JEE(Advanced) – 2017 TEST PAPER WITH SOLUTION

(HELD ON SUNDAY 21st MAY, 2017)

CHEMISTRY

SECTION–I : (Maximum Marks : 21)

- This section contains **SEVEN** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3 If only the bubble corresponding to the correct option is darkened.

Zero Marks : 0 If none of the bubbles is darkened.

Negative Marks : –1 In all other cases

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19. Which of the following combination will produce H_2 gas ?

(A) Zn metal and NaOH(aq)

(B) Au metal and NaCN(aq) in the presence of air

(C) Cu metal and conc. HNO_3

(D) Fe metal and conc. HNO_3

Ans. (A)

Sol. (A) $Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

(B) $4Au + 8NaCN + O_2 + 2H_2O \longrightarrow 4Na[Au(CN)_2] + 4NaOH$

(C) $Cu + \underset{\text{(conc.)}}{4HNO_3} \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

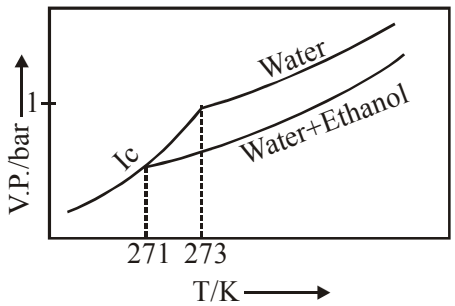
(D) Formation of passive layer of Fe_2O_3 on the surface of Fe and NO_2 gas is evolved.

20. Pure water freezes at 273 K and 1 bar. The addition of 34.5 g of ethanol to 500 g of water changes the freezing point of the solution. Use the freezing point depression constant of water as 2 K kg mol^{-1}. The figures shown below represents plots of vapour pressure (V.P.) versus temperature (T).

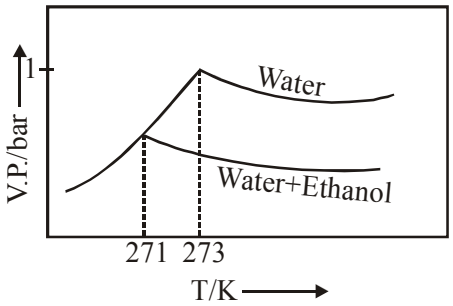
[Molecular weight of ethanol is 46 g mol^{-1}]

Among the following, the option representing change in the freezing point is -

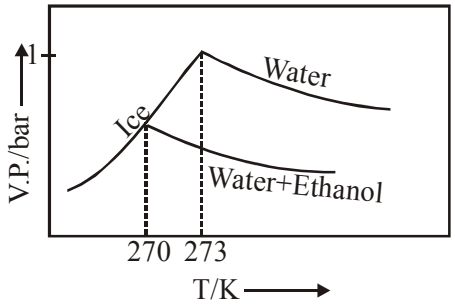
(A)



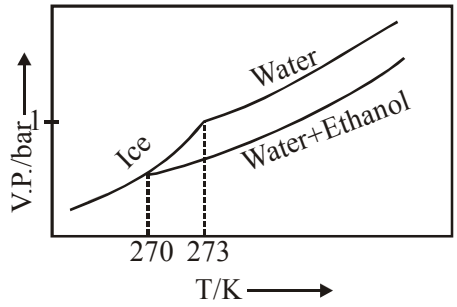
(B)



(C)



(D)



Ans. (D)

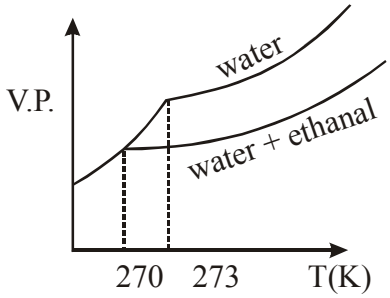
Sol. Ethanol should be considered non volatile as per given option

