1) The Lewis acidity of BF_3 is less than BCl_3 even though fluorine is more electronegative than chlorine. It is due to

a) stronger $2p$(B)-$2p$(F) σ-bonding

b) stronger $2p$(B)-$2p$(F) π-bonding

c) stronger $2p$(B)-$3p$(Cl) σ-bonding

d) stronger $2p$(B)-$3p$(Cl) π-bonding

2) Pyroxenes are a class of silicate minerals, which exhibit a polymeric chain structure. Its simplest repeat unit is

a) $[SiO_4]^{4-}$

b) $[SiO_3]^{2-}$

c) $[Si_2O_7]^{6-}$

d) $[Si_4O_{11}]^{6-}$

3) Among the following pentachlorides the one which does not exist due to the 'inert-pair effect' is

a) PCl_5

b) $BiCl_5$

c) $SbCl_5$

d) $AsCl_5$

4) Band theory predicts that magnesium is an insulator. However, in practice it acts as a conductor due to

a) presence of filled 3s orbital

b) overlap of filled 2p and filled 3s orbital

c) overlap of filled 3s and empty 3p orbital

d) presence of unfilled 3p orbital

5) The number of 'framework electron pairs' present in the borane cluster $[B_{12}H_{12}]^{2-}$ is

a) 10

b) 11

c) 12

d) 13

6) The reaction between $[PdCl_4]^{2-}$ and C_2H_4 produces a new compound. Compared to free C_2H_4, the C-C bond order of the product is

a) between 1 and 2

b) less than 1

c) unaltered

d) greater than 2

7) Among the following pair of metal ions present in Nature, the first one functions as an electron-transfer agent and the second one catalyzes the hydrolysis reactions. The correct pair is

a) Fe and Zn

b) Mg and Fe

c) Co and Mo

d) Ca and Cu

8) Structurally nickelocene is similar to ferrocene. Nickelocene attains stability due to the formation of

a) a monocation   c) a monanion

b) a dication   d) a dianion

9) The absolute configurations for compounds X and Y, respectively, are   GATE 2010 CY

Fig. 1. fig1

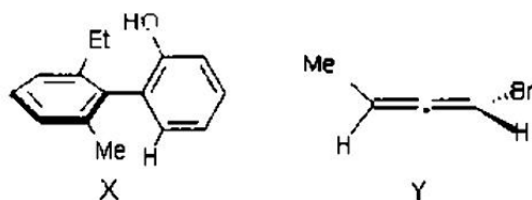a) *R*, *S*   c) *R*, *R*

b) *S*, *R*   d) *S*, *S*

10) in the reaction

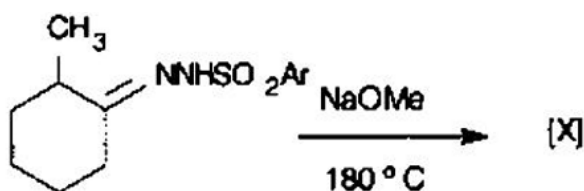Fig. 2. fig2

the major product [X] is   GATE 2010 CY

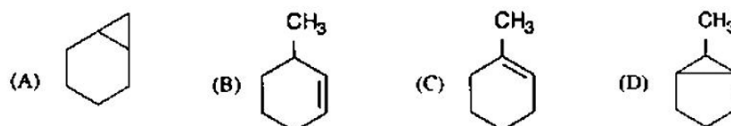
Fig. 3. fig3

11) Among the following, a pair of resolvable configurational enantiomers is given by

                                                             GATE 2010 CY

a) *cis*-1,2-dimethylcyclohexane   c) *cis*-1,4-dimethylcyclohexane

b) *cis*-1,3-dimethylcyclohexane   d) *trans*-1,3-dimethylcyclohexane
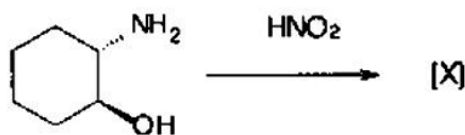
12) in the reaction

