Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Science

End Sem (Odd) Examination Dec-2018

BC3EP04 Quantum Mechanics and Spectroscopy

Programme: B.Sc. (CS) Branch/Specialisation: Computer Science

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. Which statement is correct: **1**

(a) Velocity of matter wave is less than velocity of light
(b) Phase velocity represents the average velocity of all the waves present inside the wavepacket.
(c) Only moving particle have wave associated with them
(d) Both (b) and (c)

ii. Uncertainty principle is applicable to: **1**

(a) Energy and time
(b) Position and momentum
(c) Angular momentum and angle
(d) All of these

iii. The probability of finding the particle is given by: **1**

(a) Amplitude (b) Wavefunction
(c) Frequency (d) Oscillations

iv. In the Schrodinger's equation $H\Psi = E\Psi$, H represents: **1**

(a) Hamiltonion Operator (b) Hemesberg's Operator
(c) Hilton's Operator (d) Hesenberg's Operator

v. A particle with energy less than the barrier penetrates it, this phenomenon is termed as: **1**

(a) Penetration (b) Tunneling
(c) Crossing (d) None of these

P.T.O.

vi. Alpha particles have relatively **1**
(a) Low kinetic energies (b) High potential energy
(c) High mechanical energy (d) High kinetic energy

vii. Bohr postulated in his model quantisation of **1**
(a) Energy (b) Linear momentum
(c) Angular momentum (d) Spin

viii. The effect of splitting a spectral line into several components in the presence of a static magnetic field is: **1**
(a) Zeeman effect (b) Stark effect
(c) Raman effect (d) Doppler's effect

ix. Which device is called circular accelerator? **1**
(a) LINAC (b) Counter (c) Cyclotron (d) None of these

x. In GM Counter GM stands for: **1**
(a) General manager (b) Geiger Muller
(c) Garry Morley (d) Garry Mathew

Q.2 i. Calculate the de-Broglie wavelength of a virus particle of mass 1.0×10^{-15} kg moving at a speed of 2.00 mm/sec. **2**

ii. Define wavepacket. Using the concept of wavepacket explain Heisenberg's Uncertainty principle. **3**

iii. Explain in detail the experiment which proved the existence of matter wave. **5**

OR iv. What is Compton's effect? Derive an expression for Compton's shift. **5**

Q.3 i. Explain in brief: **3**
(a) Physical significance of Wavefunction
(b) Normalization of Wavefunction

ii. Derive the Schrodinger's Time independent and Time dependent wave equation. **7**

OR iii. Calculate the energy value and wavefunction for a particle enclosed between an infinite potential well. **7**

Q.4 i. Explain the concept of alpha particle decay. **3**

ii. Explain mathematically the reflection of particle from a potential step. **7**

OR iii. Obtain ground state wavefunction for hydrogen atom using Schrodinger equation. **7**

Q.5 i. Briefly explain Emission spectra of Hydrogen atom. **3**

ii. Write short note on **7**
(a) Stern-Gerlach experiment
(b) L-S and J-J Coupling

OR iii. Explain Normal and Anamalous Zeeman Effect. **7**

Q.6 Attempt any two:

i. Write short note on **5**
(a) Liquid drop model
(b) Bainbridge mass spectrograph

ii. Explain the working of Linear particle accelerator. Give its advantages and disadvantages. **5**

iii. Explain the working of G.M Counter. **5**

******

Marking Scheme

BC3EP04 Quantum Mechanics and Spectroscopy

Q.1	i.	Which statement is correct: (d) Both (b) and (c)	**1**
	ii.	Uncertainty principle is applicable to: (d) All of these	**1**
	iii.	The probability of finding the particle is given by: (b) Wavefunction	**1**
	iv.	In the Schrodinger's equation $H\Psi = E\Psi$, H represents: (a) Hamiltonion Operator	**1**
	v.	A particle with energy less than the barrier penetrates it, this phenomenon is termed as: (b) Tunneling	**1**
	vi.	Alpha particles have relatively (d) High kinetic energy	**1**
	vii.	Bohr postulated in his model quantisation of (a) Energy	**1**
	viii.	The effect of splitting a spectral line into several components in the presence of a static magnetic field is: (a) Zeeman effect	**1**
	ix.	Which device is called circular accelerator? (c) Cyclotron	**1**
	x.	In GM Counter GM stands for: (b) Geiger Muller	**1**
Q.2	i.	Calculate the de-Broglie wavelength of a virus particle of mass 1.0×10^{-15} kg moving at a speed of 2.00 mm/sec.	**2**
		Formula — 1 mark	
		Ans 3.31×10^{-16} m — 1 mark	
	ii.	Define wavepacket. Using the concept of wavepacket explain Heisenberg's Uncertainty principle.	**3**
		Define wave packet — 1 mark	
		Explanation of Heisenberg's Uncertainity principle — 2 marks	
	iii.	Explain in detail the experiment which proved the existence of matter wave.	**5**
		Name of Experiment — 1 mark	
		Diagram — 1 mark	
		Proof — 3 marks	
OR	iv.	What is Compton's effect? Derive an expression for Compton's shift.	**5**
		Compton's effect statement — 1 mark	
		Formation of conservation equations — 1.5 marks	
		Expression of compton's — 0.5 mark	
		Derivation of equation — 2 marks	
Q.3	i.	Explain in brief:	**3**
		(a) Physical significance of Wavefunction — 1.5 marks	
		(b) Normalization of Wavefunction — 1.5 marks	
	ii.	Derive the Schrodinger's Time independent and Time dependent wave equation.	**7**
		Schrodinger's Time independent equation — 4 marks	
		Time dependent wave equation — 3 marks	
OR	iii.	Calculate the energy value and wavefunction for a particle enclosed between an infinite potential well.	**7**
		Diagram and Explanation of problem — 2 marks	
		Boundary Condition — 1.5 marks	
		Energy values — 2 marks	
		Wave function — 1.5 marks	
Q.4	i.	Explain the concept of alpha particle decay.	**3**
		About alpha particle — 1 mark	
		Rest concept — 2 marks	
	ii.	Explain mathematically the reflection of particle from a potential step.	**7**
		Diagram — 1 mark	
		Formation of equation — 2 marks	
		Boundary condition — 1 mark	
		Final Result — 3 marks	
OR	iii.	Obtain ground state wavefunction for hydrogen atom using Schrodinger equation.	**7**
		Diagram — 1 mark	
		Formation of equation — 2 marks	
		Boundary condition — 1 mark	
		Final Result — 3 marks	
Q.5	i.	Briefly explain Emission spectra of Hydrogen atom.	**3**

	ii.	Write short note on		**7**
		(a) Stern-Gerlach experiment	3.5 marks	
		(b) L-S and J-J Coupling	3.5 marks	
OR	iii.	Explain Normal and Anamalous Zeeman Effect.		**7**
		Diagram	1 mark	
		Set-up; Statement	3 marks	
		Rest	3 marks	
Q.6		Attempt any two:		
	i.	Write short note on		**5**
		(a) Liquid drop model	2.5 marks	
		(b) Bainbridge mass spectrograph	2.5 marks	
	ii.	Explain the working of Linear particle accelerator. Give its advantages and disadvantages.		**5**
		Diagram	1 mark	
		Working	2 marks	
		Advantage + disadvantage	2 marks	
	iii.	Explain the working of G.M Counter.		**5**
		Diagram	2 marks	
		Rest	3 marks	

******