PAPER : IIT-JAM 2018

CHEMISTRY-CY

1. **Section-A contains 30 Multiple Choice Questions (MCQ). Each question has 4 choices (a), (b), (c) and (d), for its answer, out of which ONLY ONE is correct. From Q.1 to Q.10 carries 1 Marks and Q.11 to Q.30 carries 2 Marks each.**
2. **Section-B contains 10 Multiple Select Questions(MSQ). Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE or MORE than ONE is/are correct. For each correct answer you will be awarded 2 marks.**
3. **Section-C contains 20 Numerical Answer Type (NAT) questions. From Q.1 to Q.10 carries 1 Mark each and Q.11 to Q.20 carries 2 Marks each. For each NAT type question, the value of answer in between 0 to 9.**
4. **In all sections, questions not attempted will result in zero mark. In Section–A (MCQ), wrong answer will result in negative marks. For all 1 mark questions, 1/3 marks will be deducted for each wrong answer. For all 2 marks questions, 2/3 marks will be deducted for each wrong answer. In Section–B (MSQ),there is no negative and no partial marking provisions. There is no negative marking in Section–C (NAT) as well.**

SECTION-A

Multiple Choice Questions (MCQ)

Q.1 – Q.10 carry ONE mark each.

1. The number of crystal systems and the number of Bravais lattices are, respectively

   (A) 14 and 7 (B) 7 and 32 (C) 32 and 14 (D) 7 and 14

2. NaF, KF, MgO and CaO are crystalline solids. They have NaCl structure. Their lattice energies vary in the order

   (A) NaF < KF < MgO < CaO (B) KF < NaF < CaO < MgO

   (C) MgO < CaO < NaF < KF (D) CaO < MgO < KF < NaF

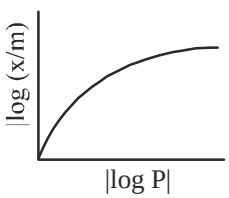
3. On hydrolysis, aluminium carbide produces

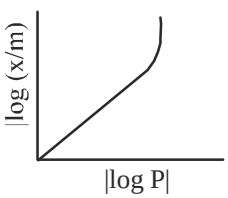
   (A) CH_4 (b) C_2H_6 (C) C_2H_4 (D) C_2H_2

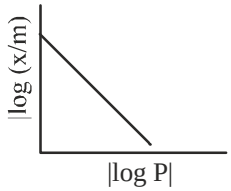
4. The value of integral $\int_{-2}^{+2} x\, e^{-2x^2}\, dx$ is

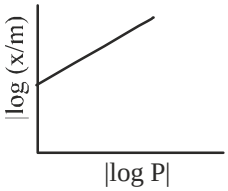
   (a) 0 (b) $\frac{1}{2}$ (c) 1 (d) 2

5. For adsoption of a gas on a solid surface, the plot that represents Freundlich isotherm is (x = mass of gas, m = mass of adsorbent, P = pressure)

   (A) 

   (B) 

(C) 

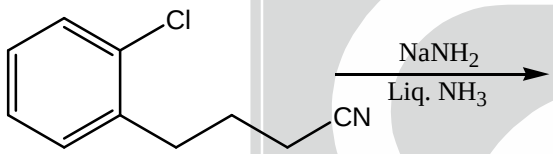
(D) 

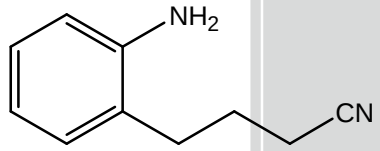
6. The C-2 epimer of D-glucose is
(A) D-Mannose (B) D-Fructose (C) D-Galactose (D) D-Gulose

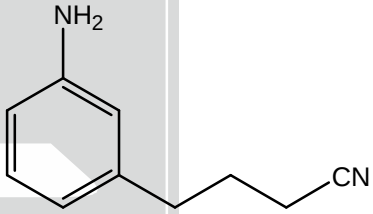
7. Carbonic anhydrase is an example of
(A) Hydrolysis enzyme (B) Redox enzyme
(C) O_2 transport protein (D) Heme protein

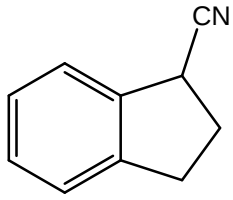
8. The compound that contains the most acidic hydrogen is
(A) $H_2C=CH_2$ (B) $HC\equiv CH$ (C) $H_2C=C=CH_2$ (D) H_3C-CH_3

