IIT JAM 2017

1. A straight line having a slop of $-\frac{\Delta U^{o}}{R}$ is obtained in a plot between

(a) ln (K_p) versus T (b) ln (K_c) versus T
(c) ln (K_p) versus 1/T (d) ln (K_C) Versus 1/T

2. The number of degrees of freedom of liquid water in equilibrium with ice is
(a) 0 (b) 1 (c) 2 (d) 3

3. The number of normal modes of vibration in naphthalene is
(a) 55 (b) 54 (c) 48 (d) 49

4. In the following sequence of reactions, the overall yield (%) of O is

$$L \xrightarrow{92\%\ \text{yield}} M \xrightarrow{78\%\ \text{yield}} N \xrightarrow{85\%\ \text{yield}} O$$

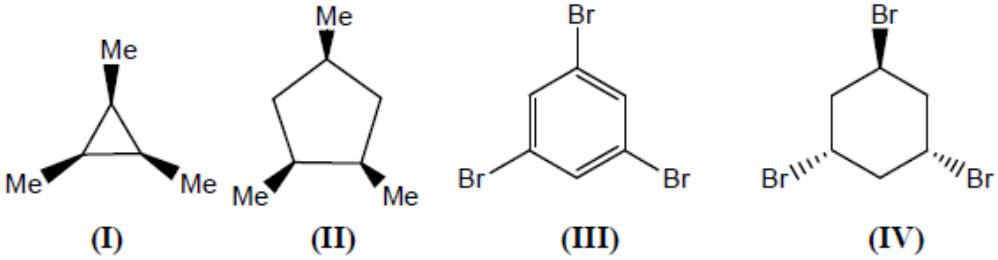
(a) 61 (b) 85 (c) 74 (d) 68

5. In the following Latimer diagram, the species that undergoes disproportionation reaction is

$$MnO_4^- \xrightarrow{+0.56} MnO_4^{2-} \xrightarrow{+0.27} MnO_4^{3-} \xrightarrow{+0.93} MnO_2 \xrightarrow{+0.15} Mn_2O_3 \xrightarrow{+0.25} Mn(OH)_2 \xrightarrow{+1.56} Mn$$

(a) MnO_4^{2-} (b) MnO_4^{3-} (c) Mn_2O_3 (d) $Mn(OH)_2$

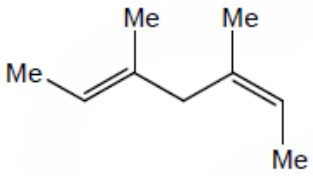
6. The compounds having C_3- axis of symmetry are



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

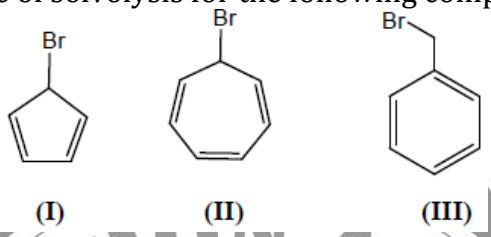
(a) I, III and IV (b) I, II and III (c) I and III (d) III and IV

7. Catalytic hydrogenation of the following compound produces saturated hydrocarbon(s). The number of stereoisomer(s) formed is



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

8. The correct order of rate of solvolysis for the following compounds is



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

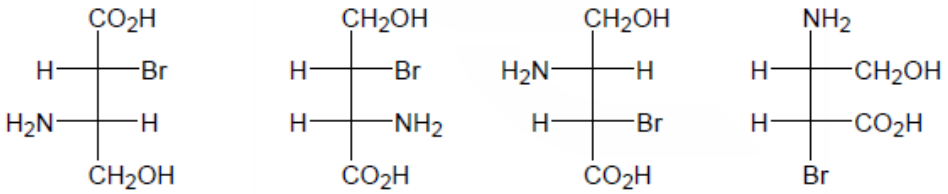
(a) I, III & IV (b) I, II & III (c) I & III (d) III & IV

9. The correct order of the boiling points of the compounds is
(a) $CH_4 > SiH_4 > SnH_4 > GeH_4$ (b) $SiH_4 > CH_4 > GeH_4 > SnH_4$
(c) $SnH_4 > GeH_4 > CH_4 > SiH_4$ (d) $SnH_4 > GeH_4 > SiH_4 > CH_4$

10. A yellow precipitate is formed upon addition of aqueous $AgNO_3$ to a solution of
(a) phosphate (b) pyrophosphate (c) metaphosphate (d) orthophosphate

Q.11 – Q.30 carry TWO marks each.

