

WEEKLY TEST RANKER'S BATCH TEST - 17 RAJPUR
 SOLUTION Date 19-01-2020

[PHYSICS]

1. I_C is 90° ahead of the applied voltage and I_L lags behind the applied voltage by 90° . So, there is a phase difference of 180° between I_L and I_C .

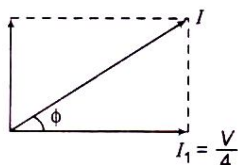
$$\therefore I = I_C - I_L = 0.2 \text{ A}$$

2.

$$I_2 = \frac{V}{X_C} = \frac{V}{3} \quad (\text{here } V = \text{rms value})$$

$$I_1 = \frac{V}{R} = \frac{V}{4}$$

I_2 is 90° ahead of applied voltage function and I_1 is in phase with it.



$$\tan \phi = \frac{V/3}{V/4} = \frac{4}{3}$$

$$\therefore \phi = 53^\circ$$

3.

I_R and I_L are in same phase and phase difference between them and applied voltage lies between 0° and 90° .

4.

$$X_L = \omega L = (5 \times 10^{-3}) (2000) = 10 \Omega$$

$$X_C = \frac{1}{\omega C} = \frac{1}{(2000)(50 \times 10^{-6})} = 10 \Omega$$

Since, $X_L = X_C$ circuit is in resonance.

$$Z = R = (6 + 4) = 10 \Omega$$

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{Z} = \frac{(20/\sqrt{2})}{10} = 1.414 \text{ A}$$

This is also the reading of ammeter.

$$V = 4 I_{\text{rms}} \\ \approx 5.6 \text{ volt}$$

$$5. \quad I_R = \frac{V_{\text{rms}}}{R} = \frac{200}{100} = 0.2 \text{ A}$$

$$X_C = \frac{1}{2\pi f C} = \frac{1}{(2\pi)(5 \times 10^3) \left(\frac{1}{\pi} \times 10^{-6}\right)}$$

$$= 100 \Omega$$

$$\therefore I_C = \frac{V_{\text{rms}}}{X_C} = \frac{200}{100} = 2 \text{ A}$$

I_C is 90° ahead of the applied voltage and I_R is in phase with the applied voltage. Hence, there is a phase difference of 90° between I_R and I_C too.

$$\therefore I = \sqrt{I_R^2 + I_C^2}$$

$$= \sqrt{(2)^2 + (0.2)^2}$$

$$= 2.02 \text{ A}$$

6.

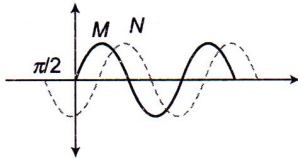
$$7. \quad V_S = \sqrt{V_R^2 + V_L^2}$$

$$= \sqrt{(70)^2 + (20)^2} = 72.8 \text{ V}$$

$$\tan \phi = \frac{X_L}{R} = \frac{V_L}{V_R} = \frac{20}{70} = \frac{2}{7}$$

8.

9. From the graph shown below. It is clear that phase lead of N over M is $-\frac{\pi}{2}$. Since time period (i.e., taken to complete one cycle) = 0.4 sec. Hence frequency $V = \frac{1}{T} = 2.5 \text{ Hz}$



$$10. \quad V_{\text{rms}} = \sqrt{\frac{1}{T} \int_0^T 10^2 dt} = 10 \text{ V}$$

11.

$$I_{\text{av}} = \frac{\int_0^{T/2} i dt}{\int_0^{T/2} dt} = \frac{\int_0^{T/2} I_0 \sin(\omega t) dt}{T/2}$$

$$= \frac{2I_0}{T} \left[\frac{-\cos \omega t}{\omega} \right]_0^{T/2} = \frac{2I_0}{T} \left[-\frac{\cos\left(\frac{\omega T}{2}\right)}{\omega} + \frac{\cos 0^\circ}{\omega} \right]$$

$$= \frac{2I_0}{\omega T} [-\cos \pi + \cos 0^\circ] = \frac{2I_0}{2\pi} [1 + 1] = \frac{2I_0}{\pi}$$

12.

In a pure inductor (zero resistance), voltage leads the current by 90° i.e. $\pi/2$.