Fig. 4. fig4

the major product [X] is
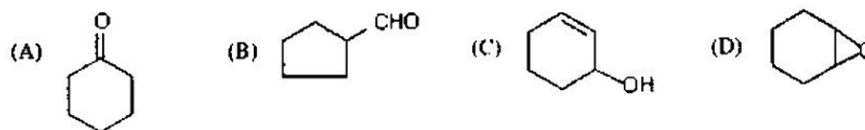
Fig. 5. fig5

13) The decreasing order of isoelectric point for the following α-amino acids is
 Lysine (I) **Alanine** (II) **Glutamic acid** (III) GATE 2010 CY

   a) I > II > III   c) III > I > II
   b) II > I > III   d) I > III > II

14) The decreasing order of the reactivity of the following compounds towards electrophiles is
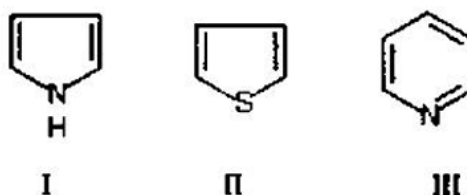   I   II   III

Fig. 6. fig6

GATE 2010 CY

   a) II > I > III   c) III > I > II
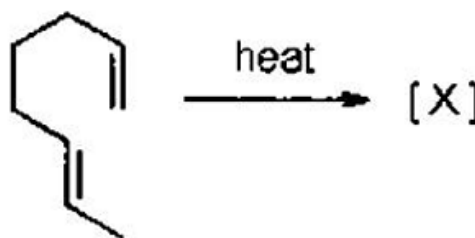   b) II > III > I   d) I > II > III

15) In the reaction

Fig. 7. fig7

the major product [x] is

GATE 2010 CY

(A)   (B)   (C)   (D)

Fig. 8. fig8

16) The decreasing order of acidity of the marked H of the following molecules is

I   II   III

Fig. 9. fig9

GATE 2010 CY

a) I > II > III
b) III > I > II

c) III > II > I
d) II > I > III

17) The decreasing order of nucleophilicity for the following anions is
$CH_3CO_2^-$, CH_3O^-, $C_6H_5O^-$, NO_3^- GATE 2010 CY

a) $CH_3CO_2^- > CH_3O^- > C_6H_5O^- > NO_3^-$
b) $CH_3O^- > NO_3^- > C_6H_5O^- > CH_3CO_2^-$

c) $CH_3O^- > C_6H_5O^- > CH_3CO_2^- > NO_3^-$
d) $C_6H_5O^- > CH_3O^- > NO_3^- > CH_3CO_2^-$

18) The molar entropy of crystalline CO at absolute zero is   GATE 2010 CY

a) Zero
b) $-R\ln 2$

c) $R\ln 2$
d) $2R\ln 2$

19) For an ideal gas

a) $(\partial P/\partial T)_V \, (\partial T/\partial V)_P \, (\partial V/\partial P)_T = 0$
b) $(\partial P/\partial T)_V \, (\partial T/\partial V)_P \, (\partial V/\partial P)_T = -1$

c) $(\partial P/\partial T)_V \, (\partial T/\partial V)_P \, (\partial V/\partial P)_T = +1$
d) $(\partial P/\partial T)_V \, (\partial T/\partial V)_P \, (\partial V/\partial P)_T = +2$

20) Among W (work), Q (heat), U (internal energy) and S (entropy)

a) W and U are path functions but Q and S are state functions
b) W and S are path functions but Q and U are state functions

c) S and U are path functions but Q and W are state functions
d) W and Q are path functions but U and S are state functions

21) For eigen functions $\psi_1 = \sqrt{\frac{1}{b}} \sin\left(\frac{\pi x}{b}\right)$ and $\psi_2 = \sqrt{\frac{2}{b}} \sin\left(\frac{2\pi x}{b}\right)$ of particle in a 1-D box of length b $(0 \le x \le b)$

a) ψ_1 is normalized and orthogonal to ψ_2

b) ψ_1 is normalized but not orthogonal to ψ_2

c) ψ_2 is normalized and orthogonal to ψ_1

d) ψ_2 is neither normalized nor orthogonal to ψ_1

22) The bond order of C_2 molecule is   GATE 2010 CY

a) 0

b) 1

c) 2

d) 3

23) Sulfur can exist in four phases. The possible number of triple points is   GATE 2010 CY

a) 1

b) 2

c) 3

d) 4

24) The standard reduction potentials at 298 K for single electrodes are given below:

Electrode	Electrode Potential (volt)
Mg^{2+} / Mg	-2.34
Zn^{2+} / Zn	-0.76
Fe^{2+} / Fe	-0.44

From this we can infer that

GATE 2010 CY

a) Zn can reduce both Mg^{2+} and Fe^{2+}

b) Fe can reduce both Mg^{2+} and Zn^{2+}

c) Mg can reduce both Zn^{2+} and Fe^{2+}

d) Mg can reduce Zn^{2+} but not Fe^{2+}

25) For the pair of reactions given below

i) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

ii) $\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightleftharpoons NH_3(g)$

