

WEEKLY TEST MEDICAL PLUS - 01 TEST - 27 R & B  
SOLUTION Date 15 -12-2019

**[PHYSICS]**

1. (a)  $q = CV$  and  $U = \frac{1}{2}CV^2 = \frac{q^2}{2C}$
2. (a)  $U = \frac{1}{2}CV^2 = \frac{1}{2} \times 4 \times 10^{-6} \times (100)^2 = 0.02 \text{ J}$
3. (d)  $\Delta U = U_2 - U_1 = \frac{V^2}{2}(C_2 - C_1)$   
 $= \frac{(100)^2}{2}(10 - 2) \times 10^{-6} = 4 \times 10^{-2} \text{ J}$
4. (d) Extra charge  $Q = (2CV - CV) = CV$  flows through potential  $V$  of the battery. Thus  $W = QV = CV^2$
5. (b) In charging of capacitor half of the supplied energy is stored in the capacitor.
6. (a)  $W_{\text{ext}} = \frac{1}{2}C'V'^2 - \frac{1}{2}CV^2$   
 $= \left(\frac{1}{2}\right)\left(\frac{C}{2}\right)(2V)^2 - \frac{1}{2}CV^2 = \frac{1}{2}CV^2$   
 $W_{\text{ext}} = \frac{1}{2} \times 50 \times 10^{-6} \times (100)^2 = 25 \times 10^{-2} \text{ J}$
7. (c)  $\Delta V = \frac{1}{2} \frac{C \times C}{(C+C)} |V - (-V)|^2 = CV^2$
8. (a) High  $K$  means good insulating property and high  $x$  means able to withstand electric field gradient to a higher value.
9. (b)  $C = \frac{\epsilon_0 AK}{d} = 4\pi\epsilon_0 r$   
 $r = \text{Radius of sphere of equivalent capacity}$   
 $\Rightarrow r = \frac{AK}{4\pi d} = \frac{100 \times 10^{-4} \times 6}{1 \times 10^{-3} \times 4 \times 3.14} = \frac{15}{3.14} = 4.77 \text{ m}$
10. (c)  
 $C \propto \frac{1}{d} \Rightarrow \frac{C_{\text{medium}}}{C_{\text{air}}} = \frac{d}{d - t + \frac{t}{K}} = \frac{6}{6 - 4.5 + \frac{4.5}{9}} = \frac{6}{2} = 3$

11. (a) Potential difference across the condenser

$$V = V_1 + V_2 = E_1 t_1 + E_2 t_2 = \frac{\sigma}{K_1 \epsilon_0} t_1 + \frac{\sigma}{K_2 \epsilon_0} t_2$$

$$\Rightarrow V = \frac{\sigma}{\epsilon_0} \left( \frac{t_1}{K_1} + \frac{t_2}{K_2} \right) = \frac{Q}{A \epsilon_0} \left( \frac{t_1}{K_1} + \frac{t_2}{K_2} \right)$$

$$12. (c) C = \frac{\epsilon_0 A}{d - t + \frac{t}{K}} = \frac{1}{4\pi \times 9 \times 10^9} \cdot \frac{\pi (0.12)^2}{\left(2 + \frac{1}{2}\right) 10^{-3}}$$

$$= \frac{2 \times 144 \times 10^{-10}}{36 \times 5} = 160 \text{ pF}$$

13. (a) In air the potential difference between the plates

$$V_{\text{air}} = \frac{\sigma}{\epsilon_0} d \quad \dots (i)$$

In the presence of partially filled medium potential difference between the plates

$$V_m = \frac{\sigma}{\epsilon_0} \left( d - t + \frac{t}{K} \right) \quad \dots (ii)$$

Potential difference between the plates with dielectric medium and increased distance is

$$V'_m = \frac{\sigma}{\epsilon_0} \left\{ (d + d') - t + \frac{t}{K} \right\} \quad \dots (iii)$$