13.

$$V_0 = i_0 Z \Rightarrow 200 = 100 Z \Rightarrow Z = 2 \Omega$$

$$\text{Also } Z^2 = R^2 + X_L^2 \Rightarrow (2)^2 = (1)^2 + X_L^2 \Rightarrow X_L = \sqrt{3} \Omega$$

14.

$$X_C = \frac{1}{2\pi\nu C} = \frac{1}{2\pi \times 4000 \times 25 \times 10^{-6}} = \frac{5}{\pi} \Omega$$

15.

$$X_C = \frac{1}{2\pi\nu C} \Rightarrow \frac{1}{1000} = \frac{1}{2\pi \times \nu \times 5 \times 10^{-6}}$$

$$\Rightarrow \nu = \frac{100}{\pi} \text{ MHz}$$

16.

In purely inductive circuit voltage leads the current by 90° .

17.

$$\text{We have } X_C = \frac{1}{C \times 2\pi f} \text{ and } X_L = L \times 2\pi f$$

18.

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} \Rightarrow X_C \propto \frac{1}{f}$$

19.

$$X_L = 2\pi\nu L = 2 \times \pi \times 50 \times \frac{1}{\pi} = 100 \Omega$$

20.

$$Z = \sqrt{R^2 + X_L^2}, X_L = \omega L \text{ and } \omega = 2\pi f$$

$$\therefore Z = \sqrt{R^2 + 4\pi^2 f^2 L^2}$$

21.

$$\begin{aligned} Z &= \sqrt{R^2 + (X_L - X_C)^2} \\ &= \sqrt{100^2 + \left(0.5 \times 100\pi - \frac{1}{10 \times 10^{-6} \times 100\pi}\right)^2} \\ &= 189.72 \Omega \end{aligned}$$

22.

$$\text{At A: } X_C > X_L$$

$$\text{At B: } X_C = X_L$$

$$\text{At C: } X_C < X_L$$

23.

$$X_L = 2\pi f L \Rightarrow X_L \propto f \Rightarrow \frac{1}{X_L} \propto \frac{1}{f}$$

i.e., graph between $\frac{1}{X_L}$ and f will be a hyperbola.



24. From phasor diagram it is clear that current is lagging with respect to E_{rms} . This may be happen in LCR or LR circuit.

$$25. \nu = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{10^{-6} \times 10^{-4}}} = \frac{10^5}{2\pi} \text{ Hz}$$

$$26. \text{Reactance } X = X_L - X_C = 2\pi fL - \frac{1}{2\pi fC}$$

$$27. \text{Phase angle } \tan \phi = \frac{\omega L}{R} = \frac{2\pi \times 200}{300} \times \frac{1}{\pi} = \frac{4}{3}$$

$$\therefore \phi = \tan^{-1} \frac{4}{3}$$

28. As explained in solution (1) for frequency $0 - f_r$, Z decreases hence ($i = V/Z$), increases and for frequency $f_r - \infty$, Z increases hence i decreases.

$$29. \text{Frequency} = \frac{1}{2\pi\sqrt{LC}}$$

So the combination which represents dimension of

$$\text{frequency is } \frac{1}{\sqrt{LC}} = (LC)^{-1/2}$$

30. Impedance of LCR circuit will be minimum at resonant frequency so $\nu_0 = \frac{1}{2\pi\sqrt{LC}}$

$$= \frac{1}{2\pi\sqrt{1 \times 10^{-3} \times 0.1 \times 10^{-6}}} = \frac{10^5}{2\pi} \text{ Hz}$$

$$31. R = 6 + 4 = 10 \Omega$$

$$X_L = \omega L = 2000 \times 5 \times 10^{-3} = 10 \Omega$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2000 \times 50 \times 10^{-6}} = 10 \Omega$$

$$\therefore Z = \sqrt{R^2 + (X_L - X_C)^2} = 10 \Omega$$

$$\text{Amplitude of current} = i_0 = \frac{V_0}{Z} = \frac{20}{10} = 2A$$

$$32. R = \frac{P}{i_{\text{rms}}^2} = \frac{240}{16} = 15 \Omega$$

$$Z = \frac{V}{i} = \frac{100}{4} = 25 \Omega$$

$$\text{Now } X_L = \sqrt{Z^2 - R^2} = \sqrt{(25)^2 - (15)^2} = 20 \Omega$$

$$\therefore 2\pi\nu L = 20 \Rightarrow L = \frac{20}{2\pi \times 50} = \frac{1}{5\pi} \text{ Hz}$$