$\Delta T_f = K_f \times m$

$\Delta T_f = 2 \times \frac{34.5}{46 \times 0.5} = 3K$

$T_f^0 = 273K$

$T_f = 270K$



21. The order of the oxidation state of the phosphorus atom in H_3PO_2, H_3PO_4, H_3PO_3 and $H_4P_2O_6$ is

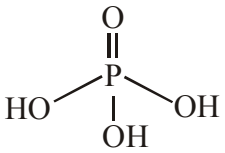
(A) $H_3PO_4 > H_4P_2O_6 > H_3PO_3 > H_3PO_2$

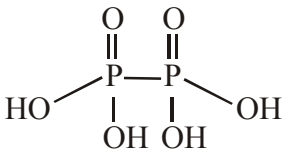
(B) $H_3PO_3 > H_3PO_2 > H_3PO_4 > H_4P_2O_6$

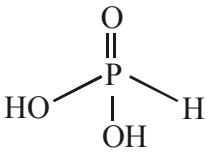
(C) $H_3PO_2 > H_3PO_3 > H_4P_2O_6 > H_3PO_4$

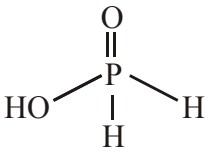
(D) $H_3PO_4 > H_3PO_2 > H_3PO_3 > H_4P_2O_6$

Ans. (A)

Sol. $H_3PO_4 \rightarrow$  ; oxidation state of P = +5

$H_4P_2O_6 \rightarrow$  ; oxidation state of P = +4

$H_3PO_4 \rightarrow$  ; oxidation state of P = +3

$H_3PO_2 \rightarrow$  ; oxidation state of P = +1

Hence Ans (A)

22. The standard state Gibbs free energies of formation of C(graphite) and C(diamond) at T = 298 K are

$$\Delta_f G^\circ \text{ [C(graphite)]} = 0 \text{ kJ mol}^{-1}$$

$$\Delta_f G^\circ \text{ [C(diamond)]} = 2.9 \text{ kJ mol}^{-1}$$

The standard state means that the pressure should be 1 bar , and substance should be pure at a given temperature. The conversion of graphite [C(graphite)] to diamond [C(diamond)] reduces its volume by $2 \times 10^{-6} \text{ m}^3 \text{ mol}^{-1}$. If C(graphite) is converted to C(diamond) isothermally at T = 298 K, the pressure at which C(graphite) is in equilibrium with C(diamond), is

[Useful information : 1 J = 1 kg m^2 s^{-2} ; 1 Pa = 1 kg m^{-1} s^{-2} ; 1 bar = 10^5 Pa]

(A) 14501 bar (B) 29001 bar (C) 58001 bar (D) 1405 bar

Ans. (A)

Sol. C(graphite) $\rightarrow$ C(diamond) ; $\Delta G^0 = \Delta_f G^0_{\text{diamond}} - \Delta_f G^0_{\text{graphite}} = 2.9$ kJ/mole at 1 bar

As $dG_T = V.dP$

$$\int_{\Delta G_1}^{\Delta G_2} d(\Delta G_T) = \int_{P_1}^{P_2} \Delta V.dP$$

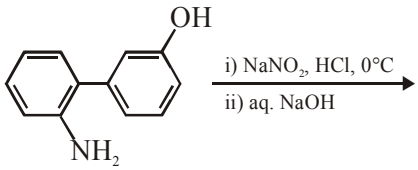
$$\Delta G_2 - \Delta G_1 = \Delta V.\ (P_2 - P_1)$$

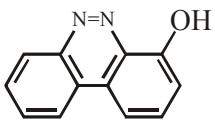
$$(2.9 \times 10^3 - 0) = (-2 \times 10^{-6})\ (1 - P_2)$$

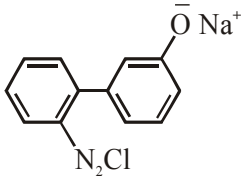
$$P_2 - 1 = \frac{2.9 \times 10^3}{2 \times 10^{-6}} \text{Pa} = 1.45 \times 10^4 \text{ bar}$$