According to question  $V_{\text{air}} = V'_m$  which gives

$$K = \frac{t}{t - d'}$$

$$\text{Hence } K = \frac{2}{2 - 1.6} = 5$$

$$14. (a) C = \frac{\epsilon_0 K A}{d} \Rightarrow \frac{C_1}{C_2} = \frac{K_1}{K_2} \times \frac{d_2}{d_1}$$

$$\frac{2}{C_2} = \frac{1}{2.8} \times \frac{(0.4/2)}{(0.4)} \Rightarrow C_2 = 11.2 \mu\text{F}$$

$$15. (d) C = \frac{\epsilon_0 A}{d} \text{ and } C' = \frac{\epsilon_0 A}{\left\{ d - \frac{d}{2} + \frac{(d/2)}{\infty} \right\}} = \frac{2\epsilon_0 A}{d}$$

$$\Rightarrow C' = 2C$$

$$16. (d) C_{\text{air}} = \frac{\epsilon_0 A}{d}, \text{ with dielectric slab } C' = \frac{\epsilon_0 A}{\left( d - t + \frac{t}{K} \right)}$$

$$\text{Given } C' = \frac{4}{3} C \Rightarrow \frac{\epsilon_0 A}{\left( d - t + \frac{t}{K} \right)} = \frac{4}{3} \times \frac{\epsilon_0 A}{d}$$

$$\Rightarrow K = \frac{4t}{4t - d} = \frac{4(d/2)}{4[(d/2) - d]} = 2$$

$$17. \text{ (b) } C = \frac{K\epsilon_0 A}{d} \propto \frac{K}{d}$$

$$\text{Hence, } \frac{C_1}{C_2} = \frac{K_1}{K_2} \times \frac{d_2}{d_1} = \frac{K}{2K} \times \frac{d/2}{d} = \frac{1}{4}$$

$$\text{Therefore, } C_2 = 4C_1$$

$$18. \text{ (d) } Q_1 = 10^{-2} \text{ C, } Q_2 = 5 \times 10^{-2} \text{ C}$$

$$\text{Total charge of the system } Q = 6 \times 10^{-6} \text{ C}$$

Charge on small sphere

$$Q'_1 = \frac{Qr_1}{r_1 + r_2} = \frac{6 \times 10^{-2} \times 1}{1 + 2} = 2 \times 10^{-2} \text{ C}$$

$$19. \text{ (c) } C_{\text{eq}} = \frac{C_1 C_2}{C_1 + C_2} = 2.4 \mu\text{F.}$$

$$\text{Charge flown} = 2.4 \times 500 \times 10^{-6} \text{ C} = 1200 \mu\text{C.}$$

$$20. \text{ (a) } \frac{1}{C_s} = \frac{1}{3} + \frac{1}{9} + \frac{1}{18} = \frac{1}{2} \Rightarrow C_s = 2 \mu\text{F}$$

$$C_p = 3 + 9 + 18 = 30 \mu\text{F} \Rightarrow \frac{C_s}{C_p} = \frac{2}{30} = \frac{1}{15}$$

$$21. \text{ (c) Charge flowing} = \frac{C_1 C_2}{C_1 + C_2} V$$

$$\text{Potential diff. across } C_1 = \frac{C_1 C_2 V}{C_1 + C_2} \times \frac{1}{C_1} = \frac{C_2 V}{C_1 + C_2}$$

$$22. \text{ (a) In parallel combination } V_1 = V_2$$

$$\text{or } \frac{q_1}{C_1} = \frac{q_2}{C_2} \Rightarrow \frac{q_1}{q_2} = \frac{C_1}{C_2}$$

$$23. C_R = C_1 + C_2 = \frac{k_1 \epsilon_0 A_1}{d} + \frac{k_2 \epsilon_0 A_2}{d}$$

$$= \frac{2 \times \epsilon_0 \frac{A}{2}}{d} + \frac{4 \times \epsilon_0 \frac{A}{2}}{d} = 2 \times \frac{10}{2} + 4 \times \frac{10}{2} = 30 \mu\text{F}$$

$$24. \text{ (d) The given circuit is equivalent to parallel combination of two identical capacitors, each having capacitance}$$

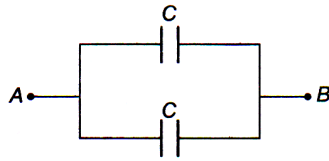
$$C = \frac{\epsilon_0 A}{d}. \text{ Hence } C_{\text{eq}} = 2C = \frac{2\epsilon_0 A}{d}$$

$$25. \text{ (b) The given arrangement is equivalent to the parallel combination of three identical capacitors. Hence}$$

$$\text{equivalent capacitance} = 3C = 3 \frac{\epsilon_0 A}{d}$$

26. (a) The given circuit is equivalent to a parallel combination two identical capacitors