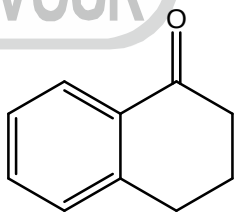
9. The major product formed in the following reaction is



(A) 

(B) 

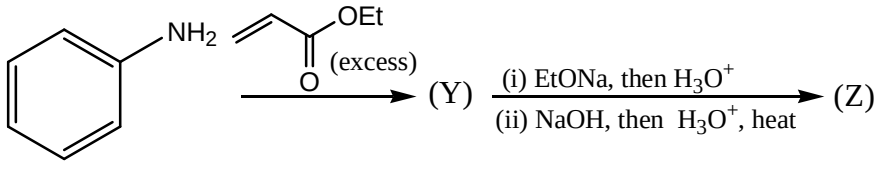
(C) 

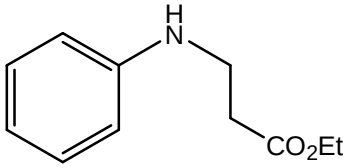
(D) 

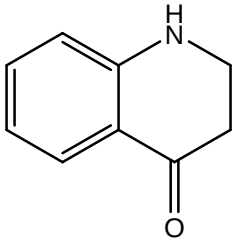
10. The **CORRECT** order of melting points of group 15 trifluorides is
(A) $PF_3 < AsF_3 < SbF_3 < BiF_3$ (B) $BiF_3 < SbF_3 < PF_3 < AsF_3$
(C) $PF_3 < SbF_3 < AsF_3 < BiF_3$ (D) $BiF_3 < AsF_3 < SbF_3 < PF_3$

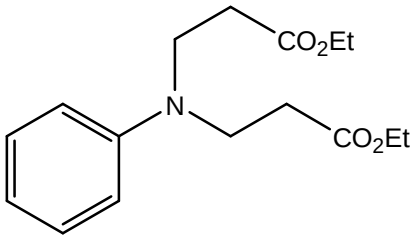
Q.11 – Q.30 carry TWO marks each.

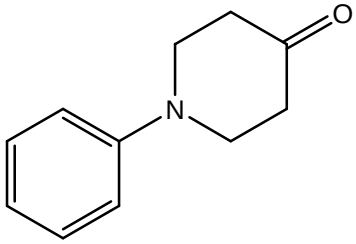
11. The major products Y and Z in the following reaction sequence are

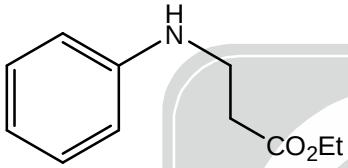


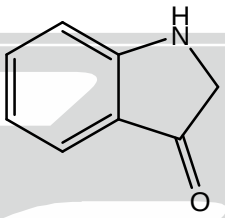
(A) (Y) = 

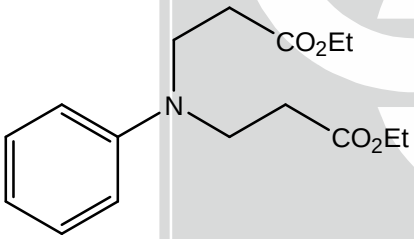
(Z) = 

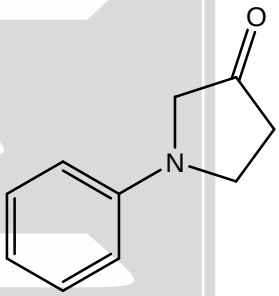
(B) (Y) = 

(Z) = 

(C) (Y) = 

(Z) = 

(D) (Y) = 

(Z) = 

12. The behavior of Cl_2 is closest to ideal gas behavior at
(A) 100ºC and 10.0 atm (B) 0ºC and 0.50 atm
(C) 200 ºC and 0.50 atm (D) –100ºC and 10.0 atm

13. With respect to periodic properties, the CORRECT statement is
(a) Electron affinity order is F > O > Cl
(B) First ionisation energy order is Al > Mg > K
(C) Atomic radius order is N > P > As
(D) Ionic radius order is $K^+ > Ca^{2+} > Mg^{2+}$

14. With reference to the variation of molar conductivity (Λ_m) with concentration for a strong electrolyte in an aqueous solution, the CORRECT statement is

(A) The asymmetry effect contributes to decrease Λ_m whereas the electrophoretic effect contribution to increase Λ_m

