AVIRAL
JEE | NEET | FOUNDATIONS

WEEKLY TEST MEDICAL PLUS - 01,02 B
SOLUTION Date 12 -01-2020

[PHYSICS]

1. We have

$$r = \frac{\sqrt{2mqV}}{qB} = \sqrt{\frac{2mV}{aB^2}}$$

$$\frac{r_1}{r_2} = \sqrt{\frac{m_1}{m_2}}$$

$$\frac{m_1}{m_2} = \frac{r_1^2}{r_2^2}$$

Hence, $$\frac{m_1}{m_2} = \frac{(2)^2}{(3)^2} = \frac{4}{9}$$

2.

3. Given $\theta = 23°$, $B = 2.6\ \text{mT} = 2.6 \times 10^{-6}\ \text{T}$

and $F = 6.5 \times 10^{-17}\ \text{N}$

We know

$$F = qvB\sin\theta$$

$$6.5 \times 10^{-17} = 1.6 \times 10^{-19} \times v \times 2.6 \times 10^{-6} \times \sin 23°$$

$$v = \frac{6.5 \times 10^{-17}}{2.6 \times 10^{-6} \times 1.6 \times 10^{-19} \times 0.39}$$

$$v = 4 \times 10^5\ \text{ms}^{-1}$$

4. Radius, $$r = \frac{mv}{qB}$$

or $$B = \frac{mv}{qr}$$

$$= \frac{9.1 \times 10^{-31} \times 1.3 \times 10^6}{1.6 \times 10^{-19} \times 0.35}$$

$$= 2.1 \times 10^{-5}\ \text{T}$$

5.

6. $$\frac{1}{2}mv^2 = eV$$

$$\frac{1}{2} \times 9.1 \times 10^{-31} \times v^2 = 1.6 \times 10^{-19} \times 182$$

$$v^2 = \frac{1.6 \times 10^{-19} \times 182 \times 2}{9.1 \times 10^{-31}}$$

$$= 64 \times 10^{12}$$

$$v = 8 \times 10^6\ \text{ms}^{-1}$$

7. We have, $M = NIA$

$$B = \mu_0 nI$$

Torque, $C = MB$

Here, $C = (n_1 I_1 A)(\mu_0 n_2 I_2)$

$$= \left(10 \times \frac{21}{44} \times 10^{-6}\right)\left(4 \times \frac{22}{7} \times 10^{-7} \times 10^{3} \times 2.5\right)$$

$$= 1.5 \times 10^{-8} \text{ N-m}$$

8. Magnetic field

$$B_1 = \frac{\mu_0}{4\pi} \cdot \frac{2i}{R} \quad \text{and} \quad B_2 = \frac{\mu_0}{4\pi} \cdot \frac{4i}{R}$$

$$B_2 - B_1 = \frac{\mu_0}{4\pi} \cdot \frac{2i}{R} = B$$

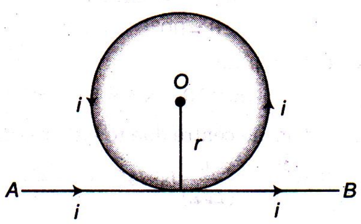
$$B_2 = 2B_1$$

$$2B_1 - B_1 = B$$

$\therefore \quad B_1 = B$

9. The magnitude of the magnetic field at point O due to straight part of wire is

$$B_1 = \frac{\mu_0 i}{2\pi r}$$



B_1 is perpendicular to the plane of the page, directed upwards (right-hand palm rule 1).
The field at the centre O due to the current loop of radius r is

$$B_2 = \frac{\mu_0 i}{2r}$$

B_2 is also perpendicular to the page, directed upward (right hand screw rule).

$\therefore$ Resultant field at O is

$$B_1 + B_2 = \frac{\mu_0 i}{2r}\left(\frac{1}{\pi} + 1\right) = \frac{\mu_0 i}{2\pi r}(\pi + 1)$$

10. If a coil of radius R is carrying current I, then magnetic field on its axis at a distance x from its centre is given by

$$B_{\text{axis}} = \frac{\mu_0}{4\pi} \frac{2\pi I R^2}{(x^2 + R^2)^{3/2}} \quad \ldots\text{(i)}$$

