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

[CpMoCl₂]₂ obeys the 18 electron rule. The correct structure of this compound is 1.

(Atomic number of Mo = 42)

1

(a)
$$(1)$$
 (1) (1) (2) (1) (2) (1) (2) (1) (2)

- (c) high for myoglobin and low for hemoglobin
- (d) low for both hemoglobin and myoglobin
- In the first row high-spin transition metal complexes $[M(H_2O)_6]Cl_2$ with d⁵ and d⁷ 5. metal ions, the d-d transitions are
 - (a) spin-forbidden for both
 - (b) spin-allowed for both
 - (c) spin-forbidden for d^5 and spin-allowed for d^7
 - (d) spin-allowed for d^5 and spin-forbidden for d^7
- Among the given boranes and heteroboranes, the example which belongs to 'closo' 6. type is
 - (a) $[B_5H_8]^-$ (b) $[C_2B_9H_{11}]^{2-}$ (c) $GeC_2B_9H_{11}$ (d) $B_6 H_{10}$
- The reaction of P_2O_5 with HNO₃ and HClO₄, respectively, gives 7.
 - (a) NO₂ and ClO₂ (b) N₂O₅ and Cl₂O₆ (c) N₂O₃ and Cl₂O₇ (d) N₂O₅ and Cl₂O₇



2.

3.

4.

(a)

(c)

(a)

At

(a)

(b)

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- 8. When crystals of sodium chloride are heated in the presence of sodium vapor, they turn yellow. This is due to the formation of
- (a) Schottky defects
 (b) Frenkel defects
 (c) F-centres
 (d) H-centres

 9. One mole of an ideal gas is compressed from 5L to 2L at constant temperature. The
- change in entropy, in JK⁻¹, of the gas is _____. (R = 8.314 J K⁻¹ mol⁻¹)
- 10. The linear momentum of a particle described by the wavefunction e^{-ikx} is(a) kh(b) -kh(c) kħ(d) -kħ
- 11. For an elementary bimolecular gas phase reaction, activation energy is
 5. 5 kJ mol⁻¹. Enthalpy of activation, in kJ mol⁻¹, at 300 K is _____.

$$(R = 8.314 JK^{-1}mol^{-1})$$

2

12. The titration of a strong acid with a strong base is represented by the plot



13. Of the following inequalities, the criterion/criteria for spontaneity of a chemical reaction is/are

$$(\Delta \mathbf{G})_{\mathbf{T},\mathbf{P}} < 0 \qquad (\Delta \mathbf{U})_{\mathbf{S},\mathbf{V}} > 0 \qquad (\Delta \mathbf{S})_{\mathbf{U},\mathbf{V}} > 0$$
(i) (ii) (iii)

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

14. A protein sample consists of an equimolar mixture of ribonuclease $(molar mass = 13.7 \text{ kg mol}^{-1})$, hemoglobin $(molar mass = 15.5 \text{ kg mol}^{-1})$, and myoglobin $(molar mass = 17.2 \text{ kg mol}^{-1})$. The statement that is true about the weight-average molar mass $(\overline{M_w})$, the number-average molar mass $(\overline{M_n})$, and



the polydispersity index (PDI) for this sample is

- (a) $\overline{M_w} > \overline{M_n} = 15.5 \text{ kg mol}^{-1} \text{ and PDI} > 1$
- (b) $\overline{M_w} > \overline{M_n} = 15.5 \ \text{kg mol}^{-1}$ and PDI < 1
- (c) $\overline{M_w} = 15.5 \text{ kg mol}^{-1} > \overline{M_n} \text{ and PDI} > 1$
- (d) $\overline{M_w} = 15.5 \ \text{kg} \ \text{mol}^{-1} < \overline{M_n} \ \text{and} \ \text{PDI} < 1$

15. The band structure given below represent a



- (a) n-type semiconductor formed by doping Si with B
- (b) n-type semiconductor formed by doping Si with P
- (c) p-type semiconductor formed by doping Si with P
- (d) p-type semiconductor formed by doping Si with B
- 16. The experimental ionization energies of hydrogen and helium atoms in their ground states are, respectively, 13.6 eV and 24.6 eV. The ground state energy of helium atom, in eV, is

(a)
$$-\frac{1}{2}(13.6) - 24.6$$
 (b) $-4(13.6) - 24.6$
(c) $-\frac{1}{4}(13.6) - 24.6$ (d) $-2(13.6) - 24.6$

17. **Ring flipping** of the compound in the following conformation leads to



18. The total number of lines expected (due to spin-spin coupling of proton with fluorine and deuterium nuclei) in the ¹H-NMR spectrum of the following compound

 \square





22. The Favourable transition state leading to the formation of the product in the following reaction, is



0





5

23. The major product of the following reaction is,



24. The major product obtained in the following reaction, is

$$H-C\equiv C-CH_{2}OH \xrightarrow{(i). LiNH_{2} (2 \text{ equiv.})/ \text{ liq. NH}_{3}}_{(ii). C_{2}H_{5}Br (1\text{ equiv.})}$$
(ii). H₃O⁺
(a) CH₃CH₂-C\equiv C-CH₂OH (b) H-C\equiv C-CH₂OCH₂CH₃
(c) CH₃CH₂-C\equiv C-CH₂NH₂ (d) H-C\equiv C-CH₂NH-CH₂CH₃

