## ***Chemistry***

For the following electrochemical cell at 298 K,

$$Pt(s)\,|\,H_2(g, 1\,\text{bar})\,|\,H^+(aq, 1\,M)\,\|\,M^{4+}(aq), M^{2+}(aq)\,|\,Pt(s)$$

$E_{cell} = 0.092\ \text{V}$ when $\dfrac{[M^{2+}(aq)]}{[M^{4+}(aq)]} = 10^x$.

Given : $E^0_{M^{4+}/M^{2+}} = 0.151\,\text{V}; 2.303\dfrac{RT}{F} = 0.059\,\text{V}$

The value of $x$ is

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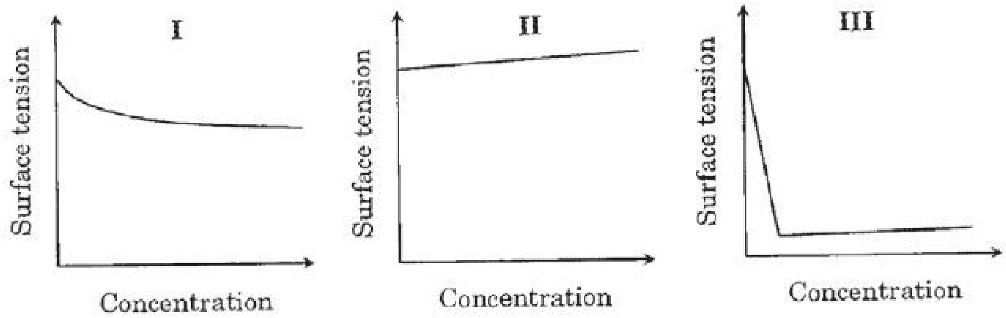
(A) $-2$ (B) $-1$ (C) $1$ (D) $2$

The qualitative sketches **I**, **II** and **III** given below show the variation of surface tension with molar concentration of three different aqueous solutions of KCl, $CH_3OH$ and $CH_3(CH_2)_{11}OSO_3^-Na^+$ at room temperature. The correct assignment of the sketches is



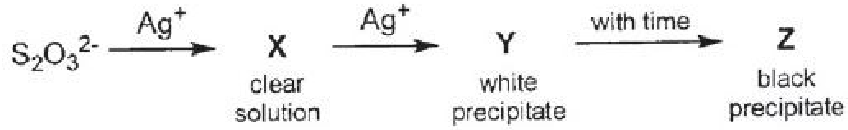

(A) **I** : KCl **II** : $CH_3OH$ **III** : $CH_3(CH_2)_{11}OSO_3^-Na^+$

(B) **I** : $CH_3(CH_2)_{11}OSO_3^-Na^+$ **II** : $CH_3OH$ **III** : KCl

(C) **I** : KCl **II** : $CH_3(CH_2)_{11}OSO_3^-Na^+$ **III** : $CH_3OH$

(D) **I** : $CH_3OH$ **II** : KCl **III** : $CH_3(CH_2)_{11}OSO_3^-Na^+$

In the following reaction sequence in aqueous solution, the species **X**, **Y** and **Z**, respectively, are




(A) $[Ag(S_2O_3)_2]^{3-}, Ag_2S_2O_3, Ag_2S$

(B) $[Ag(S_2O_3)_3]^{5-}, Ag_2SO_3, Ag_2S$

(C) $[Ag(SO_3)_2]^{3-}, Ag_2S_2O_3, Ag$

(D) $[Ag(SO_3)_3]^{3-}, Ag_2SO_4, Ag$

The geometries of the ammonia complexes of $Ni^{2+}, Pt^{2+}$ and $Zn^{2+}$, respectively, are

