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. 2×10=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) 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) Basic

(ii) Acidic

(iii) Neutral

(iv) None

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

(i) Saturated halides

(ii) Alcohols

(iii) Aldehydes

(iv) All

(g) The quantum yield of the photochemical reaction $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ is :

(i) High

(ii) Low

(iii) Both (i) and (ii)

(iv) Zero

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

(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) 1.51D

(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) $Kh = \frac{Kw}{Ka}$

(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^{Ka}. 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^{Ka} 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: 5×4=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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