33. At resonant frequency current in series LCR circuit is maximum.

34. As the current i leads the voltage by $\frac{\pi}{4}$, it is an RC

$$\text{circuit, hence } \tan \phi = \frac{X_C}{R} \Rightarrow \tan \frac{\pi}{4} = \frac{1}{\omega CR}$$

$$\Rightarrow \omega CR = 1 \text{ as } \omega = 100 \text{ rad/sec}$$

$$\Rightarrow CR = \frac{1}{100} \text{ sec}^{-1}$$

From all the given options only option (a) is correct.

35. Power = $I^2 R = \left(\frac{I_p}{\sqrt{2}}\right)^2 R = \frac{I_p^2 R}{2}$

36. Phase angle $\phi = 90^\circ$, so power $P = Vi \cos \phi = 0$

37. $V_{\text{rms}} = \frac{200}{\sqrt{2}}$, $i_{\text{rms}} = \frac{1}{\sqrt{2}}$

$$\therefore P = V_{\text{rms}} i_{\text{rms}} \cos \phi = \frac{200}{\sqrt{2}} \frac{1}{\sqrt{2}} \cos \frac{\pi}{3} = 50 \text{ watt}$$

38. $\therefore P = Vi \cos \phi$, $\therefore P \propto \cos \phi$

39. The instantaneous values of e.m.f. and current in inductive circuit are given by $E = E_0 \sin \omega t$ and $i = i_0 \sin\left(\omega t - \frac{\pi}{2}\right)$ respectively.

$$\begin{aligned} \text{So, } P_{\text{inst}} &= Ei = E_0 \sin \omega t \times i_0 \sin\left(\omega t - \frac{\pi}{2}\right) \\ &= E_0 i_0 \sin \omega t \left(\sin \omega t \cos \frac{\pi}{2} - \cos \omega t \sin \frac{\pi}{2}\right) \\ &= E_0 i_0 \sin \omega t \cos \omega t \\ &= \frac{1}{2} E_0 i_0 \sin 2\omega t \quad (\sin 2\omega t = 2 \sin \omega t \cos \omega t) \end{aligned}$$

Hence, angular frequency of instantaneous power is 2ω .

40. $i_{\text{WL}} = i_{\text{rms}} \sin \phi \Rightarrow \sqrt{3} = 2 \sin \phi \Rightarrow \sin \phi = \frac{\sqrt{3}}{2}$

$$\Rightarrow \phi = 60^\circ \text{ so p.f.} = \cos \phi = \cos 60^\circ = \frac{1}{2}$$

41. $P = E_{\text{rms}} i_{\text{rms}} \cos \phi = \frac{E_0}{\sqrt{2}} \times \frac{i_0}{\sqrt{2}} \times \frac{R}{Z}$

$$\Rightarrow \frac{E_0}{\sqrt{2}} \times \frac{E_0}{Z\sqrt{2}} \times \frac{R}{Z} \Rightarrow P = \frac{E_0^2 R}{2Z^2}$$

$$\text{Given } X_L = R \text{ so, } Z = \sqrt{2}R \Rightarrow P = \frac{E_0^2}{4R}$$

$$42. \quad \tan \phi = \frac{X_L}{R} = \frac{X_C}{R} \Rightarrow \tan 60^\circ = \frac{X_L}{R} = \frac{X_C}{R}$$

$$\Rightarrow X_L = X_C = \sqrt{3} R$$

$$\text{i.e., } Z = \sqrt{R^2 + (X_L - X_C)^2} = R$$

$$\text{So average power } P = \frac{V^2}{R} = \frac{200 \times 200}{100} = 400 \text{ W}$$

$$43. \quad P = E_v I_v \cos \phi; P = E_v \frac{E_v R}{R Z}$$

$$P = \frac{E_v^2 R}{Z^2} = \frac{110 \times 110 \times 11}{22 \times 22} \text{ W} = 275 \text{ W.}$$

$$44. \quad \text{With DC: } P = \frac{V^2}{R} \Rightarrow R = \frac{(10)^2}{20} = 5 \Omega;$$

$$\text{With AC: } P = \frac{V_{\text{rms}}^2 R}{Z^2} \Rightarrow Z^2 = \frac{(10)^2 \times 5}{10} = 50 \Omega^2$$

