

QUESTION BANK ACIDITY, BASICITY H-BONDING & TAUTOMERISM

Silvoy



Students should solve this Question Bank by 17th Sept. 2006 positively

Questions No.1 to 6 (6 questions)

Acid strength is measured by the position of equilibrium of ionisation in water. In other words acid strength is the function of the stability of conjugate base of the acid. More is the stability of conjugate base of the acid, more is the acidity of acid.

Q.1 Which one of the following is the most acidic?

Q.2 Which one of the following phenols will show highest acidity?

$$(A) \bigcirc CH_3$$

$$CH$$

$$CH$$

(C)
$$H_3C$$
 OH NO_2

(D)
$$_{\text{H}_3\text{C}}$$
 OH

Q.3 Arrange the following compounds in decreasing order of acidity?

$$(IV)$$
 \bigcirc OH

Select the correct answer from the codes given below:

(B)
$$III > II > IV$$

(C)
$$II > III > I > IV$$

(D)
$$II > III > IV > I$$

Q.4 Which one of the following is strongest acid?

(D)
$$CH_3 - COOH$$

Q.5 The correct order of acidity of the given acids:

(III)
$$CH_2 < COOH$$

will be:

(B)
$$I > II > III > IV$$

(D)
$$II > I > IV > III$$

Q.6 Which of the following is weakest acid?



Question No. 7 to 9 (3 questions)

Basicity of nitrogen containing compounds are determined by the realtive availability of the non-bonding electrons on nitrogen atom to a proton donor or Lewis acid and by the stabilisation of the positive charged nitrogen atom by solvation or, in some special cases by resonance.

Q.7 Consider the following bases:

(I) o-nitroaniline

(II) m-nitroaniline

(III) p-nitroaniline

The decreasing order of basicity is:

(A) II > III > I

(B) II > I > III

(C) I > II > III

(D) I > III > II



- Q.8 Consider the basicity of the following aromatic amines:
 - (I) aniline
- (II) p-nitroaniline
- (III) p-methoxyaniline (IV) p-methylaniline

The correct order of decreasing basicity is:

- (A) III > IV > I > II
- (B) III > IV > II > I
- (C) I > II > III > IV
- (D) IV > III > II > I
- Which one of the following is least basic in character? Q.9



- Match List I with List II and select the correct answer from the codes given below the lists: Q.10

List I

- $CH_3 C CH_2 CH_2 CH_3$ and $CH_3 CH_2 C CH_2 CH_3$ (a)
- (b) and
- (c) and
- (d) and H₂C ОΗ

List II

(1) Enantiomer

(2) Position isomers

(3) Metamers

(4) Tautomers

Codes:

(a) 3

- (A)
- (d) (c) 4 1

- 3 2
- (d)

- (B)

(a)

4

- (C)
- 3 4
- (D)
- Q.11 Arrange pH of the given compounds in decreasing order:
 - (1) Phenol
- (2) Ethyl alcohol
- (3) Formic acid
- (4) Benzoic acid

- (A) 1 > 2 > 3 > 4
- (B) 2 > 1 > 4 > 3
- (C)3 > 2 > 4 > 1
- (D) 4 > 3 > 1 > 2
- Q.12 Arrange acidity of given compounds in decreasing order:
 - (I) CH₃-NH-CH₂-CH₂-OH
- (II) CH₃-NH-CH₂-CH₂-CH₂-OH
- (III) $(CH_3)_3 \overset{\oplus}{N} CH_2 CH_2 OH$

(b)

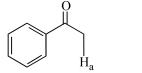
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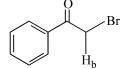
- (A) III > I > II
- (B) III > II > I
- (C) I > II > III
- (D) II > I > III



In each of the following pair of compounds, which is more basic in aqueous solution? Give an explanation for your choice:

- (a) CH₃NH₂ or CF₃NH₂
- (b)
- (c) n-PnNH₂ or CH₃CN
- CH_3CONH_2 or H_2N NH_2 $C_6H_5N(CH_3)_2$ or 2,6-dimethyl-N-N-dimethylaniline
- m-nitroaniline or p-nitroaniline (e)
- 0.14 Answer the following:
- Which proton is more rapidly abstracted by ethoxide ion and why? (a)

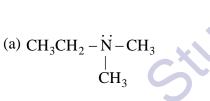


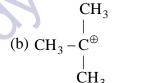


(b) Which compound is more rapidly attacked by a nucleophile and why?

