WEEKLY TEST MEDICAL PLUS - 01,02 B, 01 R
SOLUTION Date 05 -01-2020

[PHYSICS]

1. Given, $l_1 = 1k,\ l_2 = 3k,\ l_3 = 5k$
and $m_1 = 5m,\ m_2 = 3m,\ m_3 = 1m$
Resistance $R = \frac{\rho l}{A}$
where ρ is resistivity of the material of conductor.
So, $R_1 : R_2 : R_3 = \frac{l_1}{A_1} : \frac{l_2}{A_2} : \frac{l_3}{A_3} = \frac{l_1^2}{V_1} : \frac{l_2^2}{V_2} : \frac{l_3^2}{V_3}$
$= \frac{l_1^2}{m_1} : \frac{l_2^2}{m_2} : \frac{l_3^2}{m_3} = \frac{1}{5} : \frac{9}{3} : \frac{25}{1} = 1:15:125$

2. Electric power, $P = i^2 R$
∴ Current, $i = \sqrt{\frac{P}{R}}$
For resistance of 9 Ω
$$i_1 = \sqrt{\frac{36}{9}} = \sqrt{4} = 2\text{ A}$$
$$i_2 = \frac{i_1 \times R}{6} = \frac{2 \times 9}{6} = 3\text{ A}$$
$$i = i_1 + i_2 = 2 + 3 = 5\text{ A}$$
$$V_2 = iR_2 = 5 \times 2 = 10\text{ V}$$

3. The given circuit having parallel and series combination of resistance So, we can calculate,
as $R_1 = 3 + 3 = 6\,\Omega$
$R_2 = 3 + 3 = 6\,\Omega$
$\frac{1}{R_3} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{6} + \frac{1}{6}$
⇒ $R_3 = 3\,\Omega$
and $R_4 = 3\,\Omega$
$\frac{1}{R} = \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{3} + \frac{1}{3} = \frac{2}{3}$
or $R = 1.5\,\Omega$

4. . Current $i = \frac{E}{r + R}$
Power $P = i^2 R$
⇒ $P = \frac{E^2 R}{(r + R)^2}$
Power will be maximum when $r = R$
$$P_{max} = \frac{E^2}{4r}$$

5. $E_{eff} = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$

$= \frac{(2 \times 2) + (1 \times 1)}{(2 + 1)}$

$= \frac{4 + 1}{3} = \frac{5}{3}$ V

6. Three resistances are in parallel, so, effectively the resistance would be equal to

$$\frac{1}{R_{eff}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}$$

So, $R_{eff} = \frac{R}{3}$

7. Current $i = \frac{E}{R + r}$

$$2 = \frac{E}{2 + r} \quad \ldots(i)$$

and $$0.5 = \frac{E}{9 + r} \quad \ldots(ii)$$

From Eqs. (i) and (ii), we have

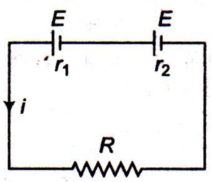
$$\frac{2}{0.5} = \frac{9 + r}{2 + r}$$

$$4 = \frac{9 + r}{2 + r}$$

$$3r = 1$$

$$r = \frac{1}{3}\,\Omega$$

8. There are two batteries with emf E each and the internal resistances r_1 and r_2 respectively.



Hence we have $i(R + r_1 + r_2) = 2E$,

thus, $i = \frac{2E}{R + r_1 + r_2}$

Now the potential difference across the first cell would be equal to $V = E - ir_1$. From the question, $V = 0$, hence, $E = ir_1 = \frac{2Er_1}{R + r_1 + r_2}$, thus, $R + r_1 + r_2 = 2r_1$, hence, $R = r_1 - r_2$.

