

# GATE 2008 Multiple Choice Questions

EE25BTECH11010-ARSH DHOKE

## Q.1 – Q.20 Carry one mark each

1. The total number of isomers of  $\text{Co(en)}_2\text{Cl}_2$  (en = ethylenediamine) is

- (a) 4
- (b) 3
- (c) 6
- (d) 5

(GATE CY 2008)

2. Metal-metal quadruple bonds are well-known for the metal

- (a) Ni
- (b) Co
- (c) Fe
- (d) Re

(GATE CY 2008)

3. The reaction of  $\text{Al}_4\text{C}_3$  with water leads to the formation of

- (a) methane
- (b) propyne
- (c) propene
- (d) propane

(GATE CY 2008)

4. The correct statement about  $\text{C}_{60}$  is

- (a)  $\text{C}_{60}$  is soluble in benzene
- (b)  $\text{C}_{60}$  does not react with *tert*-butyllithium
- (c)  $\text{C}_{60}$  is made up of 10 five-membered and 15 six-membered rings
- (d) Two adjacent five-membered rings share a common edge

(GATE CY 2008)

5. The lattice parameters for a monoclinic crystal are

- (a)  $a \neq b \neq c; \alpha = \gamma = 90^\circ$
- (b)  $a = b \neq c; \alpha \neq \beta \neq \gamma$
- (c)  $a \neq b \neq c; \alpha \neq \beta \neq \gamma$
- (d)  $a = b = c; \alpha = \gamma = 90^\circ$

(GATE CY 2008)

6. The magnetic moment of  $[\text{Ru}(\text{H}_2\text{O})_6]^{2+}$  corresponds to the presence of

- (a) four unpaired electrons
- (b) three unpaired electrons
- (c) two unpaired electrons
- (d) zero unpaired electrons

(GATE CY 2008)

7. The compound that is **NOT** aromatic is

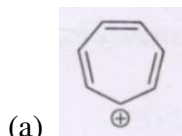


Figure 1: Option A

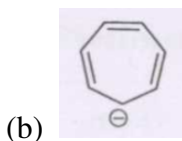


Figure 2: Option B

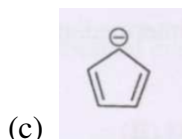


Figure 3: Option C

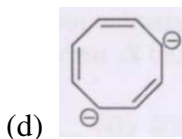


Figure 4: Option D

(GATE CY 2008)

8. The order of stability for the following cyclic olefins is

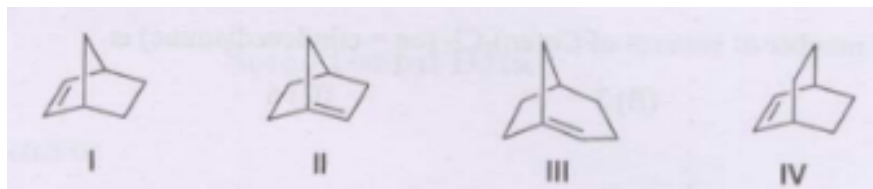


Figure 5: Figure for Q.8

- (a)  $\text{I} < \text{II} < \text{III} < \text{IV}$

- (b) I < III < IV < I
- (c) II < III < I < IV
- (d) IV < II < I < III

(GATE CY 2008)

9. The most acidic species is

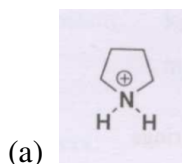


Figure 6: Option A

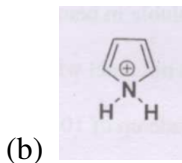


Figure 7: Option B

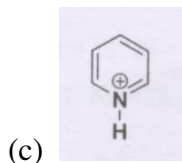


Figure 8: Option C

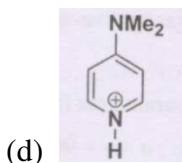


Figure 9: Option D

(GATE CY 2008)

10. The major product of the following reaction is

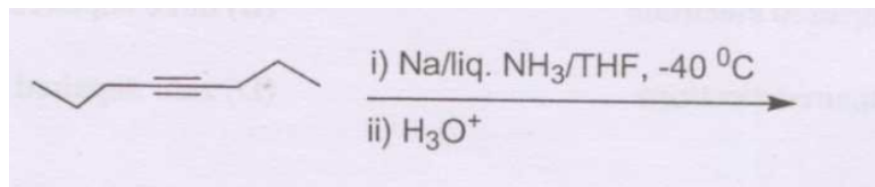


Figure 10: Figure for Q.10

(a)

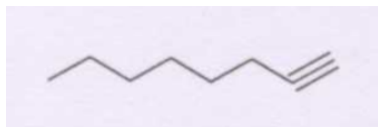


Figure 11: Option A

(b)

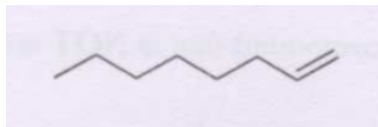


Figure 12: Option B

(c)

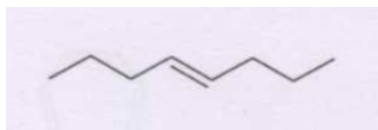


Figure 13: Option C

(d)

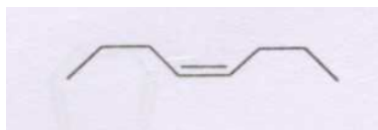


Figure 14: Option D

(GATE CY 2008)

11. In the carbylamine reaction,  $R-X$  is converted to  $R-Y$  *via* the intermediate  $Z$ .  $R-X$ ,  $R-Y$  and  $Z$ , respectively, are

- (a)  $R-NH_2$ ,  $R-NC$ , carbene
- (b)  $R-NH_2$ ,  $R-NC$ , nitrene
- (c)  $R-NC$ ,  $R-NH_2$ , carbene
- (d)  $R-OH$ ,  $R-NC$ , nitrene

(GATE CY 2008)

12. The compound that is **NOT** oxidized by  $KMnO_4$  is

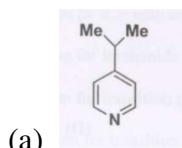


Figure 15: Option A

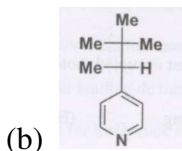


Figure 16: Option B

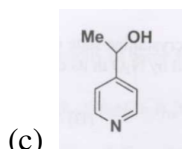


Figure 17: Option C

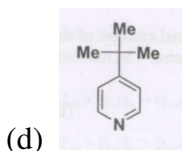


Figure 18: Option D

(GATE CY 2008)

13. Cyanogen bromide (CNBr) specifically hydrolyses the peptide bond formed by the C-side of

- |                |             |
|----------------|-------------|
| (a) methionine | (c) proline |
| (b) glycine    | (d) serine  |

(GATE CY 2008)

14. The Hammett reaction constant  $\rho$  is based on

- (a) the rates of alkaline hydrolysis of substituted ethyl benzoates
- (b) the dissociation constants of substituted acetic acids
- (c) the dissociation constants of substituted benzoic acids
- (d) the dissociation constants of substituted phenols

(GATE CY 2008)

15. The lifetime of a molecule in an excited electronic state is  $10^{-10}$  s. The uncertainty in the energy (eV) approximately is