- From the following pair, select the stronger base: Q.15
- p-methoxy aniline or p-cyanoaniline (a)
- (b) pyridine or pyrrole

- (c) CH₃CN or CH₃CH₂NH₂
- Q.16 Write equations showing the Lewis acid-base reaction that takes place when
- (a) Methyl alcohol reacts with BF₃.
- Methyl chloride reacts with AlCl₃. (b)
- (c) Dimethyl ether reacts with BF₃.
- Which of the following are lewis acids & which are lewis bases? Q.17





(d) Br ____

(e) $(CH_3)_3B$

- (f) H:
- Q.18 Which would you expect to be the stronger acid? Explain your reasoning in each instance.
- CH₂ClCO₂H or CHCl₂CO₂H (a)
- (b) CCl₃CO₂H or CHCl₂CO₂H
- (c) CH₂FCO₂H or CH₂FCH₂CO₂H
- Q.19 Write equations for the acid base reaction that would occur when each of the following compounds or solution are mixed. In each case label the stronger acid & stronger base, & the weaker acid & weaker base.
- (a) NaH is added to CH₂OH
- NaNH₂is added to CH₃CH₂OH (b)
- Gaseous NH₃ is added to ethyl lithium in hexane (c)
- NH₄Cl is added to NaNH₂ in liq. NH₃ (d)
- (CH₃)₃CONa is added to H₂O (e)
- (f) NaOH is added to (CH₃)₃ C-OH
- C_2H_5OH is added to a solution of $HC \equiv C^-Na^+$ in liquid NH_3 . (g)



- $CH_3CH_2MgBr + CH_3C \equiv CH \longrightarrow A + B$
- Q.21 Choose the member of each of the following pairs of compunds that is likely to be the stronger base.
 - (a) NH_2^- or NH_3
- (b) OH- or H₂O

(c) OH- or SH-

(d)
$$CH_3CH_2O^-$$
 or

(d)
$$CH_3CH_2O^-$$
 or \bigcirc (e) CH_2-C-OH or $CH_3CH_2O^-$ (f) NH_3 or NH_4^{\oplus}

- Q.22 Choose the member of each of the following pairs of compunds that is likely to be the weaker base.
 - (a) H_2O or H_3O^{\oplus}
- (b) H_2S , HS^- , S^{2-}