If at a particular temperature, K_{P1} and K_{P2} are the equilibrium constants for reactions i) and ii) respectively, then

a) $K_{P1} = 2K_{P2}$

b) $K_{P1} = K_{P2}^2$

c) $2K_{P1} = K_{P2}$

d) $K_{P1}^2 = K_{P2}$

26-55 Carry two marks each

26) According to VSEPR model, the shape of $[XeOF_5]^-$ is   GATE 2010 CY

a) octahedral

b) trigonal bipyramidal

c) square pyramidal

d) pentagonal monopyramidal

27) The number of unpaired electron(s) present in the species $[Fe(H_2O)_5(NO)]^{2+}$ which is formed during 'brown ring test' is   GATE 2010 CY

a) 2

b) 3

c) 4

d) 5

28) Fe_3O_4 and Co_3O_4 are metal oxides having spinel structure. Considering their CFSEs, the correct statement regarding their structure is   GATE 2010 CY
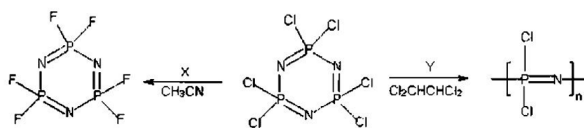
Fig. 10. fig10

a) both have normal spinel structure   spinel structure
b) both have inverse spinel structure   d) Fe_3O_4 has inverse and Co_3O_4 has normal
c) Fe_3O_4 has normal and Co_3O_4 has inverse   spinel structure

29) The mechanism of the reaction between $[Fe(CN)_6]^{4-}$ and $[Fe(bpy)_3]^{3+}$ (bpy = 2,2′-bipyridine) is   GATE 2010 CY

a) outer-sphere electron-transfer   d) ligand exchange followed by electron
b) inner-sphere electron-transfer   transfer
c) self-exchange reaction

30) The d-d absorption band of $[Fe(H_2O)_6]^{2+}$ is split due to   GATE 2010 CY

a) presence of octahedral geometry   c) dynamic Jahn-Teller distortion
b) static Jahn-Teller distortion   d) presence of trigonal bipyramidal geometry

31) The crystal-field symbol for the ground-state of $[Mn(CN)_6]^{4-}$ is   GATE 2010 CY

a) $^2T_{2g}$ c) ^3E_g
b) $^1A_{1g}$ d) $^4A_{1g}$

32) In the following reactions, the reagent/conditions X and Y are   GATE 2010 CY

a) X = BF_3; Y = heating at 125°C   c) X = NH_4F; Y = HCl
b) X = NaF; Y = heating at 250°C   d) X = CF_3SO_3H; Y = H_2SO_4

33) is a blue coloured complex. Controlled-treatment of this complex with water generates two isomeric light pink coloured complexes of composition $[Co(H_2O)_4Cl_2]$. Identify the correct point groups for $[CoCl_4]^{2-}$ and two isomeric complexes $[Co(H_2O)_4Cl_2]$.

a) D_{4h} and (C_{2v} and C_{2h})   c) D_{4h} and (C_{2v} and D_{4h})
b) T_d and (C_{2v} and D_{4h})   d) T_d and (C_{2v} and C_{4v})

34) in the reaction

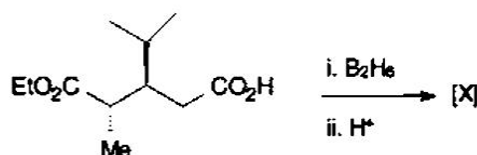Fig. 11. fig11

the major product [x] is
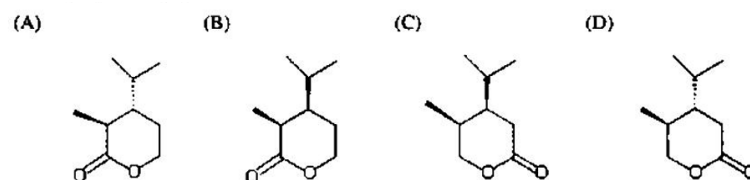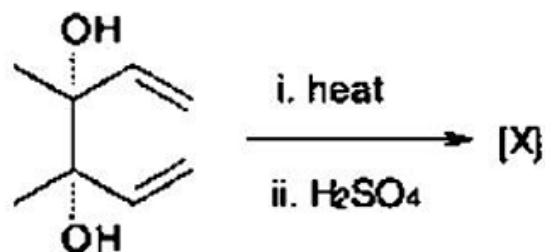

