# U.G. 1st Semester Examination - 2019

## CHEMISTRY

### [HONOURS]

**Course Code : CHEM(H)-CC-01-T**

Full Marks : 40 Time : $2\frac{1}{2}$ Hours

*The figures in the right-hand margin indicate marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

**Answers each group in separate answer books.**

## GROUP–A

## (Inorganic)

1. Answer any **one** question: $1\times1=1$

a) In an atom, the angular momentum of an electron is $\sqrt{6}\frac{h}{2\pi}$. What will be the minimum value of the Principal Quantum number of the electron?

b) Electronegativity is not an absolute property. Justify.

2. Answer any **two** questions: $2\times2=4$

a) Calculate the effective nuclear charge (Z*) at the periphery of Cr-atom.

b) Calculate the uncertainty in position of an electron whose velocity is $3\times10^{14}$ cm/sec accurate upto 0.001%. Mass of an electron is $9.1\times10^{-28}$ g.

c) Prove that the frequency of rotation of an electron moving in the n-th Bohr's orbit of a hydrogenic species is given by $\frac{4\pi^2mZ^2e^4}{n^3h^3}$.

3. Answer any **one** question: $5\times1=5$

a) Calculate the electronegativity of As in $AsF_3$ and $AsF_5$. Given: $E_{AS-AS}=146$ kJmole$^{-1}$, $E_{F-F}=155$ kJmole$^{-1}$, $E_{As}$-F($AsF_5$)=484 kJmole$^{-1}$, $E_{As}$-F($AsF_3$)=406 kJmole$^{-1}$, $X_P(F)=4.0$ ev.

b) The radial wave function for a hydrogenic system is given by

$$R_{1.0}(r)=2\left[\left(Z/a_0\right)^{\frac{3}{2}}\exp\left(-Zr/a_0\right)\right].$$

Show that the most probable radius is given by $(a_0/Z)$. [Given, the nodes exist at $r = 0, \infty$].

4. Answer any **one** question: $10 \times 1 = 10$

a) i) Determine the total number of microstates and ground state term symbol (R-S term) for a $d^2$-system.

ii) Discuss the precessional motion of electron according to Sommerfield theory.

iii) The ionization energy of Li is approximately $\frac{2}{5}$th that of hydrogen. Assuming Bohr's theory hold good for Li atom, calculate the effective nuclear charge of Li.

iv) Justify the ground state configuration of chromium is $3d^5 4s^1$. (1+2)+3+2+2=10

b) i) Electron affinity of $Mn^{3+}$ is greater than that of $Fe^{3+}$– explain.

ii) Establish a relation between electron affinity of X(g) atom and ionization potential of $X^-(g)$ ion.

iii) Why Al and Ga have almost the same atomic radius?

iv) Discuss briefly the cause of "inert-pair effect".

v) Write down two drawbacks of the Slater's rule. 2×5=10

## GROUP–B

## (Physical)

5. Answer any **two** questions: 2×2=4

a) Write equations for two equations of state, identifying all variables.

b) What are intensive properties? Give two examples.

c) State Clausius' formulation of second law of thermodynamics. Is there an alternate formulation?

6. Answer any **one** question: $1\times1=1$

a) What is an adiabatic process?

b) Which experiment showed gas particles interact through attractive force between them?

7. Answer any **one** question: $5\times1=5$

a) i) How does mean free path of a gas molecule vary with temperature and pressure of the gas?

ii) Work done reversibly is always greater than work done by irreversible means – justify. 2+3

b) i) How does specific heat of a system vary with temperature?

ii) What is the value of the exponent $\gamma$ of adiabatic process for an ideal gas?

iii) Draw diagram for a Carnot engine in T-S space identifying all parameters clearly.

2+2+1

8. Answer any **one** question: 10×1=10

a) i) Write (without derivation) expression for Boyle temperature for a van der Waals gas.

ii) Transform the equation of state $\left(p+\frac{a}{V^2}\right)V=RT$ into virial form and derive an expression for Boyle temperature for the gas.

iii) Repeat the above exercise with the equation of state P(V–b)=RT.

iv) From (i), (ii) and (iii) comment on relative importance of inner particle volume and force of interaction between particles of a van der Waals gas.

2+3+3+2

b) i) Calculate the frequency of binary collision per $cm^3$ of $CO_2$ gas at 27°C and

1 atm. pressure. Diameter of a $CO_2$ molecule is 3.34 Å.

ii) Calculate number of $CO_2$ molecule per $cm^3$ at 27°C and 1 atm. pressure.

iii) Express the difference $C_P - C_V$ in (1) a general case and (2) for an ideal gas.

3+2+(3+2)

---