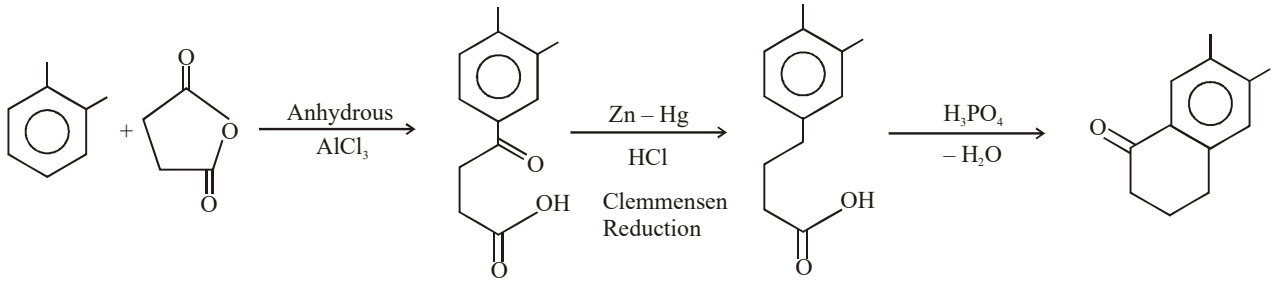
(2) A =  ; B = 

(3) A =  ; B = 

(4) A =  ; B = 

Ans (2)

Sol.



2. A diatomic molecule X_2 has a body-centred cubic (bcc) structure with a cell edge of 300 pm. The density of the molecule is 6.17 g cm^{-3}. The number of molecules present in 200 g of X_2 is :

(Avogadro constant $(N_A) = 6 \times 10^{23}$ mol^{-1})

(1) 2 N_A (2) 40 N_A (3) 4 N_A (4) 8 N_A

Ans (3)

Sol. For BCC [Z = 2]

$$d = \frac{Z \times M}{N_A \times \text{Volume}} = 6.17 \text{ gm/cm}^3$$

[Z = 2, Volume = a^3, $a = 3 \times 10^{-8}$ cm]

$$6.17 = \frac{2 \times M}{6.02 \times 10^{23} \times [3 \times 10^{-8}]^3}$$

M = 49.977 gm = molecular mass

$$\text{So number of molecules of } X_2 \text{ in 200 gram} = \frac{200}{49.977} \times N_A \approx 4N_A$$

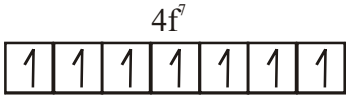
3. The correct electronic configuration and spin-only magnetic moment (BM) of Gd^{3+} (Z = 64), respectively, are:

(1) [Xe] $4f^7$ and 7.9 (2) [Xe] $5f^7$ and 8.9 (3) [Xe] $5f^7$ and 7.9 (4) [Xe] $4f^7$ and 7.9

Ans (1)

Sol. Electronic configuration of ^{64}Gd = [Xe] $4F^7$ $5d^1$ $6s^2$

Electronic configuration of $^{64}Gd^{3+}$ = [Xe] $4F^7$ $\Rightarrow$



No. of unpaired electron (n) = 7

$\mu = \sqrt{n(n+2)}\,BM = \sqrt{63} = 7.93BM$

4. A flask contains a mixture of compounds A and B. Both compounds decompose by first-order kinetics. The half-lives for A and B are 300 s and 180 s, respectively. If the concentrations of A and B are equal initially, the time required for the concentration of A to be four times that of B (in s) is : (Use In 2 = 0.693)

(1) 120 (2) 180 (3) 900 (4) 300

Ans (3)

Sol. $C_t = C_o\, e^{-Kt}$

$A_t = 4B_t$

$$C_o e^{-\frac{l\,n\,2}{300}t} = 4C_o e^{-\frac{l\,n\,2}{180}t}$$

$$e^{\left(\frac{l\,n\,2}{180}-\frac{l\,n\,2}{300}\right)t} = 4$$

$$\left(\frac{l\,n\,2}{180}-\frac{l\,n\,2}{300}\right)t = l\,n\,4$$

$$t = \frac{2\times180\times300}{120} = 900$$

5. The equation that represents the water-gas shift reaction is :

(1) $C(s) + H_2O(g) \xrightarrow{1270\ K} CO(g) + H_2(g)$

(2) $2\,C(s) + O_2(g) + 4\,N_2(g) \xrightarrow{1273\ K} 2\,CO(g) + 4\,N_2(g)$

(3) $CO(g) + H_2O(g) \xrightarrow[\text{Catalyst}]{676\ K} CO_2(g) + H_2(g)$

(4) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270\ K} CO(g) + 3\,H_2(g)$

Ans (1)

Sol. $C_{(s)} + H_2O_{(g)} \xrightarrow{473-1273K} CO_{(g)} + H_{2(g)}$ (water gas).