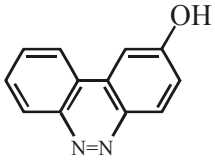
$$P_2 = 14501 \text{ bar}$$

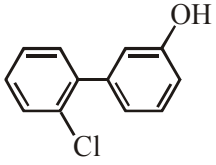
23. The major product of the following reaction is



(A) 

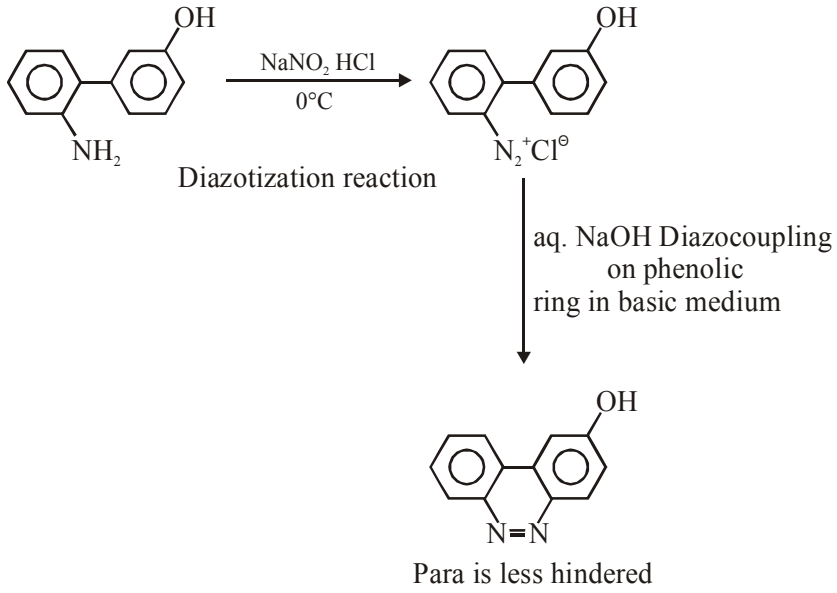
(B) 

(C) 

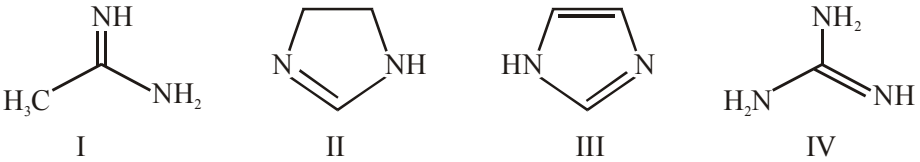
(D) 

Ans. (C)

Sol.



24. The order of basicity among the following compounds is



(A) II > I > IV > III

(B) IV > II > III > I

(C) I > IV > III > II

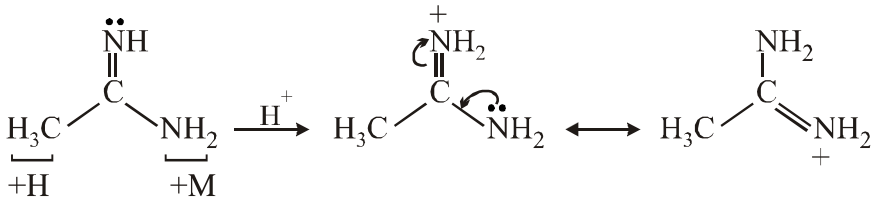
(D) IV > I > II > III

Ans. (D) IV > I > II > III

Sol. Basic strength $\propto$ stability of conjugated acid.