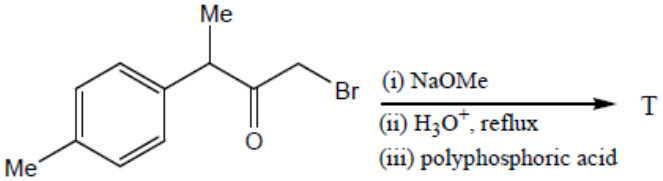
11. Among the following compounds, the pair of enantiomers is

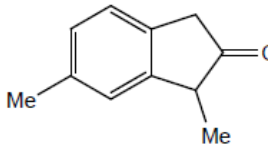


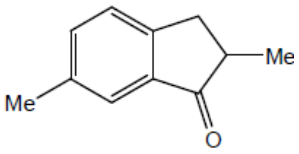
(I) **(II)** **(III)** **(IV)**

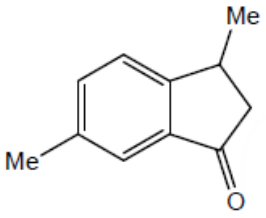
(a) I and IV (b) I and III (c) II and III (d) III and IV

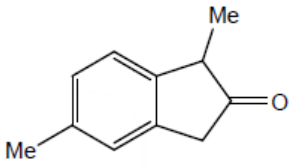
12. In the following reaction, the major product T is



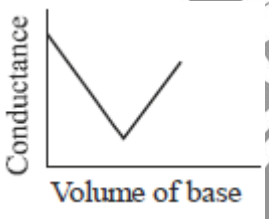
(a) 

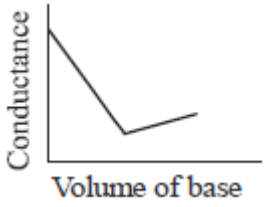
(b) 

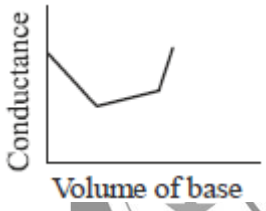
(c) 

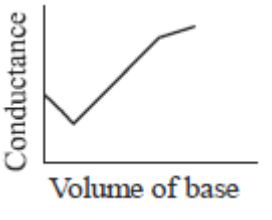
(d) 

13. In a typical conductometric titration of a strong acid with a weak base, the curve resembles

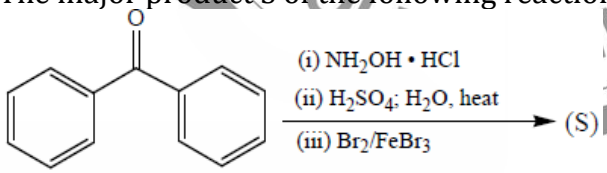
(a) 

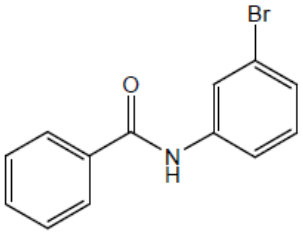
(b) 

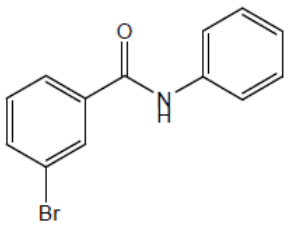
(c) 

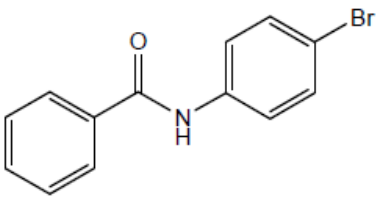
(d) 

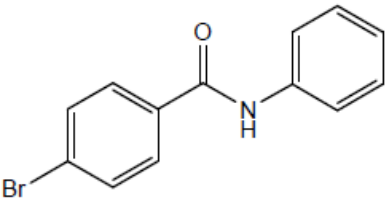
14. The major product S of the following reaction is



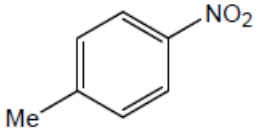
(a) 

(b) 