6. The values of the crystal field stabilization energies for a high spin d^6 metal ion in octahedral and tetrahedral fields, respectively, are :

(1) $-1.6\ \Delta_O$ and $-0.4\Delta_t$ (2) $-2.4\ \Delta_O$ and $-0.6\Delta_t$

(3) $-0.4\ \Delta_O$ and $-0.6\Delta_t$ (4) $-0.4\ \Delta_O$ and $-0.27\Delta_t$

Ans (3)

Sol. For $3d^6$ configuration, (high spin complex)

(a) For octahedral complex

$3d^6 = t_{2g}^{2,1,1}, e_g^{1,1}$

Value of CFSE $= [-0.4nt_{2g} + 0.6ne_g]\ \Delta_0 + n(P)$

$= [-0.4 \times 4 + 0.6 \times 2]\ \Delta_0 + 0$

$= -0.4\ \Delta_0$

(b) For tetrahedral complex

$3d^6 = e_g^{2,1}, t_{2g}^{1,1,1}$

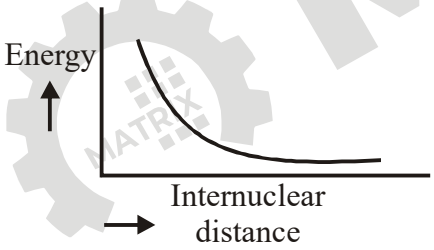
Value of CFSE $= [-0.6ne_g + 0.4nt_{2g}]\Delta_t + n(P)$

$= [-0.6 \times 3 + 0.4 \times 3]\Delta_t + 0$

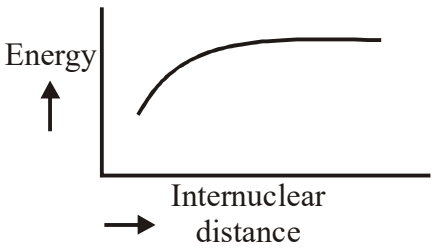
$= -0.6\Delta_t$

7. The potential energy curve for the H_2 molecule as a function of internuclear distance is :

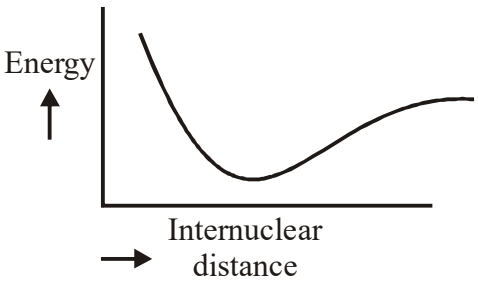
(1)



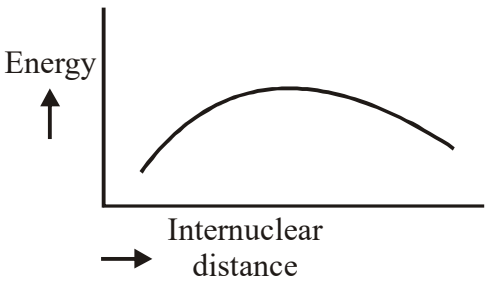
(2)



(3)

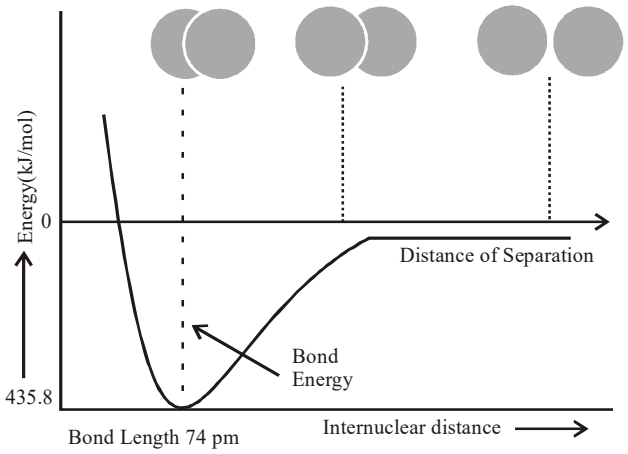


(4)