- |                     |                |
|---------------------|----------------|
| (a) $2 \times 10^5$ | (c) 0          |
| (b) $3 \times 10^6$ | (d) $10^{-14}$ |

(GATE CY 2008)

16. For a one component system, the maximum number of phases that can coexist at equilibrium is

- (a) 3 (c) 1  
(b) 2 (d) 4 (GATE CY 2008)

17. At  $T = 300$  K, the thermal energy ( $k_B T$ ) in  $\text{cm}^{-1}$  is approximately

- (a) 20000 (c) 5000  
(b) 8000 (d) 200 (GATE CY 2008)

18. For the reaction  $2X_3 \rightarrow 3X_2$ , the rate of formation of  $X_2$  is

- (a)  $3 \left( -\frac{d[X_3]}{dt} \right)$   
(b)  $\frac{1}{2} \left( -\frac{d[X_3]}{dt} \right)$   
(c)  $\frac{1}{3} \left( -\frac{d[X_3]}{dt} \right)$   
(d)  $\frac{3}{2} \left( -\frac{d[X_3]}{dt} \right)$  (GATE CY 2008)

19. The highest occupied molecular orbital of HF is

- (a) bonding (c) ionic  
(b) antibonding (d) nonbonding (GATE CY 2008)

20. The residual entropy of the asymmetric molecule  $\text{N}_2\text{O}$  in its crystalline state is  $5.8 \text{ J K}^{-1} \text{ mol}^{-1}$  at absolute zero. The number of orientations that can be adopted by  $\text{N}_2\text{O}$  in its crystalline state is

- (a) 4 (c) 2  
(b) 3 (d) 1  
(GATE CY 2008)

**Q.21 to Q.75 Carry two marks each**

21. The spectroscopic ground state symbol and the total number of electronic transitions of  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  are

- (a)  ${}^3T_{1g}$  and 2 (c)  ${}^1T_{1g}$  and 3  
(b)  ${}^3A_{2g}$  and 3 (d)  ${}^3A_{2g}$  and 2 (GATE CY 2008)

22. The structures of the complexes  $[\text{Cu}(\text{NH}_3)_4](\text{ClO}_4)_2$  and  $[\text{Cu}(\text{NH}_3)_4](\text{ClO}_4)$  in solution respectively are

- (a) square planar and tetrahedral

- (b) octahedral and square pyramidal  
 (c) octahedral and trigonal bipyramidal  
 (d) tetrahedral and square planar (GATE CY 2008)
23. In biological systems, the metal ions involved in electron transport are
- (a)  $\text{Na}^+$  and  $\text{K}^+$  (c)  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$   
 (b)  $\text{Zn}^{2+}$  and  $\text{Mg}^{2+}$  (d)  $\text{Cu}^{2+}$  and  $\text{Fe}^{3+}$
- (GATE CY 2008)
24. In a homogeneous catalytic reaction, 1.0 M of a substrate and 1.0  $\mu\text{M}$  of a catalyst yields 1.0 mM of a product in 10 seconds. The turnover frequency (TOF) of the reaction ( $\text{s}^{-1}$ ) is
- (a)  $10^2$  (c)  $10^{-3}$   
 (b)  $10^1$  (d)  $10^3$
- (GATE CY 2008)
25. The expected magnetic moments of the first-row transition metal complexes and those of the lanthanide metal complexes are usually calculated using
- (a)  $\mu_{\text{so}}$  equation (s.o. = spin only) for both lanthanide and transition metal complexes  
 (b)  $\mu_{\text{so}}$  equation for lanthanide metal complexes and  $\mu$  equation for transition metal complexes  
 (c)  $\mu_{\text{so}}$  equation for transition metal complexes and  $\mu$  equation for lanthanide metal complexes  
 (d)  $\mu_{\text{eff}}$  equation for transition metal complexes and  $\mu_{\text{so}}$  equation for lanthanide metal complexes (GATE CY 2008)
26. The Brønsted acidity of boron hydrides follows the order
- (a)  $\text{B}_2\text{H}_6 > \text{B}_4\text{H}_{10} > \text{B}_5\text{H}_9 > \text{B}_{10}\text{H}_{14}$   
 (b)  $\text{B}_2\text{H}_6 = \text{B}_4\text{H}_{10} > \text{B}_5\text{H}_9 = \text{B}_{10}\text{H}_{14}$   
 (c)  $\text{B}_{10}\text{H}_{14} > \text{B}_5\text{H}_9 > \text{B}_4\text{H}_{10} > \text{B}_2\text{H}_6$   
 (d)  $\text{B}_5\text{H}_9 > \text{B}_4\text{H}_{10} > \text{B}_2\text{H}_6 > \text{B}_{10}\text{H}_{14}$
- (GATE CY 2008)
27. NaCl is crystallised by slow evaporation of its aqueous solution at room temperature. The correct statement is
- (a) The crystals will be non-stoichiometric  
 (b) The crystals should have Frenkel defects

- (c) The percentage of defects in the crystals will depend on the concentration of the solution and its rate of evaporation
- (d) The nature of defects will depend upon the concentration of the solution and its rate of evaporation (GATE CY 2008)
28.  $\text{CaTiO}_3$  has a perovskite crystal structure. The coordination number of titanium in  $\text{CaTiO}_3$  is
- (a) 9 (c) 3
- (b) 6 (d) 12
- (GATE CY 2008)
29. If  $\text{ClF}_5$  were to be stereochemically rigid, its  $^{19}\text{F}$  NMR spectrum ( $I_{\text{for } ^{19}\text{F}} = \frac{1}{2}$ ) would be (assume that Cl is not NMR active)
- (a) a doublet and a triplet
- (b) a singlet
- (c) a doublet and a singlet
- (d) two singlets (GATE CY 2008)
30. The point group of  $\text{NSF}_3$  is
- (a)  $D_{3d}$  (c)  $D_{3h}$
- (b)  $C_{3h}$  (d)  $C_{3v}$
- (GATE CY 2008)
31. When  $\text{NiO}$  is heated with a small amount of  $\text{Li}_2\text{O}$  in air at  $1200^\circ\text{C}$ , a non-stoichiometric compound  $\text{Li}_x\text{Ni}_{1-x}\text{O}$  is formed. This compound is
- (a) an n-type semiconductor containing only  $\text{Ni}^{1+}$
- (b) an n-type semiconductor containing  $\text{Ni}^{1+}$  and  $\text{Ni}^{2+}$
- (c) a p-type semiconductor containing  $\text{Ni}^{2+}$  and  $\text{Ni}^{3+}$
- (d) a p-type semiconductor containing only  $\text{Ni}^{3+}$  (GATE CY 2008)
32. White phosphorus,  $\text{P}_4$ , belongs to the
- (a) *closo* system (b) *nido* system (c) *arachno* system (d) *hypho* system
- (GATE CY 2008)
33. Among the compounds  $\text{Fe}_3\text{O}_4$ ,  $\text{NiFe}_2\text{O}_4$  and  $\text{Mn}_3\text{O}_4$



- (a)  $\text{NiFe}_2\text{O}_4$  and  $\text{Mn}_3\text{O}_4$  are normal spinels
  - (b)  $\text{Fe}_3\text{O}_4$  and  $\text{Mn}_3\text{O}_4$  are normal spinels
  - (c)  $\text{Fe}_3\text{O}_4$  and  $\text{Mn}_3\text{O}_4$  are inverse spinels
  - (d)  $\text{Fe}_3\text{O}_4$  and  $\text{NiFe}_2\text{O}_4$  are inverse spinels
- (GATE CY 2008)