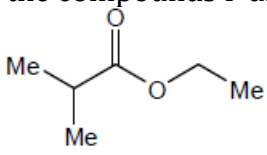
(c) 

(d) 

15. The number of proton NMR signals for the compounds P and Q, respectively, is



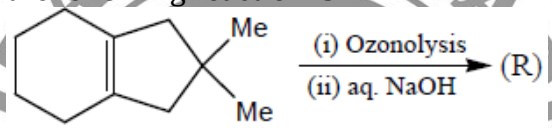
(P)

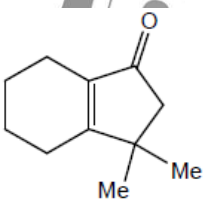


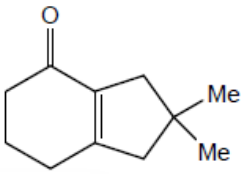
(Q)

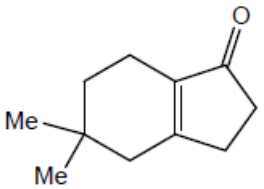
(a) 3 and 4 (b) 3 and 5 (c) 4 and 3 (d) 5 and 4

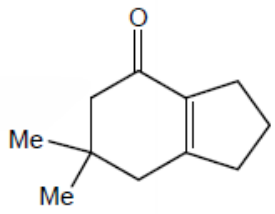
16. The product R in the following reaction is



(a) 

(b) 

(c) 

(d) 

17. For a particle in one-dimensional box of length L with potential energy V(x) = 0 for L > x > 0 and V(x) = ∞ for $x \geq 0$, an acceptable wave function consistent with the boundary conditions is (A, B, C and D are constant)

(a) $A\cos\left(\frac{n\pi x}{L}\right)$ (b) $B\left(x+x^2\right)$ (c) $Cx^3\left(x-L\right)$ (d) $\frac{D}{\sin\left(\frac{n\pi x}{L}\right)}$

18. The correct order of wavelength of absorption $\left(\lambda_{max}\right)$ of the Cr-complexes is (en = ethylenediamine)

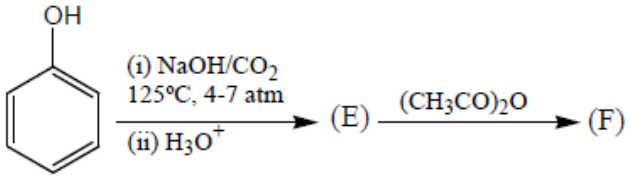
(a) $\left[CrF_6\right]^{3-} > \left[Cr(H_2O)_6\right]^{3+} > \left[Cr(en)_3\right]^{3+} > \left[Cr(CN)_6\right]^{3-}$

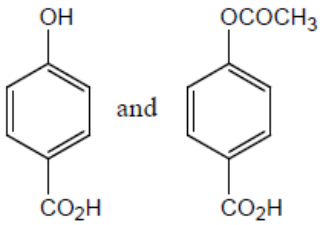
(b) $\left[Cr(H_2O)_6\right]^{3+} > \left[CrF_6\right]^{3-} > \left[Cr(en)_3\right]^{3+} > \left[Cr(CN)_6\right]^{3-}$

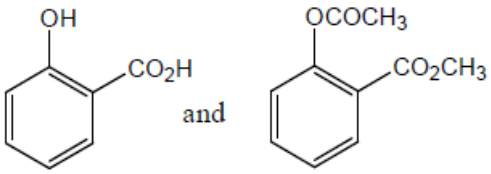
(c) $\left[Cr(CN)_6\right]^{3-} > \left[Cr(en)_3\right]^{3+} > \left[Cr(H_2O)_6\right]^{3+} > \left[CrF_6\right]^{3-}$

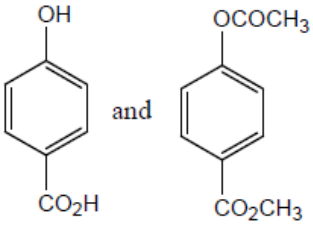
(d) $\left[Cr(en)_3\right]^{3+} > \left[Cr(CN)_6\right]^{3-} > \left[Cr(H_2O)_6\right]^{3+} > \left[CrF_6\right]^{3-}$

