

238/Chem

UG/1st Sem/CHEM(H)CC-01-T/19

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: $1 \times 1 = 1$
- 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.

[Turn over]

2. Answer any **two** questions:

2 × 2 = 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 3×10^{14} cm/sec accurate upto 0.001%. Mass of an electron is 9.1×10^{-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 $\frac{4\pi^2 m Z^2 e^4}{n^3 h^3}$.

3. Answer any **one** question:

5 × 1 = 5

a) Calculate the electronegativity of As in AsF_3 and AsF_5 . Given: $E_{\text{As-As}} = 146 \text{ kJmole}^{-1}$, $E_{\text{F-F}} = 155 \text{ kJmole}^{-1}$, $E_{\text{As-F}}(\text{AsF}_3) = 484 \text{ kJmole}^{-1}$, $E_{\text{As-F}}(\text{AsF}_5) = 406 \text{ kJmole}^{-1}$, $X_{\text{p}}(\text{F}) = 4.0 \text{ ev}$.

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

$$R_{1,0}(r) = 2 \left[\left(\frac{Z}{a_0} \right)^3 \exp\left(-Zr/a_0\right) \right].$$

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 Sommerfeld 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.

$$2 \times 5 = 10$$

GROUP-B

(Physical)

5. Answer any **two** questions: $2 \times 2 = 4$
- 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: $1 \times 1 = 1$

- a) What is an adiabatic process?
- b) Which experiment showed gas particles interact through attractive force between them?

7. Answer any **one** question: $5 \times 1 = 5$

- 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 γ 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: $10 \times 1 = 10$

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

- ii) Transform the equation of state

$$\left(p + \frac{a}{V^2} \right) V = RT \text{ into virial form and}$$

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 $3.34 \text{ \AA}$.

- 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)