9. Resistance $R = \frac{12 \times 4}{12 + 4} + 2 = \frac{48}{16} + 2$

Electric current $i = \frac{E}{R + r} = \frac{12}{6} = 2$ A

$$i_1 + i_2 = 2 \text{ A}$$

$$i \propto \frac{1}{R}$$

$\therefore$ $i_2 = 1.5$ A, $i_1 = 0.5$ A

10. $R_{eff} = \dfrac{(P+Q)(R+S)}{(P+Q+R+S)}$

$R_{eff} = \dfrac{4}{3}R$

11. Let $R = 100\,\Omega$

$\therefore$ $R' = 100 + 100 \times \dfrac{10}{100}$

$= 110\,\Omega$

$\therefore$ $\Delta R = R' - R$

$= 110 - 99 = 11\,\Omega$

12. Given, $V = 115$ V

and $P = 1250$ W

We know, $R = \dfrac{V^2}{P}$

So, $R = \dfrac{(115)^2}{1250}$

$= 10.58\,\Omega$

$R = 10.6\,\Omega$

13. Drift velocity $v_d = \dfrac{i}{nAe} = \dfrac{i \times 4}{n\pi D^2 e}$ *i.e.,* $v_d \propto \dfrac{1}{D^2}$

$\therefore$ $\dfrac{v_{d_1}}{v_{d_2}} = \dfrac{D_2^2}{D_1^2} = \left(\dfrac{1}{2}\right)^2 = \dfrac{1}{4}$

14. The resistivity of a semiconductor decreases with increase in temperature exponentially.
Hence, option (c) is correct.

15. With rise in temperature, conductivity of semiconductor increases while resistance decreases.

16. In case of stretching of wire $R \propto l^2$.
If length becomes 4 times, so, resistance becomes 16 times,
i.e., $P' = 16 \times 24 = 384\,\Omega$

17. The current i crossing area of cross-section A, can be expressed in terms of drift velocity v_d and the moving charges as

$$i = nev_dA$$

where, n is number of charge carriers per unit volume and e the charge on the carrier.

$\therefore$ $v_d = \dfrac{i}{neA}$

$= \dfrac{24 \times 10^{-3}}{(3 \times 10^{23})(1.6 \times 10^{-19})(10^{-4})}$

$= 5 \times 10^{-3}\,\text{ms}^{-1}$

18. The resistance of a wire is directly proportional to the length of the wire.
Thus, $R \propto l$, so, the length increases n-fold also since the volume of the wire remains constant, so, the area of the wire decreases n-fold.
Hence the resistance increases to n^2R as the area is inversely proportional to resistance.

19. Specific conductivity $= \dfrac{1}{\text{specific resistance}}$

$$= \frac{1}{\Omega \ \text{cm}} = (\Omega \ \text{cm})^{-1}$$

20.
$$R_t = R_0(1 + \alpha t)$$
$$20 = R_0(1 + 20\alpha)$$
and
$$60 = R_0(1 + 500\alpha)$$
$$R_t = 25\,\Omega$$
On solving, we find $t = 80°\text{C}$

21. Drift velocity in a copper conductor

$$v_d = \frac{i}{neA} = \frac{5.4}{8.4\times 10^{28} \times 1.6\times 10^{-19} \times 10^{-6}}$$
$$= 0.4\times 10^{-3}\,\text{ms}^{-1} = 0.4\ \text{mms}^{-1}$$

22. Resistance $R = \dfrac{\rho l}{A}$ or $R \propto l$

$\therefore$
$$\frac{R_1}{R_2} = \frac{l_1}{l_2} = \frac{L}{L/4} = 4$$
or
$$R_2 = \frac{R}{4} \qquad (\because R_1 = R)$$
In parallel combination of such four resistances.
$$\frac{1}{R'} = \frac{1}{R_2} + \frac{1}{R_2} + \frac{1}{R_2} + \frac{1}{R_2}$$
or
$$\frac{1}{R'} = \frac{1}{R/4} + \frac{1}{R/4} + \frac{1}{R/4} + \frac{1}{R/4}$$
or
$$\frac{1}{R'} = \frac{4}{R} + \frac{4}{R} + \frac{4}{R} + \frac{4}{R}$$
or
$$\frac{1}{R'} = \frac{16}{R} \text{ or } R' = \frac{R}{16}$$

