JEE MAIN Sept. 2020

QUESTION PAPER WITH SOLUTION

CHEMISTRY _ 5 Sep. _ SHIFT - 1

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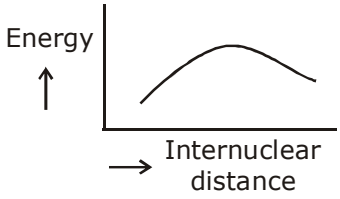
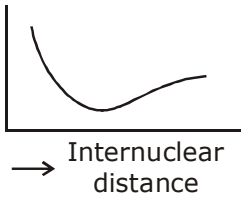
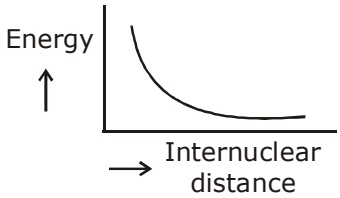
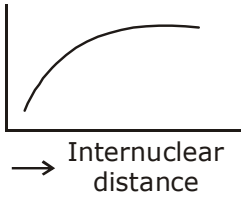
1. The potential energy curve for the H_2 molecule as a function of internuclear distance is:

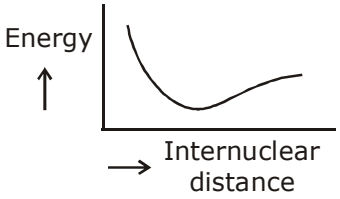
(1) 

(2) 

(3) 

(4) 

Sol. **2**



2. The most appropriate reagent for conversion of C_2H_5CN into $CH_3CH_2CH_2NH_2$ is:
(1) $NaBH_4$ (2) $Na(CN)BH_3$ (3) CaH_2 (4) $LiAlH_4$

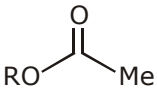
Sol. **4**

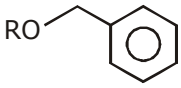
$CH_3CH_2CN \xrightarrow{LiAlH_4} CH_3CH_2CH_2NH_2$

3. Which of the following is not an essential amino acid?
(1) Valine (2) Tyrosine (3) Lysine (4) Leucine

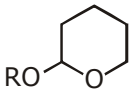
Sol. **2**
Tyrosine in not an essential amino acid

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

(1) 

(2) 

(3) $RO-CMe_3$

(4) 

Sol. **1**
Hydrolysis of ester occurs in basic medium.

5. The structure of PCl_5 in the solid state is:
(1) Square planar $[PCl_4]^+$ and octahedral $[PCl_6]^-$
(2) Tetrahedral $[PCl_4]^+$ and octahedral $[PCl_6]^-$
(3) Trigonal bipyramidal
(4) Square pyramidal

Sol. **2**
In solid state PCl_5 exist in Ionpair i.e. (PCl_4^+) and (PCl_6^-)
PCl_4^+ (sp^3_ tetrahedral)
PCl_6^- (sp^3d^2) – octahedral)

6. 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) = 6×10^{23} mol^{-1})
(1) 8 N_A (2) 2 N_A (3) 40 N_A (4) 4 N_A

Sol. **4**
$X_2 \rightarrow$ BCC
a = 300pm

$$d = 6.17 g/cm^3 = \frac{2 \times GMM}{6 \times 10^{23} \times (300 \times 10^{-10})^3}$$

$$GMM = \frac{6.17 \times 6 \times 9 \times 3 \times 10^{-1}}{2}$$

$GMM = 81 \times 6.17 \times 10^{-1}$
$= 49.97$ g/mol

$$\text{No. of molecules} = \frac{200g}{49.97\,g/mol} = 4 \text{ mol}$$

$= 4N_A$

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

(1) $CO(g) + H_2O(g) \xrightarrow[\text{Catalyst}]{673\,K} CO_2(g) + H_2(g)$

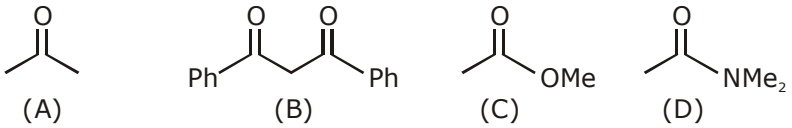
(2) $2C(s) + O_2(g) + 4N_2(g) \xrightarrow{1273\,K} 2CO(g) + 4N_2(g)$

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

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

Sol. **1**
Fact

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

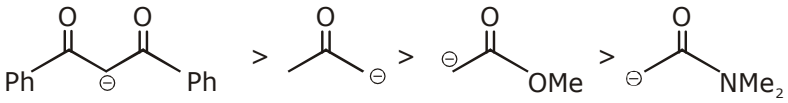


(A) (B) (C) (D)

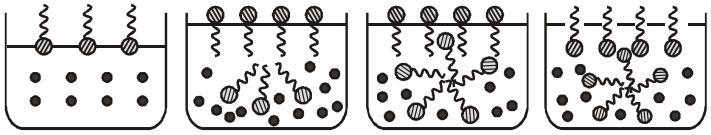
(1) (D) < (C) < (A) < (B)
(2) (A) < (C) < (D) < (B)
(3) (C) < (A) < (B) < (D)
(4) (B) < (C) < (A) < (D)

Sol. **1**

Stability order



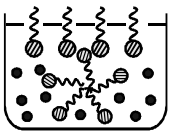
9. Identify the correct molecular picture showing what happens at the critical micellar concentration (CMC) of an aqueous solution of a surfactant (polar head; non-polar tail; water).



