Register No:

Date: 15-01-2020

ST. JOSEPH'S COLLEGE (AUTONOMOUS) BANGALORE-27

B.Sc. CHEMISTRY-I SEMESTER

SEMESTER EXAMINATION- January 2020

CH 118: CHEMISTRY-I

Time:2.5hrs **Max Marks:70**

Note: This question paper has three parts and 21 questions. All parts are compulsory.

PART A

Answer any six of the following. Each question carries 2 marks. **2*6 =12 Marks**

Q.1 What is photoelectric effect? Why photoelectric effect cannot be explained on the basis of classical wave theory.

Q.2 What is the significance of Maxwell Boltzmann distribution law?

Q.3 Write the Born Lande' equation. What are the terms involved?

Q.4 Define lattice energy. How is it related to melting point of ionic solids?

Q.5 How many atoms of Calcium are present in 87.3g of Ca? The gram atomic mass of Ca is 40.08g. (Avogadro no. = 6.023×10^{23})

Q.6 Write any two statements of the first law of thermodynamics. Give its mathematical representation and explain the terms involved.

Q.7 State any two postulates of statistical thermodynamics.

Q.8 Define covalent radius. What is the trend in covalent radii across a period?

PART B

Answer any eight of the following. Each question carries 6 marks **8*6=48 Marks**

Q.9 a) Write an expression for the allowed energy levels for a particle in the three dimensional cubic box and explain the terms therein. Give the set of quantum numbers of the degenerate states corresponding to the energy with total energy equal to i) $11(h^2/8ma^2)$ ii) $12(h^2/8ma^2)$ for a particle in a cubical box.

b) Calculate the energy corresponding to the energy level (n=2) of an electron constrained to move in a one-dimensional box of width 1 Å. Given h= 6.626×10^{-34} Js, mass of electron= 9.109×10^{-31} kg, 1Å = 1×10^{-10} m

3+3

Q.10 a) Write the time independent Schrodinger wave equation for a particle inside 1 dimensional box and explain the terms therein. Draw the radial distribution curve of 3s orbital and also indicate the nodes.

b) Write all the possible values of magnetic quantum number (m) for an electron in 4f, 3d and 2p orbital.

3+3

Q.11 Based on exchange energy, pairing energy, promotional energy and symmetric distribution of charge, explain why a $3d^5 4s^1$ electronic configuration is more stable than $3d^4 s^2$ configuration of Cr 24 (Z-29)

6

Q.12 a) With proper reasoning, predict the geometry of the following molecules using VSEPR theory:

i) ClF_3 ii) SF_4

b) Discuss any three factors affecting the electronegativity.

3+3

Q.13 a) Write the Lewis structure of the following species and indicate the one which does not obey Lewis octet rule. Also, calculate the formal charge on the central atom of the species obeying the Lewis octet rule.

(i) SO_4^{2-} (ii) PF_5

b) Draw the anti-bonding and bonding molecular orbital formed by overlapping of p-p atomic orbitals.

3+3

Q.14 a) State the Heisenberg's uncertainty principle. Calculate the uncertainty in position of an electron if the uncertainty in velocity is 5.7×10^5 ms^{-1}. Given h= 6.626×10^{-34} Js, mass of electron= 9.109×10^{-31} kg

b) Neon(Ne) has three isotopes. ^{20}Ne has a mass of 19.992 amu and an abundance of 90.48%, ^{21}Ne has a mass of 20.994 amu and an abundance of 0.27%, and ^{22}Ne has a mass of 21.991 amu and an abundance of 9.25%. Calculate the average atomic mass of Neon.

3+3

Q.15 a) On the basis of effective nuclear charge, explain the trend in atomic size down the group. Why cation is much smaller than the corresponding atom whereas anion is invariably larger than their corresponding atom?

b) For the reaction $C+2H_2 \rightarrow CH_4$. What weight of CH_4 will be produced when 10.0g of H_2 reacts with 5.0g of C. Which is the limiting reactant and how much excess moles of reactant is left after the completion of reaction? Atomic mass unit of C and H is 12.01 amu and 1.00 amu, respectively.

3+3

Q.16 a) Derive the expression for the work done in isothermal reversible expansion of an ideal gas?

b) Calculate the amount of heat necessary to raise 213.5 g of water from 25 °C to 100 °C. Molar heat capacity of water is 75.42 $J\ K^{-1}\ mol^{-1}$. Atomic mass unit of O and H is 15.99 amu and 1.00 amu, respectively.

3+3

Q.17 a) Using band theory explain the difference between conductors, semiconductors and insulators.

b) Define thermodynamic probability. Give its mathematical representation and explain the terms involved.

3+3

Q.18 a) What is resonance stabilization energy? Draw the Lewis structure and the resonance structures of CO_3^{2-} ion.

b. i) Distinguish between isothermal and adiabatic process ii) A piece of zinc of mass 5.0 g is placed in a beaker of dilute hydrochloric acid. Calculate the work done by the open system as a result of the reaction. The atmospheric pressure is 1.1 atm and the temperature 23°C. Assume volume of gas, V_g is much larger than volume of liquid V_l ($V_g >> V_l$). (Zn = 65.4 $gmol^{-1}$, R = 8.314 $JK^{-1}mol^{-1}$)

3+3

PART C

Answer any two of the following. Each question carries 5 marks. 2*5 =10 Marks

Q.19 a) Calculate the de Broglie wavelength of an electron travelling at 1% of the speed of light. (mass of electron = 9.11×10^{-31} kg, h = 6.62×10^{-34} kgm^2/s, c = 3×10^8 ms^{-1}). What would be the mass of a particle traveling at twice the speed and having the same de Broglie wavelength as that of the electron?

b) The first ionization energy of K is lower than Ca whereas the second ionization energy of K is higher than Ca. Explain

3+2

Q.20 a) Oxygen can form O_2^+, O_2^-, and O_2^{2-} ionic species. Draw the MO energy level diagram of the oxygen species showing diamagnetic behavior. Calculate the bond order of O_2 and O_2^+ and compare their bond length.

b) Deduce the ground state electronic configuration of CO molecule.

3+2

Q.21 a) In the Ostwald process, NO is oxidised to NO_2 in the second step. In the third step, the NO_2 is converted to nitric acid on absorption of water. Write balanced chemical equation for both the steps. How many grams of HNO_3 can be produced from 12g of NO and 5ml of water? (Atomic mass of O:15.99 amu; H:1.00 amu, N: 14.00 amu)

b) The heat of reaction at constant pressure for the combustion of 1 mole of liquid benzene at 25 °C is given by

$$C_6H_6(l) + \frac{7}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l) \qquad \Delta H = -3267620\ J$$

What would be the heat of reaction at constant volume? R = 8.314 $JK^{-1}mol^{-1}$

3+2

CH118- A-2D