ASSIGNMENT: GATE 2013
CY: CHEMISTRY

EE25BTECH11039 - Manupati Manideep

Q.1 - Q. 25 CARRY ONE MARK EACH.

1) The point group symmetry of $CH_2{=}C{=}CH_2$ is

a) C_{2h} b) D_{2h} c) C_{2v} d) D_{2d}

(GATE CY-2013)

2) Two trial wave functions $\phi_1 = c_1 x(a-x)$ and $\phi_2 = c_1 x(a-x) + c_2 x^2 (a-x)^2$ give ground state energies E_1 and E_2 respectively, for the microscopic particle in a 1-D box by using the variation method. If the exact ground state energy is E_0, the correct relationship between E_0, E_1 and E_2 is

a) $E_0 = E_1 = E_2$
b) $E_0 < E_1 < E_2$
c) $E_0 < E_2 < E_1$
d) $E_0 > E_2 = E_1$ (GATE CY-2013)

3) The ground state energies of H atom and H_2 molecule are -13.6 eV and -31.7 eV, respectively. The dissociation energy of H_2 is _____ eV. (GATE CY-2013)

4) A 2 L vessel containing 2 g of H_2 gas at $27°C$ is connected to a 2 L vessel containing 176 g of CO_2 gas at $27°C$. Assuming ideal behavior of H_2 and CO_2, the partial pressure of H_2 at equilibrium is _____ bar. (GATE CY-2013)

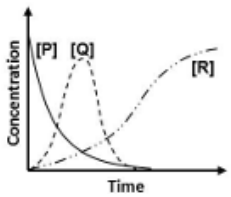
5) Consider the reaction $2\,C(s) + O_2(g) \rightleftharpoons 2\,CO(g)$ at equilibrium. The equilibrium can be shifted towards the forward direction by

a) increasing the amount of carbon in the system.
b) decreasing the volume of the system.
c) decreasing the pressure of the system.
d) increasing the temperature of the system. (GATE CY-2013)

6) A sparingly soluble electrolyte M_2X ionizes as $M_2X \rightleftharpoons 2\,M^+ + X^{2-}$. The solubility product $\left(K_{sp}\right)$, molal solubility (S) and mean molal activity coefficient $(\gamma_\pm)$ are related by

a) $K_{sp} = S^2\gamma_\pm^2$
b) $K_{sp} = S^3\gamma_\pm^3$
c) $K_{sp} = 4S^3\gamma_\pm^2$
d) $K_{sp} = 4S^3\gamma_\pm^3$ (GATE CY-2013)

7) For the first order consecutive reaction $P \rightarrow Q \rightarrow R$, under steady state approximation to [Q], the variations of [P], [Q] and [R] with time are best represented by

a)


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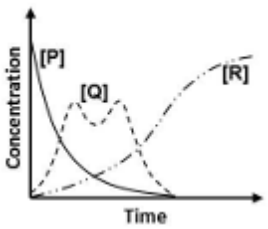

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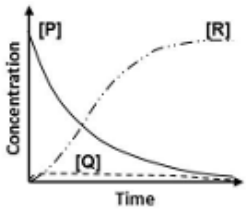

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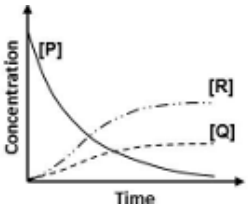


(GATE CY-2013)

8) At 273 K and 10 bar, the Langmuir adsorption of a gas on a solid surface gave the fraction of surface coverage as 0.01. The Langmuir adsorption isotherm constant is _____ bar^{-1}. (Give the answer to the third decir (GATE CY-2013)

9) Conversion of boron trifluoride to tetrafluoroborate accompanies
   a) increase in symmetry and bond elongation
   b) increase in symmetry and bond contraction
   c) decrease in symmetry and bond contraction
   d) decrease in symmetry and bond elongation (GATE CY-2013)