(B) The asymmetry effect contributes to increase Λ_m whereas the electrophoretic contributes to decrease Λ_m

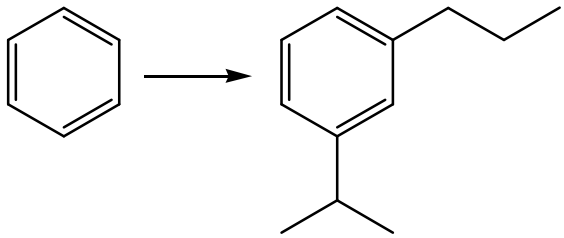
(C) Both asymmetry effect and electrophoretic effect contribute to decrease Λ_m

(D) Both asymmetry effect and electrophoretic effect contribute to increase Λ_m

15. A vector $\vec{A} = \vec{i} + x\vec{j} + 3\vec{k}$ -is rotated through an angle and is also doubled in magnitude resulting in $\vec{B} = 4\vec{i} + (4x-2)\vec{j} + 2\vec{k}$. An acceptable value of x is

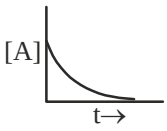
(A) 1 (B) 2 (C) 3 (D) 4/3

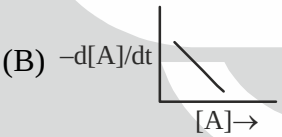
16. The sequence of three steps involved in the following conversion is

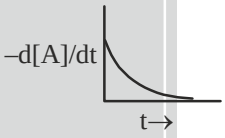


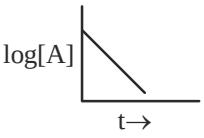
(A) (i) Friedel-Crafts alkylation; (ii) Reduction; (iii) Friedel-Crafts acylation
(B) (i) Friedel-Crafts acylation; (ii) Friedel-Crafts alkylation; (iii) Reduction
(C) (i) Friedel-Crafts acylation; (ii) Reduction; (iii) Friedel-Crafts alkylation
(D) (i) Friedel-Crafts alkylation; (ii) Friedel-Crafts acylation; (iii) Reduction

17. The reaction A $\longrightarrow$ Products, follows first-order kinetics. If [A] represents the concentration of reactant at time t, the INCORRECT variation is the shown in

(A) 

(B) 

(C) 

(D) 

18. The CORRECT order of stability for the following carbocations is

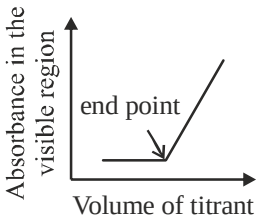
(I) **(II)** **(III)** **(IV)**

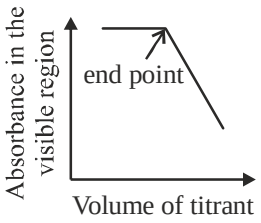
(a) I < III < IV < II (b) III < II < IV < I (c) II < IV < III < I (d) IV < III < I < II

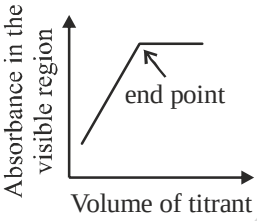
19. The decay modes of ^{14}C and ^{14}O are

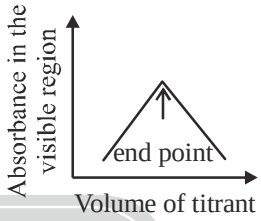
(A) β^- decay
(B) Positron emission
(C) β^- decay and positron emission, respectively
(D) Positron emission and β^- decay, respectively

20. Which plot represents a spectrophotometric titration, where the titrant alone absorbs, light in the visible region?

(A) 

(B) 

(C) 

(D) 

21. The CORRECT order of Δ_0 (the octahedral crystal field splitting of d-orbitals) values for the following anionic metal complexes is

(A) $\left[\mathrm{Ir(CN_6)}\right]^{3-} < \left[\mathrm{Rh(CN)_6}\right]^{3-} < \left[\mathrm{RhI_6}\right]^{3-} < \left[\mathrm{CoI_6}\right]^{3-}$

(B) $\left[\mathrm{CoI_6}\right]^{3-} < \left[\mathrm{RhI_6}\right]^{3-} < \left[\mathrm{Rh(CN)_6}\right]^{3-} < \left[\mathrm{Ir(CN)_6}\right]^{3-}$