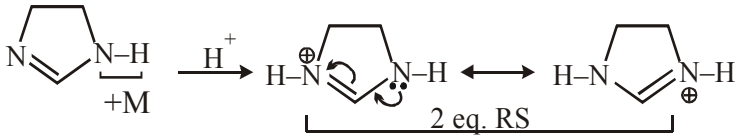
$\propto$ + M / +H / +I

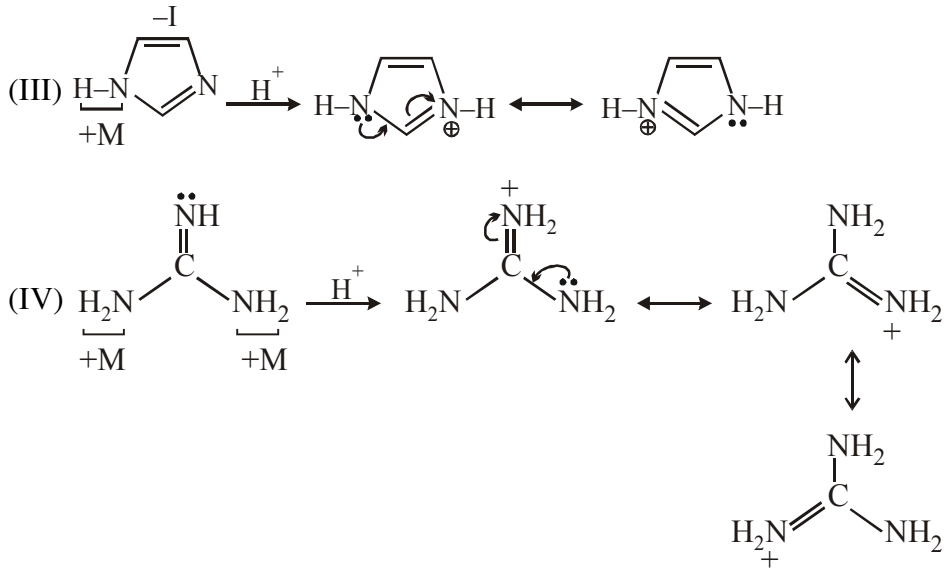
(I)



Conjugated acid stabilized by 2 equivalent R.S.

(II)





Conjugated acid stabilized by 3 equivalent R.S.

25. For the following cell :

$Zn(s) \mid ZnSO_4$ (aq.) $\parallel CuSO_4$ (aq.) $\mid Cu(s)$

when the concentration of Zn^{2+} is 10 times the concentration of Cu^{2+} , the expression for ΔG (in J mol^{-1}) is

[F is Faraday constant , R is gas constant, T is temperature , E°(cell) = 1.1V]

(A) 2.303 RT + 1.1F

(B) 2.303 RT – 2.2F

(C) 1.1 F

(D) –2.2 F

Ans. (B)

Sol. $\Delta G = \Delta G^0 + 2.303RT \log Q$

$\Delta G = - nFE^0 + 2.303RT \log Q$

Given : $E^{\circ} = 1.1$ V and n = 2

$$\Delta G = (-2 \times 1.1 \times F) + 2.303RT \log \left[\frac{[Zn^{+2}]}{Cu^{+2}]}\right.$$

$\Delta G = -2.2 F + 2.303RT$

SECTION–2 : (Maximum Marks : 28)

- This section contains **SEVEN** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is (are) correct.
- For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS
- For each question, marks will be awarded in one of the following categories :

Full Marks : +4 If only the bubble(s) corresponding to all the correct option(s) is (are) darkened.

Partial Marks : +1 For darkening a bubble corresponding **to each correct option**, Provided NO incorrect option is darkened.

Zero Marks : 0 If none of the bubbles is darkened.

Negative Marks : –2 In all other cases.

- for example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will get +4 marks; darkening only (A) and (D) will get +2 marks; and darkening (A) and (B) will get –2 marks, as a wrong option is also darkened

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26. In a bimolecular reaction, the steric factor P was experimentally determined to be 4.5. The correct option(s) among the following is(are):

(A) The value of frequency factor predicted by Arrhenius equation is higher than that determined experimentally

(B) The activation energy of the reaction is unaffected by the value of the steric factor

(C) Since P = 4.5, the reaction will not proceed unless an effective catalyst is used.

(D) Experimentally determined value of frequency factor is higher than that predicted by Arrhenius equation.