10) The correct statement with respect to the bonding of the ligands, Me_3N and Me_3P with the metal ions Be^{2+} and Pd^{2+} is,
   a) the ligands bind equally strong with both the metal ions as they are dicationic
   b) the ligands bind equally strong with both the metal ions as both the ligands are pyramidal
   c) the binding is stronger for Me_3N with Be^{2+} and Me_3P with Pd^{2+}
   d) the binding is stronger for Me_3N with Pd^{2+} and Me_3P with Be^{2+} (GATE CY-2013)

11) A crystal has the lattice parameters a ≠ b ≠ c and $\alpha = \beta = \gamma = 90°$. The crystal system is
   a) tetragonal
   b) monoclinic
   c) cubic
   d) orthorhombic

(*GATECY* – 2013)

12) The by-product formed in the characteristic reaction of $(CO)_5Cr{=}C(OMe)(Me)$ with $MeNH_2$ is
   a) CO
   b) MeOH
   c) MeCHO
   d) $MeCONH_2$

(*GATECY* – 2013)

13) The catalyst and co-catalyst used in the Wacker process, respectively, are
   a) $PdCl_2$ and Cu
   b) $CuCl_2$ and $[PdCl_4]^{2-}$
   c) Pd and CuCl
$PdCl_4^{2-}$ and $CuCl_2$

(*GATECY* – 2013)

14) Oxymyoglobin $Mb(O_2)$ and oxyhemoglobin $Hb(O_2)_4$, respectively, are
   a) paramagnetic and paramagnetic
   b) diamagnetic and diamagnetic
   c) paramagnetic and diamagnetic
   d) diamagnetic and paramagnetic

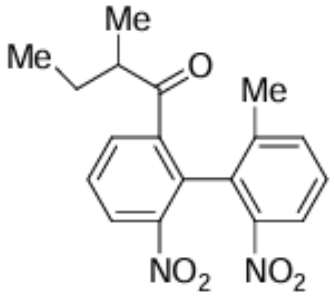
(*GATECY* – 2013)

15) Hapticity of cycloheptatriene in $Mo(C_7H_8)(CO)_3$ is _____. (*GATECY* – 2013)

16) The number of oxygen molecule(*s*) that a molecule of hemerythrin can transport is _____.

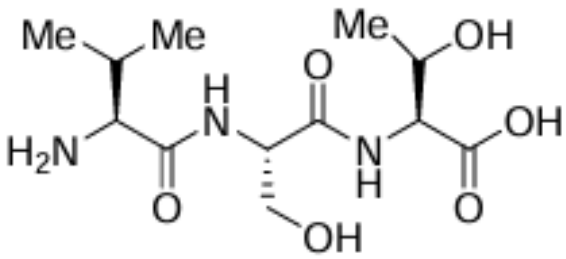
(*GATECY* – 2013)

17) The maximum number of stereoisomers possible for the compound given below is _ _ _ _ _ _.



(*GATECY* – 2013)

18) The correct sequence of the amino acids present in the tripeptide given below is



a) Val-Ser-Thr
b) Val-Thr-Ser
c) Leu-Ser-Thr
d) Leu-Thr-Ser

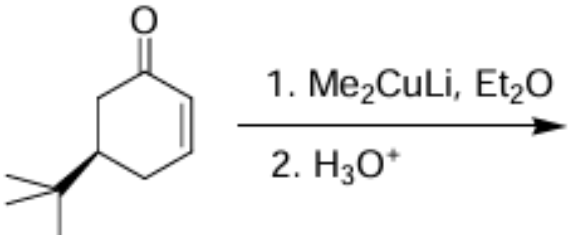
(*GATECY* – 2013)

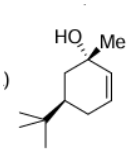
19) Among the compounds given in the options A-D, the one that can be used as a formyl anion equivalent (in the presence of a strong base) is