(C) $\left[\mathrm{CoI_6}\right]^{3-} < \left[\mathrm{Rh(CN)_6}\right]^{3-} < \left[\mathrm{RhI_6}\right]^{3-} < \left[\mathrm{Ir(CN)_6}\right]^{3-}$

(D) $\left[\mathrm{Ir(CN)_6}\right]^{3-} < \left[\mathrm{CoI_6}\right]^{3-} < \left[\mathrm{Rh(CN)_6}\right]^{3-} < \left[\mathrm{RhI_6}\right]^{3-}$

22. The electrolyte AB_2 ionises in water as

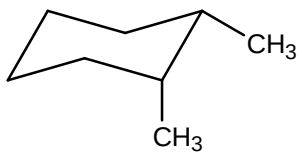
$$AB_2 \rightleftharpoons A^{2+} + 2B^-$$

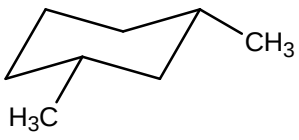
The mean ionic activity coefficient $(\gamma_\pm)$

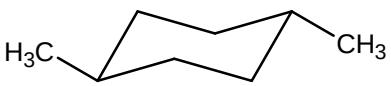
(A) $\gamma_{A^{2+}}^{\frac{1}{2}}\gamma_{B^-}$ (B) $\gamma_{A^{2+}}^{\frac{1}{2}}\gamma_{B^-}^{\frac{2}{3}}$ (C) $\gamma_{A^{2+}}^{\frac{2}{3}}\gamma_{B^-}^{\frac{1}{3}}$ (D) $\left(\gamma_{A^{2+}} + 2\gamma_{B^-}\right)^{1/2}$

23. Among the dimethylcyclohexanes, which one can be obtained in enantiopure form?

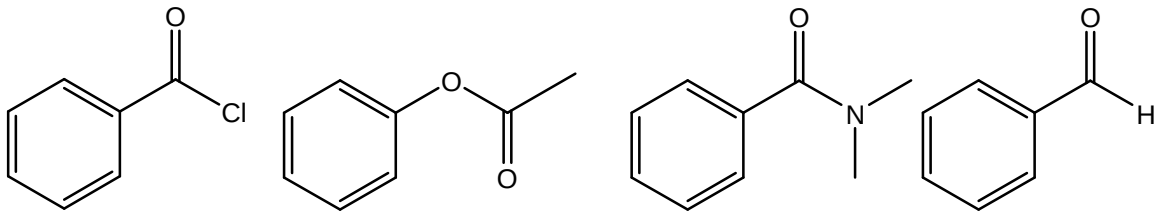
(A) 

(B) 

(C) 

(D) 

24. The CORRECT order of carbonyl stretching frequencies for the following compounds is



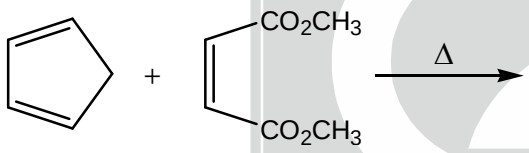
(I) **(II)** **(III)** **(IV)**

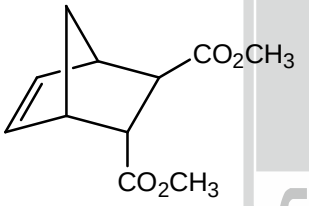
(A) II < I < III < IV (B) I < III < II < IV
(C) IV < II < III < I (D) III < IV < II < I

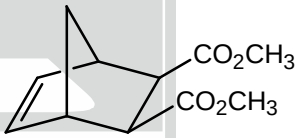
25. The CORRECT expression that corresponds to reversible and adiabatic expansion of an ideal gas is

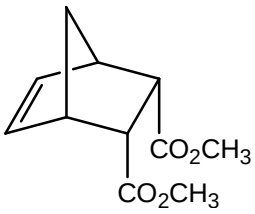
(A) $\Delta U = 0$ (B) $\Delta H = 0$ (C) $\Delta S = 0$ (D) $\Delta G = 0$

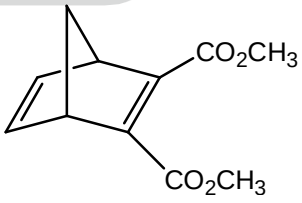
26. The major product formed in the following reaction is



(A) 

(B) 