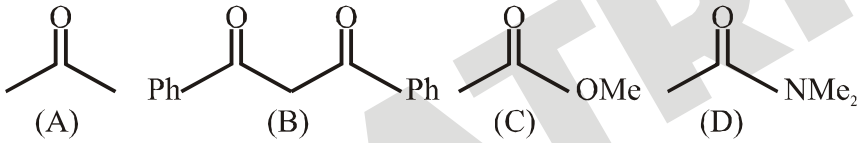


Ans (3)

Sol. Following curve is for potential energy for the formation of H_2 molecule as a function of internuclear distance of the H atoms. The minimum in the curve corresponds to the most stable state of H_2 (from NCERT).



8. The increasing order of the acidity of the α-hydrogen of the following compounds is :



(1) (A) < (C) < (D) < (B)

(2) (D) < (C) < (A) < (B)

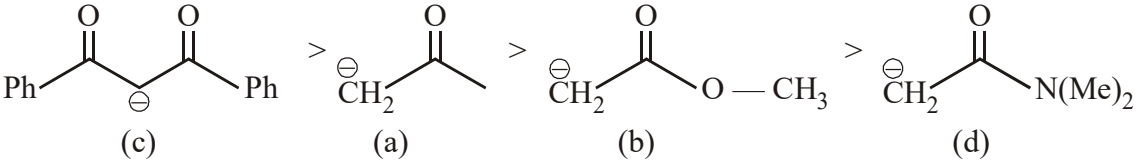
(3) (B) < (C) < (A) < (D)

(4) (C) < (A) < (B) < (D)

Ans (2)

Sol. Acidic strength of α–Hydrogen $\propto$ stability of conjugate base.

Order of stability of conjugate base.



Then order of acidic strength of α–Hydrogen.

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

9. If a person is suffering frm the deficiency of nor-adrenaline, what kind of drug can be suggested?

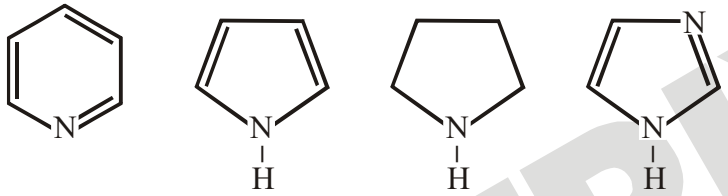
(1) Analgesic (2) Antidepressant

(3) Anti-inflammatory (4) Antihistamine

Ans (2)

Sol. If the level of noradrenaline is low for some reason, then the signal-sending activity becomes low, and the person suffers from depression. In such situations, antidepressant drugs are required.

10. The increasing order of basicity of the following compounds is :



(A) (B) (C) (D)

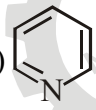
(1) (D) < (A) < (B) < (C)

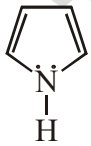
(2) (B) < (A) < (D) < (C)

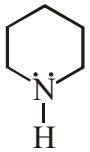
(3) (B) < (A) < (C) < (D)

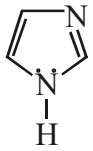
(4) (A) < (B) < (C) < (D)

Ans (2)

Sol. (A)  Nitrogen atom is sp^2 hybridised and lone pair does not participate in resonance.

(B)  Nitrogen atom is sp^2 hybridised and lone pair participate in resonance.

(C)  Nitrogen atom is sp^3 hybridised and +I of ring is present.

(D)  Nitrogen atom is sp^2 hybridsed and lone pair of that nitrogen is note participating in resonance and has partial negative charge due to resonance.

11. Identify the correct molecular picture showing what happens at the critical micellar concentration (CMC) of an aqueous solution of a surfactant (polar head; non-polar tail ; water).

(A) (B) (C) (D)

(1) (B) (2) (D) (3) (C) (4) (A)

Ans (2)

Sol. At CMC the anions are pulled into the bulk of the solution and aggregate to form a spherical shape with their hydrocarbon chains pointing towards the centre of the sphere with COO^- part remaining outward on the surface of the sphere.