(c) Cl⁻, SH⁻

- (d) F⁻, OH⁻, NH₂⁻, CH₃⁻ (e) HF, H₂O, NH₃

- (f) OH⁻, SH⁻, SeH⁻
- Label the reactants in these acid base reactions as Lewis acids (electrophiles) or Lewis bases Q.23 (nucleophiles). Use curved arrows to show the movement of electron pairs in the recations.
- $CH_3 O$ $+ CH_3 CI$ $\longrightarrow CH_3 O CH_3 + CI$ (a)
- $CH_{3} \overset{\bullet}{O}^{+} CH_{3} + \overset{\bullet}{\bullet} \overset{\bullet}{O} H \longrightarrow CH_{3} \overset{\bullet}{O}^{+} + CH_{3} \overset{\bullet}{O}^{+} H$ $CH_{3} \qquad H \qquad CH_{3} \qquad H$ $O \qquad \vdots \overset{\bullet}{O}^{+} CH_{3} \qquad H$ $U = C + H + \overset{\bullet}{\bullet} NH \qquad C + H$ (b)
- $H-C-H + NH_3 \longrightarrow H-C-H$ (c)
- $^{+}$ NH₃ $CH_3 NH_2 + CH_3 CH_2 CI_2 \longrightarrow CH_3 NH_2 CH_2CH_3 + CI_2 \longrightarrow CH_3 NH_2 CH_2 CH_$ (d)
- $(CH_3)_3CCl + AlCl_3 \longrightarrow (CH_3)_3C^+ + AlCl_4$ (e)
- $CH_2 = CH_2 + BF_3 \longrightarrow \overline{B}F_3 CH_2 \overline{C}H_2$ (f)
- $\begin{array}{ccc}
 & & & & & & & \\
 & & & & & \\
 CH_3 C CH_3 + & & & & \\
 \end{array}$ $\begin{array}{cccc}
 & & & & \\
 CH_3 C = CH_2 + H & & \\
 \end{array}$ $\begin{array}{cccc}
 & & & \\
 \end{array}$ (g)
- $\overline{B} F_3 CH_2 \overset{+}{C}H_2 + CH_2 = CH_2 \longrightarrow \overline{B} F_3 CH_2 CH_2 \overset{+}{C}H_2$ (h)
- $\overset{\bullet}{\text{CH}}_3 \overset{\bullet}{\text{C}} \overset{\bullet}{\text{CH}}_3 + \overset{\bullet}{\text{H}}_2 \text{SO}_4 \longrightarrow \overset{\bullet}{\text{CH}}_3 \overset{\bullet}{\text{C}} \overset{\bullet}{\text{CH}}_3 + \overset{\bullet}{\text{H}} \text{SO}_4^-$ (i)
- Q.24 Predict the products of the following acid_base reactions.

$$\rm H_2SO_4 \ + CH_3COO^- \ 1$$

- Q.25 Methyllithium (CH₃Li) is often used as a base in organic reactions.
- (a) Predict the products of the following acid – base reaction.

$$CH_3CH_2 - OH + CH_3 - Li \longrightarrow$$

- (b) What is the conjugate acid of CH₃Li? Would you expect CH₃Li to be a strong base or a weak base?
- Which reagent in each pair listed here would be the more reactive Nu in a protic solvent? Q.26
 - CH₃NH⁻ or CH₃NH₂ (a)

(b) H₂O or H₂O[⊕]

CH₃O or CH₃COO (c)

CH₃SH or CH₃OH (d)

Ph₃N or Ph₃P (e)

CH₃COO- or -OH (f)

H₂S or HS (g)

 NH_3 or NH_4^{\oplus} (h)



- Q.27 Arrange the following compounds in order of increasing basicity.
- (a) CH_3NH_2 , $CH_3NH_3^{\oplus}$, $CH_3NH_3^{\ominus}$

- (b) CH_3O^- , CH_3NH^- , $CH_3CH_2^-$
- (c) $CH_3CH = CH^-, CH_3CH_2CH_2^-, CH_3C \equiv C^-$
- Q.28 Suggest what species would be formed by each of the following combinations:
 - (a) PhO + CH₃COOH

- (b) $\stackrel{\oplus}{\text{HN}} \stackrel{\text{NH}}{\searrow} + \text{CH}_3\text{O}$
- (c) Pyridinium ion + trifluoroacetate ion
- Q.29 Say which pk_a belong to which functional group in case of following amino acids:
- (i) cysteine: $^{\text{COOH}}_{\text{NH}_2}$ 1.8, 8.3 & 10.8
- (ii) glutamic acid: $^{\text{HO}_2\text{C}}$ $^{\text{COOH}}$: 2.19, 4.25, 9.67
- Q.30 Record the following sets of compounds according to increasing $pK_a (=-\log Ka)$
- (a) OH OH , cyclohexane carboxylic acid.
- (b) 1-butyne, 1-butene, butane
- (c) Propanoic acid, 3-bromopropanoic acid, 2-nitropropanoic acid
- (d) Phenol, o-cresol