At centre,

$$B_{\text{centre}} = \frac{\mu_0 I}{2R} \quad \ldots\text{(ii)}$$

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{B_{\text{axis}}}{B_{\text{centre}}} = \frac{\mu_0 I R^2}{2(x^2 + R^2)^{3/2}} \times \frac{2R}{\mu_0 I}$$

$$= \frac{R^3}{(x^2 + R^2)^{3/2}} = \frac{1}{8}$$

or $$\frac{R}{(x^2 + R^2)^{1/2}} = \frac{1}{2}$$

$\Rightarrow \quad x = \sqrt{3}R$

11. . In case of straight conductor of infinite length, the magnetic field is given by

$$B = \frac{\mu_0}{4\pi} \times \frac{2i}{a}$$

$$\Rightarrow \quad 10^{-6} = \frac{10^{-7} \times 2 \times i}{0.02}$$

$$\Rightarrow \quad i = 0.1 \text{ A}$$

12. The magnetic field at a distance r from the straight wire

$$B = \frac{\mu_0 i}{2\pi r} \text{ or } B \propto \frac{1}{2}$$

or $$\frac{B_2}{B_1} = \frac{r_1}{r_2}$$

$\therefore$ $$\frac{B_2}{B} = \frac{5}{20} = \frac{1}{4} \text{ or } B_2 = \frac{B}{4}$$

13. The magnetic field due to small element conductor of length is given by

$$dB = \frac{\mu_0}{4\pi} \frac{idl \sin\theta}{r^2}$$

This value will be maximum when

$$\sin\theta = 1 = \sin 90°$$

$$\theta = 90°$$

14. Magnetic field $B = \mu_0 ni$

$$= 4\pi \times 10^{-7} \times 5 \times 1000 = 2\pi \times 10^{-3} \text{T}$$

15. Magnetic field at the centre due to either arm

$$B_1 = \frac{\mu_0}{4\pi} \times \frac{i}{(L/2)} [\sin 45° + \sin 45°]$$

$$= \frac{\mu_0}{4\pi} \times \frac{2\sqrt{2}i}{L}$$

Field at centre due to the four arms of the square

$$B = 4B_1 = \frac{\mu_0}{\pi} \times \frac{2\sqrt{2}i}{L}$$

i.e., $$B \propto \frac{1}{L}$$

16. The magnetic field is given by

$$B = \mu_0 ni$$

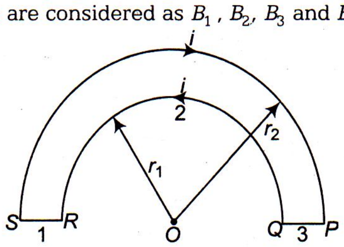
where $$\mu_0 = 4\pi \times 10^{-7} \text{T mA}^{-1},$$

$$n = \frac{1000}{50 \times 10^{-2}}, \; i = 5 \text{ A}$$

$\therefore$ $$B = 4\pi \times 10^{-7} \times \frac{1000}{50 \times 10^{-2}} \times 5$$

$$B = 1.26 \times 10^{-2} \text{T}$$

17. In the following figure, magnetic field at O due to sections 1, 2, 3 and 4 are considered as B_1, B_2, B_3 and B_4 respectively.



$$B_1 = B_3 = 0$$
$$B_2 = \frac{\mu_0}{4} \cdot \frac{i}{r_1}$$
$$B_4 = \frac{\mu_0}{4} \cdot \frac{i}{r_2}$$

So, $$B_{net} = B_2 - B_4 = \frac{\mu_0 i}{4}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

18. In general, Newton's third law is not valid for electromagnetic phenomena but for long parallel conductors and steady current, we can porve that Biot-Savart law and Lorentz force give the results in accordance with Newton's third law.

19. The magnetic field at the centre of a circle is given by
$$B = \frac{\mu_0 i}{2r}$$
where, i is current and r the radius of circle.

Also, $$i = \frac{q}{t}$$

For helium nucleus, $q = 2e$

$\therefore$ $$i = \frac{2e}{t}$$

So, $$B = \frac{\mu_0 \cdot 2e}{2rt}$$
$$= \frac{\mu_0 \times 2 \times 1.6 \times 10^{-19}}{2 \times 0.8 \times 2} = 10^{-19}\mu_0$$

20. $B = \frac{\mu_0 N i}{l}$; where N = total number of turns, l = length of the solenoid.