34. The number of M-M bonds in  $\text{Ir}_4(\text{CO})_{12}$  are

- (a) four
- (b) six
- (c) eight
- (d) zero

(GATE CY 2008)

35. Schrock carbenes are

- (a) triplets and nucleophilic
- (b) triplets and electrophilic
- (c) singlets and nucleophilic
- (d) singlets and electrophilic

(GATE CY 2008)

36. The **INCORRECT** statement about linear dimethylpolysiloxane,  $[(\text{CH}_3)_2\text{SiO}]_n$ , is

- (a) it is extremely hydrophilic
- (b) it is prepared by a KOH catalysed ring-opening reaction of  $[\text{Me}_2\text{SiO}]_4$
- (c) it has a very low glass transition temperature
- (d) it can be reinforced to give silicon elastomers

(GATE CY 2008)

37. Match the entries **a–d** with their corresponding structures **p–s**

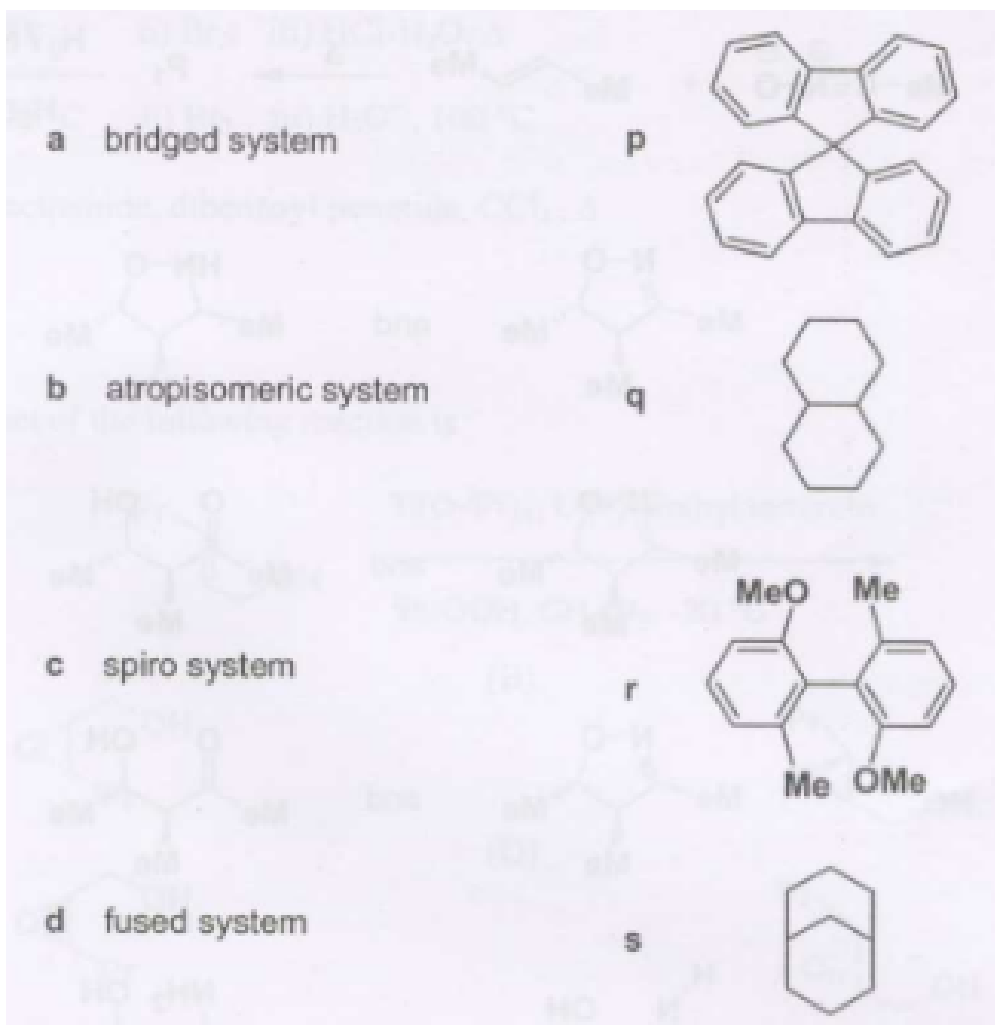


Figure 19: Figure for Q.37

- (a) a - s, b - r, c - q, d - p
- (b) a - p, b - s, c - q, d - r
- (c) a - q, b - p, c - s, d - r
- (d) a - s, b - r, c - p, d - q

(GATE CY 2008)

38. The reaction between **X** and **Y** to give **Z** proceeds via

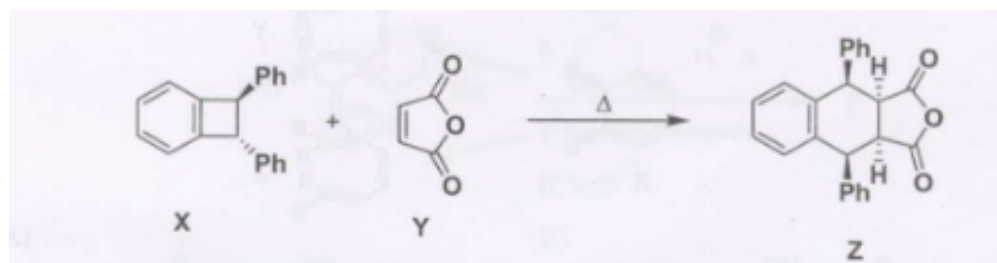


Figure 20: Figure for Q.38

- (a)  $4\pi$ -conrotatory opening of X followed by *endo* Diels–Alder cycloaddition
- (b)  $4\pi$ -disrotatory opening of X followed by *endo* Diels–Alder cycloaddition
- (c)  $4\pi$ -conrotatory opening of X followed by *exo* Diels–Alder cycloaddition
- (d)  $4\pi$ -disrotatory opening of X followed by *exo* Diels–Alder cycloaddition

(GATE CY 2008)

39. The major products  $P_1$  and  $P_2$ , respectively, in the following reaction sequence are

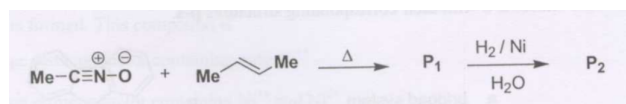


Figure 21: Figure for Q.39

(GATE CY 2008)