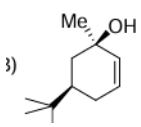
a) ethylene
b) nitroethane
c) 1,3-dithiane
d) 1,4-dithiane

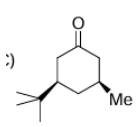
(*GATECY* – 2013)

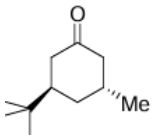
20) The major product formed in the reaction given below is



a) 

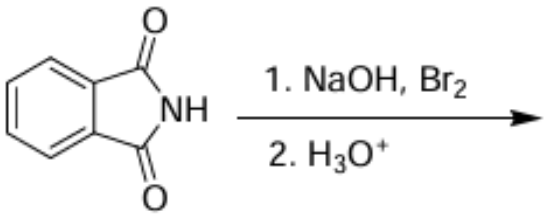
b) 

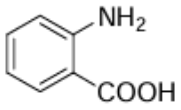
c) 

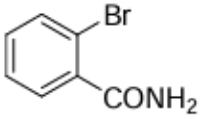
d) 

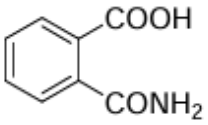
(*GATECY* – 2013)

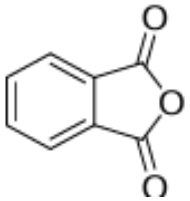
21) The major product formed in the reaction given below is



a) 

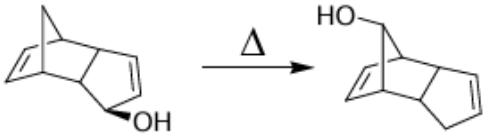
b) 

c) 

d) 

(GATE CY-2013)

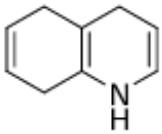
22) The pericyclic reaction given below is an example of

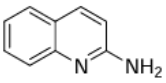


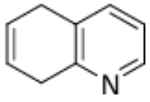
1,3 -sigmatropic shift
1,5 -sigmatropic shift
3,5 -sigmatropic shift
3,3 -sigmatropic shift

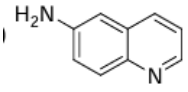
(GATE CY-2013)

23) The major product formed in the reaction of quinoline with potassium amide (KNH_2) in liquid ammonia is

a) 

b) 

c) 

d) 

(GATE CY-2013)

24) The number of signals that appear in the proton decoupled ^{13}C NMR spectrum of benzonitrile (C_7H_5N) is _____. (GATE CY-2013)

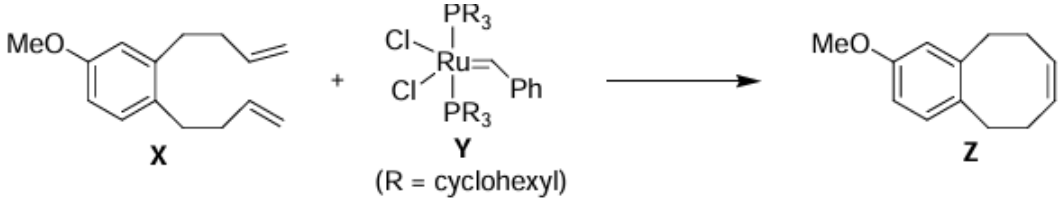
25) Among the compounds given in the options A-D, the one that exhibits a sharp band at around 3300 cm^{-1} in the IR spectrum is

a) 1,2-butadiene
b) 1,3-butadiene
c) 1-butyne
d) 2-butyne

(GATE CY-2013)

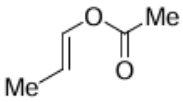
Q. 26 TO Q. 55 CARRY TWO MARKS EACH.

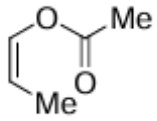
26) In the metathesis reaction given below, 4.32 g of the compound X was treated with 822 mg of the catalyst Y to yield 2.63 g of the product Z. The mol% of the catalyst used in this reaction is _____. [Atomic weights of Ru=101; P=31; Cl=35.51].