Ans. (B,D)

Sol. $K = P.A.\ e^{-Ea/RT}$

(A) If $P < 1$ $\quad A_{arr.} > A_{expt}$

(D) If $P > 1$ $\quad A_{arr.} < A_{expt}$

(C) If P is very small, then catalyst is required to carry out the reaction at measurable rate.

27. Compound **P** and **R** upon ozonolysis produce **Q** and **S**, respectively. The molecular formula of **Q** and **S** is C_8H_8O. **Q** undergoes Cannizzaro reaction but not haloform reaction, whereas **S** undergoes haloform reaction but not Cannizzaro reaction.

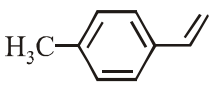
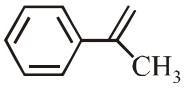
(i) $P \xrightarrow[ii)\ Zn/H_2O]{i)\ O_3/CH_2Cl_2} Q$

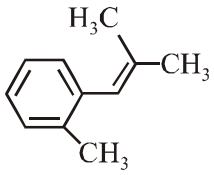
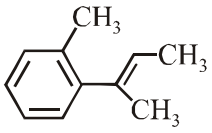
(C_8H_8O)

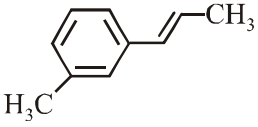
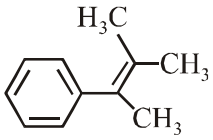
(ii) $R \xrightarrow[ii)\ Zn/H_2O]{i)\ O_3/CH_2Cl_2} S$

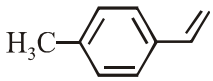
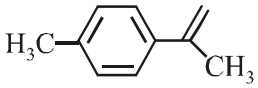
(C_8H_8O)

The option(s) with suitable combination of P and R, respectively, is(are)

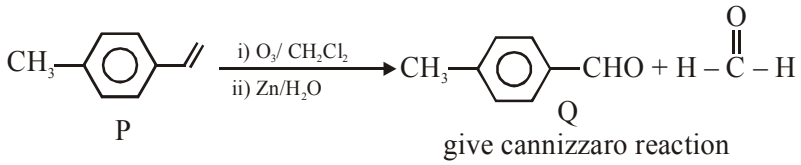
(A)  and 

(B)  and 

(C)  and 

(D)  and 

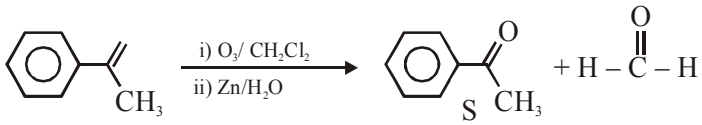
Ans. (A,C)

Sol. (A) 

P

Q

give cannizzaro reaction
but no haloform

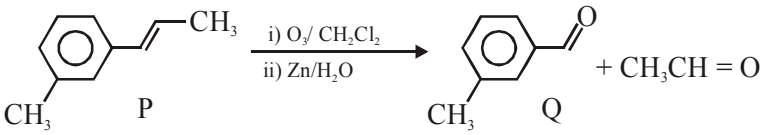


R

S

no cannizzaro
but give haloform

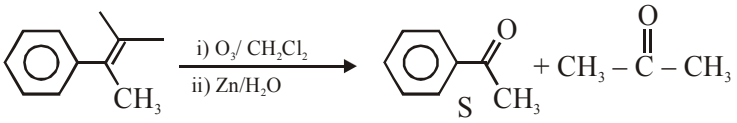
(B) Product of ozonolysis of R is having 9 carbon.

(C) 

P

Q

give cannizzaro reaction
but no haloform



R

S

no cannizzaro
but give haloform

(D) Product of ozonolysis of R is having 9 carbon.