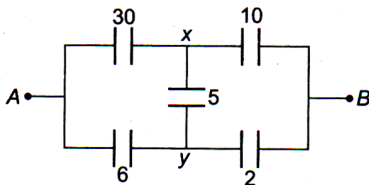
Hence equivalent capacitance between A and B is



$$C = \frac{\epsilon_0 A}{d} + \frac{\epsilon_0 A}{d}$$

$$= \frac{2\epsilon_0 A}{d}$$

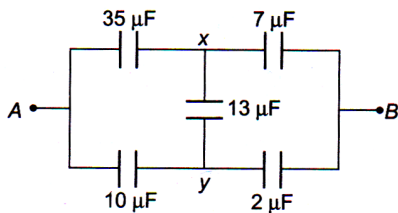
27. (b) Circuit can be redrawn as



Now  $V_x = V_y$ , Since  $\frac{30}{6} = \frac{10}{2}$

$$C_{eq} = \left( \frac{30 \times 10}{30 + 10} \right) + \left( \frac{6 \times 2}{6 + 2} \right) = 9 \mu\text{F}$$

28. (b) Circuit can be redrawn as



Now,  $V_x = V_y$

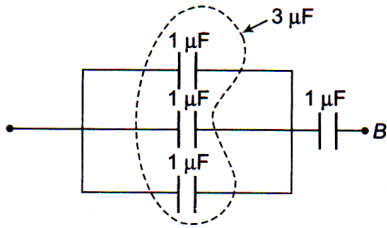
$$\text{Hence } \frac{35 \mu\text{F}}{10 \mu\text{F}} = \frac{7 \mu\text{F}}{2 \mu\text{F}}$$

$$C_{eq} = \left( \frac{7 \times 35}{7 + 35} \right) + \left( \frac{10 \times 2}{10 + 2} \right) = \frac{35}{6} + \frac{10}{6} = \frac{45}{6}$$

$$C_{eq} = \frac{15}{2}$$

29. (d) In series combination, charge is same on each capacitor.

30. (d) The circuit can be drawn as follows



$$\Rightarrow C_{AB} = \frac{3 \times 1}{3+1} = \frac{3}{4} \mu\text{F}$$

31. (b) Total capacitance of given system  $C_{eq} = \frac{8}{5} \mu\text{F}$

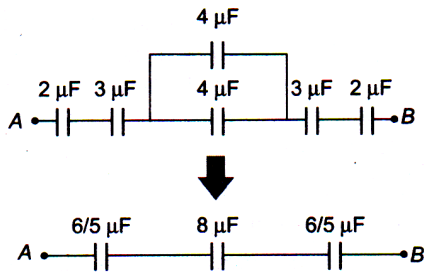
$$U = \frac{1}{2} C_{eq} V^2 = \frac{1}{2} \times \frac{8}{5} \times 10^{-6} \times 225 = 180 \times 10^{-6} \text{ J}$$

$$= 180 \times 10^{-6} \times 10^7 \text{ erg} = 1800 \text{ erg}$$

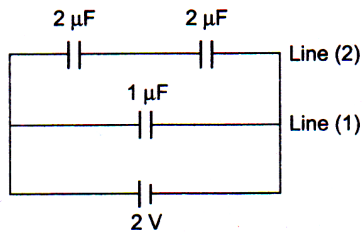
32. (c)  $Q_1 = Q_2 + Q_3$  because in series combination charge is same on both the condenser and  $V = V_1 + V_2$  because in parallel combination  $V_2 = V_3$ .

Hence  $V = V_1 + V_2$

33. (b)  $\frac{1}{C_{eq}} = \frac{5}{6} + \frac{1}{8} + \frac{5}{6} = \frac{20+3+20}{24} \Rightarrow C_{eq} = \frac{24}{43} \mu\text{F}$



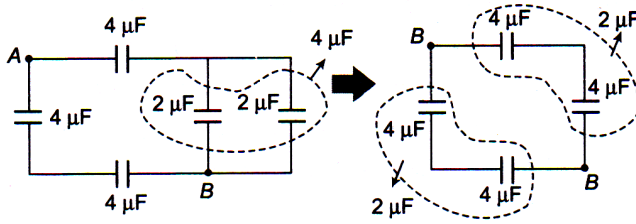
34. (d) Potential difference across both the lines is same i.e., 2 V. Hence charge flowing in line 2



$$Q = \left(\frac{2}{2}\right) \times 2 = 2 \mu\text{C}$$

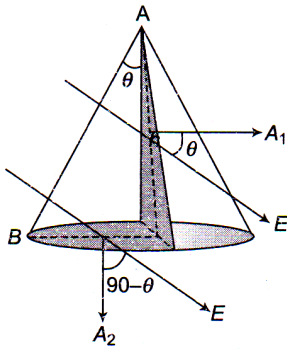
line (2) is  $2 \mu\text{C}$ .