$\Rightarrow$ $$0.2 = \frac{4\pi \times 10^{-7} \times N \times 10}{0.8} \Rightarrow N = \frac{4 \times 10^4}{\pi}$$

Since N turns are made from the winding wire, so length of the wire $(L) = 2\pi r \times N$ [$2\pi r$ = length of each turns]

$\Rightarrow$ $$L = 2\pi \times 3 \times 10^{-2} \times \frac{4 \times 10^4}{\pi}$$
$$= 2.4 \times 10^3 \text{ m}$$

21. In this case magnetic force provides necessary centripetal force *i.e.*, $qvB = \frac{mv^2}{r}$

Radius of path $r = \frac{mv}{Bq} = \frac{\sqrt{2mE}}{qB}$

$$r = \frac{\sqrt{2mE}}{Bq} = \frac{\sqrt{2m_1E_1}}{Bq}$$

or $E_1 = \frac{mE}{m_1} = \frac{(2m_1)}{m_1} \times 50 \text{ keV}$ $[\because m = 2m_1]$

$= 100 \text{ keV}$

22. The component of velocity perpendicular to H will make the motion circular while that parallel to H will make it move along a straight line. The two together will make the motion helical.

23.

24. In a perpendicular magnetic field,

Magnetic force = centripetal force

i.e., $Bqv = \frac{mv^2}{r} \Rightarrow r = \frac{mv}{Bq}$

$\therefore$ $\frac{r_1}{r_2} = \frac{v_1}{v_2} \times \frac{B_2}{B_1}$

$\frac{r_1}{r_2} = \frac{1}{2} \times \frac{1}{2}$

$r_2 = 4r_1 \Rightarrow r_2 = 4r$

25. A charged particle moves in a straight line under the action of an electric field whereas it moves in a circular path under the action of a magnetic field. Thus, for the particle moving in a circular path, $E = 0$, $B \neq 0$.

26. When particle describes circular path in a magnetic field, its velocity is always perpendicular to the magnetic force.

Power, $P = \mathbf{F} \cdot \mathbf{v} = Fv\cos\theta$

Here, $\theta = 90°$

$\therefore$ $P = 0$

But $P = \frac{W}{t} \Rightarrow W = P \times t$

Hence, work done

$W = 0$ (everywhere)

27. When electron moves in both electric and magnetic fields then,

$$qE = qvB$$

$$v = \frac{E}{B} = \frac{1500}{0.40} = 3750 \text{ ms}^{-1}$$

$$v = 3.75 \times 10^3 \text{ ms}^{-1}$$

28. Radius of circular path $r_a = \frac{m_a v_a}{qB}$ and $r_b = \frac{m_b v_b}{qB}$

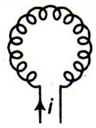
According to questions

$$r_a > r_b$$

$\therefore$ $\frac{m_a v_a}{qB} > \frac{m_b v_b}{qB}$

or $m_a v_a > m_b v_b$

29. Toroid is ring shaped closed solenoid.



30. According to Fleming's right-hand rule, the force on the charge will be towards west.

31. If magnet is cut along the axis of megnet of length l, then new pole strength becomes half *i.e.*, $m' = \frac{m}{2}$ and new length remains same *i.e.*, $l' = l$.

$\therefore$ New magnetic moment

$$M' = \frac{m}{2} \times l = \frac{ml}{2} = \frac{M}{2}$$

If non magnet is cut perpendicular to the axis of magnet, then new pole strength $m' = m$ and new length $l' = l/2$

$\therefore$ New magnetic moment

$$M' = m \times \frac{l}{2} = \frac{ml}{2} = \frac{M}{2}$$

32. For longitudinal positions

$$B_1 \propto \frac{2M}{d^3}$$

For transverse positions

$$B_2 \propto \frac{M}{d^3}$$

$$\therefore \qquad \frac{B_1}{B_2} = 2:1$$

33. Work done in rotating the magnet through an angle θ from initial position (*i.e.*, $\theta_1 = 0°$) is given by

$$W = MB(\cos\theta_1 - \cos\theta)$$
$$= MB(\cos 0° - \cos\theta)$$
$$= MB(1 - \cos\theta)$$

34. In non uniform magnetic field a magnetic needle experiences a force and a torque.

35. Torque is a vector quantity and it is given by

$$\boldsymbol{\tau} = \mathbf{M} \times \mathbf{B}$$
$$= (50\hat{i}) \times [0.5\,\hat{i} + 3.0\hat{j}]$$
$$= 150\,(\hat{i} \times \hat{j})$$
$$= 150\,\hat{k}\ \text{N-m}$$

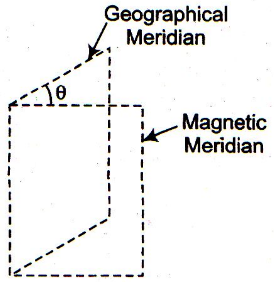
36. A freely hanged magnet stays with its magnetic axis parallel to magnetic meridian.