12. The most appropriate reagent for conversion of C_2H_5CN into $CH_3CH_2CH_2NH_2$ is :

(1) CaH_2 (2) $LiAlH_4$ (3) $NaBH_4$ (4) $Na(CN)BH_3$

Ans (2)

Sol. $C_2H_5CN \xrightarrow{LiAlH_4} CH_3CH_2CH_2NH_2$

13. The structure of PCl_5 in the solid state is :

(1) trigonal bipyramidal

(2) square planar $[PCl_4]^+$ and octahedral $[PCl_6]^-$

(3) tetrahedral $[PCl_4]^+$ and octahedral $[PCl_6]^-$

(4) square pyramidal

Ans (3)

Sol. $2PCl_5(s) \rightarrow [PCl_4]^+ \ [PCl_6]^-$

	Hybridisation	Structure
$[PCl_4]^+$	sp^3	tetrahedral
$[PCl_6]^-$	sp^3d^2	octahedral

14. The condition that indicates a polluted environment is :

(1) BOD value of 5 ppm

(2) 0.03% of CO_2 in the atmosphere

(3) eutrophication

(4) pH of rain water to be 5.6

Ans (3)

Sol. (1) Clean water should have B.O.D. value of less than 5 ppm whereas highly polluted water could have a B.O.D value of 17 ppm or more.

(2) In general in atmosphere CO_2 is 0.03% by volume.

(3) The process in which nutrient enriched water bodies support a dense plant population which kill animal life by depriving it of oxygen results in subsequent loss of biodiversity is known as Eutrophication.

(4) Normal rain water has pH of 5.6

15. The difference between the radii of 3rd and 4th orbits of Li^{2+} is ΔR_1. The difference between the radii of 3rd and 4th orbits of He^+ is ΔR_2. Ratio $\Delta R_1 : \Delta R_2$ is :

(1) 8 : 3 (2) 2 : 3 (3) 3 : 2 (4) 3 : 8

Ans (2)

Sol. Radius of n^{th} orbit $= r_n = 0.529 \times \frac{n^2}{Z}$ Å

(a) For He^+ ion (Z = 2)

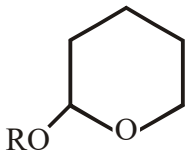
$$\Delta R_2 = \frac{0.529}{2}[16-9]$$

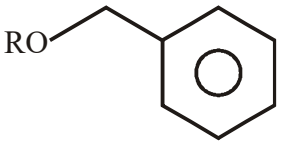
(b) For Li^{2+} ion (Z = 3)

$$\Delta R_1 = \frac{0.529}{3}[16-9]$$

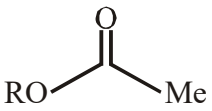
Then value of $\frac{\Delta R_1}{\Delta R_2} = \frac{2}{3}$

16. Which of the following derivatives of alcohols is unstable in an aqueous base?

(1) 

(2) 

(3) $RO - CMe_3$

(4) 

Ans (4)

Sol. In basic medium esters undergo hydrolysis but normally ethers and acetals are stable in basic medium.

17. Which of the following is not an essential amino acid?

(1) Lysine (2) Valine (3) Leucine (4) Tyrosine

Ans (4)

Sol. Tyrosine is a non essential amino acid.

18. Consider the following reaction :

$N_2O_4(g) \rightleftharpoons 2NO_2(g); \Delta H^0 = +58kJ$

For each of the following cases (a, b), the direction in which the equilibrium shifts is :

(a) Temperature is decreased.

(b) Pressure is increased by adding N_2 at constant T.

(1) (a) towards reactant, (b) towards product

(2) (a) towards reactant, (b) no change

(3) towards product, (b) no change

(4) towards product, (b) towards reactant

Ans (2)

Sol. For endothermic reactions value of K_{eq} decreases on decreasing temperature hence reaction will shift in backward direction on decreasing temperature.

On adding inert gas at constant volume, pressure will increase but no shifting will take place

19. In the sixth period, the orbitals that are filled are :

(1) 6s, 5d, 5f, 6p (2) 6s, 5f, 6d, 6p (3) 6s, 4f, 5d, 6p (4) 6s, 6p, 6d, 6f

Ans (3)

Sol. In 6^{th} period 6s, 4f, 5d and 6p orbitals are gradually filled.