35. (c) The given circuit can be simplified as follows



Equivalent capacitance between  $A$  and  $B$  is  $C_{AB} = 4 \mu\text{F}$

36. (a) Flux entering the cone from side  $AB$  will ultimately also pass through area  $A_1$  and  $A_2$ .



$$\begin{aligned} \text{So, } \phi &= EA_1 \cos \theta + EA_2 \cos (90 - \theta) \\ &= E \left( \frac{1}{2} 2Rh \cos \theta + \frac{\pi}{2} R^2 \sin \theta \right) \\ &= ER (h \cos \theta + \pi(R/2) \sin \theta) \end{aligned}$$

37. (c)  $\alpha = 60^\circ$ ,

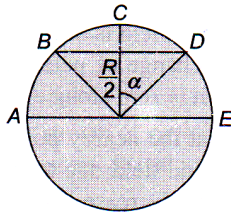
Solid angle subtended by  $BCD$ ,

$$\omega = 2\pi (1 - \cos \alpha) = \pi$$

Solid angle subtended by  $ABDE$ ,

$$\omega_{(ABCDE)} - \omega_{(BCD)} = 2\pi - \pi = \pi$$

$$\text{Hence flux through } ABDE: \phi = \frac{q}{\epsilon_0} \frac{\pi}{4\pi} = \frac{q}{4\epsilon_0}$$



38. (d) Force on charge  $F = q(E_a) = q \times \frac{k \cdot 2p}{r^3} \Rightarrow F \propto \frac{1}{r^3}$

When  $r \rightarrow$  doubled;  $F \rightarrow \frac{1}{8}$  times

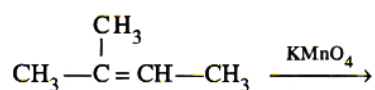
39. (a) As the dipole will feel two forces which are although opposite but not equal.  
 $\therefore$  A net force will be there and as these forces act at different points of a body. A torque is also there.
40. (b) Maximum torque =  $pE$   
 $= 2 \times 10^{-6} \times 3 \times 10^{-2} \times 2 \times 10^5 = 12 \times 10^{-3}$  N-m.
41. (b) Electric lines of force never cross each other because if electric lines of force cross each other, then the electric field at the point of intersection will have two directions simultaneously which is not possible.
42. (a) In a hollow spherical shield (hollow), the charge is present on its surface but charge is zero at every point inside the hollow sphere. Hence, the metallic shield in form of hollow shell may be built to block an electric field.
43. (b) When the bob is placed in an electric field, the bob time period of simple pendulum having charged bob is placed in a horizontal electric field then the period will be decreased because there will be an increase in the restoring force.
44. (b) Free electrons present in the metal are moving randomly in all directions, in absence of electric field. Hence, the average velocity of electrons is zero. Because of it the current does not flow in the metal in the absence of electric field.
45. (c) In a medium,

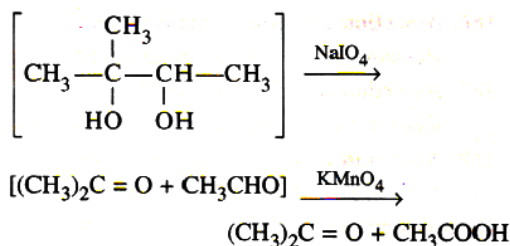
$$F_m = \frac{F}{K}$$

From above expression it is quite clear that greater the value of  $K$  smaller is the force between the two charges. Electric dipole moment is directly proportional to dielectric constant.

### [CHEMISTRY]

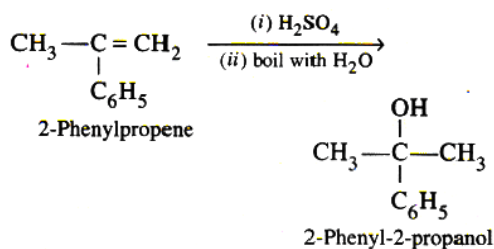
46. Reactivity towards electrophilic substitution decreases as the electron density in the benzene ring decreases. Thus, option (a) is correct, i.e., III > I > II > IV.
- 47.