37. At magnetic poles, angle of dip is 90°, so horizontal component of earth

$$B_H = B\cos\theta = B\cos 90° = 0°$$

38. A dip needle in a plane perpendicular to magnetic moridian will remain always vertical.

39. Angle between magnetic meridian and geographical meridian is called angle of declination.



40. Total strength of magnetic field

$$B^2 = B_H^2 + B_V^2$$

$\therefore$ $$B_V = \sqrt{B^2 - B_H^2}$$

$$= \sqrt{(0.5)^2 - (0.3)^2} = 0.4$$

$$\tan\phi = \frac{B_V}{B_H} = \frac{0.4}{0.3} = \frac{4}{3}$$

$\therefore$ $$\phi = \tan^{-1}\left(\frac{4}{3}\right)$$

41. Vibration magnetometer is simple instrument which is used to find out the magnetic moment of a magnet or to compare the magnetic moments of two bar magnets. Here the magnet is made to oscillate and its time period is calculated, hence the instrument is called vibration magneitormeter. It's time period is given by

$$T = 2\pi\sqrt{\left(\frac{I}{MH}\right)}$$

42. Time period of vibrating magnet is given by

$$T = 2\pi\sqrt{\left(\frac{I}{MH}\right)}$$

$\therefore$ $$\frac{T_1}{T_2} = \sqrt{\left(\frac{M_2}{M_1}\right)}$$

$\therefore$ $$\frac{M_1}{M_2} = \frac{T_2^2}{T_1^2}$$

$$= \frac{(60/15)^2}{(60/10)^2} = \frac{4}{9}$$

43. For a tangent galvanometer if I amp are current flows through coil then this current is proportional to angle of deflection (of the needle).

$$I \propto \tan\theta$$

$\therefore$ $$\frac{I_1}{I_2} = \frac{\tan\theta_1}{\tan\theta_2}$$

$\Rightarrow$ $$\frac{2}{I_2} = \frac{\tan 30°}{\tan 60°}$$

$\therefore$ $$I_2 = 6\text{ A}$$

44. Time period, $T \propto \frac{1}{\sqrt{B_H}} = \frac{1}{\sqrt{B\cos\theta}}$

$\therefore \quad \frac{T_1}{T_2} = \sqrt{\frac{B_2\cos\theta_2}{B_1\cos\theta_1}}$

$\therefore \quad \frac{B_1}{B_2} = \frac{T_2^2}{T_1^2} \times \frac{\cos\theta_2}{\cos\theta_1}$

$= \left(\frac{3}{2}\right)^2 \times \frac{\cos 60^\circ}{\cos 30^\circ}$

$\therefore \quad \frac{B_1}{B_2} = \frac{9}{4\sqrt{3}}$

45. $L = \pi R \;\therefore R = \frac{L}{\pi}$

New effective length will become, $L' = 2R = \frac{2L}{\pi}$

[CHEMISTRY]

46. The bond dissociation enthalpy C — X (where X is halogen) is C — Cl > C — Br > C — I

47. The dipole moment of CH_3X (where X is halogen) follows the order $CH_3F < CH_3Cl > CH_3Br$

48. Longer the hydrocarbon chain, the larger the boiling point.

49. CH_3F has minimum boiling point amongst the given halomethanes.

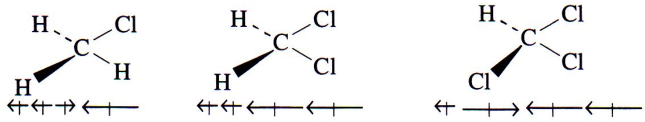
50. Larger the branching of hydrocarbon chain, lesser the boiling point. Hence, the correct order is
$CH_3(CH_2)_3Cl > CH_3CH_2CHClCH_3 > (CH_3)_3CCl$

51. The skeleton of isomers are

C—C—C—CBr_2; C—C—C(Br)—CBr; C—C(Br)—C—CBr; C—C(Br)—C(Br)—C; BrC—C—C—CBr; C—C—$C(Br_2)$—C

52. The reagent $SOCl_2$ is most effective.

53. In CH_2Cl_2 all bond moments reinforce each other, while in CH_3Cl and $CHCl_3$ only one CCl and CH bond moments reinforce each other as shown in the following figure.