Fig. 12. Enter Caption

35) In the reaction

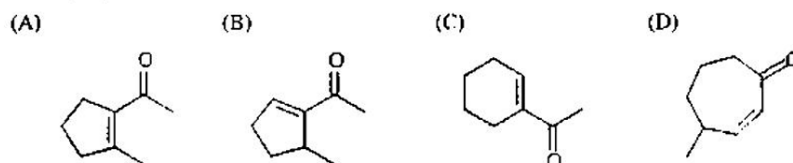
Fig. 13. fig13

Fig. 14. fig14

36) in the following sequence
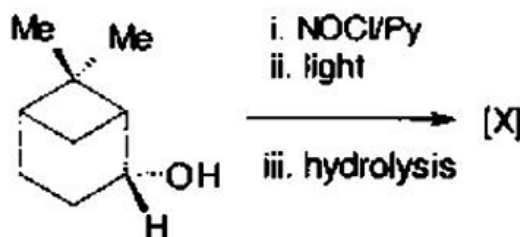
Fig. 15. fig15

the major product [X] is

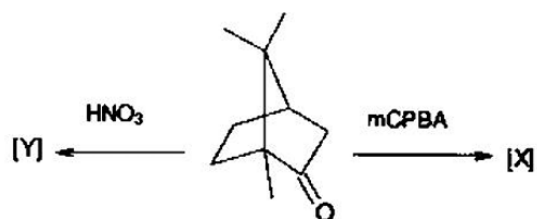(A)   (B)   (C)   (D)
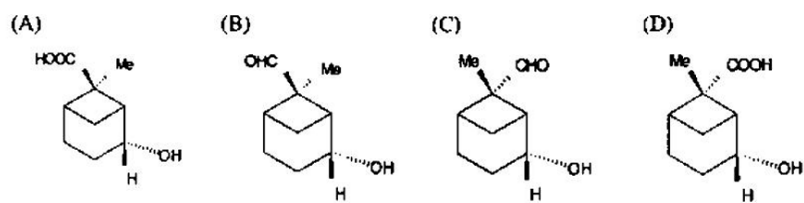
Fig. 16. fig16

37) In the reaction

$$[Y] \xleftarrow{\text{HNO}_3} \qquad \xrightarrow{\text{mCPBA}} [X]$$

Fig. 17. fig17

the major produc [x] is   GATE 2010 CY

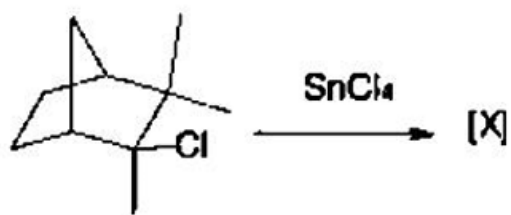

(A)   (B)

