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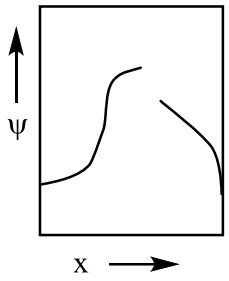
GATE – 2015 – CY

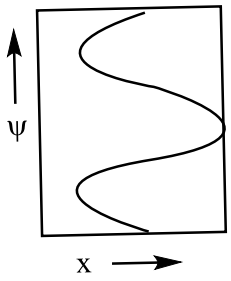
Q.1 – Q.25 Multiple Choice Question (MCQ) & NAT, carry ONE mark each (for each wrong answer: – 1/3). (No Negative Marks for NAT)**

1. Which one of the following plots represents an acceptable wavefunction?

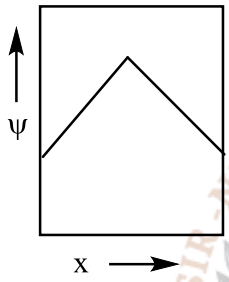
(a)



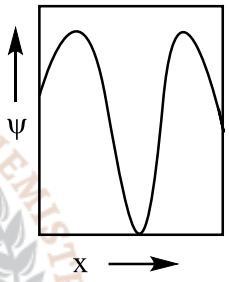
(b)



(c)



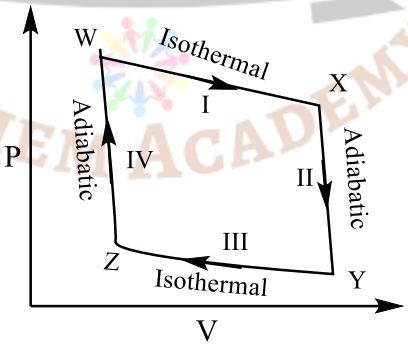
(d)



2. When the operator, $-\hbar^2 d^2/dx^2$, operates on the function e^{-ikx}, the result is

(a) $k^2\hbar^2 e^{-ikx}$ (b) $ik^2\hbar^2 e^{-ikx}$ (c) $i\hbar^2 e^{-ikx}$ (d) $\hbar^2 e^{-ikx}$

3. From the given Carnot cycle undergone by an ideal gas, identify the processes in which the change in internal energy is NON-ZERO.



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

4. For an ideal gas with molar mass-M, the molar translational entropy at a given temperature is proportional to

(a) $M^{3/2}$ (b) $M^{1/2}$ (c) e^M (d) ln(M)

5. Which one of the following defines the absolute temperature of a system?

(a) $\left(\frac{\partial U}{\partial S}\right)_V$ (b) $\left(\frac{\partial A}{\partial S}\right)_V$ (c) $\left(\frac{\partial H}{\partial S}\right)_V$ (d) $\left(\frac{\partial G}{\partial S}\right)_V$

6. Which of the following properties are characteristics of an ideal solution?

(i) $(\Delta_{mix}G)_{T,P}$ **is negative** **(ii)** $(\Delta_{mix}S)_{T,P}$ **is postiive**

(iii) $(\Delta_{mix}V)_{T,P}$ **is positive** **(iv)** $(\Delta_{mix}H)_{T,P}$ **is negative**

(a) (i) and (iv) (b) (i) and (ii) (c) (i) and (iii) (d) (iii) and (iv)

7. The expression for the equilibrium constant (K_{eq}) for the enzyme catalyzed reaction given below, is

$$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} ES \underset{k_4}{\overset{k_3}{\rightleftharpoons}} P + E$$

(a) $\frac{k_1k_3}{k_2k_4}$ (b) $\frac{k_1k_2}{k_3k_4}$ (c) $\frac{k_2k_3}{k_1k_4}$ (d) $\frac{k_1k_4}{k_2k_3}$

8. Given the E^0 values for the following reaction sequence,

$$Mn^{6+} \xrightarrow{1.28\ V} Mn^{5+} \xrightarrow{2.9\ V} Mn^{4+} \xrightarrow{0.96\ V} Mn^{3+} \xrightarrow{1.5\ V} Mn^{2+}$$

the computed value of E^0 for $Mn^{6+} \longrightarrow Mn^{2+}$ (in volts) is _____