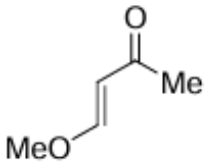


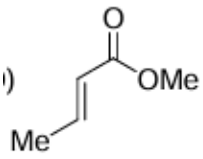
(GATE CY-2013)

27) An organic compound Q exhibited the following spectral data:
IR: 1760 cm^{-1}
^{1}H NMR: δ (ppm): 7.2 $(1H, d, J = 16.0Hz)$, 5.1 $(1H, m)$, 2.1 $(3H, s)$, 1.8 $(3H, d, J = 7.0Hz)$
^{13}C NMR: δ (ppm): 170 (carbonyl carbon).
Compound Q is

a) 

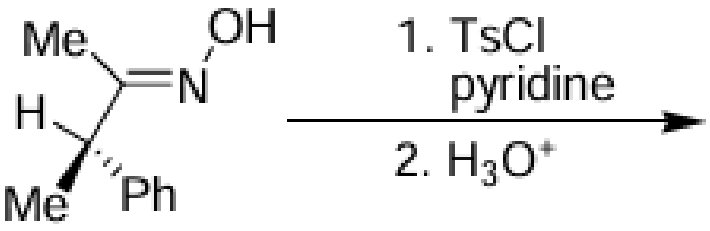
b) 

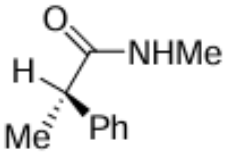
c) 

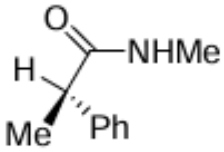
d) 

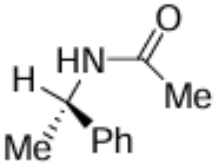
(GATE CY-2013)

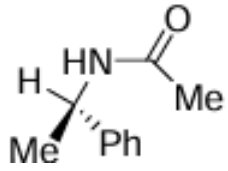
28) The major product formed in the Beckmann rearrangement of the compound given below is



a) 

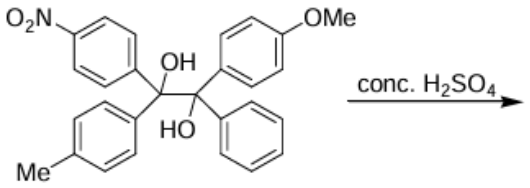
b) 

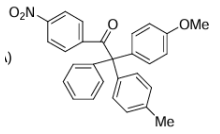
c) 

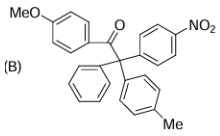
d) 

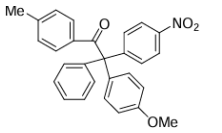
(GATE CY-2013)

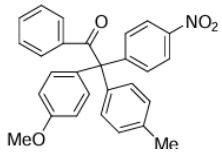
29) The major product formed in the reaction given below is



a) 

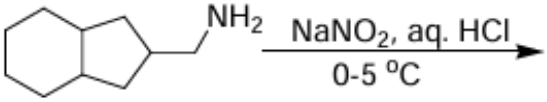
b) 

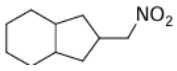
c) 

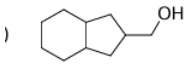
d) 

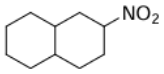
(GATE CY-2013)

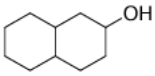
30) The major product formed in the reaction given below is



a) 

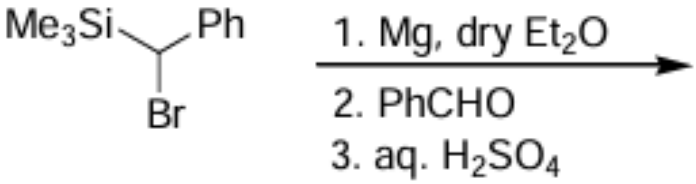
b) 

