

RAMAKRISHNA MISSION VIDYAMANDIRA
(Residential Autonomous College affiliated to University of Calcutta)

FIRST YEAR [2018-21]

B.A./B.Sc. FIRST SEMESTER (July – December) 2018

Mid-Semester Examination, September 2018

Date : 24/09/2018

Time : 11 am – 1pm

INDUSTRIAL CHEMISTRY (Honours)

Paper: I

Full Marks : 50

[Use a separate Answer Book for each Unit]

Unit - I

Answer any three questions from question no. 1 to 5.

(3×5)

1. a) Arrange the third period elements with increasing second ionization energy values. 2
b) Is atomic density a periodic property? If yes, justify your answer. 1+1
c) Write the IUPAC name for element with atomic no. 109. 1
2. a) Why is the ionization potential of Phosphorus greater than sulphur? Name the element 'X' in the third period of periodic table having three unpaired electrons? 2+1
b) Write the relationship between electronegativity values on Pauling and Mulliken scale. Which is the most ionic compound? 1+1
3. Choose the correct option: (5 × 1)
 - a) Which of the following noble gases has its ionization potential value closest to O₂?
(i) He (ii) Ne (iii) Xe (iv) Ar
 - b) Largest difference in radii is found in case of which pair
(i) Li, Na (ii) Na, K (iii) K, Rb (iv) Rb, Cs
 - c) Which orbital is most penetrating to the nucleus among the following given below?
(i) 2p (ii) 5s (iii) 2s
(iv) More than one option is correct
 - d) Which is the main cause for diagonal relationship among elements?
(i) Low electron affinity (ii) Equal Ionisation Potential
(iii) High electronegativity difference (iv) None of these
 - e) Which group of the periodic table is known as *coinage metals*?
(i) Group 12 (ii) Group I-B (iii) Group 2 (iv) None of these
4. a) Mention the merits and demerits of Bohr's theory.
b) The electron energy in hydrogen atom is given by $E = -(21.7 \times 10^{-12}) / n^2$ erg. Calculate the energy required to remove an electron completely from $n = 2$ orbit. What is the wavelength of light (in cm) that can be used to cause this transmission? 3+2

5. a) What does azimuthal quantum number and magnetic quantum number indicate?
 b) According to Bohr's theory, the electronic energy of H-atom in the Bohr's orbit is given by $E = -\left(21.7 \times 10^{-19}\right) / n^2$ Joule. Calculate the largest wavelength that will be needed to remove an electron from the 3rd Bohr orbit of He^+ ion.

3+2

Unit - II

Answer any two questions from question no. 6 to 9

(2 × 5)

6. a) Define 'thermodynamic equilibrium'.
 b) State 'Zeroth law' of thermodynamics. From this derive the idea of 'empirical temperature'.
7. During a quasi-static adiabatic expansion of an ideal gas, prove the following relation $PV^\gamma = \text{const}$, where, P, V are respectively the pressure and volume of the gas and γ is a constant. Show that the work done in expanding from the state (P_i, V_i) to a state (P_f, V_f) is

2+3

$$W = \frac{P_i V_i}{\gamma - 1} \left[1 - \left(\frac{P_f}{P_i} \right)^{\frac{\gamma - 1}{\gamma}} \right].$$

5

8. a) The molar heat capacity at constant pressure of a gas varies with the temperature according to the relation $c_p = a + bT - \frac{c}{T^2}$ where, T is temperature and a, b, c are constants. How much heat is transferred during an isobaric process in which n moles of gas undergo a temperature rise from T_i to T_f ?
 b) The molar heat capacity of a metal at low temperature varies with the temp (T) according to the relation $C = \frac{a}{T^3} + bT$ where a, T_0, b are constants. How much heat is transferred during a process in which the temperature changes from T_0 to $2T_0$?
9. a) Write down the operational principle of a 'Carnot engine' with a schematic indicator diagram.
 b) Starting with the efficiency relation of a Carnot engine, derive the idea of Kelvin temperature scale.