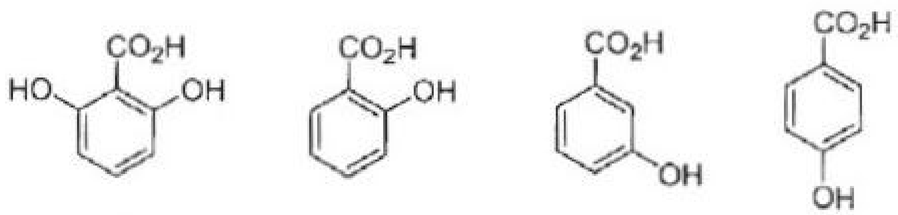
(A) octahedral, square planar and tetrahedral

(B) square planar, octahedral and tetrahedral

(C) tetrahedral, square planar and octahedral

(D) octahedral, tetrahedral and square planar

The correct order of acidity for the following compounds is




I II III IV

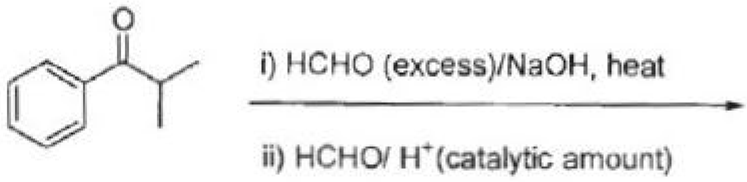
(A) I > II > III > IV

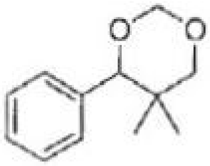
(B) III > I > II > IV

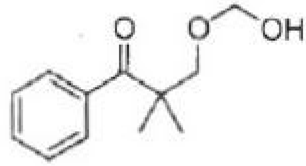
(C) III > IV > II > I

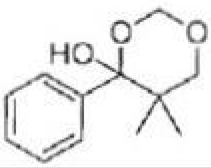
(D) I > III > IV > II

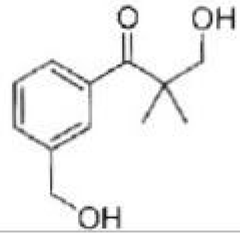
The major product of the following reaction sequence is




(A) 


(B) 


(C) 


(D) 


According to Molecular Orbital Theory,

(A) $C_2^{2-}$ is expected to be diamagnetic

(B) $O_2^{2+}$ is expected to have a longer bond length than $O_2$

(C) $N_2^+$ and $N_2^-$ have the same bond order

(D) $He_2^+$ has the same energy as two isolated He atoms

Mixture(s) showing positive deviation from Raoult's law at 35 °C is(are)

(A) carbon tetrachloride + methanol
(B) carbon disulphide + acetone
(C) benzene + toluene
(D) phenol + aniline

The **CORRECT** statement(s) for cubic close packed (*ccp*) three dimensional structure is(are)

(A) The number of the nearest neighbours of an atom present in the topmost layer is 12
(B) The efficiency of atom packing is 74%
(C) The number of octahedral and tetrahedral voids per atom are 1 and 2, respectively
(D) The unit cell edge length is $2\sqrt{2}$ times the radius of the atom

Extraction of copper from copper pyrite ($CuFeS_2$) involves

(A) crushing followed by concentration of the ore by froth-flotation

(B) removal of iron as slag

(C) self-reduction step to produce 'blister copper' following evolution of $SO_2$

(D) refining of 'blister copper' by carbon reduction

The nitrogen containing compound produced in the reaction of $HNO_3$ with $P_4O_{10}$

(A) can also be prepared by reaction of $P_4$ and $HNO_3$

(B) is diamagnetic

(C) contains one N-N bond

(D) reacts with Na metal producing a brown gas

For 'invert sugar', the correct statement(s) is(are)

(Given: specific rotations of (+)-sucrose, (+)-maltose, L-(−)-glucose and L-(+)-fructose in aqueous solution are +66°, +140°, −52° and +92°, respectively)

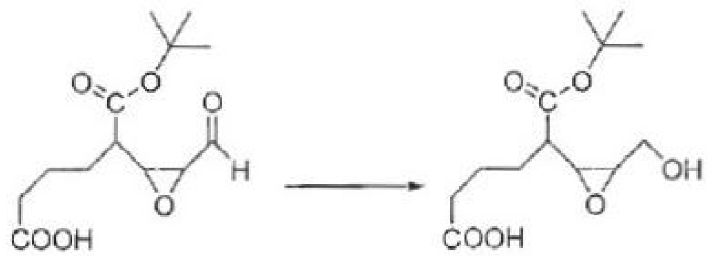
(A) 'invert sugar' is prepared by acid catalyzed hydrolysis of maltose