23.
$$\frac{R_1}{R_2} = \frac{(1 + \alpha t_1)}{(1 + \alpha t_2)}$$
$$\Rightarrow \quad \frac{1}{2} = \frac{(1 + 0.00125 \times 27)}{(1 + 0.00125 \times t)}$$
$$\Rightarrow \quad t = 854°\text{C} \Rightarrow T = 1127\ \text{K}$$

24. Heat produced $H = \dfrac{V^2 t}{R \times J}$ cal

$$H = \frac{Pt}{J} = \frac{1500 \times 7 \times 60}{4.2}$$
$$1.5 \times 10^5 \ \text{cal} = 150 \ \text{kcal}$$

25. The ratio of the intensities of the electric field (E) at any point within a conductor and the current density (J) at that point is called specific resistance or resistivity of the conductor

$$\rho = \frac{E}{J}$$

Specific resistance is the characteristic of the material of the conductor.

26. Slope of the V-i curve at any point is equal to resistance at that point.
From the curve slope for T_1 > slope for T_2
$$R_{T_1} < R_{T_2}$$
$\Rightarrow$ Also at higher temperature resistance will be higher so,
$$T_2 > T_1$$

27. Current density relates with electric field as

$$J = \sigma E = \frac{E}{\rho} i$$

where σ = conductivity and ρ = resistivity or specific resistance of substance.

28. Wire AB is uniform so, current through wire AB at every point across section will be same. Hence, current density $J = (i/A)$ at every point of the wire will be same.

29. Applying Kirchhoff's law at point D, we get

$$I_1 = I_2 + I_3$$

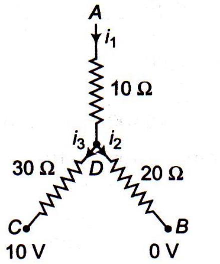
$$\frac{V_A - V_D}{10} = \frac{V_D - 0}{20} + \frac{V_D - V_C}{30}$$

or $$70 - V_D = \frac{V_D}{2} + \frac{V_D - 10}{3}$$

$\Rightarrow$ $$V_D = 40\text{ V}$$

$\Rightarrow$ $$i_1 = \frac{70 - 40}{10} = 3\text{ A}$$

$$i_2 = \frac{40 - 0}{20} = 2\text{ A}$$



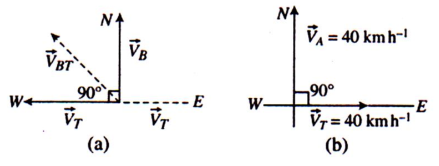
and $$i_3 = \frac{40 - 10}{30} = 1\text{ A}$$

30. Drift velocity per unit electric field is called mobility of electron, *i.e.*, $$\mu = \frac{v_d}{E} = \frac{E}{\rho neE}$$

Now, $$\rho = \frac{m}{ne^2\tau}$$

$\therefore$ $$\mu = \frac{ne^2\tau}{mne} = \frac{e\tau}{m}$$

31. **To find the relative velocity of bird w.r.t. train, superimpose velocity $-\vec{V}_T$ on both the objects. Now as a result of it, the train is at rest, while the bird possesses two velocities, $\vec{V}_B$ towards north and $-\vec{V}_T$ along west.**

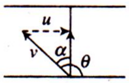


$$|\vec{V}_{BT}| = \sqrt{|\vec{V}_B|^2 + |-\vec{V}_T|^2}$$ **[By formula, $\theta = 90°$]**

$$= \sqrt{40^2 + 40^2} = 40\sqrt{2}\ \text{km h}^{-1}$$ **north–west**

32. Relative velocity of boat with respect to water is

$$\vec{v}_b - \vec{v}_w = 3\hat{i} + 4\hat{j} - (-3\hat{i} - 4\hat{j}) = 6\hat{i} + 8\hat{j}$$



33. Relative velocity of bird with respect to train is

$$V_{BT} = V_B + V_T = 5 + 10 = 15\ \text{ms}^{-1}$$

[Because they are going in opposite directions]

Time taken by the bird to cross the train is $\frac{150}{5} = 10$ s

34. The time taken to reach the ground depends on the height from which the bullets are fired when the bullets are fired horizontally. Here height is same for both the bullets, and hence the bullets will reach the ground simultaneously.