20. An Ellingham diagram provides information about :

(1) the temperature dependence of the standard Gibbs energies of formation of some metal oxides.

(2) the pressure dependence of the standard electrode potentials of reduction reactions involved in the extraction of metals.

(3) the kinetics of the reduction process.

(4) the conditions of pH and potential under which a species is thermodynamically stable.

Ans (1)

Sol. Ellingham diagram is graph of ΔG^0 vs T of any / element oxide. Since

$\Delta G^0 = \Delta H^0 - T\Delta S^0$

for most metal oxide formation

metal (s) + oxygen (g) $\rightarrow$ metal oxide (s)

$\Delta H^0 = -$ ve

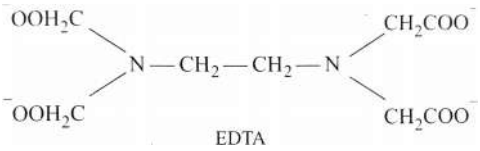
$\Delta S^0 = -$ ve

so graph will be a straight line with – ve, y – intercept & +ve slope.

21. The total number of coordination sites in ethylenediaminetetraacetate ($EDTA^{4-}$) is _____.

Ans. (6)

Sol.



EDTA

Number of donor sites = 6. So denticity will be 6.

22. The minimum number of moles of O_2 required for complete combustion of 1 mole of propane and 2 moles of butane is_____.

Ans. 18

Sol. (1) Combustion reaction of C_3H_8.

$$C_3H_8 + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$$

For 1 mole of C_3H_8, minimum 5 moles of O_2 are required.

(2) Combustion reaction of C_4H_{10}

$$C_4H_{10} + \frac{13}{2}O_2(g) \rightarrow 4CO_2(g) + 5H_2O(\ell)$$

For 2 mole of C_4H_{10}, minimum 13 moles of O_2 are required.

So total minimum moles of O_2 required = 5 + 13 = 18

23. An oxidation-reduction reaction in which 3 electrons are transferred has ΔG^0 of 17.37 kJ mol^{-1} at 25°C. The value of E^0_{cell} (in V) is_____ $\times 10^{-2}$. (1 F = 96,500 C mol^{-1})

Ans. 6

Sol. $\Delta G^0 = -nFE^0_{cell}$

$17.37 \times 1000 = -3 \times 96500\ E^0_{cell}$

$E^0_{cell} = -0.06 = -6 \times 10^{-2}$

24. A soft drink was bottled with a partial pressure of CO_2 of 3 bar over the liquid at room temperature. The partial pressure of CO_2 over the solution approaches a value of 30 bar when 44 g of CO_2 is dissolved in 1 kg of water at room temperature. The approximate pH of the soft drink is _____ $\times 10^{-1}$.

(First dissociation constant of $H_2CO_3 = 4.0 \times 10^{-7}$; log 2 = 0.3 ; density of the soft drink = 1 g mL^{-1})

Ans. 37

Sol. $p = k \times n_{CO_2}$

$$\frac{3}{30} = \frac{n_{CO_2}}{1}$$

$$n_{CO_2} = 0.1$$

$$p^H = \frac{1}{2}\left[p^{k_a} - \log c\right]$$

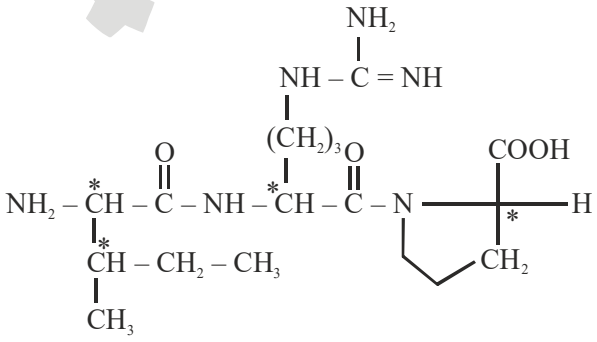
$$p^H = \frac{1}{2}\left[6.4 - \log 0.1\right]$$

= 3.7

25. The number of chiral carbon(s) present in peptide, I*l*e-Arg-Pro, is _____.

Ans. 4

Sol.



* represent chiral carbon