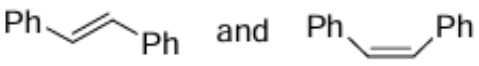
c) 

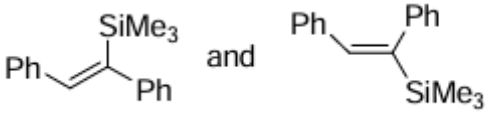
d) 

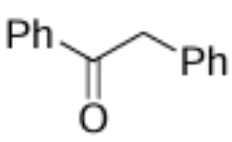
(GATE CY-2013)

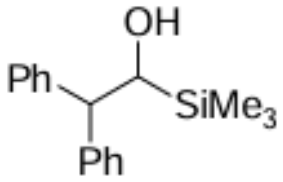
31) The major product(*s*) formed in the reaction sequence given below is(*are*)



a) 

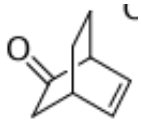
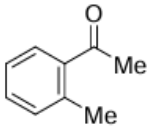
b) 

c) 

d) 

(GATE CY-2013)

32) Match the compounds in column I with the photochemical reactions that they can undergo given in column II.

Column I	**Column II**
(*i*) 	(*p*) oxa-di-π-methane rearrangement
(*ii*) 	(*q*) Paterno-Buchi reaction
(*iii*) 	(*r*) intramolecular [2+2]-cycloaddition
	(*s*) photoenolisation

a) (*i*)-(*q*); (*ii*)-(*s*); (*iii*)-(*p*)
b) (*i*)-(*r*); (*ii*)-(*p*); (*iii*)-(*s*)
c) (*i*)-(*p*); (*ii*)-(*r*); (*iii*)-(*q*)
d) (*i*)-(*r*); (*ii*)-(*s*); (*iii*)-(*p*)

(GATE CY-2013)

33) e^{-2x^2} is an eigen function of the operator $\left(\frac{d^2}{dx^2} - 16x^2\right)$. The corresponding eigen value is

a) +4 b) -4 c) +2 d) -2

(GATE CY-2013)

34) The infrared spectrum of HCl gas shows an absorption band centered at 2885 cm^{-1}. The zero point energy of HCl molecule under harmonic oscillator approximation is

a) 2.8665×10^{-22} J
b) 2.8665×10^{-20} J
c) 5.7330×10^{-22} J
d) 5.7330×10^{-20} J

(GATE CY-2013)

35) For the reaction $X_2O_4(l) \longrightarrow 2\,XO_2(g)$ at 298 K, given the values, ΔU = 9 kJ and ΔS = 84 J K^{-1}, ΔG is

a) -11.08 kJ
b) +11.08 kJ
c) -13.55 kJ
d) +13.55 kJ

(GATE CY-2013)

36) The change in enthalpy when 3 mol of liquid benzene transforms to the vapor state at its boiling temperature (80°C) and at 1 bar pressure is _____ kJ. (GATE CY-2013)

37) The moment of inertia of a homonuclear diatomic molecule is 7.5×10^{-45} kg m^2. Its rotational partition function at 500 K is _____. (GATE CY-2013)

38) For a reaction of the type $X \underset{k_2}{\overset{k_1}{\rightleftharpoons}} Y$, the correct rate expression is ($[X]_0 and [X] correspond to the concentrations of X a$

a) $-\frac{d[X]}{dt} = k_1[X]_0 - (k_1 + k_2)[X]$
b) $-\frac{d[X]}{dt} = (k_1 + k_2)[X] - k_2[X]_0$
c) $-\frac{d[X]}{dt} = (k_1 + k_2)[X]_0 - k_1[X]$
d) $-\frac{d[X]}{dt} = (k_1 - k_2)[X] - k_1[X]_0$

(GATE CY-2013)