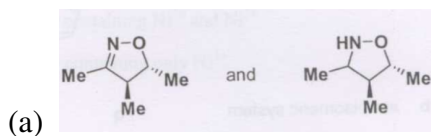


Figure 22: Option A

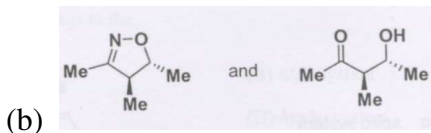


Figure 23: Option B

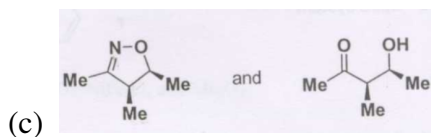


Figure 24: Option C

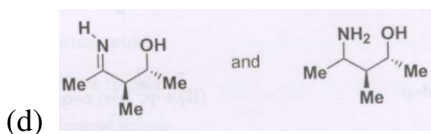


Figure 25: Option D

40. The products *Y* and *Z* are formed, respectively, from *X* via

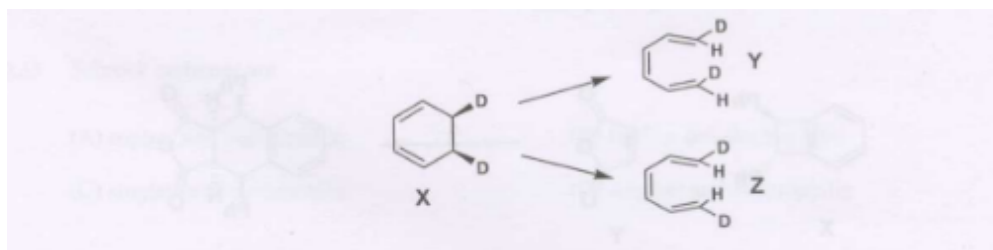


Figure 26: Figure for Q.40

- (a)  $h\nu$ , conrotatory opening and  $\Delta$ , disrotatory opening
- (b)  $h\nu$ , disrotatory opening and  $\Delta$ , conrotatory opening
- (c)  $\Delta$ , conrotatory opening and  $h\nu$ , disrotatory opening
- (d)  $\Delta$ , disrotatory opening and  $h\nu$ , conrotatory opening

(GATE CY 2008)

41. *o*-Bromophenol is readily prepared from phenol using the following conditions:

- (a) i)  $(\text{CH}_3\text{CO})_2\text{O}$ ; ii)  $\text{Br}_2$ ; iii)  $\text{HCl}-\text{H}_2\text{O}$ ,  $\Delta$
- (b) i)  $\text{H}_2\text{SO}_4$ ,  $100^\circ\text{C}$ ; ii)  $\text{Br}_2$ ; iii)  $\text{H}_3\text{O}^+$ ,  $100^\circ\text{C}$

- (c) N-Bromosuccinimide, dibenzoyl peroxide,  $\text{CCl}_4$ ,  $\Delta$   
 (d)  $\text{Br}_2/\text{FeBr}_3$

(GATE CY 2008)

42. The major product of the following reaction is

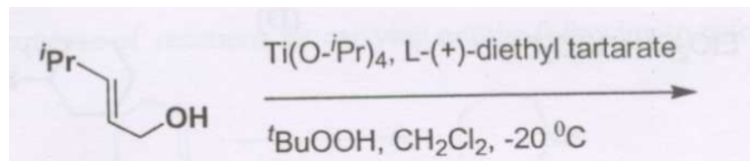


Figure 27: Figure for Q.42

(GATE CY 2008)

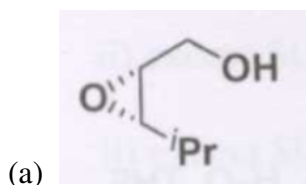


Figure 28: Option A

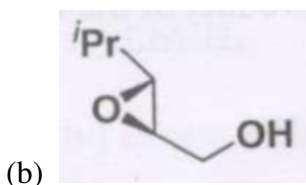


Figure 29: Option B

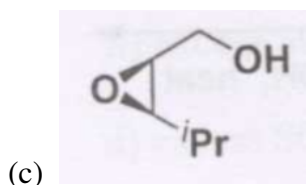


Figure 30: Option C

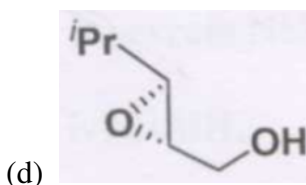


Figure 31: Option D

43. The photochemical reaction of 2-methylpropane with  $\text{F}_2$  gives 2-fluoro-2-methylpropane and 1-fluoro-2-methylpropane in 14:86 ratio. The corresponding ratio of the bromo products in the above reaction using  $\text{Br}_2$  is most likely to be:

- (a) 14 : 86
- (b) 50 : 50
- (c) 1 : 9
- (d) 99 : 1

(GATE CY 2008)

44. The major product *P* of the following reaction is

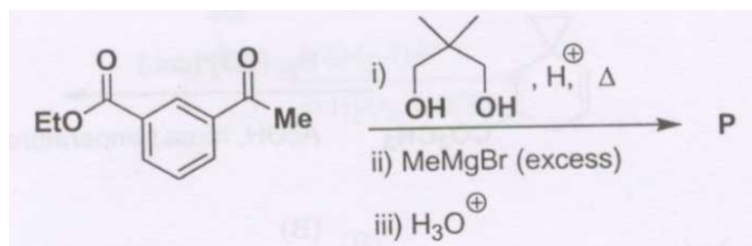


Figure 32: Figure for Q.44

(GATE CY 2008)

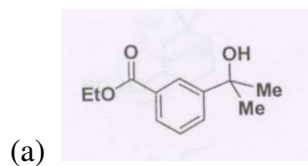


Figure 33: Option A

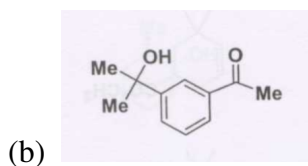


Figure 34: Option B

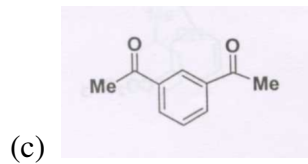


Figure 35: Option C

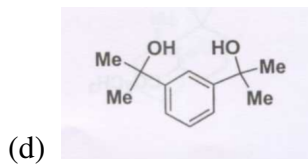


Figure 36: Option D

45. The reagent **X** in the following reaction is

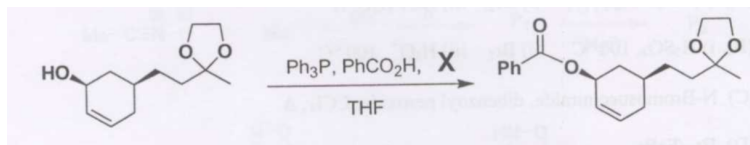
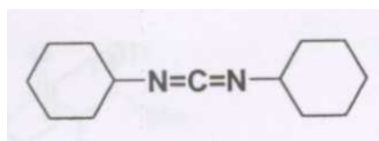


Figure 37: Figure for Q.45

(GATE CY 2008)

- (a)  $\text{HO}_2\text{CN}=\text{NCO}_2\text{H}$
- (b)  $\text{EtO}_2\text{CHC}=\text{CH}-\text{CO}_2\text{Et}$
- (c)  $\text{EtO}_2\text{CN}=\text{NCO}_2\text{Et}$



(d)

Figure 38: Option D

46. The major product of the following reactions is

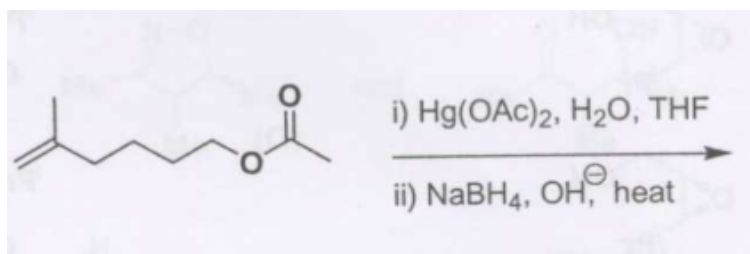


Figure 39: Figure for Q.46

(GATE CY 2008)