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

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

Sol. **4**



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

(1) Antihistamine (2) Antidepressant

(3) Anti-inflammatory (4) Analgesic

Sol. **2**

If nor-adrenaline is low, person may suffer from depression. Hence, anti depressant drug is suggested.

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

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

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

Sol. **4**

d^6(octahedral) $\rightarrow$ high spin complex

$= t_{2g^4}\ eg^2$

$$\text{CFSE} = \left(-\frac{2}{5}\times 4 + \frac{3}{5}\times 2\right)\Delta_0$$

$$= \left(\frac{-8+6}{5}\right)\Delta_0$$

$= -0.4\Delta_0$

d^6 (tetrahedral) $\rightarrow$ high spin complex

$= eg^3 t_{2g^3}$

$$\text{CFSE} = \left(-\frac{3}{5}\times 3 + \frac{2}{5}\times 3\right)\Delta_t$$

$= -0.6\Delta_t$

12. 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 ln 2 = 0.693)

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

Sol. **4**

$A_t = A_0 . e^{-k_1 t}$

$B_t = B_0 . e^{-k_2 t}$

$k_1 = \frac{\ln 2}{300}$

$k_2 = \frac{\ln 2}{180}$

A_t and B_t are related as [A] = 4[B]

$A_0 . e^{-k_1 t} = 4 \times B_0 . e^{-k_2 t}$

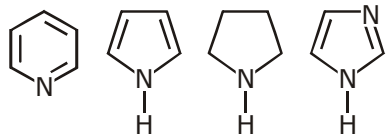
$\frac{t}{180} - \frac{t}{300} = 2$

$\frac{t}{3} - \frac{t}{5} = 120$

$\frac{2t}{15} = 120$

t = 900 sec

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



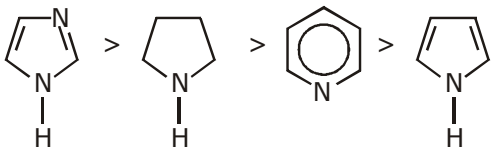
(A) (B) (C) (D)

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

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

Sol. **4**

Correct order of basicity



14. The condition that indicates a polluted environment is:
(1) pH of rain water to be 5.6 (2) BOD value of 5 ppm
(3) 0.03% of CO_2 in the atmosphere (4) eutrophication

Sol **4**
Eutrophication is the condition in which excessive richness of nutrients in a lake or water body, which causes dense growth of plant life and BOD increases.

15. In the sixth period, the orbitals that are filled are:
(1) 6s, 5d, 5f, 6p (2) 6s, 4f, 5d, 6p (3) 6s, 6p, 6d, 6f (4) 6s, 5f, 6d, 6p

Sol. **2**
(Fact) $\rightarrow$ energy order of orbital's according to Aufbau principle
6s < 4f < 5d < 6p

16. 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) 3 : 8 (3) 3 : 2 (4) 2 : 3

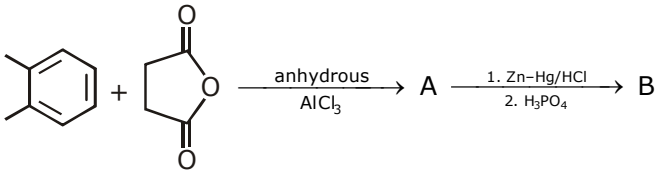
Sol. **4**

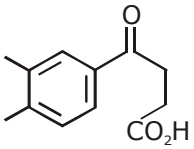
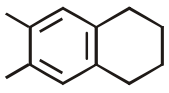
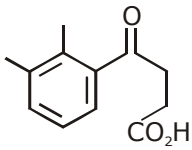
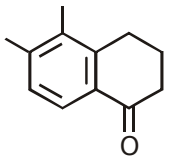
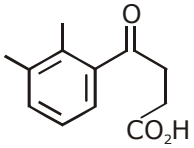
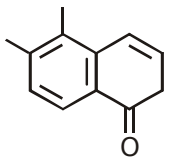
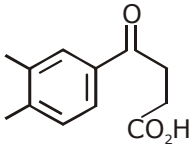
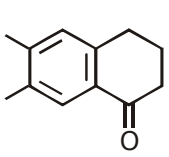
$$(R_4 - R_3)_{Li^{+2}} = \frac{0.529}{3}\{4^2 - 3^2\} = \Delta R_1$$