35. $$\frac{R}{T^2} = \frac{u^2 \sin 2\theta / g}{4u^2 \sin^2\theta / g^2} = \frac{g}{2}\cot\theta$$

i.e., $gT^2 = 2R\tan\theta$

If T is doubled, then R becomes 4 times.

36. For the person to be able to catch the ball, the horizontal component of velocity of the ball should be same as the speed of the person, i.e.,

$$v_0 \cos\theta = \frac{v_0}{2} \quad \text{or} \quad \cos\theta = \frac{1}{2} \quad \text{or} \quad \theta = 60°$$

37. Let $u_x = 3\ \text{m s}^{-1}$, $a_x = 0$

$v_y = u_y + a_y t = 0 + 1 \times 4 = 4\ \text{m s}^{-1}$

$v = \sqrt{v_x^2 + v_y^2} = \sqrt{3^2 + 4^2}$

Angle made by the resultant velocity w.r.t. direction of initial velocity, i.e., x-axis, is

$$\beta = \tan^{-1}\frac{v_y}{v_x} = \tan^{-1}\frac{4}{3}$$

38. Range $= 150 = ut$ and $h = \frac{15}{100} = \frac{1}{2} \times gt^2$

or $t^2 = \frac{2 \times 15}{100 \times g} = \frac{30}{1000}$ or $t = \frac{\sqrt{3}}{10}$

$$u = \frac{150}{t} = \frac{150 \times 10}{\sqrt{3}} = 500\sqrt{3}\ \text{m s}^{-1}$$

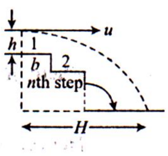
39. $$\frac{R}{T^2} = g\frac{\sin 2\theta}{4\sin^2\theta} = \frac{g}{2}\cot\theta = 5\cot\theta$$

Given $\frac{R}{T^2} = 5$; Hence, $5 = 5\cot\theta$ or $\theta = 45°$

40. If the ball hits the nth step, then horizontal distance traversed $= nh$. Here, velocity along horizontal direction $= u.n = ut$ (i)

Initial velocity along vertical direction is 0.

$$nh = 0 + \frac{1}{2}gt^2 \quad \text{(ii)}$$



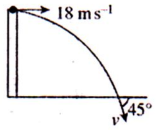
41. Suppose the angle made by the instantaneous velocity with the horizontal be α. Then

$$\tan\alpha = \frac{v_y}{v_x} = \frac{u\sin\theta - gt}{u\cos\theta}$$

Given that $\alpha = 45°$, when $t = 1$ s; $\alpha = 0°$, when $t = 2$ s
This gives $u\cos\theta = u\sin\theta - g$ (i)
and $u\sin\theta - 2g = 0$ (ii)
Solving Eqs. (i) and (ii), we find $u\sin\theta = 2g$ and $u\cos\theta = g$.
Squaring and adding,

$$u = \sqrt{5}g = 10\sqrt{5} \ \ \text{m s}^{-1}$$

42. $v\cos 45° = u = 18 \text{ m s}^{-1}$



$\Rightarrow \quad v = 18\sqrt{2} \text{ m s}^{-1}$
Vertical component

$$v\sin 45° = 18\sqrt{2} \times \frac{1}{\sqrt{2}} = 18 \text{ m s}^{-1}$$

43. $v_x = u_x = 100 \text{ m s}^{-1}$, $v_y = u_y + a_y t = 0 + 10 \times 10$

$$\tan\theta = \frac{v_y}{v_x} = \frac{100}{100} = 1 \quad \Rightarrow \quad \theta = 45°$$