(a)

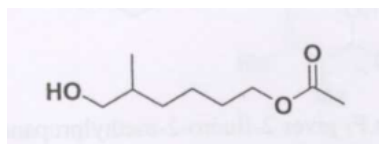


Figure 40: Option A

(b)

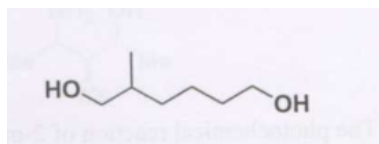


Figure 41: Option B

(c)

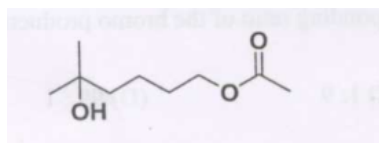


Figure 42: Option C

(d)

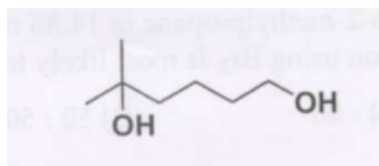


Figure 43: Option D

47. The major product of the following reaction is

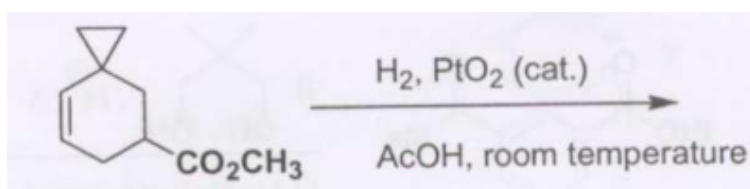


Figure 44: Figure for Q.47

(GATE CY 2008)



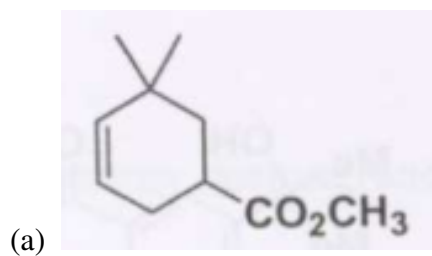


Figure 45: Option A

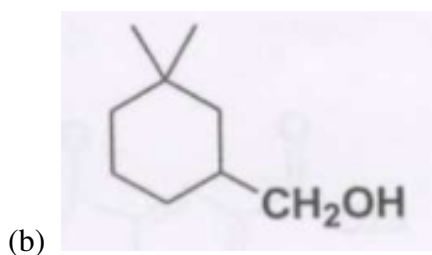


Figure 46: Option B

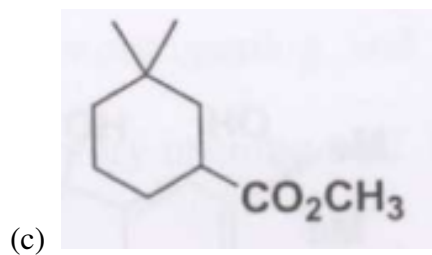


Figure 47: Option C

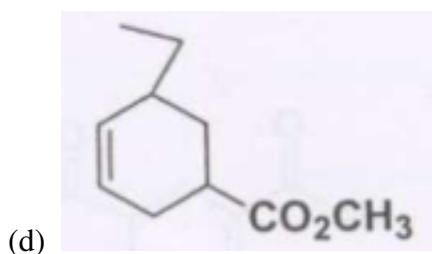


Figure 48: Option D

48. In the following compound, the hydroxy group that is most readily methylated with  $\text{CH}_2\text{N}_2$  is

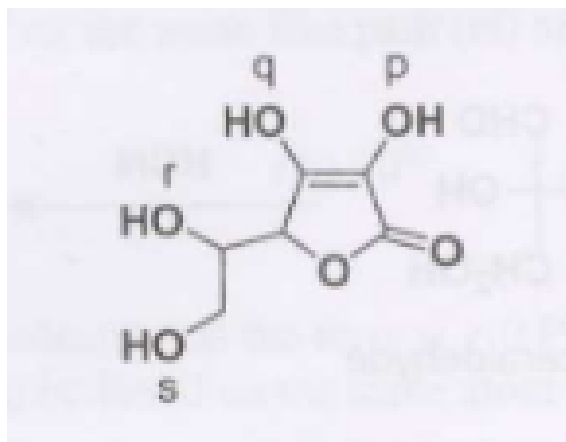


Figure 49: Figure for Q.48

- |       |       |
|-------|-------|
| (a) p | (c) r |
| (b) q | (d) s |

(GATE CY 2008)

49. The most appropriate sequence of reactions for carrying out the following transformation is



Figure 50: Figure for Q.49

- (a) i)  $\text{O}_3/\text{H}_2\text{O}_2$ ; ii) excess  $\text{SOCl}_2/\text{pyridine}$ ; iii) excess  $\text{NH}_3$ ; iv)  $\text{LiAlH}_4$   
 (b) i)  $\text{O}_3/\text{Me}_2\text{S}$ ; ii) excess  $\text{SOCl}_2/\text{pyridine}$ ; iii)  $\text{LiAlH}_4$ ; iv) excess  $\text{NH}_3$   
 (c) i)  $\text{O}_3/\text{H}_2\text{O}_2$ ; ii) excess  $\text{SOCl}_2/\text{pyridine}$ ; iii)  $\text{LiAlH}_4$ ; iv) excess  $\text{NH}_3$   
 (d) i)  $\text{O}_3/\text{Me}_2\text{S}$ ; ii) excess  $\text{SOCl}_2/\text{pyridine}$ ; iii) excess  $\text{NH}_3$ ; iv)  $\text{LiAlH}_4$

(GATE CY 2008)

50. The number of optically active stereoisomers possible for 1,3-cyclohexanediol in its chair conformation is

- (a) 4  
 (b) 3  
 (c) 2  
 (d) 1

(GATE CY 2008)

51. The major product of the following reactions is

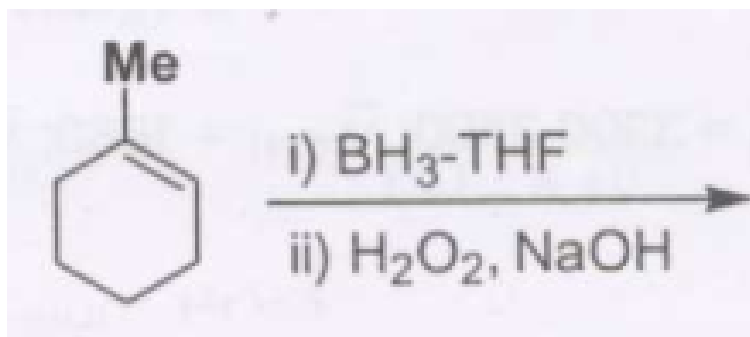


Figure 51: Figure for Q.51

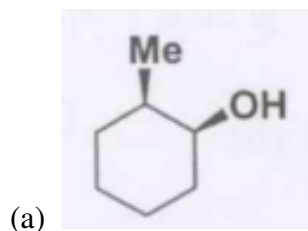


Figure 52: Option A

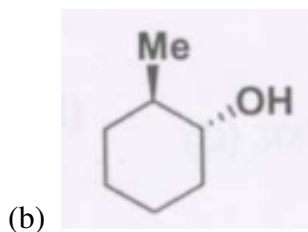


Figure 53: Option B

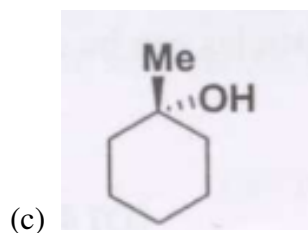


Figure 54: Option C

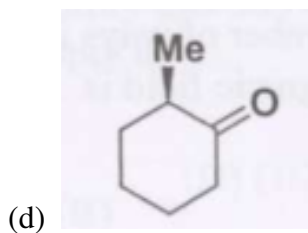


Figure 55: Option D

(GATE CY 2008)