54. The S_N1 reaction may or may not involve the inversion of stereochemistry around carbon atom of the substrate.

55. The nucleophilicity of halides follows the order $Cl^- < Br^- < I^-$

56. Crowding around the centre of reaction decreases rate of reaction. The correct order is
$CH_3(CH_2)_3Cl > (CH_3)_2CHCH_2Cl > CH_3CH_2CHClCH_3$

57. The more electronegativity of atom, lesser the nucleophilicity. The correct order is $H_3N > H_2O > HF$.

58. Polar solvents accelerate the rate of S_N1 reaction.

59. The increase in bulkiness of alkyl group decreases reactivity for the S_N2 reaction. The correct order is
$CH_3 > 1^\circ > 2^\circ$.

60. The weaker the base, larger the leaving group ability. The order of acid strength of the conjugate acids is
$F_3CSO_2OH > CH_3SO_2OH > HOAc > MeOH$
The order of corresponding conjugate bases is $F_3CSO_2O^- < CH_3SO_2O^- < {}^-OAc < MeO^-$
The same will also be leaving group ability.

61. More the electronegativity of the atom to which H is attached, lesser the nucleophilicity of the anion. Thus CH_3^- has the highest nucleophilicity.

62. Stronger the C—X bond, lesser the reactivity of the alkyl halides for a S_N2 reaction. Thus, the correct order is RI > RBr > RCl > RF.

63. $CH_3CH(Br)—CH(CH_3)_2 \xrightarrow[\text{slow}]{-Br^-} CH_3\overset{+}{C}HCH(CH_3)_2 \xrightarrow{\sim:H} CH_3CH_2\overset{+}{C}(CH_3)_2 \xrightarrow[-H^+,\ \text{fast}]{+H_2O} CH_3CH_2C(OH)(CH_3)_2$

64. Bases are better nucleophiles than their conjugate acids

65. In going from left to right across the periodic table, nucleophilicity decreases.

66. In going down a group in the periodic table, nucleophilicity increases.

67. When the nucleophilic and basic sites are the same, nucleophilicity parallels basicity.

68. The steric hindrance causes the decreases in the rate of S_N2 reaction.

69. $CH_3CH{=}CHCH_2Cl + CN^- \rightarrow CH_3CH{=}CHCH_2CN$

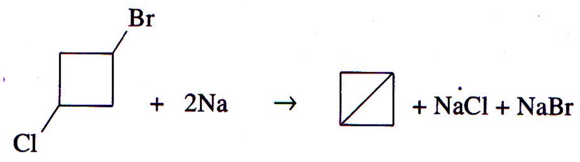
$$N{\equiv}\bar{C}:\ CH_3—CH{=}CH—CH_2—Cl \longrightarrow CH_3—CH(CN)—CH{=}CH_2 + Cl^-$$

The second reaction is said to follow S_N2' mechanism.

70. The electron-attracting F atoms stabilizes the intermediate carbanion. Hence, $F_2C{=}CHBr$ will exhibit this mechanism.

71. With acetone as solvent, the reaction proceeds with the characteristics of both S_N1 and S_N2 mehanisms. The S_N1 involves hydride shift giving structure L.

72. The reaction involves intramolecular elimination of halogens by using sodium. (Wurtz reaction).



73. The reaction involves nucleophilic substitution of a halogen by PhS^-. It is easy to carry such substitution in alkyl halide than in aryl halide. The substitution will proceed via S_N2 mechanism, which results into the inversion of configuration of carbon atom at which substitution reaction occurs.

74. The reaction is $R'CHO + RMgX \longrightarrow R'CH(OMgX)R \xrightarrow{H_2O} R'CH(OH)R$

75. $HCOOC_2H_5 + RMgX \longrightarrow RCHO + Mg(OC_2H_5)X$

76. $H_2O + RMgX \longrightarrow RH + Mg(OH)X$

77. $(CH_3)_3CMgCl \xrightarrow{D_2O} (CH_3)_3CD$

78. $R'COOR'' + RMgX \rightarrow R'—C(OMgX)(R)—OR'' \xrightarrow{-MgX(OR'')} R'—C(=O)—R \xrightarrow{RMgX} R'—C(OMgX)(R)—R \xrightarrow{H^+} R'—C(OH)(R)—R$

79. $R'COCl \xrightarrow[-MgCl]{2RMgX} R'—C(R)(OMgX)—R \xrightarrow{H_2O} R'—C(R)(OH)—R$

