[124] SEAT No._____ No. of Printed Pages : 2

SARDAR PATEL UNIVERSITY
Vallabh Vidyanagar
M. Sc. (Physics) 2nd Semester Examination
Monday, 18th March, 2019
Time: 02:00 pm to 05:00 pm
Subject: PS02CPHY21 [Classical and Quantum Mechanics]
Total Marks: 70

Note: (1) Figures to the right indicate marks.
(2) Symbols have their traditional meaning.

Q:1 **Attempt all of the following Multiple-choice type questions. [01 mark each]** [08]

(1) Time independent constraints are known as_____.
(a) holonomous (c) scleronomous
(b) non-holonomous (d) rhenomous

(2) _____ of the system is given by D'Alembert's principle.
(a) Virtual displacement (c) Relative displacement
(b) Actual displacement (d) Virtual energy

(3) $[u, vw] =$ _____ $+ v[u, w]$
(a) $[u, v]w$ (c) $[uv, w]$
(b) $u[v, w]$ (d) $[v, uw]$

(4) Hamilton Jacobi equations has _____ variables.
(a) n-1 (c) n+1
(b) n (d) n-2

(5) $L_z/\hbar$ plays the role of generator of infinitesimal _____.
(a) rotations (c) inversion
(b) translation (d) spinor

(6) $\sum_{a,i} |ai\rangle\langle ai| =$
(a) δ_{ai} (c) 0
(b) δ_{ia} (d) $\hat{1}$

(7) $[J_+, J_-] =$
(a) $2\hbar J_x$ (c) 0
(b) $2\hbar J_z$ (d) $2\hbar J_y$

(8) $\frac{1}{2}(J_+ - J_-) =$
(a) Jx (c) 0
(b) Jy (d) Jz

(P.T.O.)

Q:2 **Answer any 7 of the following 9 questions briefly. [02 marks each]** [14]

1 Write the condition for a transformation to be canonical and prove it.
2 Explain constraints using examples.
3 Define with suitable examples, types of equilibrium.
4 Explain normal modes of vibration. Write expression of frequency.
5 Define Hilbert space.
6 Show that any operator is diagonal in its own representation.
7 Obtain the relation $\left[\Sigma_x, \Sigma_y\right] = i\Sigma_z$.
8 Find $\left[J_z, J_+\right]$ and $\left[J_z, J_-\right]$.
9 What are C-G coefficients?

Q:3 (a) Explain infinitesimal transformation and discuss the relation between infinitesimal transformation and Poisson's bracket. [6]

(b) Discuss and derive the equation of canonical transformation. Using it solve the problem of simple harmonic oscillator in one dimension. [6]

OR

(b) Explain D'Alembert's principle. Using it derive Lagrange's equation. [6]

Q:4 (a) Define Hamilton Jacobi equation and discuss the harmonic oscillator in the Hamilton Jacobi method. [6]

(b) Discuss in detail coupled oscillator and find its coordinates and frequency. [6]

OR

(b) Discuss the linear triatomic molecule in detail and derive eigen frequencies and eigen vectors for the molecule. [6]

Q:5 (a) Explain representation of state vectors. Deduce the relation $(\chi)_A = [F]_A (\psi)_A$. [6]

(b) Explain the unitary transformation induced by translation of coordinate system and show that $\left|x\right\rangle' = e^{-i\xi \hat{p}_x/\hbar}\left|x\right\rangle$. [6]

OR

(b) Considering continuous basis show that $\left\langle x\right|\hat{p}\left|\psi\right\rangle = -i\hbar\frac{\partial\psi}{\partial x}$. [6]

Q:6 (a) Explain spin angular momentum and for a spin-1/2 particle show that $\vec{S} = \frac{1}{2}h\vec{\sigma}$. [6]

(b) Discuss the matrix representation of J in the |jm> basis. [6]

OR

(b) Write a note on addition of angular momentum. [6]

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