52. In the following reaction,

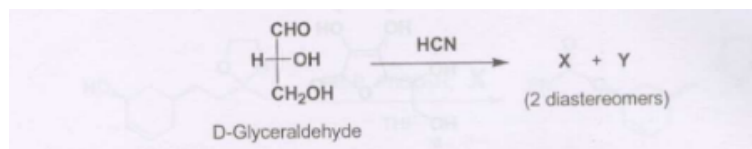


Figure 56: Figure for Q.52

The absolute configurations of the chiral centres in X and Y are

- (a) 2S, 3R and 2R, 3R
- (b) 2R, 3R and 2R, 3S
- (c) 2S, 3S and 2R, 3R
- (d) 2S, 3R and 2S, 3R

(GATE CY 2008)

53. The IR stretching frequencies ( $\text{cm}^{-1}$ ) for the compound X are as follows: 3300–3500 (s, br); 3000 (m); 2225 (s); 1680 (s).

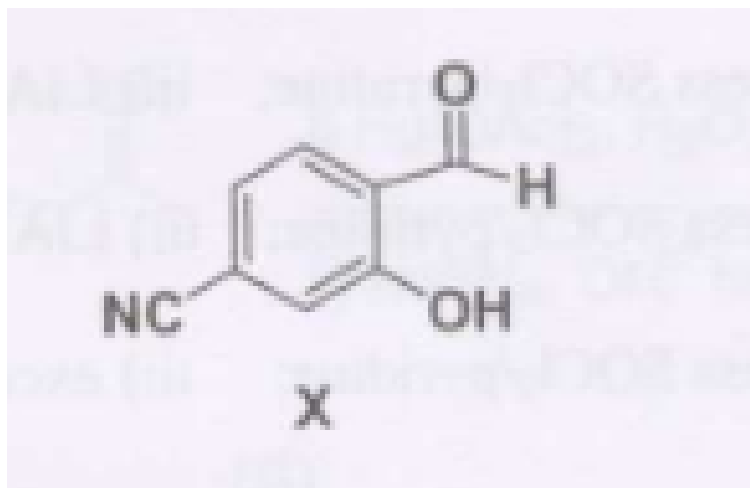


Figure 57: Figure for Q.53

The correct assignment of the absorption bands is:

- (a)  $\bar{\nu}_{\text{OH}} = 3300\text{--}3500$ ;  $\bar{\nu}_{\text{CH}} = 3000$ ;  $\bar{\nu}_{\text{CN}} = 2225$ ;  $\bar{\nu}_{\text{CO}} = 1680$
- (b)  $\bar{\nu}_{\text{OH}} = 3000$ ;  $\bar{\nu}_{\text{CH}} = 3300\text{--}3500$ ;  $\bar{\nu}_{\text{CN}} = 2225$ ;  $\bar{\nu}_{\text{CO}} = 1680$
- (c)  $\bar{\nu}_{\text{OH}} = 3300\text{--}3500$ ;  $\bar{\nu}_{\text{CH}} = 3000$ ;  $\bar{\nu}_{\text{CN}} = 1680$ ;  $\bar{\nu}_{\text{CO}} = 2225$

(d)  $\bar{\nu}_{\text{OH}} = 3000$ ;  $\bar{\nu}_{\text{CH}} = 3300\text{--}3500$ ;  $\bar{\nu}_{\text{CN}} = 1680$ ;  $\bar{\nu}_{\text{CO}} = 2225$

(GATE CY 2008)

54. The  $T_d$  point group has 24 elements and 5 classes. Given that it has two 3-dimensional irreducible representations, the number of one-dimensional irreducible representations is

(a) 1

(c) 2

(b) 6

(d) 3

(GATE CY 2008)

55. The total number of ways in which two nonidentical spin  $\frac{1}{2}$  particles can be oriented relative to a constant magnetic field is

(a) 1

(c) 3

(b) 2

(d) 4

(GATE CY 2008)

56. Approximately one hydrogen atom per cubic meter is present in interstellar space. Assuming that the H-atom has a diameter of  $10^{-10}$  m, the mean free path (m) approximately is

(a)  $10^{10}$

(b)  $10^{19}$

(c)  $10^{24}$

(d)  $10^{14}$

(GATE CY 2008)

57. The wavefunction of a diatomic molecule has the form  $\psi = 0.89 \varphi_{\text{covalent}} + 0.45 \varphi_{\text{ionic}}$ . The chance that both electrons of the bond will be found on the same atom in 100 inspections of the molecule approximately is

(a) 79

(b) 20

(c) 45

(d) 60

(GATE CY 2008)

58. For the reaction given below, the relaxation time is  $10^{-4}$  s. Given that 10% of A remains at equilibrium, the value of  $k_1$  ( $\text{s}^{-1}$ ) is

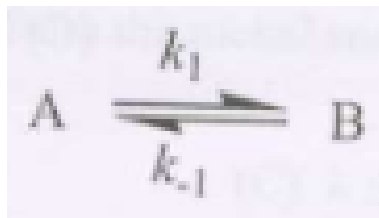


Figure 58: Figure for Q.58

- (a)  $9 \times 10^5$
- (b)  $10^5$
- (c)  $10^6$
- (d)  $9 \times 10^6$

(GATE CY 2008)

59. The minimum number of electrons needed to form a chemical bond between two atoms is

- (a) 1
- (b) 2
- (c) 3
- (d) 4

(GATE CY 2008)

60. The ground state electronic energy (Hartree) of a helium atom, neglecting the inter-electron repulsion, is

- (a) -1.0
- (b) -0.5
- (c) -2.0
- (d) -4.0

(GATE CY 2008)

61. A particle is confined to a one-dimensional box of length 1 mm. If the length is changed by  $10^{-9}$  m, the % change in the ground state energy is

- (a)  $2 \times 10^4$
- (b)  $2 \times 10^7$
- (c)  $2 \times 10^2$
- (d) 0

(GATE CY 2008)

62. A certain molecule can be treated as having only a doubly degenerate state lying at  $360 \text{ cm}^{-1}$  above the nondegenerate ground state. The approximate temperature (K) at which 15% of the molecules will be in the upper state is

- (a) 500
- (b) 150
- (c) 200

(d) 300

(GATE CY 2008)

63. A box of volume  $V$  contains one mole of an ideal gas. The probability that all  $N$  particles will be found occupying one half of the volume leaving the other half empty is