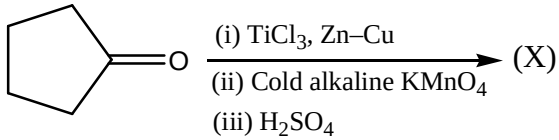
(C) 

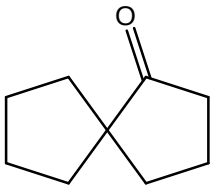
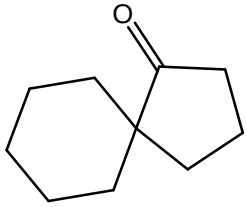
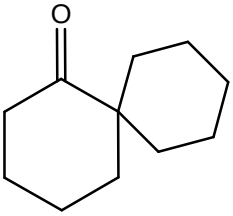
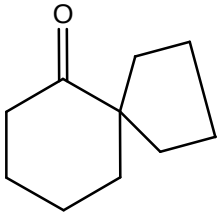
(D) 

27. Among the following metal carbonyl species, the one with the highest metal-carbon back bonding is

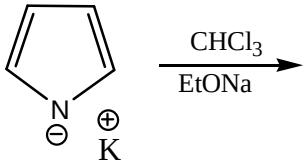
(A) $\left[Ti(CO)_6\right]^{2-}$ (B) $\left[V(CO)_6\right]^{-}$ (C) $Cr(CO)_6$ (D) $\left[Mn(CO)_6\right]^{+}$

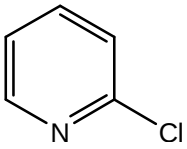
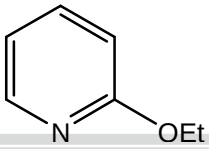
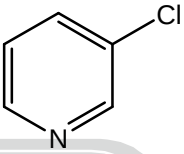
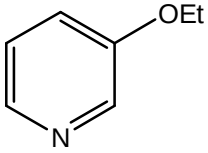
28. The product (X) in the following reaction sequence is



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

29. The major product formed in the following reaction is



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

30. Consider the following four xenon compounds : XeF_2, XeF_4, XeF_6 and XeO_3. The pair of xenon compounds expected to have non-zero dipole moment is

(A) XeF_4 and XeF_6 (B) XeF_2 and XeF_4 (C) XeF_2 and XeO_3 (D) XeF_6 and XeO_3

SECTION-B

Multiple Select Questions (MSQ)

Q.1 – Q.10 carry TWO marks each.

1. The CORRECT statement(s) about carbene is(are)
   (A) Carbene is neutral species
   (B) Carbene is an intermediate in the Curtius rearrangement
   (C) Carbene can insert into both σ and π-bonds
   (D) Carbene is generated from amines on reaction with ntirous acid

2. The CORRECT expression(s) for isothermal expansion of 1 mol of an ideal gas is(are)

   (A) $\Delta A = RT\ell n\dfrac{V_{initial}}{V_{final}}$ (B) $\Delta G = RT\ell n\dfrac{V_{initial}}{V_{final}}$

   (C) $\Delta H = RT\ell n\dfrac{V_{final}}{V_{initial}}$ (D) $\Delta S = R\ell n\dfrac{V_{final}}{V_{initial}}$

3. Which of the following metal(s) is(are) extracted from its (their) sulfide ore(s) by self-reduction/ air reduction method?
   (A) Cu (B) Al (C) Au (D) Pb

4. Choose the CORRECT answer(s) with respect to the magnesium-EDTA titration carried out in the pH range 7–10.5, using Solochrome black as indicator
   (A) Magnesium-indicator complex is more stable than the magnesium-EDTA complex
   (B) At the end point, the colour changes from red to blue
   (C) After the end point, the colour of the solution is due to the indicator
   (D) pH range of 7-10.5 is necessary for observing the specific colour change

5. Consider the following six solid binary oxides CaO, Al_2O_3, PbO, Cs_2O, SiO_2 and Sb_2O_3. The pair(s) of ionic oxides is(are)
   (A) CaO and Al_2O_3 (B) CaO and PbO
   (C) Cs_2O and Al_2O_3 (D) SiO_2 and Sb_2O_3

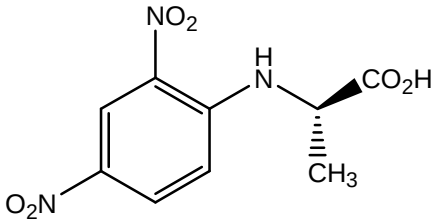
6. In a saturated calomel electrode, the saturation is with respect to
   (A) KCl (B) Hg_2Cl_2 (C) $HgCl_2$ (D) AgCl