(C)   (D)
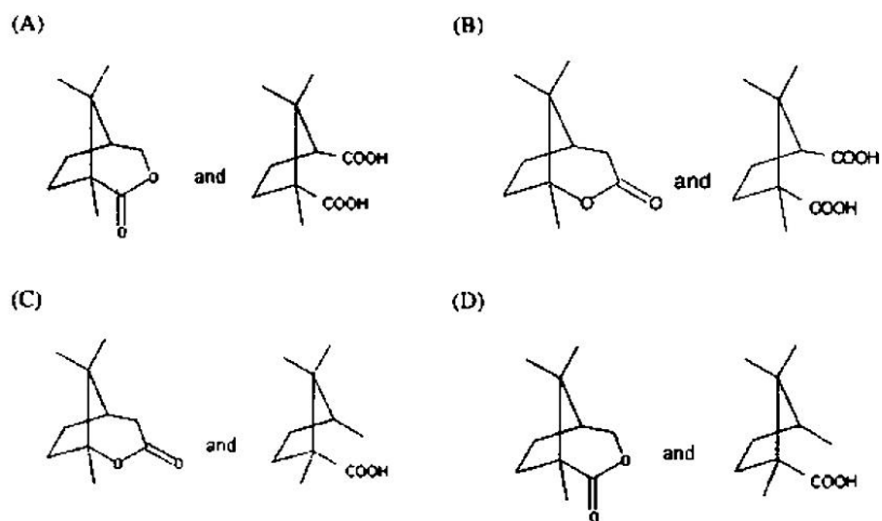
Fig. 18. fig18

38) in the reaction
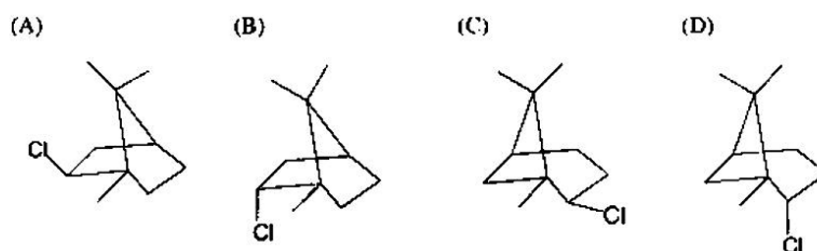
Fig. 19. fig19

GATE 2010 CY the major PRODUCT [x] is

Fig. 20. fig20

39) in the reaction

the major products. [X] and [Y], respectively, are

Fig. 21. fig21

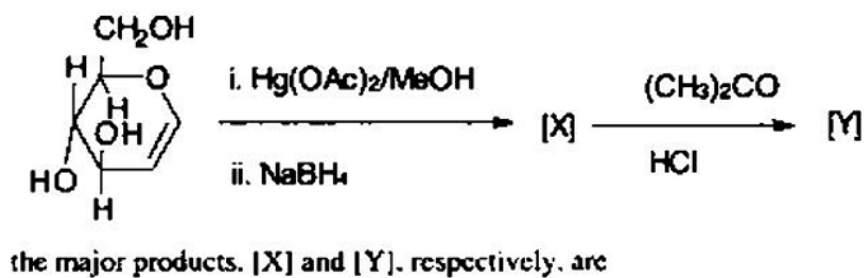GATE 2010 CY

(A)

(B)

(C)

(D)

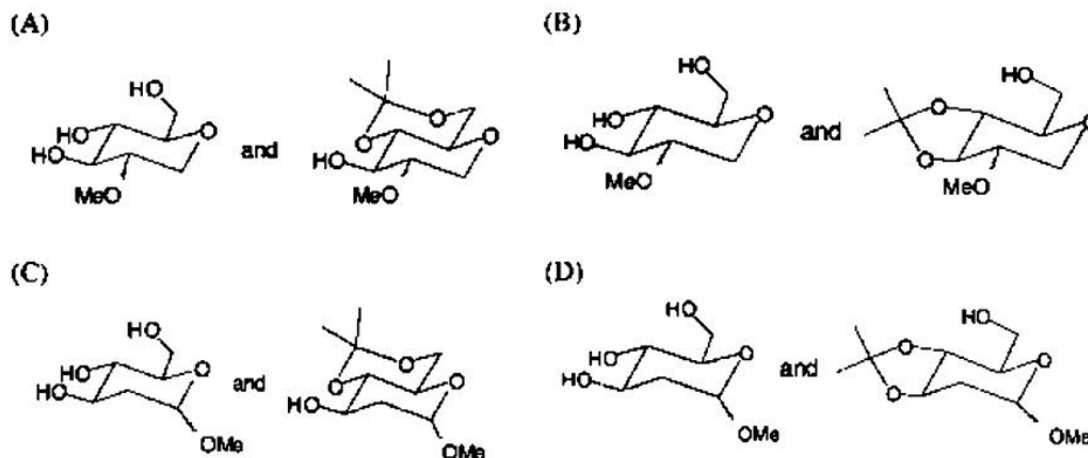Fig. 22. fig22

40) The change in entropy when two moles of Argon gas are heated at constant volume from 300 K to 500 K is   GATE 2010 CY

a) -12.74 J K^{-1} mole^{-1}

b) -6.37 J K^{-1} mole^{-1}

c) 6.37 J K^{-1} mole^{-1}

d) 12.74 J K^{-1} mole^{-1}

41) At any temperature T, the fugacity coefficient (γ) is given by

$$\ln \gamma = \int_0^P \frac{Z-1}{P'} dP'$$

where Z is the compressibility factor. The fugacity coefficient of a real gas governed by equation of state $P(V - b) = RT$ with b a constant is given by