44. $u_x = 16\cos 60° = 8 \text{ m s}^{-1}$
Time taken to reach the wall = 8/8 = 1 s
Now $u_y = 16\sin 60° = 8\sqrt{3} \ \text{m s}^{-1}$

$$h = 8\sqrt{3} \times 1 - \frac{1}{2} \times 10 \times 1 = 13.86 - 5 = 8.9 \text{ m}$$

45. Given $\frac{\sqrt{3}u}{2} = u\cos\theta$ = speed at maximum height

or $\cos\theta = \frac{\sqrt{3}}{2}$ or $\theta = 30°$ (i)

Given that $PH_{max} = R$ (ii)

We know $H_{max} = \frac{R\tan\theta}{4}$

$$P = \frac{R}{H_{max}} = \frac{4}{\tan\theta} = \frac{4}{\tan 30°} = 4\sqrt{3}$$

[CHEMISTRY]

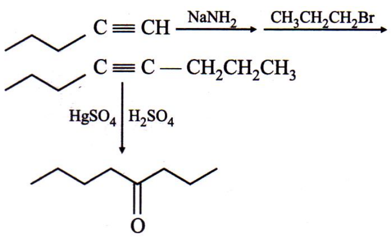
46. **(d)** Mild oxidizing agents like PCC [Pyridinium chlorochromate] are particularly used for the conversion of $R - CH_2OH \rightarrow R - CHO$.

47. (d)

48. **(c)** $CH_3COCl \xrightarrow[\text{Pd/BaSO}_4]{2H} CH_3CHO + HCl$

49.

(b)



50. **(d)** Gem dihalides.

$$CH_3\overset{O}{\overset{\|}{C}}-Cl \xrightarrow{KOH\ (aq)} CH_3-\overset{O}{\overset{\|}{C}}-OH + KCl$$
[SN reaction]

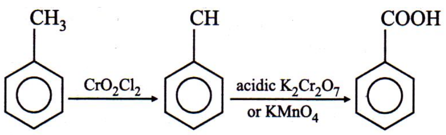
$$CH_3-CH_2-Cl \xrightarrow{KOH\ (aq)} CH_3-CH_2-OH$$
[S_N2 reaction]

$$Cl-CH_2-CH_2-Cl \xrightarrow{KOH\ (aq)} \underset{OH}{CH_2}-\underset{OH}{CH_2}$$
[S_N2 reaction]

$$CH_3-\underset{Cl}{CH}-Cl \xrightarrow{KOH\ (aq)} CH_3-\underset{OH}{CH}-OH \xrightarrow{-H_2O} CH_3-\overset{O}{\overset{\|}{C}}-H$$
(unstable) (acetaldhyde)

51.
(c)

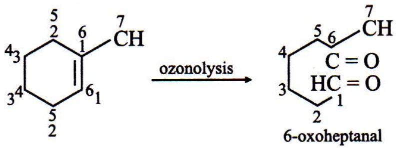
52. **(c)**



This is Etard's reaction

53. (a)
54. (d)

55. **(a)**



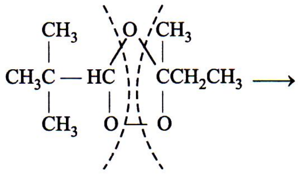
56. **(a)**

$$C_9H_{18} + O_3 \rightarrow H_3C-\underset{CH_3}{\overset{CH_3}{C}}-CHO + \underset{\text{2-butanone}}{CH_3CH_2COCH_3}$$
2,2 dimethyl propanal

On the basis of product formation, it would be alkene

$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-HC=\overset{CH_3}{C}-CH_2CH_3$$
2,2,4-trimethyl-3-hexene

$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-HC=\overset{CH_3}{C}-CH_2CH_3 \xrightarrow{O_3}$$



$$CH_3\underset{CH_3}{\overset{CH_3}{C}}-CHO + CH_3C-\overset{O}{\overset{\|}{C}}H_2CH_3$$

57. **(c)** Reactivity follows the ease with which a nucleophile can attack at carbonyl carbon. Greater the steric hindrance at carbonyl carbon, smaller is the reactivity.