28. For a reaction taking place in a container in equilibrium with its surroundings, the effect of temperature on its equilibrium constant K in terms of change in entropy is described by

(A) With increase in temperature, the value of K for exothermic reaction decreases because the entropy change of the system is positive

(B) With increase in temperature, the value of K for endothermic reaction increases because unfavourable change in entropy of the surroundings decreases

(C) With increase in temperature, the value of K for exothermic reaction decreases because favourable change in entropy of the surroundings decreases

(D) With increase in temperature, the value of K for endothermic reaction increases because the entropy change of the system negative

Ans. (BC)

Sol. $\Delta S_{surr.} = \frac{-q_{process}}{T_{surr.}}$

If $\Delta H > 0$ on $T \uparrow K_{eq} \uparrow$, $\Delta S_{surr.} < 0$ (Surrounding is unfavourable)

If $\Delta H < 0$ on $T \uparrow K_{eq} \downarrow$, $\Delta S_{surr.} > 0$ (Surrounding is favourable)

29. The option(s) with only amphoteric oxides is (are):

(A) Cr_2O_3, CrO, SnO, PbO

(B) NO, B_2O_3, PbO, SnO_2

(C) Cr_2O_3, BeO, SnO, SnO_2

(D) ZnO, Al_2O_3, PbO, PbO_2

Ans. (C,D)

Sol. (C) Cr_2O_3 , BeO , SnO , SnO_2
all are amphoteric oxides

(D) ZnO , Al_2O_3 , PbO , PbO_2
all are amphoteric oxides

30. Among the following, the correct statement(s) is are

(A) $Al(CH_3)_3$ has the three-centre two-electron bonds in its dimeric structure

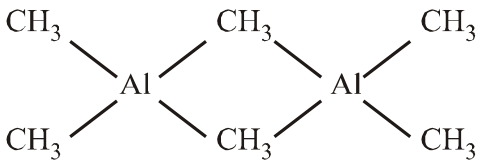
(B) $AlCl_3$ has the three-centre two-electron bonds in its dimeric structure

(C) BH_3 has the three-centre two-electron bonds in its dimeric structure

(D) The Lewis acidity of BCl_3 is greater than that of $AlCl_3$

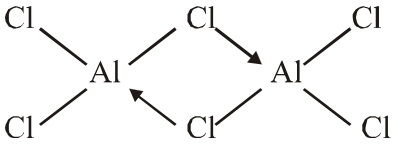
Ans. (ACD)

Sol. (A)



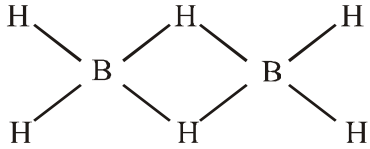
Two 3c - 2e⁻ bond
(three-centre-two-electron)

(B)



Two 3c - 4e⁻ bond
(three-centre-four-electron)

(C)



Two 3c - 2e⁻ bond
(three-centre-two-electron)

(D) Lewis acidic strength decreases down the group. The decrease in acid strength occurs because as size increases, the attraction between the incoming electron pair and the nucleus weakens.
Hence Lewis acidic strength of BCl_3 is more than $AlCl_3$.

31. The correct statement(s) about surface properties is (are)

(A) Cloud is an emulsion type of colloid in which liquid is dispersed phase and gas is dispersion medium

(B) Adsorption is accompanied by decrease in enthalpy and decrease in entropy of the system.

(C) Brownian motion of colloidal particles does not depend on the size of the particles but depends on viscosity of the solution.

(D) The critical temperatures of ethane and nitrogen and 563 K and 126 K, respectively. The adsorption of ethane will be more than that of nitrogen on same amount of activated charcoal at a given temperature.

Ans. (B,D)

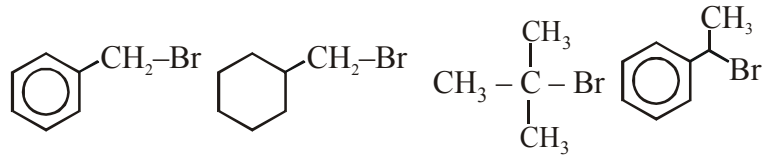
Sol. (A) Emulsion is liquid in liquid type colloid.
(B) For adsorption, $\Delta H < 0$ & $\Delta S < 0$
(C) Smaller the size and less viscous the dispersion medium, more will be the brownian motion.
(D) Higher the T_C , greater will be the extent of adsorption.