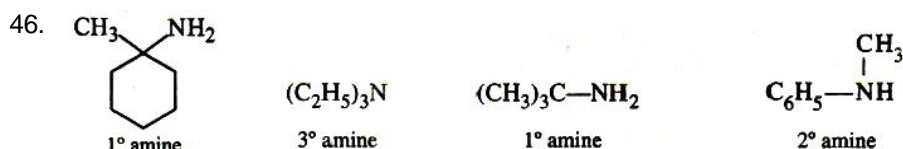
$$\text{Also } Z^2 = R^2 + 4\pi^2 v^2 L^2$$

$$\Rightarrow 50 = (5)^2 + 4(3.14)^2 v^2 (10 \times 10^{-3})^2 \Rightarrow v = 80 \text{ Hz.}$$

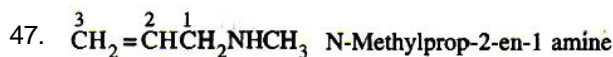
$$45. \quad P = \frac{1}{2} V_0 i_0 \cos \phi \Rightarrow 1000 = \frac{1}{2} \times 200 \times i_0 \cos 60^\circ$$

$$\Rightarrow i_0 = 20 \text{ A} \Rightarrow i_{\text{rms}} = \frac{i_0}{\sqrt{2}} = \frac{20}{\sqrt{2}} = 10\sqrt{2} \text{ A.}$$

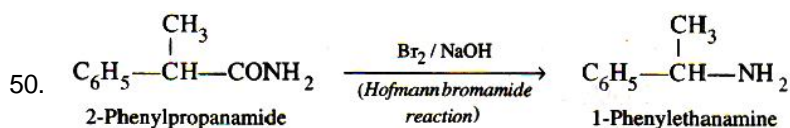
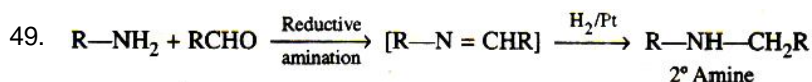
[CHEMISTRY]



Thus, option (b) is correct.



48. Due to delocalisation of a lone pair of electrons present on the N-atom into the benzene ring, $\text{C}_6\text{H}_5\text{NH}_2$ is the weakest base.

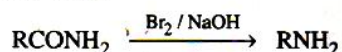


51.

52. Electron-donating groups (i.e., CH_3) increase while electron-withdrawing groups (i.e., NO_2) decrease the basicity of amines. Thus, option (d) is correct.

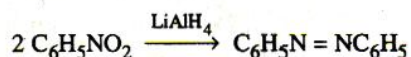
53. Amines (a, b) have a stronger tendency to accept a proton and hence are stronger Bronsted bases than phenol (c) and alcohol (d). Since phenol is more acidic than alcohol, therefore, phenol (c) has the least tendency to accept a proton and hence it is the weakest Bronsted base.
- 54.
55. Aniline is a weaker base than NH_3 due to delocalization of lone pair electrons of the N atom over the benzene ring. Pyrrole (c) is not at all basic because the lone pair of electrons on the N-atom is donated towards aromatic sextet formation. Therefore, pyrrolidine (d) has a strong tendency to accept a proton and is hence it is the strongest Bronsted base.
56. NH_3 is more basic than H_2O , therefore, NH_2^- is a stronger base than OH^- . Thus, the decreasing order of basic strength is option (a), i.e., $\text{NH}_2^- > \text{OH}^- > \text{NH}_3 > \text{H}_2\text{O}$.
57. The amine which is most basic is most reactive, i.e., $(\text{CH}_3)_2\text{NH}$.
58. 1° and 2° Amines due to intermolecular H-bonding have higher boiling points (and hence less volatile than 3° amines and hydrocarbons of comparable molecular mass. Further, due to polar C-N bonds, 3° amines are more polar than hydrocarbons which are almost non-polar. Therefore, due to weak dipole-dipole interactions, 3° amines have higher boiling point (i.e., less volatile) than hydrocarbons. In other words, $\text{CH}_3\text{CH}_2\text{CH}_3$ has the least b.p. and hence is most volatile.