GATE 2010 CY

a) $\dfrac{RT}{bP}$

b) $e^{\frac{RT}{bP}}$

c) $\dfrac{bP}{RT}$

d) $e^{\frac{bP}{RT}}$

42) The specific rate constant of decomposition of a compound is represented by

$$\ln k = 5.0 - \frac{12000}{T}$$

The activation energy of decomposition for this compound at 300 K is

GATE 2010 CY

a) 24 kcal/mole

b) 12 kcal/mole

c) 24 cal/mole

d) 12 cal/mole

43) The commutator $\{x^3, p_x\}$ is equal to   GATE 2010 CY

a) $-\dfrac{3hx^2}{2\pi i}$

b) $\dfrac{hx}{2\pi i}$

c) $\dfrac{hx^2}{2\pi i}$

d) $\dfrac{3hx^2}{2\pi i}$

44) An electron of mass 'm' is confined to a one dimensional box of length 'b'. If it makes a radiative transition from second excited state to the ground state, the frequency of the photon emitted is   GATE 2010 CY

a) $\dfrac{9h}{8mb^2}$

b) $\dfrac{3h}{8mb^2}$

c) $\dfrac{h}{mb^2}$

d) $\dfrac{2h}{mb^2}$

45) The point group of ClF_3 molecule and its corresponding number of irreducible representations are respectively

GATE 2010 CY

a) C_{3v} and 4

b) C_{2v} and 4

c) C_{3v} and 3

d) C_{2v} and 3

46) The most populated rotational state for HCl ($B = 8.5$ cm^{-1}) at 300 K is

GATE 2010 CY

a) 2

b) 3

c) 5

d) 7

47) The ratio of life times of two states that give rise to line widths of 1.0 cm^{-1} and 0.2 cm^{-1} respectively is   GATE 2010 CY

a) 1 : 2

b) 1 : 5

c) 2 : 1

d) 5 : 1

Common Data for Questions 48 and 49:

A six-coordinate transition-metal complex is ESR and Mössbauer active. The effective magnetic moment of this complex is ~5.9 B.M.

48) The metal-ion along with its oxidation state and the number of unpaired electrons present are

GATE 2010 CY

a) Fe(II) and 4

b) Mn(II) and 5

c) Fe(III) and 1

d) Fe(III) and 5

49) The complex is

GATE 2010 CY

a) $Mn(H_2O)_6^{2+}$

b) $Fe(CN)_6^{3-}$

c) $Fe(H_2O)_6^{2+}$

d) $Fe(H_2O)_6^{3+}$

Common Data for Questions 50 and 51:

An organic compound [X] ($C_{12}H_{16}O_3$) exhibits the following spectral data:

IR: ~1720 cm^{-1}

^{1}H NMR: 2.35 (s, 6H), 3.30 (s, 3H), 3.83 (t, 2H), 4.42 (t, 2H), 7.07 (s, 1H), 7.58 (s, 2H)
The compound [X] with an excess of MeMgBr gives a 1:1 mixture of compounds [Y] and
[Z]. The compound [Z] exhibits the following ^{1}H NMR data: 2.0 (bs, 1H), 3.30 (s, 3H),
3.56 (t, 2H), 3.70 (t, 2H).