25. The major product formed in the following reaction, is



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- 26. The Larmor frequency of ¹H at 1 Tesla (T) is 42.57 MHz. If the magnetogyric ratios for ¹H and ¹³C are 26.75 × 10⁷ rad $T^{-1}s^{-1}$ and 6.72 × 10⁷ rad $T^{-1}s^{-1}$, respectively, the Larmor frequency of ¹³C, in MHz, at 1 Tesla will be _____
- 27. At 1 bar and 298 K, for the process $A_{(s)} \rightarrow A_{(liq)}$, the ΔG is 200 J mol⁻¹ and the ΔV_m is -2×10^{-6} m³ mol⁻¹. The minimum pressure, in bar, at which the process becomes spontaneous at 298 K is _____. (1 bar = 10⁵ Pa)
- 28. The reaction $A \Rightarrow B$, is first order in both the directions. The forward and reverse rate constants are $4.2 \times 10^{-4} \text{ s}^{-1}$ and $1.04 \times 10^{-3} \text{ s}^{-1}$, respectively. The relaxation time for this reaction in a temperature jump experiment is _____seconds.
- 29. Adsorption of CO on charcoal at 273 K follows Langmuir isotherm. A plot of P(k Pa)/V(cm³) versus P (k Pa) is linear with a slope of 0.01 y-intercept of 0.5. The equilibrium constant, K (k Pa⁻¹), for the adsorption is _____.
- **30.** For the following reaction,

A + B
$$k_1 = 10^5 \text{ L mol}^{-1} \text{ s}^{-1}$$
 I $k_2 = 10 \text{ s}^{-1}$ P

if steady state approximation can be applied on [I], the observed rate constant of product formation, in L mol⁻¹s⁻¹, will be _____

31. The correct set of infra-red spectral bands (in cm⁻¹) for the v_{CO} stretching mode of the given carbonyl complex is



(a) 1827, 1783, 1766

(b) 1973, 1827, 1794

(d) 1960, 1918

(c) 1833, 1775, 1650

32. The ¹⁹F NMR spectrum of ClF₃ when measured at -60 °C will be observed as a

- (a) singlet (b) doublet
- (c) doublet and triplet (d) doublet of doublet and a doublet of triplet
- **33.** Among the given platinum (II) complexes, the one that is thermally the most unstable is





- (a) $Ph_3P_{H_2}$ Ph_3P $Pt_2C(CH_3)_3$ Ph_3P $CH_2C(CH_3)_3$
- (c) $Ph_3P_{\prime\prime\prime}$ Pt $CH_2CH_2CH_2CH_3$ Ph_3P $CH_2CH_2CH_2CH_3$



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34. The shapes of [XeF₅]⁺ and [XeF₅]⁻, respectively, are

- (a) pentagonal planar and square pyramidal
- (b) pentagonal planar and trigonal bipyramidal
- (c) square pyramidal and pentagonal bipyramidal
- (d) square pyramidal and pentagonal planar
- 35. Sodium salt of pseudohalogens X, Y and Z form colorless solutions in water. Solution of X decolorizes I₃⁻ solution with brisk effervescence. Solution of Y gives an intense red colour on reaction with Fe³⁺ solution. Solution of Z gives an intense blue color on reaction with a solution containing Fe³⁺ and Fe²⁺ ions. The pseudohalogens X, Y and Z respectivley are
 - (a) CN^- , N_3^- and CNS^- (b) N_3^- , CNS^- and CN^-
 - (c) N_3^- , CN^- and $CNS^ UDY_{AM-TN-27-00193}$ (d) N_3^- , CNS^- and CNO^-
- 36. On reacting 1.55 g of a diol with an excess of methylmagnesium iodide, 1.12 L (corrected to STP) of methane gas is liberated. The molecular mass (g mol⁻¹) of the diol is ______
- 37. The structure of the compound having the following characteristics spectral data, is

IR : 1690 cm^{-1} .

¹H-NMR : 1.30 (3H, t, J = 7.2 Hz); 2.41 (2H, q, J = 7.2 Hz); 2.32 (3H, s);7.44 (1H, t, J = 7.0 Hz); 7.57 (1H, dt, J = 7.0, 3.0 Hz); 7.77 (1H, t, J = 3.0 Hz); 7.90 (1H, dt, J = 7.0, 3.0 Hz)

EI mass : m/z 119 (100 %); 57 (80 %)



0

8



38. The major products **X** and **Y** formed in the following formed in the following synthetic scheme, are



39. The major products **S** and **T** formed in the following synthetic scheme, are





40. Among the following, the transformation(s) that can be accomplished using umpolung concept is(are)



41. A disaccharide does NOT give a positive test for Tollen's reagent. Upon acidic hydrolysis, it gives an equimolar mixture of two different monosaccharides, both of which can be oxidized by bromine water. This disaccharide is