- (e) Hexylamine, aniline, methylamine
- Q.31 Explain which compound is the weaker base.
- (b) $CH_2 = CH CH = CH CH_2^- \text{ or } CH_2 = CH CH_2^-$
- OH OH CF₃
- Q.32 Rank the following amines in increasing basic nature.
- $(a) \qquad \bigodot^{NH_2}$ (i)
- NH₂ CH₃ (ii)
- NH₂ NO₂

(d)

(iv)

- (b) NH₂ CH₃
- NH₂
- $\bigcup_{\text{CH}_3}^{\text{NH}_2}$
- CH₂-NH₂

- (i)
- (ii)
- (iii)

(iv)

- (c) (i)
- (ii)
- (iii)

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- Q.33 Dimethyl furmamide (DMF) is an example of polar aprotic solvent, aprotic meaning it has no hydrogen atoms attached to highly electronegative atoms.
- (a) Draw what you predict to be its most important resonance forms.
- (b) DMF when used as the reaction solvent, greatly enhances the reactivity of nucleophiles. e.g. $NaCN + CH_3CH_2Br \longrightarrow CH_3CH_2 C \equiv N + NaBr$ Suggest an explanation for this effects.
- Q.34 Arrange the basic strength of the following compounds.
- (a) OH-
- CH₃COO-
- Cl-

(i)

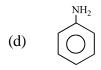
- (ii)
- (iii)

- (b) $CH \equiv C^{-}$
- $CH_2 = CH^-$
- CH₃CH₂

(i)

- (ii)
- (iii)

- (c) $CH_2 = CHCH_2NH_2$ (i)
- CH₃CH₂CH₂NH₂
- $CH \equiv C CH_2NH_2$ (iii)



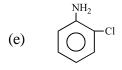




(i)

(ii)

(iii)





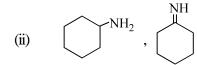


- (i)
- (ii)

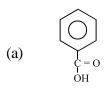
(iii)

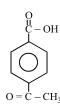
- (f)
- Cl⁻ (i)
- RCOO-(ii)
- OH-(iii)
- RO-(iv)
- NH₂⁻ (v)

- Q.35 Set the following in increasing order of pk_b :
- (i) CH_3NH_2 , $(CH_3)_2NH$, $(CH_3)_3N$, NH_3
- [In ageous medium]



- (iii)
- NH , NNH
- Q.36 Arrange the following in increasing acid strength:







(i)

(ii)

(iii)

(b) OH

- CH₃- OH
- OH CN

(i)

(ii)

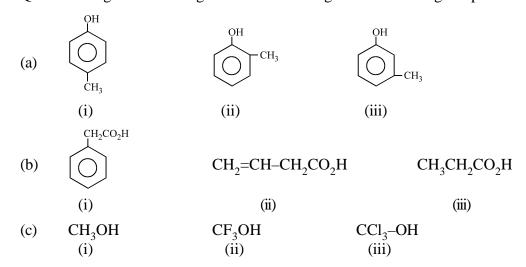
(iii)



- Q.37 Set the following in increasing order of pk_a:
- (i) Methane sulfonic acid, acetic acid & methanol.
- (ii) $CH_3 CH_2 CH_3$, $CH_2 = CH CH_3$, $CH_3 CHO$, $CHO CH_2 CHO$, CH_4
- (iii) CH_3NO_2 , $(NO_2)_2 CH_2$, $(NO_2)_3 CH$

(iv)
$$OH \longrightarrow NO_2 \longrightarrow NO_2$$

- (v) CH_3COOH , NO_2-CH_2-COOH , CH_3-C-CH_2-C-OH \parallel \parallel O O
- (vi) H H H H CN
- Q.38 Cyanic acid (HO–C=N) & isocyanic acid (H–N=C=O) differ in the positions of their electrons but their structure do not represent resonance structures.
- (a) Explain
- (b) Loss of a proton from cyanic acid yields the same anion as that obtained by loss of a proton from isocyanic acid. Explain.
- Q.39 Arrange the increasing order of acidic strength of the following compounds.





Q.40 Explain which is a stronger acid.