- (a)  $1/2$
- (b)  $2/N$
- (c)  $(1/2)^N$
- (d)  $(1/2)^{6N}$

(GATE CY 2008)

64. According to the Debye-Hückel limiting law, the mean activity coefficient of  $5 \times 10^{-4} \text{ mol kg}^{-1}$  aqueous solution of  $\text{CaCl}_2$  at  $25^\circ\text{C}$  is (the Debye-Hückel constant 'A' can be taken to be 0.509)

- (a) 0.63
- (b) 0.72
- (c) 0.80
- (d) 0.91

(GATE CY 2008)

65. The operation of the commutator  $\left(x, \left(\frac{d}{dx}\right)\right)$  on a function  $f(x)$  is equal to

- (a) 0
- (b)  $f(x)$
- (c)  $-f(x)$
- (d)  $x \frac{df}{dx}$

(GATE CY 2008)

66. If a gas obeys the equation of state  $P(V - nb) = nRT$ , the ratio  $(C_P - C_V)/(C_P - C_V)_{\text{ideal}}$  is

- (a)  $> 1$
- (b)  $< 1$
- (c) 1
- (d)  $(1 - b)$

(GATE CY 2008)

67. Physisorbed particles undergo desorption at  $27^{\circ}\text{C}$  with an activation energy of  $16.628\text{ kJ mol}^{-1}$ . Assuming first-order process and a frequency factor of  $10^{12}\text{ Hz}$ , the average residence time (in seconds) of the particles on the surface is

- (a)  $8 \times 10^{-10}$
- (b)  $8 \times 10^{-11}$
- (c)  $2 \times 10^{-9}$
- (d)  $1 \times 10^{-12}$

(GATE CY 2008)

68. The rotational constants for CO in the ground and the first excited vibrational states are  $1.9$  and  $1.6\text{ cm}^{-1}$ , respectively. The % change in the internuclear distance due to vibrational excitation is

- (a) 9
- (b) 30
- (c) 16
- (d) 0

(GATE CY 2008)

69. The mechanism of enzyme (E) catalysed reaction of a substrate (S) to yield product (P) is:

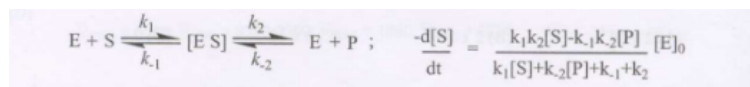


Figure 59: Figure for Q.69

If a small amount of S is converted to P, the maximum rate for the reaction will be observed for:

- (a)  $(k_1 + k_2) \gg k_1 [\text{S}]_0$
- (b)  $(k_1 + k_2) \ll k_1 [\text{S}]_0$
- (c)  $(k_2 + k_{-1}) = (k_1 + k_1)$
- (d)  $k_2 \ll k_1$

(GATE CY 2008)

70. The lowest energy state of the  $(1s)^2(2s)^1(3s)^1$  configuration of Be is

- (a)  $^1S_0$
- (b)  $^1D_2$
- (c)  $^3S_1$
- (d)  $^3P_1$

(GATE CY 2008)



## Common Data Questions

Common Data for Questions 71, 72 and 73: An electron accelerated through a potential difference of  $\varphi$  volts impinges on a nickel surface, whose (100) planes have a spacing  $d = 351.8 \times 10^{-12}$  m (351.8 pm).

71. The de-Broglie wavelength of the electron is  $\lambda/\text{pm} = (a/\varphi)^{1/2}$ . The value of 'a' in volts is:

- (a)  $1.5 \times 10^{-18}$
- (b)  $1.5 \times 10^6$
- (c)  $6.63 \times 10^5$
- (d)  $2.5 \times 10^{18}$

(GATE CY 2008)

72. The condition for observing diffraction from the nickel surface is:

- (a)  $\lambda \gg 2d$
- (b)  $\lambda \leq 2d$
- (c)  $\lambda \leq d$
- (d)  $\lambda \geq d$

(GATE CY 2008)

73. The minimum value of  $\varphi$  (V) for the electron to diffract from the (100) planes is:

- (a) 3000
- (b) 300
- (c) 30
- (d) 3

(GATE CY 2008)

Common Data for Questions 74 and 75: An iron complex  $[\text{FeL}_3]^{2+}$  (L = neutral monodentate ligand) catalyses the oxidation of  $(\text{CH}_3)_2\text{S}$  by perbenzoic acid.

74. The formation of the organic product in the above reaction can be monitored by:

- (a) gas chromatography
- (b) cyclic voltammetry
- (c) electron spin resonance
- (d) fluorescence spectroscopy

(GATE CY 2008)

75. The oxidation state of the metal ion in the catalyst can be detected by:

- (a) atomic absorption spectroscopy
- (b) Mössbauer spectroscopy
- (c) HPLC
- (d) gas chromatography

(GATE CY 2008)

## 1 Linked Answer Questions: Q.76 to Q.85 carry two marks each

Linked Answer Questions 76 and 77:

In the reaction,

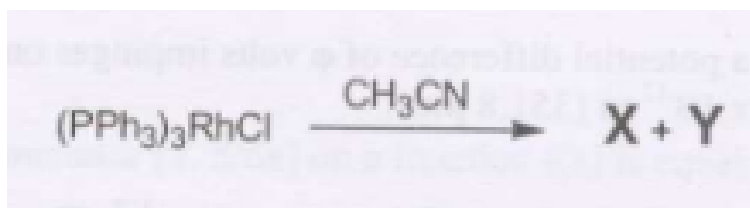


Figure 60: Figure for Q.76

76. Compound X is

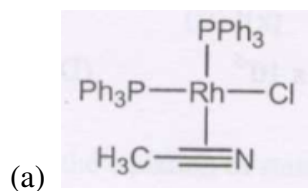


Figure 61: Option A

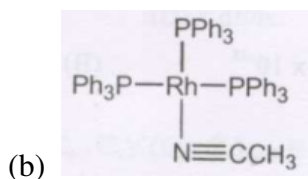


Figure 62: Option B

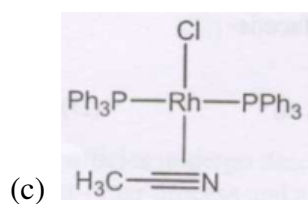


Figure 63: Option C

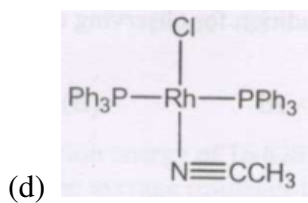
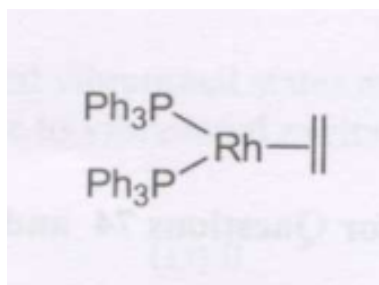


Figure 64: Option D

(GATE CY 2008)

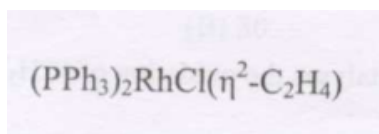
77.  $\text{Rh}(\text{PPh}_3)_3\text{Cl}$  reacts very fast with a gaseous mixture of  $\text{H}_2$  and  $\text{C}_2\text{H}_4$  to immediately give Z. The structure of Z is