(B) 'invert sugar' is an equimolar mixture of D-(+)-glucose and D-(−)-fructose

(C) specific rotation of 'invert sugar' is −20°

(D) on reaction with $Br_2$ water, 'invert sugar' forms saccharic acid as one of the products

Reagent(s) which can be used to bring about the following transformation is(are)



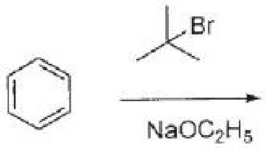

(A) $LiAlH_4$ in $(C_2H_5)_2O$

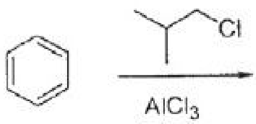
(B) $BH_3$ in THF

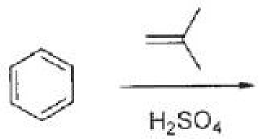
(C) $NaBH_4$ in $C_2H_5OH$

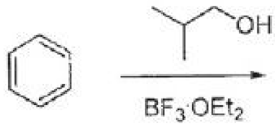
(D) Raney $Ni/H_2$ in THF

Among the following, reaction(s) which gives(give) *tert*-butyl benzene as the major product is(are)

(A) 


(B) 


(C) 


(D) 


Thermal decomposition of gaseous $X_2$ to gaseous X at 298 K takes place according to the following equation :

$$X_2(g) \rightleftharpoons 2X(g)$$

The standard reaction Gibbs energy, $\Delta_r G^\circ$, of this reaction is positive. At the start of the reaction, there is one mole of $X_2$ and no X. As the reaction proceeds, the number of moles of X formed is given by $\beta$. Thus, $\beta_{equilibrium}$ is the number of moles of X formed at equilibrium. The reaction is carried out at a constant total pressure of 2 bar. Consider the gases to behave ideally. (Given : $R = 0.083$ L bar $K^{-1}$ $mol^{-1}$)

The equilibrium constant $K_p$ for this reaction at 298 K, in terms of $\beta_{equilibrium}$, is

(A) $\dfrac{8\beta^2_{equilibrium}}{2-\beta_{equilibrium}}$ (B) $\dfrac{8\beta^2_{equilibrium}}{4-\beta^2_{equilibrium}}$ (C) $\dfrac{4\beta^2_{equilibrium}}{2-\beta_{equilibrium}}$ (D) $\dfrac{4\beta^2_{equilibrium}}{4-\beta^2_{equilibrium}}$

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The **INCORRECT** statement among the following, for this reaction, is

(A) Decrease in the total pressure will result in formation of more moles of gaseous X

(B) At the start of the reaction, dissociation of gaseous $X_2$ takes place spontaneously

(C) $\beta_{equilibrium} = 0.7$

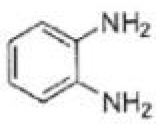
(D) $K_C < 1$

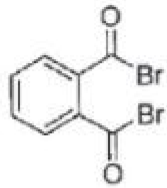
**PARAGRAPH 2**

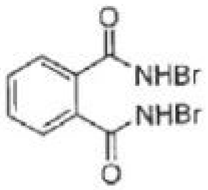
Treatment of compound **O** with $KMnO_4/H^+$ gave **P**, which on heating with ammonia gave **Q**. The compound **Q** on treatment with $Br_2/NaOH$ produced **R**. On strong heating, **Q** gave **S**, which on further treatment with ethyl 2-bromopropanoate in the presence of KOH followed by acidification, gave a compound **T**.

(O)

The compound **R** is

(A) 

(B) 

(C) 

(D) 

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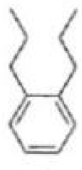

(O)

The compound **T** is

(A) glycine (B) alanine (C) valine (D) serine