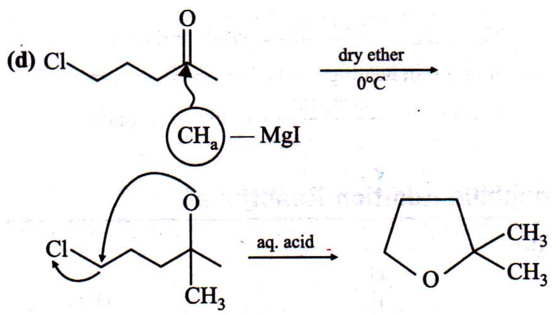
58. **(c)** Reaction of PhMgBr with carbonyl compounds is an example of nucleophilic addition on carbonyl group which increases with the increase in electron-deficiency of carbonyl carbon and less steric hindrance on carbonyl carbon.

Thus acetaldehyde is the most reactive while $C_6H_5COC_6H_5$ least

$$CH_3-\overset{O}{\overset{\|}{C}}-H > CH_3-\overset{O}{\overset{\|}{C}}-CH_3 > C_6H_5-\overset{O}{\overset{\|}{C}}-C_6H_5$$

supplies least electron to group; supplies electrons maximum due to + M effect of C_6H_5

59. **(d)**



60. **(c)** $\underset{\text{Acetone}}{CH_3COCH_3} \xrightarrow{CH_3MgI} \underset{\text{tert-Butyl alcohol}}{(CH_3)_3COH}$

61. **(c)** $CH_3COCH_3 + CH_3MgCl \rightarrow \underset{(X)}{(CH_3)_3C-OMgCl}$

$\xrightarrow{\text{hydrolysis}} \underset{(Y)}{(CH_3)_3C-OH} + Mg(OH)Cl$

62. **(a)** Increase in alkyl group, the reactivity decreases.

63. (d)

64. **(c)** Addition of HCN to carbonyl compounds is an example of nucleophilic addition.

65. **(a)** Acetone forms sodium bisulphate adduct but acetophenone does not. Aromatic ketones do not gives addition product with $NaHSO_3$.

66. **(a)** $6HCHO + 4NH_3 \rightarrow \underset{\text{Urotropine}}{(CH_2)_6N_4} + 6H_2O$

67. **(c)** $C_2H_5CHO + 2Cu^{+2} + 5OH^- \rightarrow \underset{\text{Red ppt}}{Cu_2O} + 3H_2O + C_2H_5COO^-$

$CH_3COCH_3 + 2Cu^{+2} + 5OH^- \rightarrow$ No reaction

68. (c)

69. COOH–CHOH–CHOH–CHOH–CHOH–CH_2OH $\xrightarrow{4HIO_4}$ 3HCOOH + HCHO + CHOCOOH

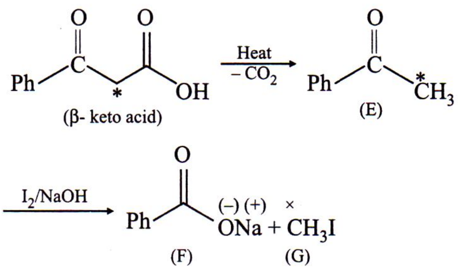
70. **(b)** Wolff–Kishner reduction does not convert >CO to CHOH but converts it to > CH_2.

71. D

72. **(b)** Zn(Hg), HCl cannot be used when acid sensitive group like –OH is present, but NH_2NH_2, OH^- can be used. (c) and (d) will convert it to alcohol.

