

2021

Time : 3 Hours

Full Marks : 100

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

Answer any five questions in which Q No. 1 is compulsory.

1. Select the most appropriate answer of the following. $2 \times 10 = 20$

(a) To every observable is classical mechanics the operator in quantum mechanics is :

- (i) Linear only
- (ii) Hermitian only
- (iii) Linear and Hermitian
- (iv) None

(b) The probability of finding the electron at a distance r from the nucleus is called :

- (i) Basic
- (ii) Acidic
- (iii) Neutral
- (iv) None

(f) Which of the following compounds involves $\pi \rightarrow \sigma^*$ transition :

- (i) Saturated halides
- (ii) Alcohols
- (iii) Aldehydes
- (iv) All

(g) The quantum yield of the photochemical reaction $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$ is :

- (i) High
- (ii) Low
- (iii) Both (i) and (ii)
- (iv) Zero

(h) The total molecular partition function is the product of :

(i) Angular probability distribution

(ii) Radial probability distribution

(iii) Both (i) and (ii)

(iv) None

(c) The selection rules for transitions between the vibrational-rotational levels are :

(i) $\Delta V = \pm 1, \Delta J = 1$

(ii) $\Delta V = \pm 1$

(iii) $\Delta J = 1$

(iv) $\Delta V = \pm 1, \pm 2, \pm 3$ and $\Delta J = \pm 1$

(d) If Ψ_1 and Ψ_2 are two set of Eigen functions,

$\int \Psi_1 \Psi_2 di = 0$, the wave function is :

(i) Normalized

(ii) Orthogonal

(iii) Both (i) and (ii)

(iv) All

(e) When salts of strong bases and weak acids are hydrolyzed, the resulting solution is :

(i) Translational and vibrational partition function

(ii) Translational and rotational partition function

(iii) Rotational and vibrational partition function

(iv) Translational, rotational and vibrational partition function

(i) The dipole moment of BF_3 molecule is :

(i) 1 D

(ii) 1.51 D

(iii) 1.297 D

(iv) Zero

(j) For salts of weak acids and weak bases :

(i)
$$Kh = \frac{Kw}{Ka \times Kb}$$

(ii)
$$Kh = \frac{Kw}{Kb}$$

(iii) $K_h = \frac{K_w}{K_a}$

(iv) All

2. Explain Einstein law of photochemical equivalence. What are primary and secondary processes? Explain the reasons of low and high quantum yield. 10+5+5=20
3. Explain the translational, rotational and vibrational partition function. Derive an expression for the molecular translational partition function of an ideal gas. 10+10=20
4. What do you mean by selection rule? What is the selection rule for pure vibrational and pure rotational spectra? Which of the following molecules may give the rotational spectrum? H_2, HCl, N_2, DCl 5+5+10=20
5. Define P^H and P^{K_a} . Derive Henderson equation for a buffer. How can P^H be determined from a quinhydrone electrode?

Calculate the P^H before and after the addition of 0.01 mole of NaOH to 1 liter of a buffer solution of 0.1 M acetic acid and 0.1 M in sodium acetate. The value of P^{K_a} is 4.76
5+5+5+5=20

6. Explain solubility and solubility product of a sparingly soluble salt? How is solubility product determined from e. m. f. measurements.
The solubility of AgCl in water at 25°C is 0.00179 g per litre. calculate its solubility product. 6+9+5=20
7. Explain dipole moment. How can we measure dipole moment from refractivity method what information regarding the structure of molecule can be obtained from dipole moment. 5+10+5=20
8. Write the Schrodinger wave equation for H- atom. What are the polar co-ordinates? How quantum numbers are related with polar co-ordinates of H atom? 2+3+5+10=20
Define radial wave functions and its significance.

9. Write short notes on any four of the following: $5 \times 4 = 20$

- (a) Paramagnetism, diamagnetism and ferromagnetism
- (b) Franck-Condon principle
- (c) Isotope effect in Rotational spectrum
- (d) Black body radiation
- (e) Potentiometric titration
- (f) Angular wave functions
- (g) Polarizability and selection rule in Raman spectra.

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