32. For the following compounds, the correct statement(s) with respect of nucleophilic substitution reactions is(are);

(I) (II) (III) (IV)

(A) I and II follow S_N2 mechanism
(B) The order of reactivity for I, III and IV is : IV > I > III
(C) I and III follow S_N1 mechanism
(D) Compound IV undergoes inversion of configuration

Ans. (A,B,C,D)

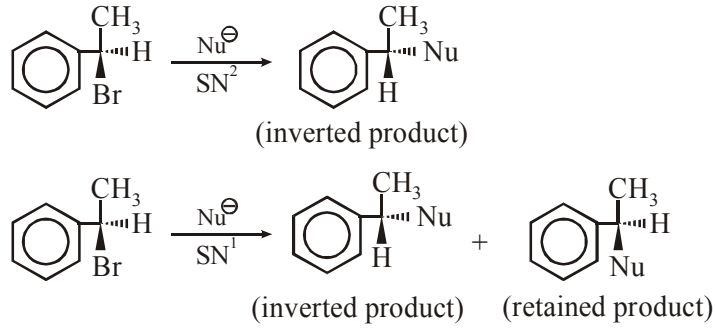
Sol. 

(A) I and II follow S_N2 mechanism as they are primary

(B) Reactivity order IV > I > III

(C) I and III follows S_N1 mechanism as they form stable carbocation

(D) Compound IV undergoes inversion of configuration.



SECTION–3 : (Maximum Marks : 12)

- This section contains **TWO** paragraphs.
- Based on each paragraph, there are **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in <u>one of the following categories</u> :

Full Marks : +3 If only the bubble corresponding to the correct option is darkened.

Zero Marks : 0 In all other cases.

Paragraph for Q.33 & 34

Upon heating $KClO_3$ in the presence of catalytic amount of MnO_2 , a gas **W** is formed. Excess amount of **W** reacts with white phosphorus to give **X.** The reaction of **X** with pure HNO_3 gives **Y** and **Z**.

33. **W** and **X** are, respectively

(A) O_3 and P_4O_6 (B) O_2 and P_4O_{10} (C) O_3 and P_4O_{10} (D) O_2 and P_4O_6

34. **Y** and **Z** are , respectively

(A) N_2O_4 and H_3PO_3 (B) N_2O_4 and HPO_3

(C) N_2O_5 and HPO_3 (D) N_2O_3 and H_3PO_4

Solution for paragraph Q.33 & 34

$$2KClO_3 \xrightarrow[\Delta]{MnO_2} 2KCl + \underset{(W)}{3O_2}$$

$$\underset{\text{white phosphorous}}{P_4} + \underset{\text{(excess) (W)}}{5\,O_2} \longrightarrow \underset{(X)}{P_4O_{10}}$$

$$\underset{(X)}{P_4O_{10}} + 4\,HNO_3 \longrightarrow \underset{(Y)}{2N_2O_5} + \underset{(Z)}{(HPO_3)_4}$$

33. **Ans. (B)**

Sol. W and X are respectively

$W = O_2$ and $X = P_4O_{10}$

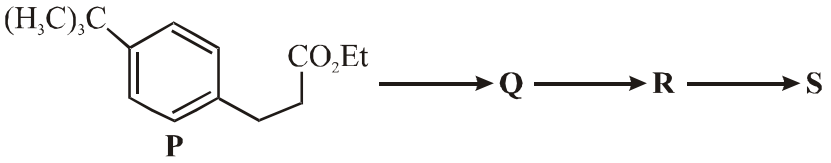
34. **Ans. (C)**

Sol. Y and Z are respectively

$Y = N_2O_5$ and $Z = HPO_3$

Paragraph for Q.35 & 36

The reaction of compound P with CH_3MgBr (excess) in $(C_2H_5)_2O$ followed by addition of H_2O gives **Q**, The compound **Q** on treatment with H_2SO_4 at 0ºC gives **R**. The reaction of **R** with CH_3COCl in the presence of anhydrous $AlCl_3$ in CH_2Cl_2 followed by treatment with H_2O produces compounds S. [Et it compounds **P** is ethyl group]