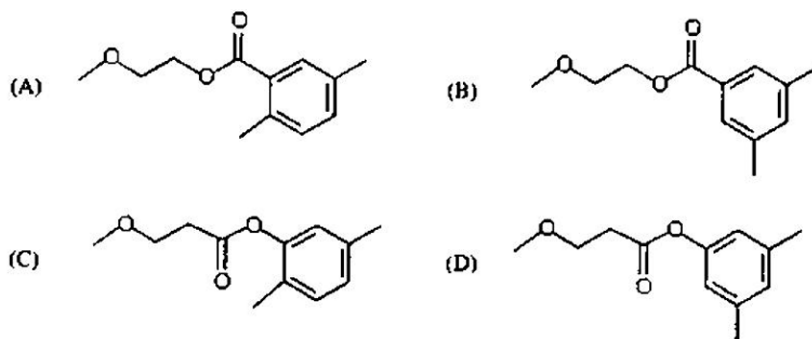50) The compound [X] is

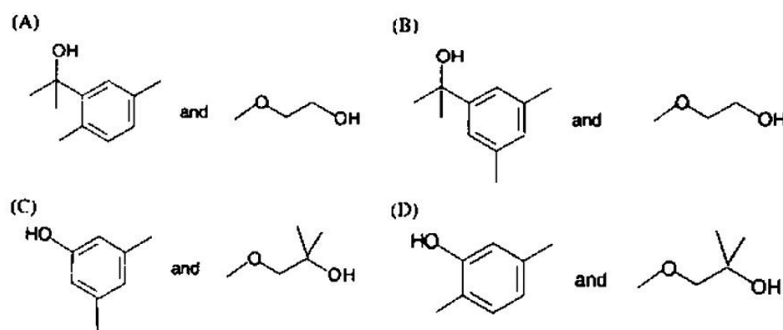GATE 2010 CY

Fig. 23. fig23

51) The compound [Y] is   GATE 2010 CY

Fig. 24. fig24

statement for questions 52 and 53
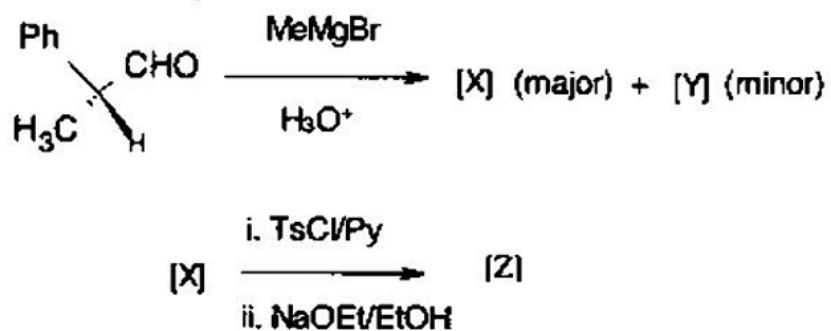
In the reaction sequence

Fig. 25. fig25

52) the compound [X] is   GATE 2010 CY
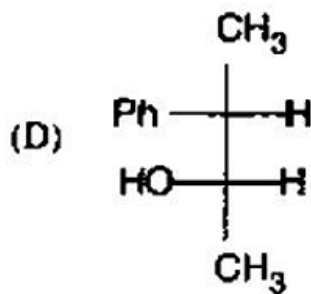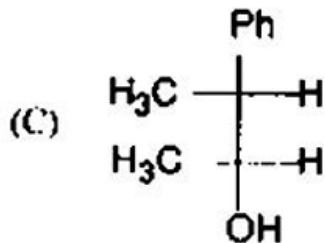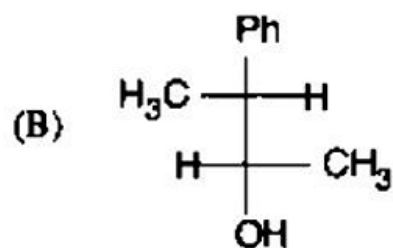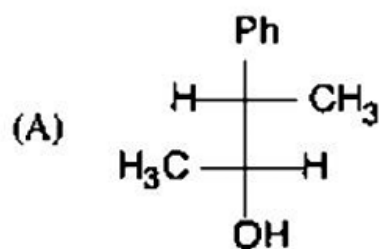