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42. The major products M and N in the following reaction sequence are



45. The following synthetic transformation can be achieved using

9

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(r)	(i)NH ₂ OH	/H+, (ii)	NaOH
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(a) p only	(b) p and q	(c) q and r	(d) r only

- 46. Consider a two-state system at thermal equilibrium with equal degeneracy where the excited state is higher in energy than the ground state by 0.1 eV. The ratio of the population of the excited state to that of the ground state, at a temperature for which $K_B T = 0.05 \text{ eV}$, is ΔT
- 47. Of the vibrational modes given below, the IR active mode(s) is(are)



48. A system is described by the following real wavefunction.



The probability (P) of finding the particle in a region dx around points I, II and III in the figure obeys the trend

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

49. The temperature-composition (T-x) phase diagram of the two-component system



made of X and Y is given below. At a temperature of 288 K and starting at the point P, Y is added until the composition reaches S. Which of the following statements is NOT TRUE?



- (a) At P, the solid and liquid are present in almost equal proportions
- (b) At Q, the system is all liquid
- (c) At S, the system has more solid than liquid
- (d) At R, the liquid is pure X
- 50. For a system subjected to only P-V work, entropy is given by

$$-\left(\frac{\partial G}{\partial T}\right)_{P} \qquad -\left(\frac{\partial G}{\partial P}\right)_{T} \qquad -\left(\frac{\partial A}{\partial V}\right)_{T} \qquad -\left(\frac{\partial A}{\partial T}\right)_{V}$$
(I)
(a) I and II
(b) I and IV
(c) I only
(d) II only

- 51. According to Irving-Williams series, the number of d-electrons for the first row transition metal (M) ion having the highest overall stability constant (log β) for $[M(EDTA)]^{2-}$ is _____
- 52. The magnitude of the difference in the crystal field stabilization energies, in Δ_0 (ignoring pairing energy), of $[Fe(H_2O_6)^{2+}$ and $[Fe(CN_6)^{4-}$ is _____
- 53. The calculated and observed magnetic moments differ considerably for an aqua complex of a Lanthanide (III) ion as a result of low-lying states of high J. The ion, among the following, is

(a)
$$Ce^{3+}$$
 (b) Pr^{3+} (c) Eu^{3+} (d) Yb^{3+}

- 54. In the electronic spectra of $[CrF_6]^{3-}$, absorption bands observed at 670, 440 and 290 nm are, respectively, due to the transitions,
 - ${}^{4}A_{2g} \rightarrow {}^{4}T_{1g}(P) \quad , \quad {}^{4}A_{2g} \rightarrow {}^{4}T_{1g}(F) \quad \text{ and } \quad {}^{4}A_{2g} \rightarrow {}^{4}T_{2g}$ (a)





- (b) ${}^{4}A_{2g} \rightarrow {}^{4}T_{1g}(P)$, ${}^{4}A_{2g} \rightarrow {}^{4}T_{2g}$ and ${}^{4}A_{2g} \rightarrow {}^{4}T_{1g}(F)$
- (c) ${}^{4}A_{2g} \rightarrow {}^{4}T_{1g}(F)$, ${}^{4}A_{2g} \rightarrow {}^{4}T_{1g}(P)$ and ${}^{4}A_{2g} \rightarrow {}^{4}T_{2g}$
- (d) ${}^{4}A_{2g} \rightarrow {}^{4}T_{2g}$, ${}^{4}A_{2g} \rightarrow {}^{4}T_{1g}(F)$ and ${}^{4}A_{2g} \rightarrow {}^{4}T_{1g}(P)$

55. Amongst the following, the group that is bound to the metal ion in coenzyme B_{12} is

(a) methyl

(b) cyanide

(c) adenosyl

(d) hydroxyl

Q.No	Ans		Q.No	Ans		Q.No	Ans
1.	с		21.	d		41.	d
2.	b		22.	d		42.	a
3.	а		23.	b		43.	с
4.	с		24.	a		44.	b
5.	с		25.	с		45.	b
6.	с	E.	26.	10.67 to 10.71		46.	0.13 to 0.14
7.	d	- À.	27.	1000 to 1001	1	47.	d
8.	с	R	28.	666.67 to 685.00	ST	48.	b
9.	-7.65 to -7.48	7 S	29.	0.019 to 0.021	R	49.	d
10.	d		30.	99.85 to 100	Y	50.	b
11.	0.50 to 0.52	Л	31.	а		51.	8.90 to 9.10
12.	с	N.	32.	с		52.	1.90 to 2.10
13.	d		33.	с		53.	с
14.	a		34.	d		54.	d
15.	d		35.	b		55.	с
16.	b	22	36.	61.6 to 62.1	A		
17.	b	2n	37.	a	Dr.		
18.	5.99 to 6.01	5	38.	b			
19.	a		39.	a			
20	С		40	Ь			

Answer Key

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