(c)
$$OH OH$$
 OH OH $OH OH$ OH $OH OH$ OH $OH OH$

(d)
$$\bigcirc_{O=C-CH_3}^{OH}$$
 or $\bigcirc_{CH_3}^{OH}$

(b)
$$CH_3 - CH_2 - CH_2 - OH \text{ or } CH_3 - CH = CH - OH$$

(c)
$$CH_3 - CH = CH - CH_2 - OH \text{ or } CH_3 - CH = CH - OH$$

- Q.42 Which is a stronger base? & Why.
 - (a) ethylamine or aniline

- (b) ethylamine or ethoxide ion
- (c) phenoxide ion or ethoxide ion
- (d) cyclohexylamine or aniline
- Q.43 The K_a of phenylacetic acid is 5.2×10^{-5} , and the p K_a of propionic acid is 4.87.

O

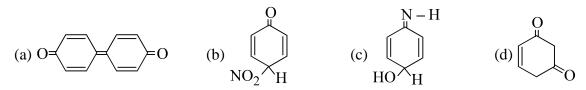
$$CH_2 - C - OH$$
 $CH_3 - CH_2 - C - OH$

phenylacetic acid,
 $K_a = 5.2 \times 10^{-5}$

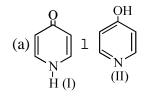
propionic acid,
 $pK_a = 4.87$

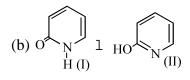
- (a) Calculate the pK_a of phenylacetic acid and the K_a of propionic acid.
- (b) Which of these is the stronger acid?
- (c) Predict whether the following equilibrium will favor the reactants or the products.

Q.44 Which of the following system show H-bonding during tautomerism.



- Q.45 What is the attacking site of conjugate base of triketo form of phloroglucinol in protic & aprotic solvent.
- Q.46 In each of the following pairs which is more stable:







(c)
$$H$$
 (I) H (II) H (III) H (

In each of the following pairs which is less stable: Q.47

(a)
$$_{CH_3}$$
 $_{(I)}$ $_{(II)}$ $_$

The actrof the following pairs winch is infole stable :

(a)
$$CH_3$$
 CH_2 CH_3 CH_3 CH_4 CH_5 CH_5 CH_5 CH_5 CH_5 CH_6 CH_7 CH_8 CH_8 CH_8 CH_8 CH_8 CH_9 CH

In each of the following pairs which is less stable: Q.49

$$(a) \begin{array}{c} & & & & & & & & & \\ & & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & \\ & & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & \\ & & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & \\ & \\ & \\ & \\ & & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\$$



Q.50 In each of the following pairs which will have higher enol content:

(a)
$$CH_2$$
 and CH_3 CH_3

(b) CH_2 $COO Et$ and CH_3 CH_2 $COC H_3$

(c) CH_3 CH_2 CH_2 CH_3 CH_3 CH_4 CH_5 CH_5 CH_5 CH_6 CH_7 CH_8 C

Q.51 In each of the following pairs which will have less enol content:

(a) O and
$$CH_3$$
 (b) O and O and CH_3 (c) O and O and CH_3 - CHO

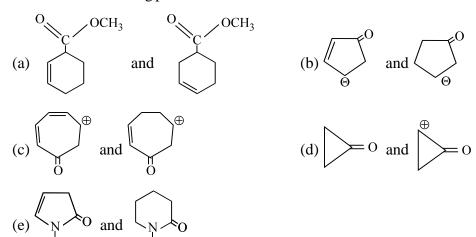
(e) CH_2 - CHO and CH_3 - CHO

Q.52 In each of the following pairs which will have higher enol content:

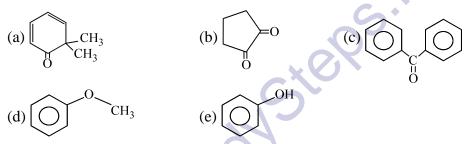
(a)
$$CH_2$$
 - CHO and CH_2 - CHO (b) CH_3 and CH_3 $CH_$