9. The absorption spectrum of $[Ti(H_2O)_6]^{3+}$ in solution comprises of a maximum with a shoulder. The reason for the shoulder is

(a) ligand-to-metal charge transfer (b) metal-to-ligand charge transfer

(c) Jahn-Teller distortion (d) nephelauxetic effect

10. The ease of formation of the adduct, $NH_3.BX_3$ (where $X = F, Cl, Br$) follows the order

(a) $BBr_3 < BCl_3 < BF_3$ (b) $BCl_3 < BF_3 < BBr_3$

(c) $BF_3 < BCl_3 < BBr_3$ (d) $BBr_3 < BF_3 < BCl_3$

11. An efficient catalyst for hydrogenation of alkenes is $[Rh(PPh_3)_3Cl]$. However, $[Ir(PPh_3)_3Cl]$ does not catalyze this reaction, because

(a) PPh_3 binds stronger to Ir than to Rh (b) Cl binds stronger to Ir than to Rh

(c) PPh_3 binds stronger to Rh than to Ir (d) Cl binds stronger to Rh than to Ir

12. Among the given pH values, the O_2 binding efficiency of hemoglobin is maximum at

(a) 6.8 (b) 7.0 (c) 7.2 (d) 7.4

13. The intense red color of $[Fe(bpy)_3]^{2+}$, (bpy = 2,2'-bipyridine) is due to

(a) metal-to-ligand charge transfer (MLCT) (b) ligand-to-metal charge transfer (LMCT)

(c) d-d transition (d) inter-valence charge transfer (IVCT)

14. The compound with planar geometry is

(a) $N(t\text{-}Bu)_3$ (b) NPh_3 (c) NF_3 (d) $N(SiH_3)_3$

15. **The electrical conductivity of a metal**

(a) increases with increasing temperature

(b) decreases with increasing temperature

(c) is independent of temperature

(d) shows oscillatory behaviour with temperature

16. **Which one of the following statements is INCORRECT?**

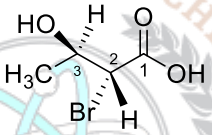
(a) Frenkel defect is a cation vacancy and a cation interstitial

(b) Frenkel defect is an anion vacancy and a cation interstitial

(c) Density of a solid remains unchanged in case of Frenkel defects

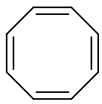
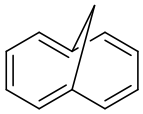
(d) Density of a solid decreases in case of Schottky defects

17. **The absolute configuration of C2 and C3 in the following compound is**



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

18. **Among the following compounds, the one that is non-aromatic, is**

(a)  (b)  (c)  (d) 

19. **The correct order of reactivity of p-halonitrobenzenes in the following reaction is,**

(X = F, Cl, Br, I)

p-fluoronitrobenzene **I**

p -chloronitrobenzene **II**

p -bromonitrobenzene **III**

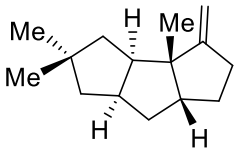
p -iodonitrobenzene **IV**

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

20. **Tollen's test is NEGATIVE for**

(a) mannose (b) maltose (c) glucose (d) sucrose

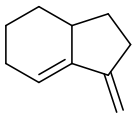
21. **The compound given below is a**

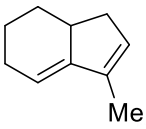


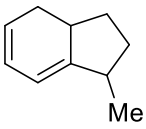
Hirsutene

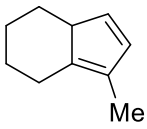
(a) sesterterpene (b) monoterpene (c) sesquiterpene (d) triterpene

22. Amongst the following the compound that DOES NOT act as a diene in Diels-Alder reaction is

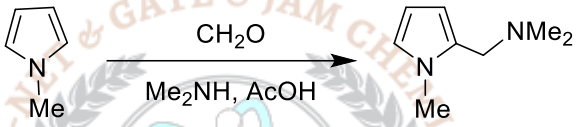
(a) 

(b) 

(c) 

(d) 

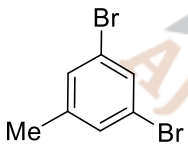
23. The following conversion is an example of