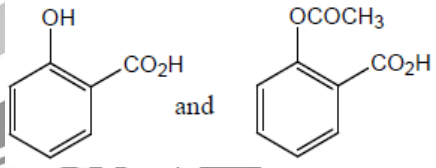
19. In the following reaction, the major products E and F, respectively, are



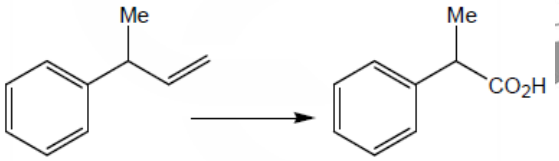
(a) 

(b) 

(c) 

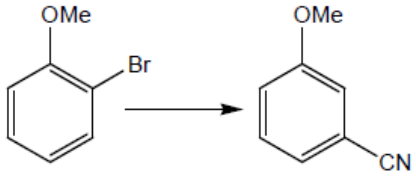
(d) 

20. The following conversion is carried out using



(a) Hydroboration-oxidation followed by Jones oxidation
(b) Wacker oxidation followed by haloform reaction
(c) oxy-mercuration-demercuration followed by Jones oxidation
(d) ozonolysis followed by haloform reaction

21. The correct set of reagents for the following conversion is



(a) (i) $NaNH_2$/liq,NH_3; (ii) $NaNO_2$/dil.HCl; (iii) CuCN, heat
(b) (i) HNO_3/H_2SO_4; (ii) Zn/HCl; (iii) $NaNO_2$/dil.HCl; (iv) CuCN, heat
(c) (i) Mg/ether, H_3O^+; (ii) $(EtO)_2CO$; (iii) NH_4OH; (iv) PCl_5\
(d) (i) Mg/ether,H_3O^+; (ii) HNO_3/H_2SO_4; (iii) $NaNO_2$/dil. HCl; (iv) CuCN, heat

22. The homogeneous catalyst used in water-gas shift reaction is
(a) $PdCl_2$ (b) Cr_2O_3
(c) $\left[RhCl(PPh_3)_3\right]$ (d) $\left[RuCl_2(bipyridyl)_2\right]$

23. Nitrosyl ligand binds to d-metal atoms in linear and bent fashion and behaves respectively, as
(a) NO^+ and NO^+ (b) NO^+ and NO^- (c) NO^- and NO^- (d) $NO^-$and NO^+

24. $\frac{dy}{dx} = -\frac{y}{x}$ is differential equation for a/an
(a) circle (b) ellipse (c) bell-shaped curve (d) Hyperbola

25. The correct order of enthalpy of hydration for the transition metal ions is
(a) $Cr^{2+} > Mn^{2+} > Co^{2+} > Ni^{2+}$ (b) $Ni^{2+} > Co^{2+} > Mn^{2+} > Cr^{2+}$
(c) $Ni^{2+} > Co^{2+} > Cr^{2+} > Mn^{2+}$ (d) $Cr^{2+} > Mn^{2+} > Ni^{2+} > Co^{2+}$

26. Ionisation energy of hydrogen atom in ground state is 13.6 eV. The energy released (in eV) for third member of Balmer series is
(a) 13.056 (b) 2.856 (c) 0.967 (d) 0.306

27. The coordination number of Al in crystalline $AlCl_3$ and liquid $AlCl_3$, respectively, is
(a) 4 and 4 (b) 6 and 6 (c) 6 and 4 (d) 3 and 6

28. Value of the given determinant is
$$\begin{bmatrix} 1 & 3 & 0 \\ 2 & 6 & 4 \\ -1 & 0 & 2 \end{bmatrix}$$
(a) –12 (b) 0 (c) 6 (d) 12

29. For a first order reaction A (g) → 2B(g) + C(g), the rate constant in terms of initial pressure (p_0) and pressure at time t (p_t), is given by

(a) $\frac{1}{t}\ln\frac{p_0}{p_t - p_0}$ (b) $\frac{1}{t}\ln\frac{2p_0}{3p_0 - p_t}$ (c) $\frac{1}{t}\ln\frac{3p_0}{p_t - p_0}$ (d) $\frac{1}{t}\ln\frac{3p_0}{3p_t - p_0}$

30. The metal ion (M^{2+}) in the following reaction is

$M^{2+} + S^{2-} \rightarrow$ Black prcipitate $\xrightarrow{\text{hot conc. } HNO_3}$ White precipitate

(a) Mn^{2+} (b) Fe^{2+} (c) Cd^{2+} (d) Cu^{2+}

SECTION - B

Q.31 – Q.40 carry TWO marks each.