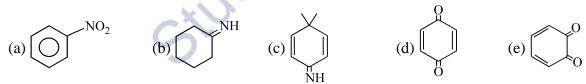
Q.53 In each of the following pairs which will have less enol content:



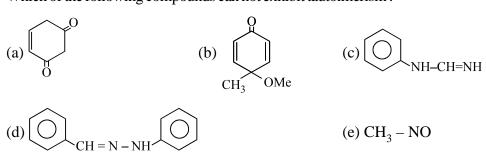
- Q.54 Which of the following compounds can exhibit tautoimerism:
 - (a) $CH_2 = C = O$ (b) C
- (b) $CH_2 = CH OH$ (c) HO CH = CH OH
 - (d) CH_3CN (e) CH_2
- Q.55 Which of the following compounds can not exhibit tautoimerism:



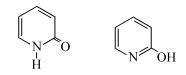
Q.56 Which of the following compounds can exhibit tautoimerism:



Q.57 Which of the following compounds can not exhibit tautoimerism:

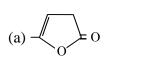


Q.58 What is the relationship between these two molecules? Discuss the structure of the anion that would be formed by the deprotonation of each compound.





- Write down tautomeric structure of 5,5 dimethylcyclohexane –1,3 –dione (dimedone).
- Q.60 Draw enol forms of these carbonyl compounds and comment on the stability of the enol forms.



(a)
$$NH - N = NH$$
 and

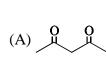
(b)
$$CH_2$$
 O $NH - CH = CH_2$

Shows tautomeric forms of (a) & (b).

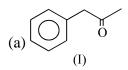
Isatin was the first compound to show tautomerism. Q.62

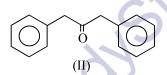
What is the tautomeric form of isatin.

Q.63 1, 3 – dicarbonyl compounds such as (A) are usually mostly enolized. Why is this? Draw the enols available to compounds A & B comment on the different pattern of enolization.



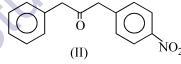
In each of the following sets of compounds write the increasing order of % enol content Q.64

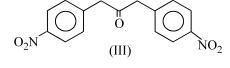


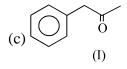




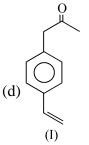


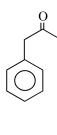


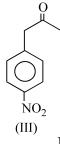


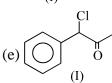


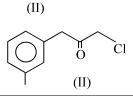








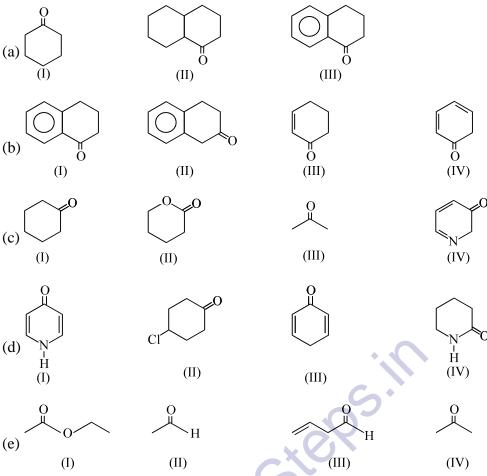








Q.65 In each of the following sets of compounds write the decreasing order of % enol content.



- Q.66 Out of enol form of cyclobutanone and enol form of triketocyclobutane, which is more stable? Give reason also.
- Q.67 OH has lower boiling point than even when former has OH group. Explain.

Q.68
$$_{\text{CH}_3}^{\text{O}}$$
 $_{\text{CH}_3}^{\text{O}}$ $_{\text{CD}_3}^{\text{O}}$ $_{\text{CD}_3}^{\text{O}}$ $_{\text{CH}_3}^{\text{O}}$ $_{\text{CH}_2}^{\text{O}}$ $_{\text{CH}_3}^{\text{O}}$ $_{\text{CH}_3}^{\text{O}}$

Among these give ease of enolization.

Q.69 % enol content of acetylacetone in following solvents is found as:

Explain the observation.