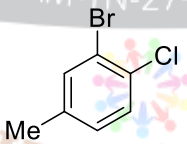


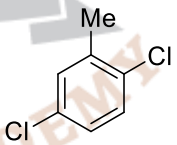
(a) Arndt-Eistert homologation (b) Mannich reaction

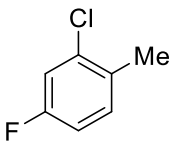
(c) Michael addition (d) Chichibabin amination reaction

24. The mass spectrum of a dihalo-compound shows peaks with relative intensities of 1 : 2 : 1 corresponding to M, M + 2 and M + 4 (M is the mass of the molecular ion), respectively. The compound is

(a) 

(b) 

(c) 

(d) 

25. Reaction of *benzaldehyde* and *p-methylbenzaldehyde* under McMurry coupling conditions ($TiCl_3$ and $LiAlH_4$) gives a mixture of alkenes. The number of alkenes formed is _____

Q.26 – Q.55 MCQ & NAT, carry TWO marks each (for each wrong answer: – 2/3). (No Negative Marks for NAT)**

26. The difference in the ground state energies (kJ/mol) of an electron in one-dimensional boxes of lengths 0.2 nm and 2 nm is _____

27. The mean ionic activity coefficient of 0.001 molal $ZnSO_{4(aq)}$ at 298 K according to the Debye-Huckel limiting law is _____

(Debye-Huckel constant is 0.509 $molal^{-1/2}$)

28. The process given below follows the Langmuir adsorption isotherm

$$A_{2(g)} \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2A_{ads}$$

If θ denotes the surface coverage and P denotes the pressure, the slope of the plot of $1/\theta$ versus $1/\sqrt{P}$ is

(a) $1/(K_{eq})^2$ (b) $1/K_{eq}$ (c) $-1/K_{eq}$ (d) $1/(K_{eq})^{1/2}$

29. For a gas phase unimolecular reaction at temperature 298 K, with a pre-exponential factor of $2.17 \times 10^{13}\ s^{-1}$, the entropy of activation ($JK^{-1}mol^{-1}$) is ___

30. A liquid has vapor pressure of $2.02 \times 10^3\ Nm^{-2}$ at 293 K and heat of vaporization of 41 KJ mol^{-1}. The boiling point of the liquid (in Kelvin) is _____

31. The rotational partition function of a diatomic molecule with energy levels corresponding to $J = 0$ and 1, is (where, ε is a constant)

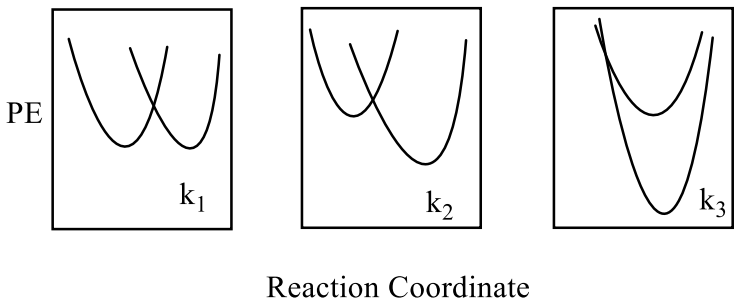
(a) $1 + e^{-2\varepsilon}$ (b) $1 + 3e^{-2\varepsilon}$ (c) $1 + e^{-3\varepsilon}$ (d) $1 + 3e^{-3\varepsilon}$

32. The internal energy of an ideal gas follows the equation $U = 3.5\ PV + k$, where k is a constant. The gas expands from an initial volume of $0.25\ m^3$ to a final volume of $0.86\ m^3$. If the initial pressure is $5\ Nm^{-2}$, the change in internal energy (in joules) is (given $PV^{1.3} = constant$) _____

33. The solubility product of $AgBr_{(s)}$ is 5×10^{-13} at 298 K. If the standard reduction potential of the half-cell, $E^0_{Ag|AgBr_{(s)}|Br^-}$ is 0.07 V, the standard reduction potential, $E^0_{Ag^+|Ag}$(in volts) is _____

