U.G. 1st Semester Examination - 2021
CHEMISTRY
[HONOURS]
Course Code : CHEM-H-CC-T-01

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.

GROUP–A
(Inorganic)
[Marks : 20]

1. Answer any **one** question: 1×1=1

   a) Write down the value of spin multiplicity for the ground state of N.

   b) What do you mean by effective nuclear charge?

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

   a) Discuss the penetrating power of the different orbitals.

   b) Calculate Z^* and σ for one 3d electron of Cu.

   c) Electron can never at rest in an atom-explain why?

[Turn Over]

d) Calculate the ratio of the value of Rydberg constant of Be^{3+} ion with that of He^+ ion.

3. Answer any **one** question: 5×1=5

   a) What is radial distribution function? Draw a qualitative plots of radial probability functions against distance from the nucleus for 3s atomic orbital of hydrogen atom. What information would you get from these plots?   1+3+1

   b) Determine the ground state term symbol for the Cr atom. Prove that the ionization potential of Na (g) is equal in magnitude with Electron affinity of Na^+(g) but opposite in sign.   3+2

4. Answer any **one** question: 10×l=10

   a) i) Determine the number of microstates associated with ^4P and ^3F term.

   ii) A cricket ball weight is 200g. If the uncertainty in its position is 5 pm what is the uncertainty in the velocity of the ball?

   iii) Offer an explanation for the fact that the spectrum of atomic hydrogen consists of a series of lines even though H has only one electron.

iv) Briefly discuss Sommerfeld's atomic model/theory. 2+3+2+3

b) i) The interionic distance in chlorine molecule is 1.98 Å. Calculate the Allred Rochow electronegativity using Slater's rule.

ii) Discuss Pauling method for the determination of univalent ionic radii.

iii) Define and compare between covalent radii and van der Waals radii.

iv) Third ionization enthalpy of Mn is exceptionally high - explain why?

3+3+2+2

GROUP-B

(Physical)

[Marks :20]

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

a) Draw the PV vs. P curve with explanation when the gas equation is $P(V-b) = RT$.

b) For a process at constant pressure, $\Delta H = Q_p$. Does it follow that Q_p is a state function? Give reason.

6. Answer any **two** questious: $2 \times 2 = 4$

a) For a gas at $T_c = 304.2$ K and $P_c = 73.746 * 10^5$ Pa, calculate the van der Waal's constants and radius of gas molecules.

b) Explain the effect of temperature rise on the mean free path of an ideal gas held at constant pressure.

c) A certain mass of an ideal gas expands into vacuum to twice its initial volume. Calculate ΔU and ΔS for the proccss.

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

a) Define critical pressure, critical volume, and critical temperature by drawing Andrew's plot. Explain that the value of Cp-Cv of all ideal gases is the same but the value of Cp/Cv is different. 3+2

b) Calculate the enthalpy of formation of NH_3 given the enthalpy of combustion of NH_3 and H_2 as -90.6 and - 68.3 kcal mol^{-1} respectively. What is the reduced equation of state? 3+2

c) Calculate the entropy-change when Argon at 25°C and 1.00 atm pressure in a container of volume 500 ml is allowed to expand to 1000 ml and is heated simultaneously at 100°C.

$(C_v = 12.48 \text{ J mol}^{-1} \text{ K}^{-1}$ for Argon at 25°C and 1 atm).   5

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

a)   Write Maxwell's three-dimensional formula for the molecular velocity distribution of gas. Explain the corresponding distribution function. Draw a graph of how this distribution changes with temperature. Explain the Amagat's plot of CO_2 at 40°C using the van der Waals equation. What is the principle of equipartition of energy? Explain.

$1+2+2+2+1+2=10$

b)   Calculate w, q, ΔU, ΔH for (i) isothermal and reversible, (ii) isothermal and irreversible, (iii) adiabatic and reversible (iv) adiabatic and irreversible processes. Tabulate these results and state what important conclusions you can draw from these results. Plot P - V curves for adiabatic and isothermal changes.

[Given, $C_v=1.5R$]. $2+2+2+2+1+1=10$

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