Fig. 26. fig26

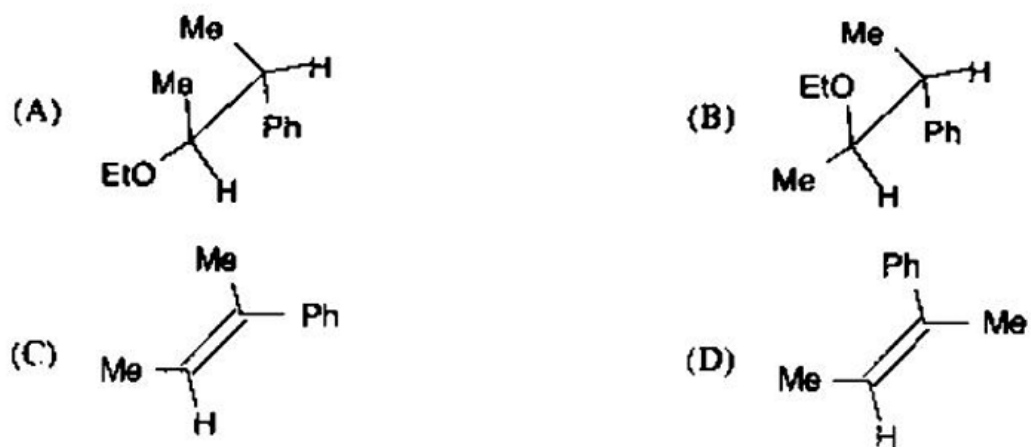53) the compound [Z] is   GATE 2010 CY

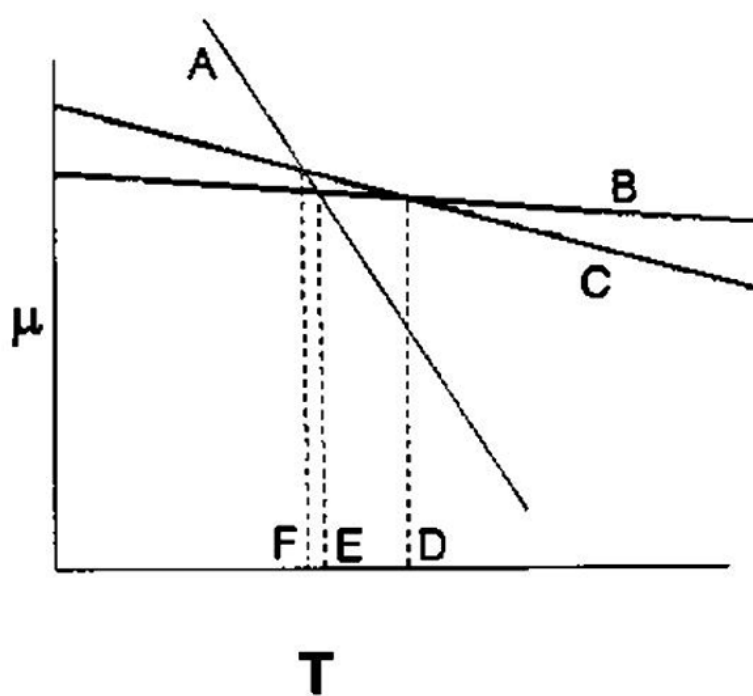Fig. 27. fig27

Statements for linked questions 54 and 55

Fig. 28. fig28

54) Based on the above diagram:

GATE 2010 CY

a) A represents the change in chemical potential as a function of temperature for the solid phase. B for the liquid and C for the gas

b) A represents the change in chemical potential as a function of temperature for the liquid phase, B for the gas and C for the solid

c) A represents the change in chemical potential as a function of temperature for the gas phase, B for the liquid and C for the solid

d) A represents the change in chemical potential as a function of temperature for the gas phase, B for solid and C for the liquid

55) From the same diagram

GATE 2010 CY

a) D represents boiling point, E sublimation point and F melting point

b) E represents boiling point, D sublimation point and F melting point

c) E represents melting point, F sublimation point and D boiling point

d) D represents melting point, F boiling point and E sublimation point

General Aptitude Questions
56-60 carry one mark each

56) 25 persons are in a room. 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is: GATE 2010 CY

a) 2

b) 17

c) 13

d) 3

57) If we manage to _ _ _ _ _ _ _ our natural resources, we would leave a better planet for our children.

GATE 2010 CY

a) uphold

b) restrain

c) cherish

d) conserve

58) Unemployed : Worker

GATE 2010 CY

a) fallow : land

b) unaware : sleeper

c) wit : jester

d) renovated : house

59) Circuitous

GATE 2010 CY

a) cyclic

b) indirect

c) confusing

d) crooked

60) Choose the most appropriate word from the options given below to complete the following sentence:
His rather casual remarks on politics _____ his lack of seriousness about the subject.

GATE 2010 CY

a) masked

c) betrayed

b) belied

d) suppressed

61-65 carry two marks each

61) Hari (H), Gita (G), Irfan (I) and Saira (S) are siblings (i.e., brothers and sisters). All were born on 1st January. The age difference between any two successive siblings (that is born one after another) is less than 3 years. Given the following facts:

i. Hari's age + Gita's age > Irfan's age + Saira's age.

ii. The age difference between Gita and Saira is 1 year. However, Gita is not the oldest and Saira is not the youngest.

iii. There are no twins.

In what order were they born (oldest first)?

a) HSGI

c) IGSH

b) SGHI

d) IHSG

62) 5 skilled workers can build a wall in 20 days; 8 semi-skilled workers can build a wall in 25 days; 10 unskilled workers can build a wall in 30 days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers, how long will it take to build the wall? GATE 2010 CY

a) 20 days

c) 16 days

b) 18 days

d) 15 days

63) **Modern warfare has changed from large scale clashes of armies to suppression of civilian populations. Chemical agents that do their work silently appear to be suited to such warfare; and regretfully, there exist people in military establishments who think that chemical agents are useful tools for their cause.**
Which of the following statements best sums up the meaning of the above passage?
GATE 2010 CY

a) Modern warfare has resulted in civil strife.

be undesirable.

b) Chemical agents are useful in modern warfare.

d) People in military establishments like to use chemical agents in war.

c) Use of chemical agents in warfare would

64) Given digits 2, 2, 3, 3, 3, 4, 4, 4, 4 how many distinct 4 digit numbers greater than 3000 can be formed? GATE 2010 CY

a) 50

c) 52

b) 51

d) 54

65) If 137 + 276 = 435 how much is 731 + 672? GATE 2010 CY

a) 534

c) 1623

b) 1403

d) 1513