2+3

2+3

Answer any one question from question no. 10 to 11

(1 × 5)

10. a) What is the density (in g/L) of a gas with a molar mass of 60 g/mol at 0.75 atm and 27°C?
 b) The partial pressure of argon in the atmosphere is 0.0093 atm. What is the argon pressure at 50 km if the temp is 20°C? $g = 9.807 \text{ m/s}^2$, in SI, 0.0399 kg/mol.
 c) What is the shape of P-V curve for Ideal gas?

2+2+1

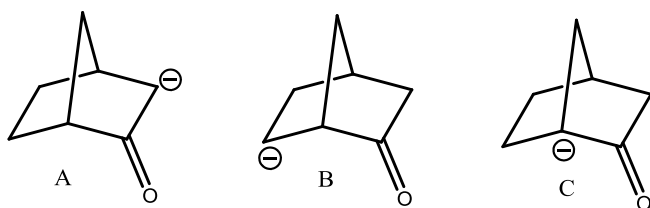
11. a) Write down the Maxwell distribution expresses. Derive most probable speed using this distribution function. 1+2
- b) What is “degree of freedom”? Calculate the total degree of freedom of linear diatomic molecule. 1+1

Unit - III

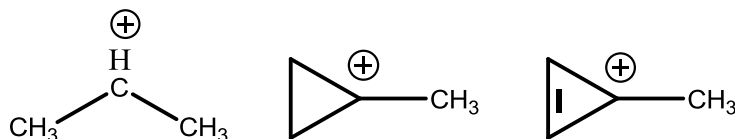
Answer any four questions from question no. 12 to 17.

(4 × 5)

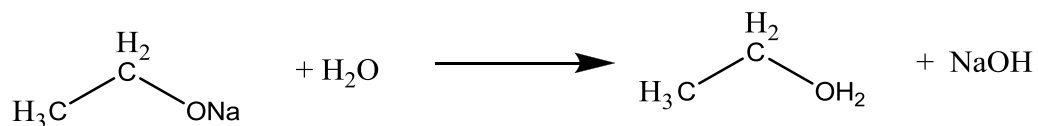
12. Choose the correct answer: 1 × 5
- a) Negative charge of carbanion can be dispersed by
 (i) (+I) effect and resonance (ii) (–I) effect and resonance
 (iii) Hyperconjugation (iv) (+M) effect and resonance
- b) Which of the following free radical has the maximum ease of formation?
 (i) 1° (ii) 2° (iii) 3° (iv) CH₃
- c) The shape of carbocation is
 (i) Pyramidal (ii) Bent (iii) Linear (iv) Trigonal Planar
- d) Correct statement about energy of carbene is
 (i) Singlet and triplet carbene has equal energy
 (ii) Singlet carbene has higher energy than triplet carbene
 (iii) Singlet carbene has lower energy than triplet carbene
 (iv) None of the above
- e) A substance that donates a pair of electrons to form coordinate covalent bond is called
 (i) Lewis acid (ii) Lewis base
 (iii) Bronsted-Lowry acid (iv) Bronsted-Lowry base
13. a) Arrange the following carbanions in increasing order of stability with justification: 3



- b) Arrange the following carbocations in increasing order of stability with justification: 2



14. a) Give the example of a singlet and a triplet carbene. Comment on their bond angle. 2
- b) Among these which combinations act as strong acid. 2
 Aniline in liquid ammonia; acetic acid in water; acetic acid in con. Sulphuric acid; acetic acid in liquid ammonia.
- c) Indicate the strong and weak acid-base in the chemical equation: 1



15. a) Draw the orbital picture of allene and isoprene indicating the state of hybridisation of carbon atoms.
- b) Phenol does not exist as cyclohexadienone. Explain. 2+2+1
16. a) Arrange the following molecules in increasing order of dipole moment with proper explanation: CH_3F , CH_3Cl , CH_3Br , CH_3I
- b) Write the difference between tautomerism and mesomeric effect. $2 \times 2\frac{1}{2}$
17. a) Draw the different resonating structure of diazomethane and find out the most contributing structure from them.
- b) Between ortho and para nitrophenol which one is higher boiling and why? 3+2

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