39) The temperature dependence of partition functions are as follows:

$$q_{\text{translation}} \propto T^{3/2}$$
$$q_{\text{rotation}} \propto T \ (linear molecule)$$
$$q_{\text{rotation}} \propto T^{3/2} \ (non - linear molecule)$$
$$q_{\text{vibration}} \propto T^0$$

According to the conventional transition state theory ($CTST$), the temperature dependence of the Arrhenius pre-exponential factor for a reaction of the type given below is
linear molecule + linear molecule → non-linear transition state → products

a) T^{-1} b) T^0 c) T^1 d) T^2

(GATE CY-2013)

40) Decarbonylation reaction of [cis-$(CH_3CO)Mn\left(^{13}CO\right)(CO)_4$] yields X, Y and Z, where X = [$(CH3)Mn(CO)_5$]; Y = [cis-$(CH_3)Mn\left(^{13}CO\right)(CO)_4$]; Z = [trans-$(CH_3)Mn\left(^{13}CO\right)(CO)_4$]. The molar ratio of the products ($X : Y : Z$) in this reaction is

a) 1:1:1 b) 1:2:1 c) 1:1:2 d) 2:1:1

(GATE CY-2013)

41) According to polyhedral electron count rule, the structure of $Rh_6(CO)_{16}$ is

a) closo b) nido c) arachno d) hypho

(GATE CY-2013)

42) The increasing order of melting points of the halides NaCl, CuCl and NaF is
a) CuCl ¡ NaCl ¡ NaF
b) NaF ¡ NaCl ¡ CuCl
c) NaF ¡ CuCl ¡ NaCl
d) CuCl ¡ NaF ¡ NaCl

(GATE CY-2013)

43) The correct electronic configuration and spin only magnetic moment of Gd^{3+} (at. no. 64) are
Xe $4f^7$ and 7.9 BM
Xe $4f^7$ and 8.9 BM
Xe $4f^6 5d^1$ and 7.9 BM
Rn $5f^7$ and 7.9 BM

(GATE CY-2013)

44) Among the following octahedral complexes, the one that has the highest enthalpy of hydration is
a) $[Ca(H2O)_6]^{2+}$
b) $[Mn(H2O)_6]^{2+}$
c) $[V(H2O)_6]^{2+}$
d) $[Cr(H2O)_6]^{2+}$

(GATE CY-2013)

45) A metal crystallizes in face-centered cubic lattice with a lattice parameter of 4.20 Å. The shortest atom to atom contact distance in the lattice is

a) 4.20 Å
b) 2.97 Å
c) 2.42 Å
d) 2.10 Å

(GATE CY-2013)

46) Polarographic method of analysis to obtain individual amounts of Cu^{2+} and Cd^{2+} in a given mixture of the two ions $\left(Cu^{2+} and Cd^{2+}\right)$ is achieved by measuring their
a) half-wave potentials
b) migration currents
c) decomposition potentials
d) diffusion currents

(GATE CY-2013)

47) The ground state term of $[Ni(H2O)_6]^{2+}$ is

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

(GATE CY-2013)

Common Data Questions

Common Data for Questions 48 and 49:

N,N-Dimethylformamide (*DMF*) gives different patterns of signals for the methyl protons when its ^{1}H NMR spectrum is recorded at different temperatures.

48) Match the patterns of the NMR signals given in column I with temperatures given in the column II.

I	**II**
(*i*) Two singlets, for three protons each, at δ 2.87 and 2.97 ppm	(*x*) 25°C
(*ii*) One sharp singlet for six protons at δ 2.92 ppm	(*y*) 120°C
(*iii*) One broad signal for six protons	(*z*) 150°C

a) (*i*)-(*x*); (*ii*)-(*y*); (*iii*)-(*z*)
b) (*i*)-(*x*); (*ii*)-(*z*); (*iii*)-(*y*)
c) (*i*)-(*z*); (*ii*)-(*x*); (*iii*)-(*y*)
d) (*i*)-(*z*); (*ii*)-(*y*); (*iii*)-(*x*)

(GATE CY-2013)

49) Based on the above data, the calculated difference in the frequencies of the two methyl singlets, if the spectrum is recorded on a 300 MHz spectrometer, is _____ Hz. (GATE CY-2013)

Common Data for Questions 50 and 51:

Heating a mixture of ammonium chloride and sodium tetrahydridoborate gives one liquid product(*X*), along with other products, under ambient conditions.