34. One mole of a substance is heated from 300 K to 400 K at constant pressure. The C_P of the substance is given by, $C_P(J\ K^{-1}\ mol^{-1}) = 5 + 0.1\ T$. The change in entropy, in $J\ K^{-1}\ mol^{-1}$, of the substance is _____

35. The potential energy (PE) versus reaction coordinate diagrams for electron transfer reactions with rate constants k_1, k_2 and k_3, are given below. The inreasing order of the rate constants is



(a) $k_2 < k_3 < k_1$ (b) $k_2 < k_1 < k_3$

(c) $k_3 < k_2 < k_1$ (d) $k_3 < k_1 < k_2$

36. **The distance between two successive (110) planes in a simple cubic lattice with lattice parameter 'a' is**

(a) $\sqrt{2}\,a$ (b) $\sqrt{3}\,a$ (c) $2\sqrt{2}\,a$ (d) $\frac{a}{\sqrt{2}}$

37. **The percent transmittance of 8×10^{-5} M solution of $KMnO_4$ is 39.8 when measured at 510 nm in a cell of path length of 1 cm. The absorbance and the molar extinction coefficient (in $M^{-1}cm^{-1}$) of this solution are, respectively**

(a) 0.30 and 4500 (b) 0.35 and 4800 (c) 0.4 and 5000 (d) 0.48 and 5200

38. **The value of 'g' and the number of signals observed for the reference standard, diphenylpicrylhydrazyl (DPPH), in the solid state ESR spectrum are, respectively**

(a) 2.0036 and 1 (b) 2.0036 and 3 (c) 2.2416 and 1 (d) 2.2416 and 3

39. **Ammonolysis of S_2Cl_2 in an inert solvent gives**

(a) S_2N_2 (b) $S_2N_2Cl_2$ (c) $S_2N_2H_4$ (d) S_4N_4

40. **The complexes $K_2[NiF_6]$ and $K_3[CoF_6]$ are**

(a) both paramagnetic (b) both diamagnetic

(c) paramagnetic and diamagnetic (d) diamagnetic and paramagnetic

41. **The point group of IF_7 is**

(a) D_{6h} (b) D_{5h} (c) C_{6V} (d) C_{5V}

42. **When one CO group is replaced by PPh_3 in $[Cr(CO)_6]$, which one of the following statement is TRUE?**

(a) The Cr-C bond length increases and CO bond length decreases

(b) The Cr-C bond length decreases and CO bond length decreases

(c) The Cr-C bond length decreases and CO bond length increases

(d) The Cr-C bond length increases and CO bond length increases

43. **Identify X in the reaction, $[Pt(NH_3)_4]^{2+} + 2HCl \longrightarrow X$**

(a) cis -$[PtCl_2(NH_3)_2]$ (b) trans-$[PtCl_2(NH_3)_2]$

(c) $[PtCl(NH_3)_3]^+$ (d) $[PtCl_3(NH_3)_3]^-$

44. **Identify the function of hemocyanin and the metal responsible for it**

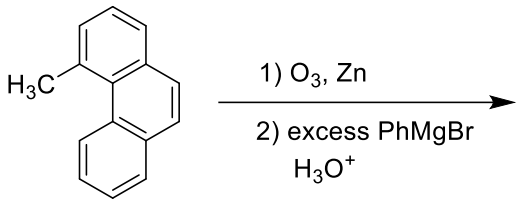
(a) O_2 transport and Fe (b) O_2 transport and Cu

(c) electron transport and Fe (d) electron transport and Cu

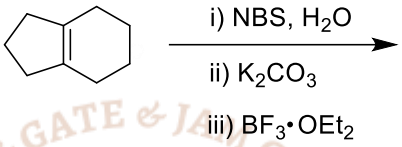
45. **The limiting current (in μA) from the reduction of 3×10^{-4} M Pb^{2+}, using a**

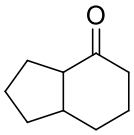
dropping mercury electrode (DMF) with characteristics, $m = 3.0\ mg\ s^{-1}$ and $t = 3s$, is _____ (diffusion coefficient of $Pb^{2+} = 1.2 \times 10^{-5}\ cm^2\ s^{-1}$)

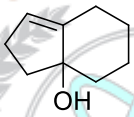
46. The number of possible stereoisomers obtained in the following reaction is _____