(a)  $\text{H}_3\text{C}-\text{CH}_3$



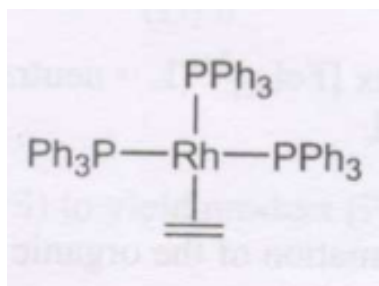
(b)

Figure 65: Option B



(c)

Figure 66: Option C



(d)

Figure 67: Option D

(GATE CY 2008)

## Linked Answer Questions 78 and 79

The reaction of  $\text{PCl}_3$  with methanol in the presence of triethylamine affords compound X. EI mass spectrum of X shows a parent ion peak at  $m/z = 124$ . Microanalysis of X shows that it contains C, H, O and P. The  $^1\text{H}$  NMR spectrum of X shows a doublet at 4.0 ppm. The separation between the two lines of the doublet is approximately 15 Hz ( $J_{\text{for } ^1\text{H and } ^{31}\text{P}} = \frac{1}{2}$ ).

78. Compound X is:

- (a)  $(\text{CH}_3\text{O})_2\text{P}$
- (b)  $(\text{CH}_3\text{O})_2\text{PO}$
- (c)  $(\text{CH}_3\text{O})_2\text{P}(\text{O})\text{OH}$
- (d)  $(\text{CH}_3\text{O})_2\text{PH}$

(GATE CY 2008)

79. Upon heating, compound X is converted to Y, which has the same molecular formula as that of X. The  $^1\text{H}$  NMR spectrum of Y shows two doublets centered at 3.0 ppm (separation of two lines = 20 Hz) and 4.0 ppm (separation of two lines = 15 Hz) respectively.

Compound Y is:

- (a)  $(\text{CH}_3\text{O})_2\text{P}(\text{O})(\text{OH})$
- (b)  $(\text{CH}_3\text{O})_2\text{P}$
- (c)  $(\text{CH}_3\text{O})(\text{CH}_3)\text{P}(\text{O})$
- (d)  $(\text{CH}_3\text{O})(\text{CH}_3)\text{P}(\text{OH})$

(GATE CY 2008)

## Linked Answer Questions 80 and 81

For butyrophenone ( $\text{PhCOCH}_2\text{CH}_2\text{CH}_3$ ),

80. The most probable fragmentation observed in the electron impact ionization (EI) mass spectrometry is

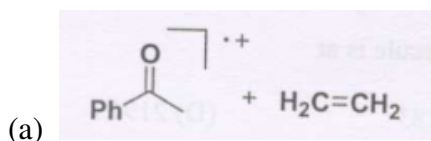


Figure 68: Option A

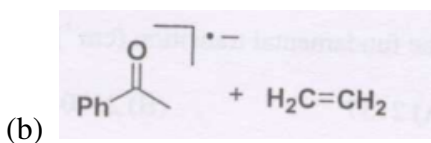


Figure 69: Option B

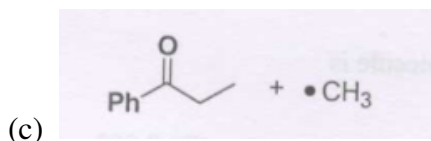


Figure 70: Option C

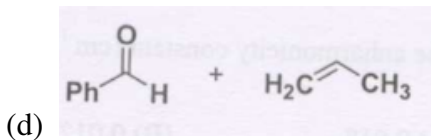


Figure 71: Option D

(GATE CY 2008)

81. Photoirradiation leads to the following set of products.

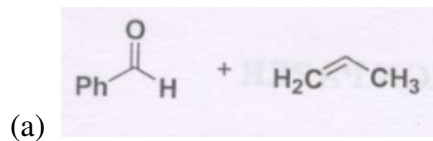


Figure 72: Option A

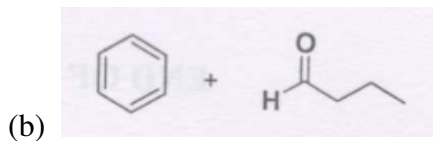


Figure 73: Option B

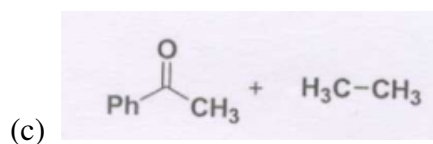


Figure 74: Option C

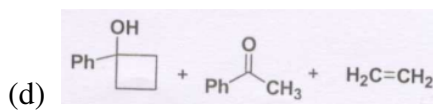


Figure 75: Option D

(GATE CY 2008)

Linked Answer Questions 82 and 83:

In the following reaction,

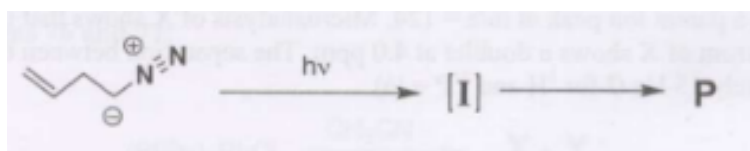


Figure 76: Figure for Q.82

82. the reactive intermediate *I* and the product *P* are

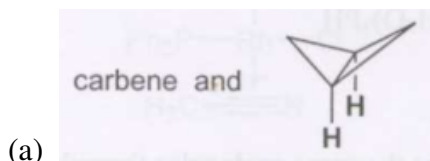


Figure 77: Option A

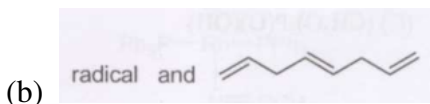


Figure 78: Option B

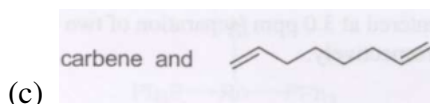


Figure 79: Option C

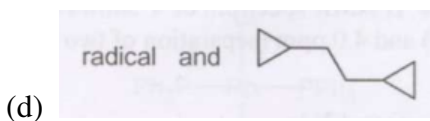


Figure 80: Option D

(GATE CY 2008)

83. The product P shows 'm' and 'n' number of signals in  $^1\text{H}$  and  $^{13}\text{C}$  NMR spectra, respectively. The values of 'm' and 'n' are

- (a)  $m = 3$  and  $n = 2$
- (b)  $m = 2$  and  $n = 3$
- (c)  $m = 2$  and  $n = 2$
- (d)  $m = 4$  and  $n = 3$

(GATE CY 2008)

Linked Answer Questions 84 and 85:

The infrared spectrum of a diatomic molecule exhibits transitions at 2144, 4262 and  $6354\text{ cm}^{-1}$  corresponding to excitations from the ground state to the first, second, and third vibration states respectively.

84. The fundamental transition ( $\text{cm}^{-1}$ ) of the diatomic molecule is at

- (a) 2157
- (b) 2170
- (c) 2183
- (d) 2196

(GATE CY 2008)

85. The anharmonicity constant ( $\text{cm}^{-1}$ ) of the diatomic molecule is

(a) 0.018

(c) 0.006

(b) 0.012

(d) 0.003

(GATE CY 2008)

**END OF THE QUESTION PAPER**