59. Only treatment of amide with Br_2 in aqueous solution of NaOH will give an amine with lesser number of carbon atoms than in the reactant while

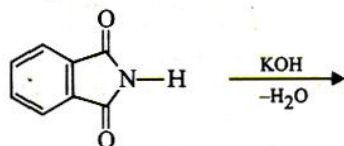


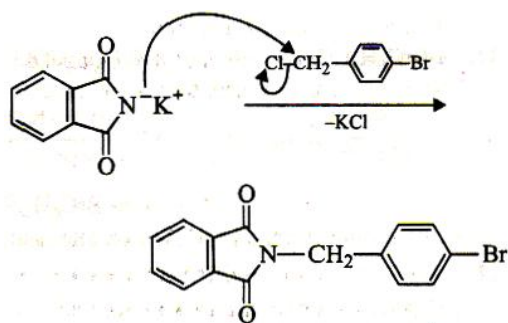
all the remaining reactions give an amine with the same number of carbon atoms as in the reactant.

60. Nitrobenzene on reduction with LiAlH_4 gives azobenzene

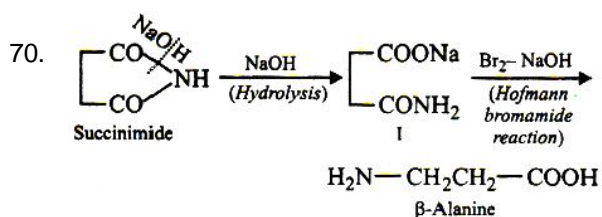
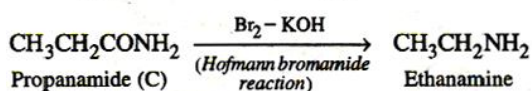
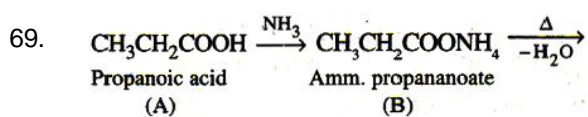
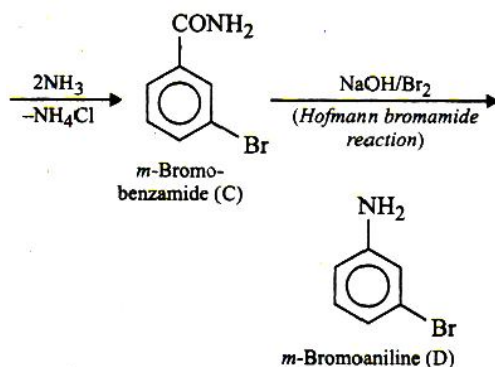
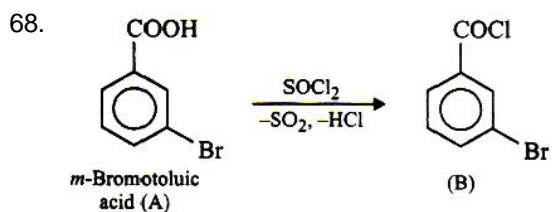
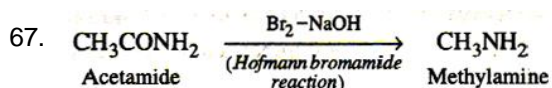