50) Compound X is
a) $NH_4[BH_4]$

b) $[(NH3)_2BH_2][BH_4]$
c) $N_3B_3H_6$
d) $N_3B_3H_{12}$

(GATE CY-2013)

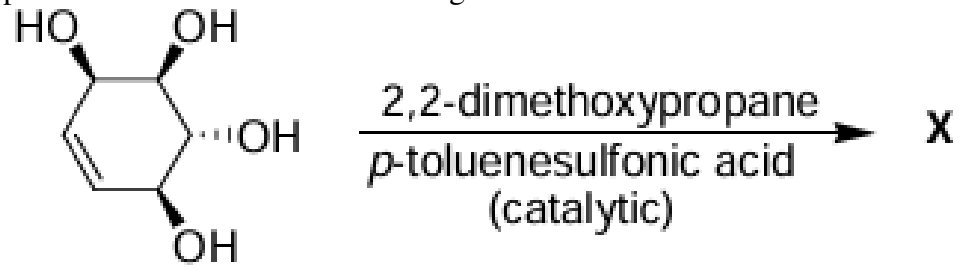
51) Compound X is an example of
a) ionic liquid
b) saturated heterocycle
c) molecular cage
d) unsaturated heterocycle

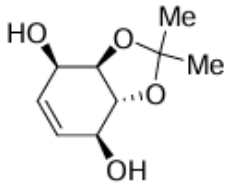
(GATE CY-2013)

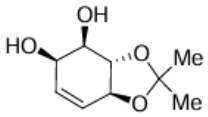
Linked Answer Questions

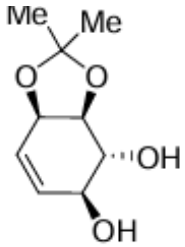
Statement for Linked Answer Questions 52 and 53:

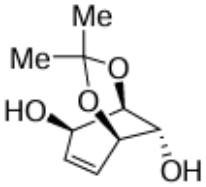
52) The major product X formed in the reaction given below is



a)


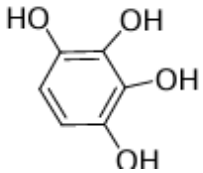
b)


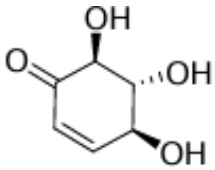
c)


d)


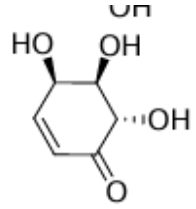
(GATE CY-2013)

53) Oxidation of the product X, obtained in the above reaction, with active manganese dioxide, followed by acidic hydrolysis gives

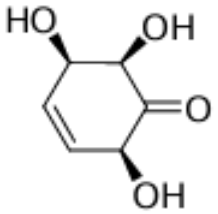
a)


b)


c)



d)



(GATE CY-2013)

Statement for Linked Answer Questions 54 and 55:

The standard half-cell reduction potential of $Fe^{3+}(aq)\,|\,Fe$ is -0.036 V and that of $OH^{-}(aq)\,|\,Fe\,(OH)_3(s)\,|\,Fe$ is -0.786 V.