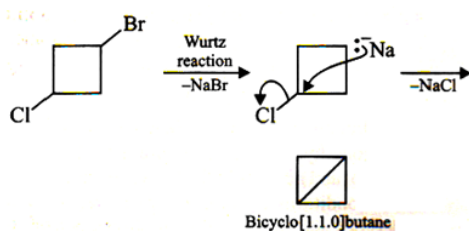
48.

49.



50.

Since bromides are more reactive than chlorides, therefore, Wurtz reaction occurs on the side of Br atom



51.

52.

Since,  $\text{CH}_3$  group is electron-donating, therefore, electron density in toluene is higher than in benzene and hence polysubstitution occurs during F.C. alkylation when the benzene ring contains electron-donating groups. All other groups (*i.e.*,  $\text{CH}_3\text{CO}$ ,  $\text{NO}_2$  and  $\text{SO}_3\text{H}$ ) are electron withdrawing and hence in these cases polysubstitution does not occur.

53.

Both  $\text{OCH}_3$  and  $\text{CH}_3$  are *o*, *p*-directing groups. The possible position of attack which are facilitated by both  $\text{OCH}_3$  and  $\text{CH}_3$  are shown by arrows below :



Since,  $\text{OCH}_3$  group is bulkier than  $\text{CH}_3$  group, therefore, due to steric hindrance the reaction does not occur at positions 2 and 6 but instead occurs at position 4.





54.

In a homologous series, higher the number of C-atoms, higher is the b.p.

55.

Acidic hydrogen is present in alkynes, attached to the triply bonded C-atoms. They can be easily removed by means of a strong base.

56.

For isomeric alkanes, the one having longest straight chain has highest b.p. because of larger surface area.

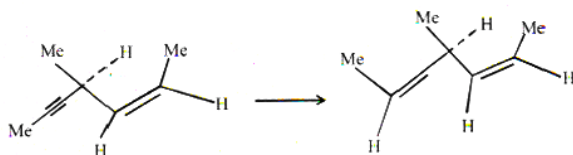
57.

58.

**TIPS/Formulae :**

Addition on triple bond takes place by the *syn*-addition of hydrogen.

Since the configuration of the double bond already present is *cis*, the compound formed will have a plane of symmetry and hence optically inactive.

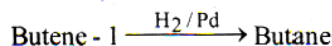


59.

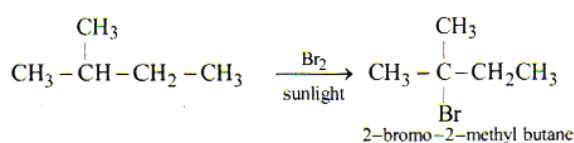
Greater the extent of branching, lesser is the boiling point of the hydrocarbon, so order of b.p is III > II > I.

60.

Alkenes combine with hydrogen under pressure and in presence of a catalyst (Ni, Pt or Pd) and form alkanes.



61.

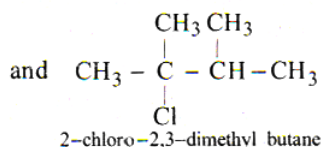


Ease of replacement of H-atom  $3^\circ > 2^\circ > 1^\circ$ .

62.

$\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ | \quad | \\ \text{CH}_3 - \text{CH} - \text{CH} - \text{CH}_3 \end{array}$ . Since it contains only two types of H-atoms hence it will give only two mono

chlorinated compounds viz.  $\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ | \quad | \\ \text{Cl} - \text{CH}_2 - \text{CH} - \text{CH} - \text{CH}_3 \\ \text{1-chloro-2,3-dimethyl butane} \end{array}$



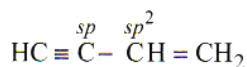
63.



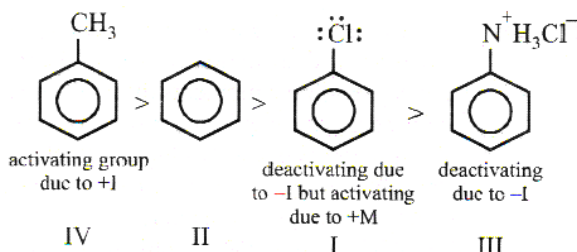
$$\text{No of } \sigma \text{ bonds} = 2 + 1 + 1 + 1 + 1 + 1 = 7;$$

$$\text{No of } \pi \text{ bonds} = 1 + 2 = 3$$

64.