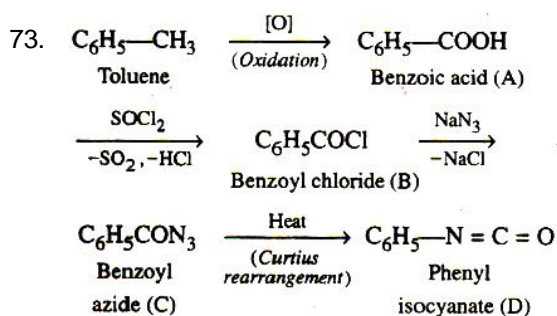
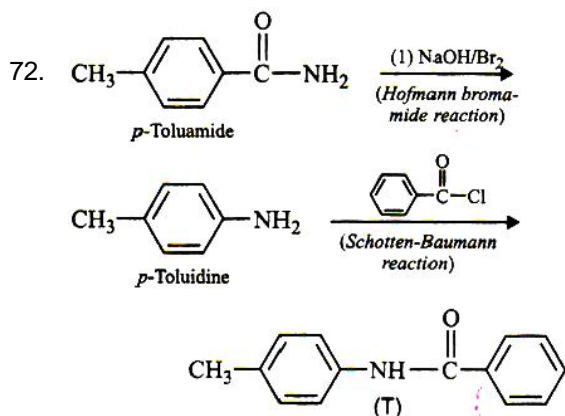
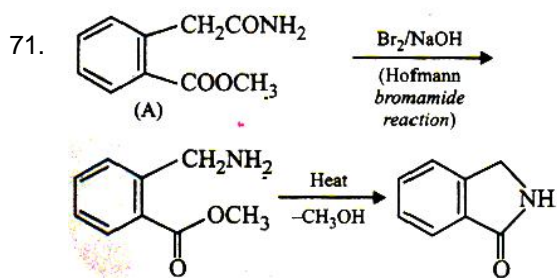
61. $-\text{NO}_2$ is a powerful deactivating group. It reduces the electron density in the benzene ring considerably. As a result, it does not undergo F.C. reactions.
62. $-\text{NO}_2$ is a *m*-directing group and hence 1,3-dinitrobenzene is formed.
63. 2° Alkyl bromides undergo dehydrohalogenation to yield alkenes.
- 64.---
65. Alkyl halides are more reactive than aryl halides towards nucleophilic substitution reaction. Therefore, reaction occurs at the more reactive CH_2Cl instead of at Br as shown below :





66. N-Methylbenzylamine ($\text{CH}_3\text{NHCH}_2\text{C}_6\text{H}_5$) being a 2° amine cannot be prepared by Gabriel's synthesis.





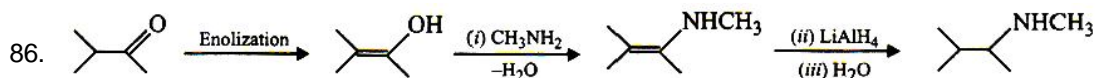
74.---

75. In the gaseous phase, basicity increases as the +I-effect of the alkyl groups increases, *i.e.*, CH_3NH_2 (I) < $(\text{CH}_3)_2\text{NH}$ < $(\text{CH}_3)_3\text{N}$ (III). However, due to -I-effect of the C_6H_5 - group, $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$ (IV) is even a weaker base than CH_3NH_2 (I). Thus, the overall, basic character increases in the order : IV < I < II < III.
76. In the gaseous phase, basicity increases as the +I-effect of the alkyl groups increases. Thus, option (b) is correct.
77. All aliphatic amines (*i.e.*, methanamine, ethanamine dimethylaniline) are more basic than benzenamine (aniline). Further, due to the presence of two CH_3 groups on N in N,N-dimethylaniline, it is more basic than aniline or benzenamine. Hence, benzenamine is the weakest base and hence has the highest pK_b value.

78. $C_6H_5CH_2NH_2$ is the strongest base since the lone pair of electrons on the N-atom is not delocalized over the benzene ring while in all the remaining amines, it is delocalized over the benzene ring.
79. In (c), electrons on the N atom are delocalized over two double bond but in (d), electrons are more strongly delocalized over the benzene ring but in (b), electrons are not delocalized, at all, therefore, it is the strongest base. Further, being a 2° amine, it is more basic than even NH_3 . Thus, option (b) is correct.
80. A weak base has a strong conjugate acid. Since aniline is the weakest base, therefore, its conjugate acid is the strongest acid.
81. 2° Amines are more basic than 1° and 3° amines. Among the 2° amines, (b) and (c); (b) is less basic since the lone pair of electrons on the nitrogen atom is contributed towards the aromatic sextet formation. Hence, piperidine, i.e., option (c) is correct.
82. -
83. Amines are more basic than ethers, therefore, (d) is least basic. Out of (a), (b) and (c); (c) is least basic due to donation of its lone pair of electrons towards aromatic sextet formation. Out of (a) and (b), since 2° amines are more basic than 3° amines, therefore, (a) is the most basic amine.

84.-

85.-



87.

88.

Since compound A (C_3H_9N) reacts with HNO_2 to give alcohol and N_2 gas, therefore, it must be a *primary aliphatic amine*. Further, since 1° aliphatic amine (A) on warming with $CHCl_3$ and caustic potash gave compound (C) which on reduction gave isopropylmethylamine, therefore, 1° amine (A) must be isopropylamine, i.e., option (a) is correct.