1. IR active molecule(s) is/are

(a) CO_2 (b) CS_2 (c) OCS (d) N_2

2. The INCORRECT statement(s) among the following is/are

(a) $[4\pi + 2\pi]$ cycloaddition reactions are carried out presence of light

(b) $[2\pi + 2\pi]$ cycloaddition reaction between keto group and an alkene is photochemical allowed

(c) $[4\pi + 2\pi]$ cycloaddition reactions are thermally allowed

(d) Transoid dienes undergo Diels-Alder reactions

3. Intensive variable(s) is/are

(a) temperature (b) volume (c) pressure (d) density

4. Wave nature of electromagnetic radiation is observed in

(a) diffraction (b) interference

(c) photoelectric effect (d) Compton scattering

5. Among the following, the species having see-saw shape is are

(a) SF_4 (b) XeF_4 (c) ClF_4^+ (d) ClF_4

6. Among the following, the correct statement(s) is/are

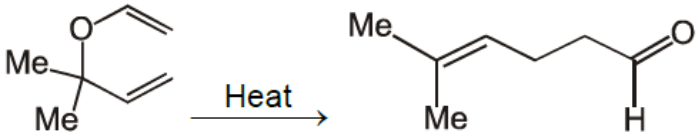
(a) Guanine is a purine nucleobase

(b) Glycine and praline are achiral amino acids

(c) DNA contains glycosidic bonds and pentose sugars

(d) Sucrose is a non-reducing sugar

7. The following conversion(s) is are example(s) of



(a) oxy-Cope rearrangement (b) sigma tropic rearrangement
(c) Claisen rearrangement (d) pericyclic reaction

8. The "heme" containing protein(s) is/are
(a) cytochrome C (b) hemocyanin (c) hemerythrin (d) myoglobin

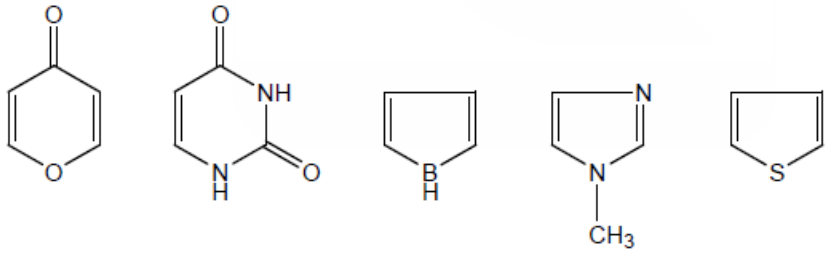
9. Jahn-Teller distortion is/are observes in octahedral complex with d-electron configuration of
(a) d^5-high spin (b) d^5-low spin (c) d^6-high spin (d) d^6-low spin

10. The indicator(s) appropriate for the determination of end point in the titration of a weak acid with a strong base is/are
(a) phenolphthalein (b) thymol blue
(c) bromophenol blue (d) methyl orange

SECTION – C

Q.41 – Q.50 carry One mark each.

1. Among the following, the number of aromatic compound(s) is _____



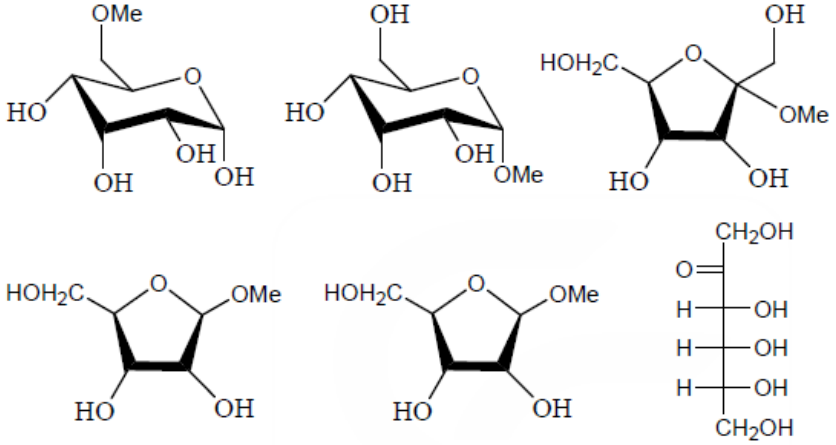
2. At 298 K atm, The molar enthalpies of combustion of cyclopropane and propene are –2091 kJ mol^{-1} and –2058 kJ mol^{-1}, respectively. The enthalpy change (in kJ mol^{-1}) for the conversion of one mole of propene to one mole of cyclopropane is _____.