7. Which of the following set(s) of quantum numbers is(are) NOT allowed?

(A) $n = 3, \ell = 2, m_\ell = -1$ (B) $n = 4, \ell = 0, m_\ell = -1$

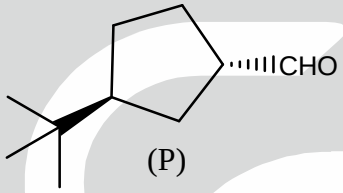
(C) $n = 3, \ell = 3, m_\ell = -3$ (D) $n = 5, \ell = 3, m_\ell = +2$

8. Tetrapeptide(s) that gives (give) the following product on reaction with Sanger's reagent followed by hydrolysis is(are)

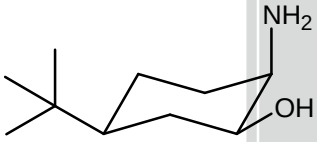


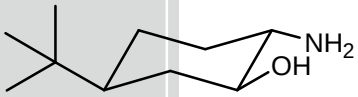
(A) Ala-Gly-Leu-Phe (B) Asp-Phe-Leu-Pro (C) Asp-Gly-Tyr-Phe (D) Ala-Phe-Tyr-Pro

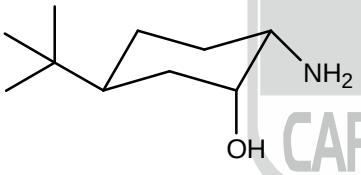
9. One reaction with $NaNO_2$ and HCl, which of the following amino alcohol(s) will yield compound P?

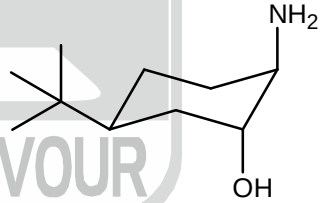


(P)

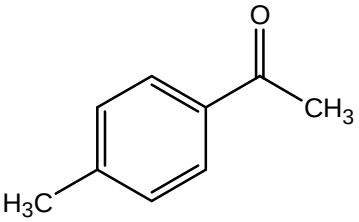
(A) 

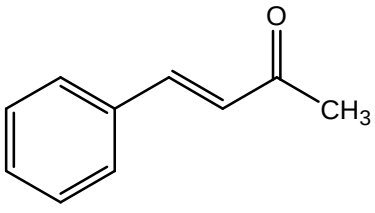
(B) 

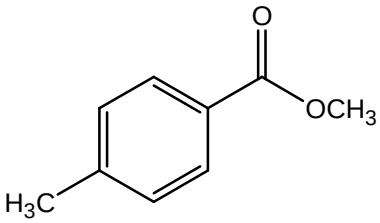
(C) 

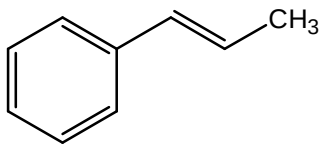
(D) 

10. The compound(s) that shows (show) positive haloform test is(are)

(A) 

(B) 

(C) 

(D) 

SECTION-C

Numerical Answer Type (NAT)

Q.1 – Q.10 carry ONE mark each.

1. Consider the reaction, $CO(g)+\frac{1}{2}O_2(g)\longrightarrow CO_2(g)$

   The value of ΔU for the reaction at 300K is –281.8 kJ mol^{-1}. The value of ΔH at same temperature is _____kJ mol^{-1}(rounded upto the first decimal place)
   (R = 8.3 J K^{-1} mol^{-1})

2. The value of C_v for 1 mole of N_2 gas predicted from the principle of equipartition of energy, ignoring vibrational contribution, is _____ JK^{-1} mol^{-1} (rounded up to two decimal places)

3. The nuclear spin quantum number (I) of a nucleus is $\frac{3}{2}$. When placed in an external magnetic field, the number of possible spin energy states it can occupy is _____

4. The time for 50% completion of a zero order reaction is 30 min. Time for 80% completion of this reaction is _____min.

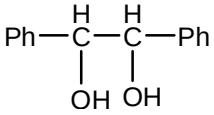
5. The number of possible isomers for [Pt(py)(NH_3)BrCl] is _____(py is pyridine).