35. The reactions, **Q** to **R** and **S** to **S**, are -

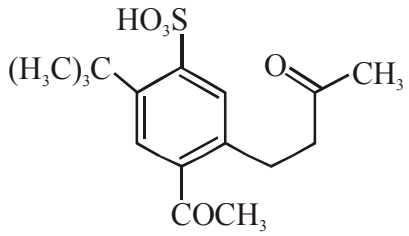
(A) Dehydration and Friedel -Crafts acylation

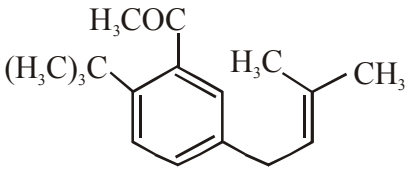
(B) Friedel-Crafts alkylation, dehydration and Friedel-Crafts acylation

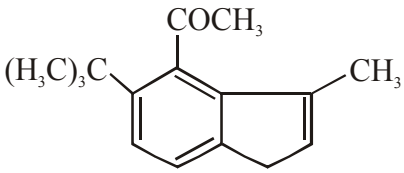
(C) Aromatic sulfonation and Friedel-Crafts acylation

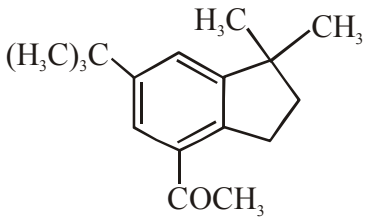
(D) Friedel-Crafts alkylation and Fridel-Crafts acylation

36. The product **S** is -

(A) 

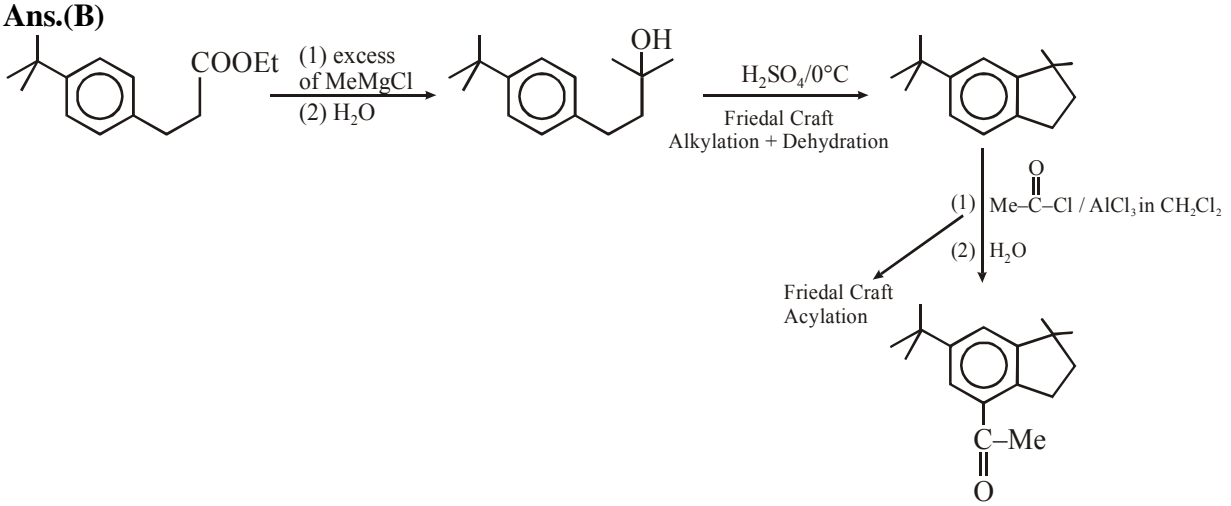
(B) 

(C) 

(D) 

Solution for paragraph Q.35 & 36

35. Ans.(B)

Sol. 

36. Ans.(D)

Sol.