80. The relative order of reactivities of RBr's is $3° > 2° > 1°$.

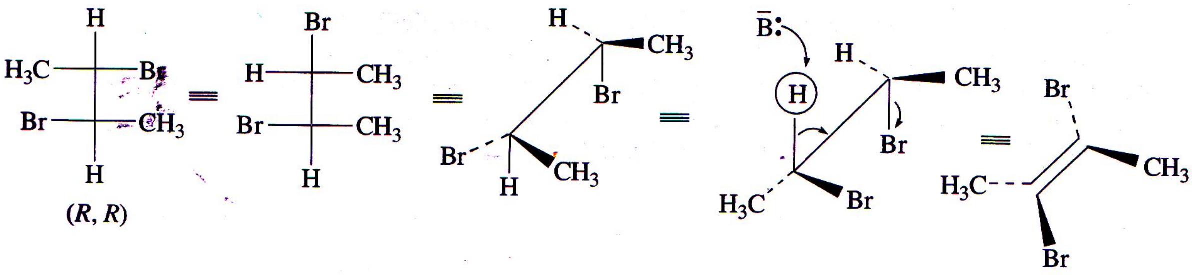
81. There are three possible products. These are
cis-$CH_3CH{=}CHCH_2CH_3$; *trans*-$CH_3CH{=}CHCH_2CH_3$ and $H_2C{=}CHCH_2CH_2CH_3$.
The most substituted alkene is produced with the highest yield as predicted by the Saytzeff's rule, with *trans* dominating over *cis*.

82. The rate of reaction depends directly on the leavability of X^-. The weakest base is the best leaving group. Hence, the reactivities follow the order RCl < RBr < RI.

83. The reaction is $CH_3\underset{\displaystyle Br}{\underset{|}{C}}HCH_2CH_3 \xrightarrow{\text{ethanolic KOH}} CH_3CH{=}CHCH_3$

2-butene (major product)

84.

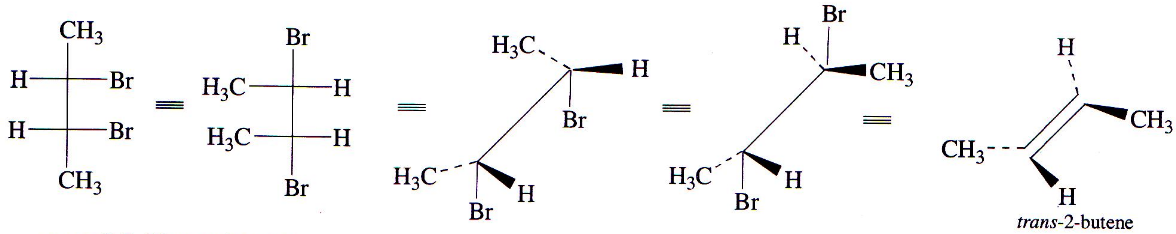


(*R*, *R*)

trans-2-bromo-2-butene

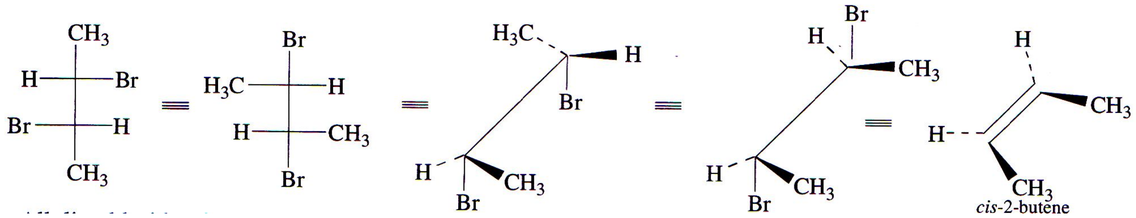
(*RS*)-isomer gives *cis*-2-bromo-2-butene.

85.



trans-2-butene

meso-2,3-dibromobutane

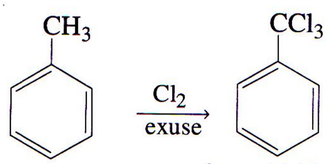


cis-2-butene

86. Allylic chloride ($CH_2{=}CHCH_2Cl$) reacts rapidly with $AgNO_3$ in the cold. $CH_3CH_2CH_2Cl$ is less reactive, it gives white precipitate only on warming. Vinyl chloride ($CH_3CH{=}CHCl$) is inert to $AgNO_3$.

87. Fittig reaction involves two molecules of aryl halides.

88. Under the condition of light and heat, chlorination of side chain occurs.



benzotrichloride

89. Chlorination of benzene proceeds via electrophilic substitution mechanism.

90. Fluorination of benzene is highly exothermic.