6. The volume of 0.3 M ferrous ammonium sulphate solution required for the completion of redox titration with 20 mL of 0.1 M potassium dichromate solution is _____mL

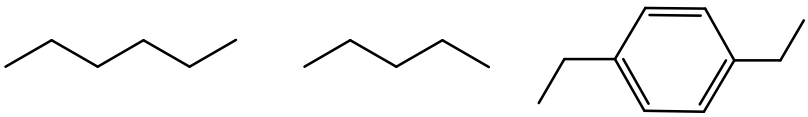
7. The number of hydrogen bond(s) present in a gaunine-cytosine base pair is _____

8. Assuming ideal gas behaviour, the density of O_2 gas at 300K and 1.0 atm is _____gL^{-1} (rounded up to two decimal places) [R = 0.082 $Latmmol^{-1}K^{-1}$, molar mass of O_2 = 32]

9. The number of stereoisomers possible for the following compounds is _____



10. Among the following hydrocarbon(s), how many of them would give rise to three groups of proton NMR peaks with 2 : 2 : 3 untegration ratio?



Q.11 – Q.20 carry TWO marks each.

11. For H_2 molecule, the fundamental vibrational frequency $(\overline{\nu}_e)$ in wave numbers can be taken as 4400 cm^{-1}. The zero-point energy of the molecule is _____kJ mol^{-1} (rounded up to two decimal places) [h = 6.6×10^{-34} Js, c = 3×10^3 ms^{-1}, N_A = 6×10^{23} mol^{-1}]

12. The electron of a hydrogen atom is in its n^{th} Bohr orbit having de-Broglie wavelength of 13.4Å. The value of *n* is _____(rounded upto the nearest integer)
    [Radius of n^{th} Bohr orbit = 0.53 n^2 Å, $\pi = 3.14$]

13. How many of the following interhalogen species have 2 lone pairs of electrons on the central atom?

ClF_3, ClF_2^-, ClF_5 and ICl_2^+

14. The magnitude of crystal field stabilization energy (CFSE) of octahedral $[Ti(H_2O)_6]^{3+}$ complex is 7680 cm^{-1}. The wavelength at the maximum absorption (λ_{max}) of this complex is _____nm(rounded up to the nearest integer)

15. For the reaction $H_2(g)+\frac{1}{2}O_2(g)\longrightarrow H_2O(\ell)$, the following information is given T = 300K

$\Delta\bar{H}^0 = -285\ kJ\ mol^{-1}$ $\quad \bar{S}^0_{H_2O}(\ell) = 70\ JK^{-1}\ mol^{-1}$

$\bar{S}^0_{O_2}(g) = 204\ JK^{-1}\ mol^{-1}$ $\quad \bar{S}^0_{H_2}(\ell) = 130\ JK^{-1}\ mol^{-1}$

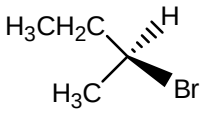
$\Delta\bar{S}^0_{universe}$ for the reaction is _____J K^{-1} mol^{-1}.

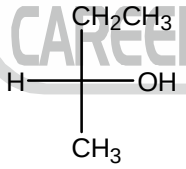
16. ^{24}Na decays to one-fourth of its initial amoount in 29.8 hours. Its decay constant is _____$hour^{-1}$ (rounded up to the four decimal places).

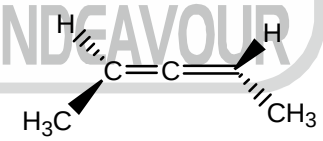
17. Elemental analysis of an organic compound containing C, H and O gives percentage composition C : 39.9% and H : 6.7%. If the molecular weight of the compound is 180, the number of carbon atoms present in the molecule is _____

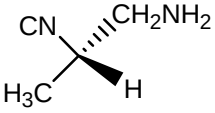
18. The emf of a standard cadmium cell is 1.02 V at 300K. The temperature coefficient of the cell is -5.0×10^{-3} VK^{-1}. The value of ΔH^0 for the cell is _____kJ mol–1 (rounded up to two decimal places)
[1F = 96500 C mol^{-1}]

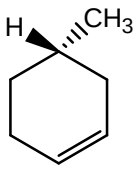
19. The number of compounds having S-configuration among the following is _____











20. The solubility of PbI_2 in 0.10 M KI (aq) is _____$\times10^{-7}$ M (rounded up to two decimal places) (The solubility product $K_{sp} = 7.1\times10^{-9}$]