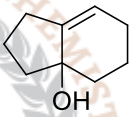


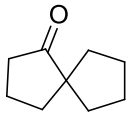
47. The major product formed in the following reaction is



(a) 

(b) 

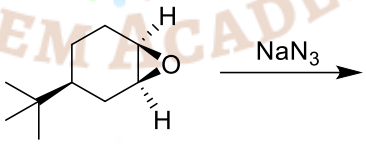
(c) 

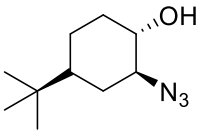
(d) 

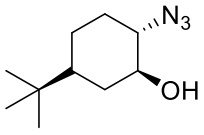
48. The most suitable reagent(s) to effect the following transformed is

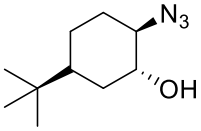
(a) N_2H_4, KOH, heat (b) $TsNHNH_2$, CF_3COOH (c) $LiAlH_4$ (d) Na, liq. NH_3

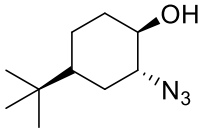
49. The major product formed in the following reaction is



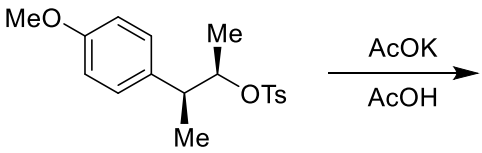
(a) 

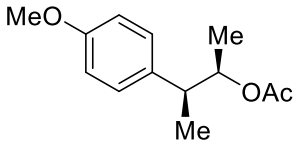
(b) 

(c) 

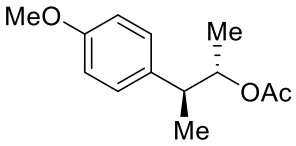
(d) 

50. Solvolysis of the given optically active compound gives, mainly

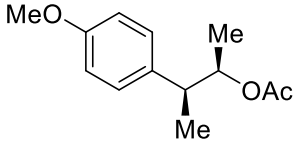


(a) 

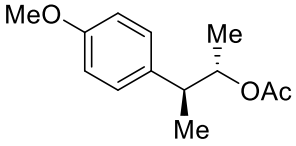
(Optically active)

(b) 

(Optically active)

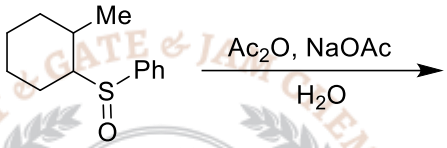
(c) 

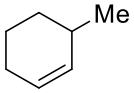
racemic
(optically inactive)

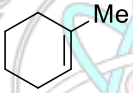
(d) 

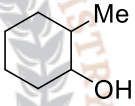
racemic
(optically inactive)

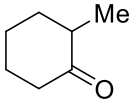
51. The major product formed in the following reaction is



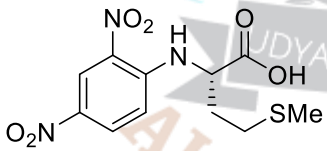
(a) 

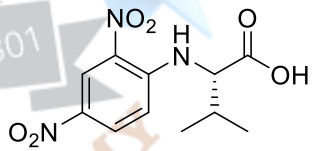
(b) 

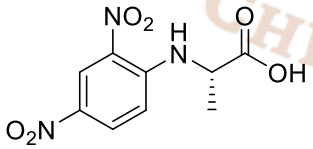
(c) 

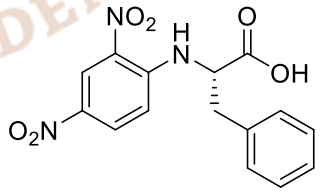
(d) 

52. The tetrapeptide, Ala-Val-Phe-Met, on reaction with Sanger's reagent, followed by hydrolysis gives

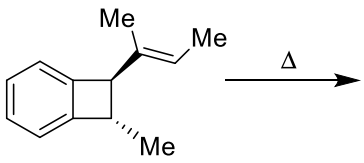
(a) 

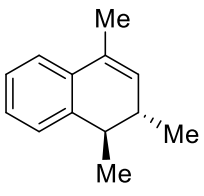
(b) 