$$(R_4 - R_3)_{He^{+2}} = \frac{0.529}{2}\{4^2 - 3^2\} = \Delta R_2$$

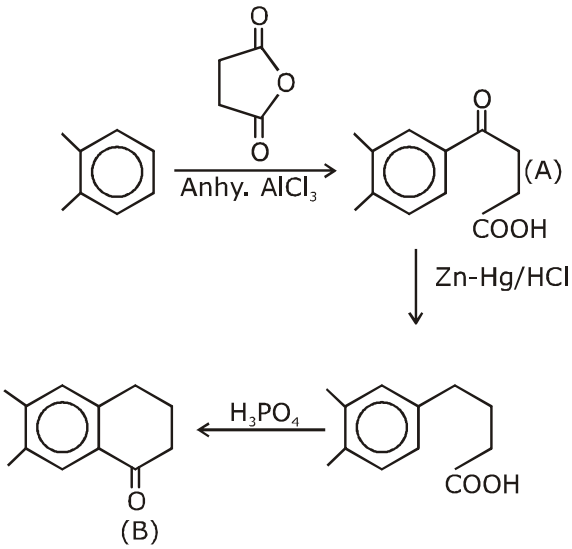
$$\frac{\Delta R_1}{\Delta R_2} = \frac{1/3}{1/2} = \frac{2}{3}$$

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



(1) A =  ; B = 
(2) A =  ; B = 
(3) A =  ; B = 
(4) A =  ; B = 

Sol. **4**



18. The correct electronic configuration and spin-only magnetic moment (BM) of Gd^{3+} (Z = 64), respectively, are:
(1) [Xe] $5f^7$ and 7.9 (2) [Xe] $4f^7$ and 7.9 (3) [Xe] $5f^7$ and 8.9 (4) [Xe] $4f^7$ and 8.9

Sol. **2**

Gd $\rightarrow [Xe]^{54}\ 4f^7\ 5d^1\ 6s^2$

Z=64

$\downarrow -3e^{\ominus}$

$Gd^{+3} = [Xe]^{54}\ 4f^7$

$\mu = \sqrt{7(7+2)} = \sqrt{63}$

= 7.9 BM

19. An Ellingham diagram provides information about:
(1) The pressure dependence of the standard electrode potentials of reduction reactions involved in the extraction of metals.
(2) The conditions of pH and potential under which a species is thermodynamically stable.
(3) The kinetics of the reduction process.
(4) The temperature dependence of the standard Gibbs energies of formation of some metal oxides.

Sol. **4**

Fact

20. Consider the following reaction:
$N_2O_4\,(g) \rightleftharpoons 2NO_2\,(g)$; $\Delta H^o = +58$ kJ
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) (a) towards product, (b) towards reactant
(4) (a) towards product, (b) no change

Sol. **2**
$N_2O_4(g) \rightleftharpoons 2NO_2(g)$
$\Delta H° = +58$ kJ
(towards reactant)
(a) temp $\downarrow \Rightarrow$ Backward shift as it is endothermic reaction
(b) As 'N_2' will not react with both N_2O_4 & NO_2, as moles increases in reactants, as much as in products, a = hence there is no change in equilibria.
$\therefore$ no change

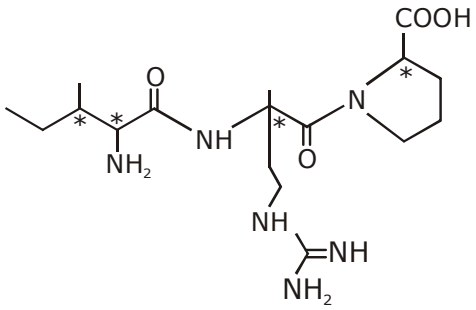
21. The minimum number of moles of O_2 required for complete combustion of 1 mole of propane and 2 moles of butane is _____.

Sol. **18**
$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
1 mol 5 mol

$C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O$
2 mol 13 mol
Total required mol of $O_2 = 5 + 13 = 18$

22. The number of chiral carbon(s) present in piptide, Iie-Arg-Pro, is _____ .

Sol. **4**



23. 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})

Sol. **37**

$CO_2 + H_2O \rightarrow H_2CO_3$

30 bar .....→ 1 m/lit.

3 bar .....→ 0.1 m/lit

$$H_2CO_3 \rightleftharpoons H^{\oplus} + HCO_3^-$$

t = 0	0.1	0	0
Eq.	$0.1(1-\alpha)$	0.1α	0.1α

$$4 \times 10^{-7} = \frac{0.1\alpha^2}{1-\alpha}$$

$(1-\alpha) \simeq 1$

$\alpha^2 = 4 \times 10^{-6}$

$\alpha = 2 \times 10^{-3}$

$[H^+] = 2 \times 10^{-4}M$

$pH = -[-4 \times \log(2)] = 3.7 = 37 \times 10^{-1}$

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

Sol. **6**

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

$17.37 \times 1000 = -3 \times 96500 \times E^\circ$

$$E^\circ = \frac{17370}{3 \times 96500}$$

$$E^\circ = \frac{579}{9650} \text{ volt}$$

$= 0.06 = 6 \times 10^{-2}$ volt

Ans. 6

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

Sol. **6**

$EDTA^{4-}$ is hexadentate ligand

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