54) For the determination of solubility product $\left(K_{sp}\right)$ of $Fe\,(OH)_3$, the appropriate cell representation and its emf are, respectively,

a) $Fe\,|\,Fe\,(OH)_3(s)\,|\,OH^{-}(aq)\,||\,Fe^{3+}(aq)\,|\,Fe,\ -0.750\ V$
b) $Fe\,|\,Fe^{3+}(aq)\,||\,OH^{-}(aq)\,|\,Fe\,(OH)_3(s)\,|\,Fe,\ -0.750\ V$
c) $Fe\,|\,Fe\,(OH)_3(s)\,|\,OH^{-}(aq)\,||\,Fe^{3+}(aq)\,|\,Fe,\ +0.750\ V$
d) $Fe\,|\,Fe^{3+}(aq)\,||\,OH^{-}(aq)\,|\,Fe\,(OH)_3(s)\,|\,Fe,\ -0.822\ V$

(GATE CY-2013)

55) The value of $\ln\left(K_{sp}\right)$ for $Fe\,(OH)_3$ at 298 K is

a) -38.2 b) +87.6 c) -96.0 d) -87.6

(GATE CY-2013)

Q. 56 – Q. 60 carry one mark each.

56) If $3 \le X \le 5$ and $8 \le Y \le 11$ then which of the following options is TRUE?

a) $\frac{3}{5} \le \frac{X}{Y} \le \frac{8}{5}$
b) $\frac{3}{11} \le \frac{X}{Y} \le \frac{5}{8}$
c) $\frac{3}{11} \le \frac{X}{Y} \le \frac{8}{5}$
d) $\frac{3}{5} \le \frac{X}{Y} \le \frac{8}{11}$

(GATE CY-2013)

57) The Headmaster _____ to speak to you.

Which of the following options is incorrect to complete the above sentence?

a) is wanting
b) wants
c) want
d) was wanting

(GATE CY-2013)

58) Mahatama Gandhi was known for his humility as

a) he played an important role in humiliating exit of British from India.
b) he worked for humanitarian causes.
c) he displayed modesty in his interactions.
d) he was a fine human being.

(GATE CY-2013)

59) All engineering students should learn <u>mechanics</u>, <u>mathematics</u> and <u>how to do computation</u>.
I II III IV

Which of the above underlined parts of the sentence is not appropriate?

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

(GATE CY-2013)

60) Select the pair that best expresses a relationship similar to that expressed in the pair:
water: pipe::
a) cart: road
b) electricity: wire
c) sea: beach
d) music: instrument

(GATE CY-2013)

Q.61 to Q.65 carry two marks each

61) Velocity of an object fired directly in upward direction is given by $v = 80 - 32t$, where t (*time*) is in seconds. When will the velocity be between 32 m/s and 64 m/s?
a) $(1, 3/2)$
b) $(1/2, 1)$
c) $(1/2, 3/2)$
d) $(1, 3)$

(*GATECY* – 2013)

62) In a factory, two machines M_1 and M_2 manufacture 60% and 40% of the auto-components respectively. Out of the total production, 2% of M_1 and 3% of M_2 are found to be defective. If a randomly drawn auto-component from the combined lot is found defective, what is the probability that it was manufactured by M_2?
a) 0.35
b) 0.45
c) 0.5
d) 0.4

(*GATECY* – 2013)

63) Following table gives data on tourists from different countries visiting India in the year 2011.

Country	Number of Tourists
USA	2000
England	3500
Germany	1200
Italy	1100
Japan	2400
Australia	2300
France	1000

Which two countries contributed to one third of the total number of tourists who visited India in 2011?
a) USA and Japan
b) USA and Australia
c) England and France
d) Japan and Australia

(*GATECY* – 2013)

64) If $|-2x + 9| = 3$ then the possible value of $|-x| - x^2$ would be:
a) 30
b) -30
c) -42
d) 42

(*GATECY* – 2013)

65) All professors are researchers. Some scientists are professors. Which of the given conclusions is logically valid and inferred from the above arguments:

a) All scientists are researchers
b) All professors are scientists
c) Some researchers are scientists
d) No conclusion follows

(*GATECY* – 2013)

END OF THE QUESTION PAPER