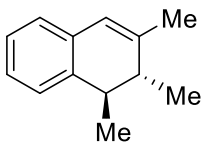
(c) 

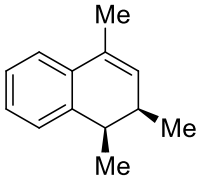
(d) 

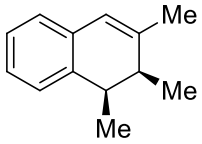
53. The major product formed in the following reaction is



(a) 

(b) 

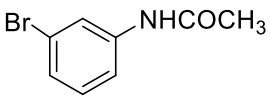
(c) 

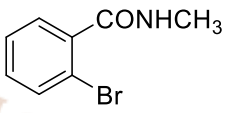
(d) 

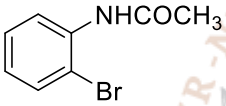
54. **The Beckmann rearrangement of a bromoacetophenone oxime (C_8H_8BrNO) gives a major product having the following**

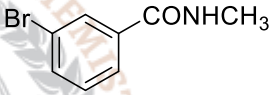
^{1}H-NMR : $9.89\ (s, 1H)$, $7.88\ (s, 1H)$, $7.45\ (d, 1H, J = 7.2\ Hz)$, $7.17\ (m, 1H)$, $7.12\ (d, 1H, J = 7.0\ Hz)$, $2.06\ (s, 3H)$

The structure of the product is

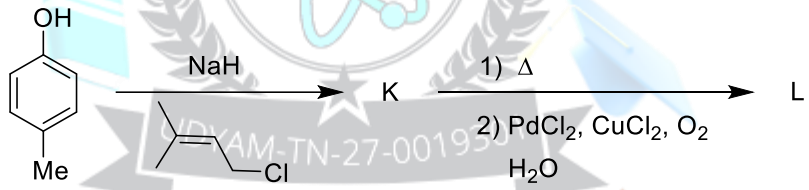
(a) 

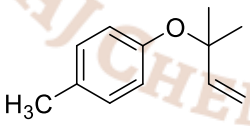
(b) 

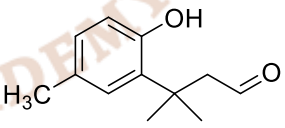
(c) 

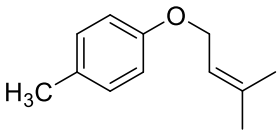
(d) 

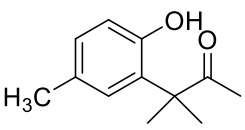
55. **The major products, K and L formed in the following reactions are**

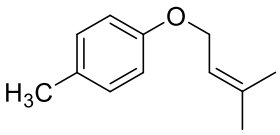


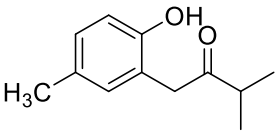
(a) K = 

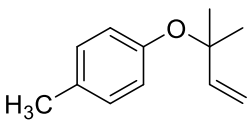
; L = 

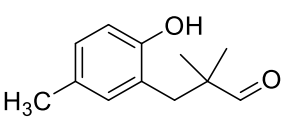
(b) K = 

; L = 

(c) K = 

; L = 

(d) K = 

; L = 

Answer Key

Q.No	Ans		Q.No	Ans		Q.No	Ans
1.	d		21.	c		41.	b
2.	a		22.	b		42.	c
3.	b		23.	b		43.	b
4.	d		24.	a		44.	b
5.	a		25.	6		45.	3.5 to 3.8
6.	b		26.	896 to 900		46.	8
7.	a		27.	0.73 to 0.75		47.	d
8.	1.6 to 1.7		28.	d		48.	a
9.	c		29.	10.2 to 10.6		49.	d
10.	c		30.	380 to 385		50.	c
11.	a		31.	b		51.	d
12.	d		32.	−1.38 to − 1.33		52.	c
13.	a		33.	0.79 to 0.82		53.	b
14.	d		34.	11.3 to 11.5		54.	a
15.	b		35.	d		55.	b
16.	b		36.	d			
17.	d		37.	c			
18.	a		38.	a			
19.	b		39.	d			
20.	d		40.	d			