3. The number of unpaired electron(s) in K_2NiF_6 is _____

4. The number of S – S bond(s) in tetrathionate ion is _____

5. At an operating frequency of 350 MHz, the shift (in Hz) of resonance from TMS (tetramethylsilane) of a proton with chemical shift of 2 ppm is _____

6. The number of reducing sugars among the following is _____



7. For a reaction $2A + B \rightarrow C + D$, if rate of consumption of A is 0.1 mol L^{-1} s^{-1}, the rate of production of C (in mol L^{-1} s^{-1}) is _____.

8. The maximum $2A + B \rightarrow C + D$, if rate of consumption of A is 0.1 mol L^{-1} s^{-1}, the rate of production of C (in mol L^{-1} s^{-1}) is _____

9. The number of isomeric structure of di-substituted borazine $\left(B_3N_3H_4X_2\right)$ is _____

10. For a cell reaction, $Pb(s) + Hg_2Cl_2(s) \rightarrow PbCl_2(s) + 2Hg(l)$, $\left(\frac{\partial E^0}{\partial T}\right)_P$ is 1.45×10^{-4} VK^{-1}. The entropy change (in J mol^{-1} K^{-1}) for the reaction is _____ [Given 1 F = 96500 C mol^{-1}]

11. The total number of pair of enantiomers possible with molecular formula $C_5H_{12}O$ is _____

12. The adsorption of a gas follows the Langmuir isotherm with K = 1.25 kPa^{-1} at 25°C. The pressure (in Pa) at which surface coverage is 0.2 is _____.

13. Silver crystallizes in a face-centred cubic lattice. The lattice parameter of silver (in picometer) is _____. [given: Avogadro's number = 6.023 × 10+23 ^{mol}–1, molar mass of silver = 107.87 g mol^{-1} and density of crystal = 10.5 g cm^{-3}]

14. The separation of 123 planes (in nm) in an orthorhombic cell with a = 0.25 nm, b = 0.5 nm and c = 0.75 nm is _____. (Final answer should be rounded off to two decimal places)

15. A radioactive element undergoes 80% radioactive decay in 300 min. The half-life for this species in minutes is _____.

16. The standard reduction potentials of Ce^{4+}/Ce^{3+} and Fe^{3+}/Fe^{2+} are 1.44 and 0.77 V, respectively. The $\log^{10}K$ (K is the equilibrium constant) value for the following reaction is _____. (Final answer should be rounded off to decimal places)
$Ce^{4+} + Fe^{2+}$ $Ce^{3+} + Fe^{3+}$
[Given: RT/F = 0.257 V]

17. In 200 g of water, 0.01 mole of NaCl and 0.02 mole of sucrose are dissolved. Assuming solution to be ideal, the depression in freezing point of water (in*C) will be _____. (Final answer should be rounded off to two decimal places)
[Given: K_f (H_2O) = 1.86 K kg mol^{-1}]

18. Consider an isothermal reversible compression of one mole of an ideal gas in which the pressure of the system is increased from 5 atm at 300K. The entropy change of the surrounding (in JK^{-1}) is _____.
(Final answer should be rounded off to two decimal places)
[Given: R = 8.314 J mol^{-1} K^{-1}]

19. The amount of bromine (atomic wt. = 80) required (in gram) for the estimation of 42.3 g of phenol (molecular wt. = 94 g mol^{-1}) is _____

20. A vessel contains a mixture of H_2 and N_2 gas. The density of this gas mixture is 0.2 g L^{-1} at 300 K and 1 atm. Assuming that both the gases behave ideally, the mole fraction of N(g) in the vessel is _____.
(Final answer should be rounded off to two decimal places)
[Given: R = 0.082 L atm mol^{-1} K^{-1}, atomic wt. of hydrogen = 1.0 and atomic wt. of nitrogen = 14.0]