65.

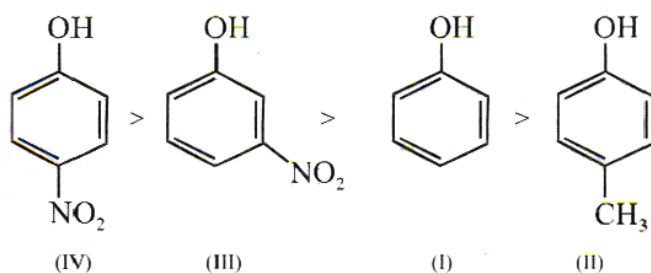


66.

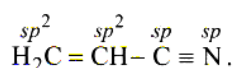
- NOTE :  $-\text{NO}_2$  is an electron-attracting group where as  $-\text{CH}_3$  is an electron-releasing group.

An **electron - attracting substituent** tends to disperse the negative charge of the phenoxide ion and thus, makes it more stable. This, in turn, **increases the acid strength of phenol**. The substituent in para position is more effective than in the meta position as the former involves a resonating structure bearing negative charge on the carbon attached to the electron - withdrawing substituent.

An **electron - releasing substituent** tends to intensify the negative charge of the phenoxide ion and thus makes it more unstable. This, in turn, **decreases the acid strength of phenol**. Hence, the order of acid strength is



67.



68.

The ring to which  $-\text{NH}$  group is attached is activated due to the lone pairs on N (+M and +E effects); while the ring to which  $-\text{C} = \text{O}$  is attached is deactivated. Hence, the electrophile would go to the *para*-position of the activated ring.

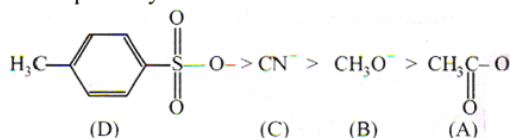


69.

Due to similar charges on adjacent atoms, the structure (a) is least stable.

70.

In moving down a group, the basicity and nucleophilicity are inversely related, *i.e.* nucleophilicity increases while basicity decreases. In going from left to right across a period, the basicity and nucleophilicity are directly related. Both of the characteristics decrease as the electronegativity of the atom bearing lone pair of electrons increases. If the nucleophilic centre of two or more species is same, nucleophilicity parallels basicity, *i.e.* more basic the species, stronger is its nucleophilicity. Hence based on the above facts, the correct order of nucleophilicity will be



71.

Unsaturated hydrocarbons decolourise alk.  $\text{KMnO}_4$  solution;  $\text{C}_2\text{H}_4$  ( $\text{H}_2\text{C}=\text{CH}_2$ ) is an alkene.

72.

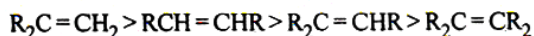
73.

Peroxide affects only the addition of  $\text{HBr}$ ; addition of  $\text{HCl}$  and  $\text{HI}$  on alkenes proceeds through usual ionic mechanism in presence or absence of peroxide. Further (d) being  $2^\circ$  carbocation is more stable than (a), hence more likely to be formed.

74.

**TIPS/Formulae :**

The relative rates of hydrogenation decreases with increase of steric hinderance.

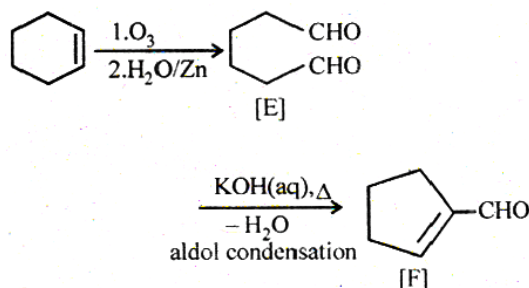


Among the four olefins, (a) and (b) are less stable (Saytzeff rule). Further in (a), the bulky alkyl groups are on same side (*cis*-isomer), hence it is less stable.

75.

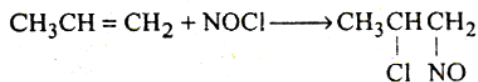
In propyne ( $\text{CH}_3\text{C}\equiv\text{CH}$ ), the terminal hydrogen is acidic and reacts with ammonical  $\text{AgNO}_3$ .