73. **(c)** $CH_3CHO + \underset{\text{(Fehling solution)}}{2Cu^{2+}} + OH^- \rightarrow CH_3COOH + \underset{\text{(red)}}{Cu_2O^-}$

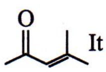
74. **(c)**



β-keto acids undergo decarbonylation by simple heating, from that we get carbonyl compound of type $CH_3-\overset{O}{\overset{\|}{C}}-$ which undergoes iodoform reaction.

75. (c)

76. **(b)** $CH_3-\overset{O}{\overset{\|}{C}}-CH_3+3Cl_2 \rightarrow CH_3-\overset{O}{\overset{\|}{C}}-CCl_3+3HCl$

77. **(c)**  It is an α, β-unsaturated ketone which can be formed in an aldol condensation followed by dehydration.

78. **(c)** Although both $CH_3CH_2COCH_3$ and $(CH_3)_3COOH_3$ contain α-hydrogen, yet $(CH_3)_3CCOH_3$ does not undergo aldol condensation due to steric hindrance.

79. Cationic detergents are quaternary ammonium salts of amine with acetates, chlorides or bromides as anion.

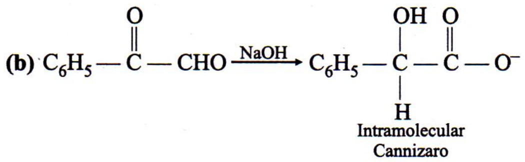
80. (b)

81. **(c)** $2CH_3CHO \xrightarrow[\text{NaOH}]{\text{dil.}} CH_3 - \overset{OH}{\overset{|}{CH}} - CH_2CHO$

82. (d)

83. (c)

84.



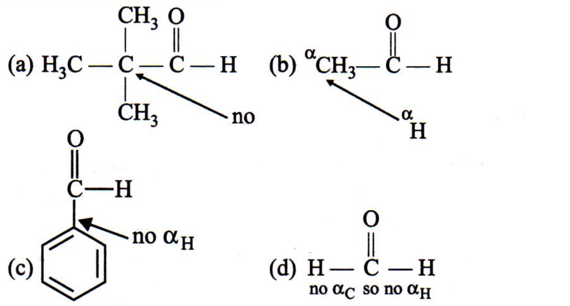
85.

(b) This is Cannizzaro's reaction:

$2C_6H_5CHO + NaOH \rightarrow C_6H_5COONa + C_6H_5CH_2OH$

86.

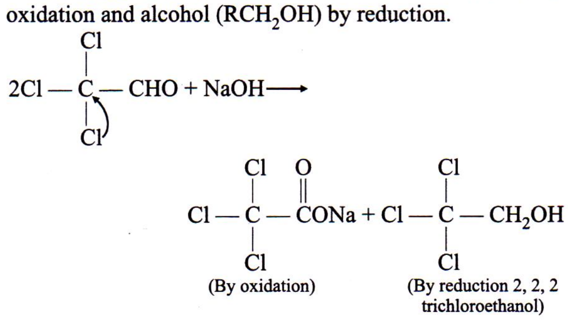
(b) The compound containing α-H atom does not undergo Cannizzaro's reaction.



87. $-NH_2$ is electron donating group but-CN is electron withdrawing group.

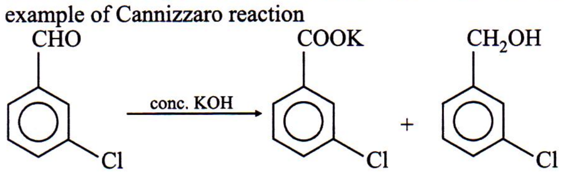
88.

(a) Cannizzaro's reaction is given by aldehydes (RCHO) lacking H at α-carbon or lacking α-carbon (as in HCHO). With NaOH, there is formation of acid salt ($RCOO^-$) by oxidation and alcohol (RCH_2OH) by reduction.



89.

(d) Chlorobenzaldehyde does not contain α-H atom. It is an example of Cannizzaro reaction



90.