Explain the observation.

This tautomeric system exist almost exclusively in favour of phenol and it is insensitive to change in solvent.

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ANSWER KEY

- **Q.1** Q.2 \mathbf{C} Q.3 D **Q.4** В Q.5 C 0.6 В **Q.7** В Α Q.8 Q.10 A Q.11 В Q.12 A 0.9 Α Α (a) H_b, (b) iiQ.13 (a) i, (b) ii, (c) i, (d) ii, (e) iQ.14 Q.15 (a) i, (b) i, (c) ii0.17 LA b,e LB acdf Q.18 (a) 2; (b) 1; (c) 1 Q.20 $CH_3CH_3 + CH_3C \equiv CMgBr$ Q.21 (a) 1; (b) 1; (c) 1; (d) 1; (e) 2; (f) 1 Q.22 (a) 2; (b) 1; (c) 1; (d) 1; (e) 1; (f) 3 Q.26 (a) 1; (b) 1; (c) 1; (d) 1; (e) 2; (f) 2; (g) 2; (h) 1 Q.27 (a) 2<1<3; (b) 1<2<3; (c) 3<1<2 (a) PhOH + AcO^{\Box} , (b) MeOH + $\stackrel{|}{N}$ Q.28 ΝΗ, (c) no reaction COOH COOH HO₂C 2.19 1.8 Q.29 (i) cysteine: $\frac{113}{8.3}$ (ii) glutamic acid: NH_2 10.89.67 Q.30 (a) 3<2<1; (b) 1<2<3; (c) 3<2<1; (d) 2<1<3; (e) 2<3<1 (a) 2; (b) 1; (c) 2; (d) 2 Q.31 Q.32 (a) 3<2<1<4; (b) 1<2<3<4; (c) 3<1<2 Q.34 (a) 1>2>3; (b) 1<2<3; (c) 3<1<2; (d) 2<1<3; (e) 1<2<3; (f) 1<2<3<4<5 Q.35 (i) 4>3>1>2; (ii) 1<2; (iii) 1<2 Q.36 (a) 1<2<3; (b) 3>1>2; (c) 1<3<2 Q.37 (i) 1<2<3; (ii) 1>5>2>3>4; (iii) 1>2>3; (iv) 1>3>4>2; (v) 1>3>2; (vi) 2>1>3; (vii) 3>4>2>1 0.39 (a) 3>1>2; (b) 1>2>3; (c) 2>3>1 (a) 2; (b) 2; (c) 1; (d) 1; (e) 1 0.40 (a) 1; (b) 2; (c) 2; (d) 1 Q.41 (a) 2; (b) 2; (c) 2 0.42 $^{-5}$, (c) reactant Q.46 (a) 2; (b) 2; (c) 1; (d) 1; (e) 1 Q.43 Q.47 Q.48 (a) 2; (b) 2; (c) 1; (d) 2; (e) 1 (a)2; (b) 2; (c) 2; (d) 2; (e) 1 Q.49 Q.50 (a) 2; (b) 1; (c) 1; (d) 1 (a)1; (b) 2; (c)1; (d) 2 Q.51 (a) 2; (b) 1; (c) 2; (d) 1; (e) 2 Q.52(a) 1; (b) 1; (c) 1; (d) 1 Q.53 (a) 2; (b) 2; (c) 2; (d) 1; (e) 2 Q.54 a, b, c, d, e Q.55 a, c, d Q.56 b Q.57 Q.58 **Tautamers** b OН Q.59 both are more stable ÒН CH₃O =N-NH₂ (b) CH₂ Q.61 (a) Q.62 (B) (a) 2>1>3>4; (b) 3>2>1; (c) 3>2>1; (d) 3>1>2; (e) 3>1>2 Q.64 0.65(a) 3>1>2; (b) 4>2>1>3; (c) 4>3>1>2; (d) 1>3>4>2; (e) 3>2>4>1 Q.66 enol form of triketocyclobutane

3>1>2

Q.68