76.

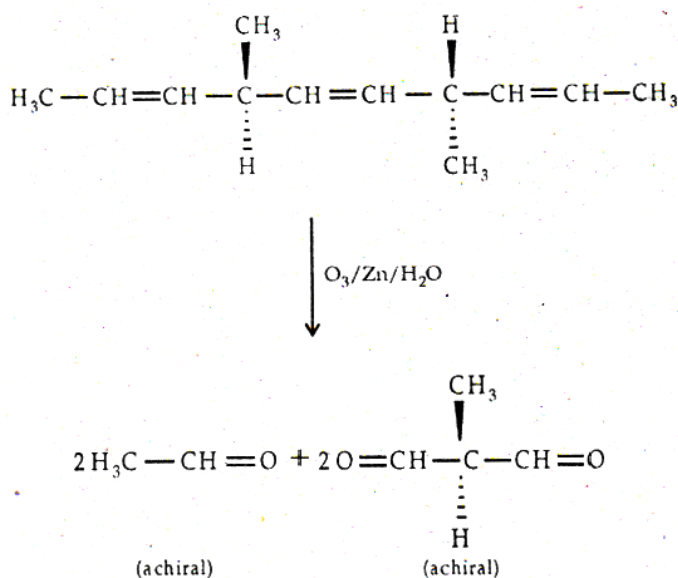


77.

Nitrosyl chloride adds on olefins according to Markovnikof's rule, where  $\text{NO}^+$  constitutes the positive part of the addendum.



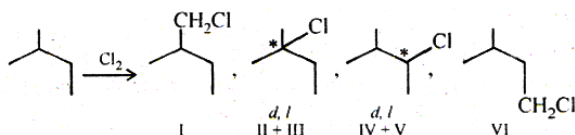
78.



79.

**Allene ( $\text{C}_3\text{H}_4$ )** is  $\text{H}_2\overset{sp^2}{\text{C}}=\overset{sp}{\text{C}}=\overset{sp^2}{\text{CH}_2}$

80.



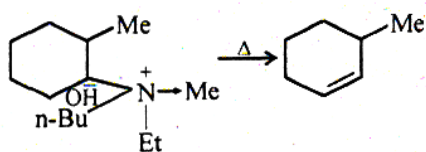
So, the value of N will be  $1 + 2 + 2 + 1 = 6$ .

Since enantiomers have nearly same physical properties, II and III as well as IV and V can't be separated, hence the number of isomers (M) will be

$1 + 1 + 1 + 1 = 4$ .

81.

**Hofmann's rule :** When theoretically more than one type of alkenes are possible in eliminations reaction, the alkene containing least alkylated double bond is formed as major product. Hence



**NOTE :** It is less sterically  $\beta$ -hydrogen is removed



82.

Nitro group is electron withdrawing group, so it deactivates the ring towards electrophilic substitution.

83.

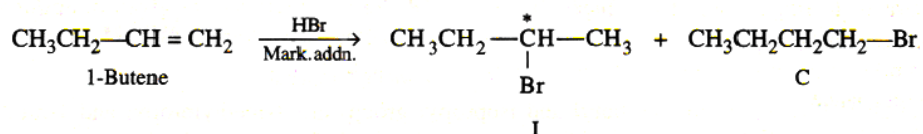
Reactivity decreases down the group as the electronegativity or the electrode potential of the halogen decreases down the group. Thus, option (a) is correct.

84.

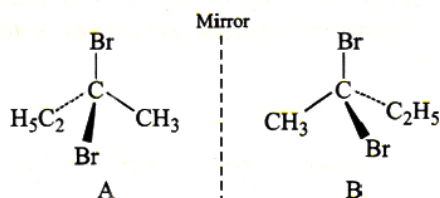
For geometrical isomerism, it is essential that each carbon atom of the double bond must have different substituents. Now option (d) does not show geometrical isomerism since it has two  $\text{CH}_3$  groups on the same carbon atom of the double bond.

85.

Addition of  $\text{HBr}$  to 1-butene occurs in accordance with Markovnikov's rule giving I as the major and C as the minor product.



Since I contains a chiral carbon, it exists in two enantiomers (A and B) which are mirror images of each other



Thus, the mixture consists of A and B as major and C as minor product.