2015

(5th Semester)

PHYSICS

SEVENTH PAPER

(Classical Mechanics and Thermal Physics)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* Show that a two-body problem can be reduced to a one-body problem. Hence obtain the equation of motion of the equivalent one body. 2+3=5

(b) Using Kepler's second law show that the force acting on a planet is central. 2

Or

(a) Deduce Hamilton's canonical equations from Lagrangian equation. 3

(b) Explain d' Alambert's principle and derive the equation of motion from generalized coordinates. 1+3=4

2. What is Brownian motion? Discuss Einstein's theory of translational Brownian motion. 1+6=7

Or

Explain Stern's experimental verification of Maxwell's law of distribution of velocities. 7

3. (a) What is triple point? 1

(b) Discuss Saha's theory of thermal ionisation. Mention its applications. 5+1=6

Or

(a) Derive differential equation for diffusion of gases. 3

(b) Define entropy. Show that the entropy of a perfect gas remains constant in a reversible process but increases in an irreversible process. 1+3=4

4. (a) Starting with Boltzman distribution law, deduce an equation for the equipartition of energy. 5

(b) Differentiate between accessible and inaccessible states. 2

Or

(a) What do you mean by ensemble? Discuss the different types of ensemble. 1+3=4

(b) State and explain equal a priori probability. 1+2=3

5. (a) From MB distribution law, deduce the equation for the wave function and the energy levels of a single particle in a rectangular box. 2+2=4

(b) Deduce an equation for Fermi-Dirac statistics. 3

Or

Establish the Stefan-Boltzman law of blackbody radiation and hence establish an expression for radiation pressure. 5+2=7

★ ★ ★

2015

(5th Semester)

PHYSICS

SEVENTH PAPER

(Classical Mechanics and Thermal Physics)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 5)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×5=5

1. The gravitational potential outside the shell due to their spherical shell is given by

(a) $V = -\frac{GM}{r}$ ( )

(b) $V = \frac{GM}{r}$ ( )

(c) $V = \frac{GM}{r^2}$ ( )

(d) $V = -\frac{GM}{r^3}$ ( )

2. The r.m.s. velocity of an ideal gas is directly proportional to

(a) T^2 ( )

(b) T^3 ( )

(c) $T^{1/3}$ ( )

(d) $T^{1/2}$ ( )

3. The enthalpy during an isobaric process is given by the relation

(a) $h_f + h_i = H$ ( )

(b) $h_f - h_i = H$ ( )

(c) $h_i - h_f = H$ ( )

(d) None of the above ( )

4. The canonical particle function of a discrete system is given by

(a) $z = \Sigma\, e^{E/k_B T}$ ( )

(b) $z = \Sigma\, e^{-E/k_B T}$ ( )

(c) $z = \Sigma\, e^{k_B T/E}$ ( )

(d) $z = \Sigma\, e^{-k_B T/E}$ ( )

5. The mean occupation number of particles in any energy state ε_s is given by

(a) $\langle n_s \rangle = \dfrac{1}{e^{\beta(\varepsilon_s + \mu)} \pm 1}$ ( )

(b) $\langle n_s \rangle = \dfrac{e^{\beta(\varepsilon_s + \mu)} \pm 1}{N}$ ( )

(c) $\langle n_s \rangle = \dfrac{1}{e^{\beta(\varepsilon_s - \mu)} \pm 1}$ ( )

(d) $\langle n_s \rangle = e^{\beta(\varepsilon_s - \mu)} \pm 1$ ( )

SECTION—II

(*Marks* : 15)

Answer the following questions : $3 \times 5 = 15$

1. Establish Poisson's equation for Gravitational potential.

2. Show that n, the number of molecules per unit volume of an ideal gas is given by

$$n = \frac{PN}{RT}$$

where the symbols have their usual meanings.

3. Derive the specific heat relation

$$C_P - C_V = -T\left(\frac{\partial V}{\partial T}\right)_P^2 \left(\frac{\partial P}{\partial V}\right)_T$$

4. What is phase space?

5. How does Fermi energy vary with temperature?

***

Subject Code : **V/PHY (viii) (A)** **Booklet No. A** 172

....

....

V/PHY (viii) (A)

....

....

2015

(5th Semester)

led in by the
ıdidate

PHYSICS

Semester

EIGHTH (A) PAPER

ce / Commerce /

(**Spectroscopy**)

) Exam., 2015

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

ype

1. State Bohr's postulates for hydrogen-like atom. Derive an expression for total energy of the electron in the *n*th orbit of a hydrogen-like atom. What is the significance of the negative sign in the expression for energy? 2+4+1=7

Or

Discuss Stern-Gerlach experiment. Discuss its importance. 4+3=7

nature of
igilator(s)

2015

(5th Semester)

PHYSICS

EIGHTH (A) PAPER

(Spectroscopy)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. State Bohr's postulates for hydrogen-like atom. Derive an expression for total energy of the electron in the *n*th orbit of a hydrogen-like atom. What is the significance of the negative sign in the expression for energy? 2+4+1=7

Or

Discuss Stern-Gerlach experiment. Discuss its importance. 4+3=7

2. Apply Pauli's principle to account for the periodic classification of elements. 7

Or

Describe the general features of spectra of alkali-like atoms. Show how the concept of spinning electron accounts for the doubling of levels in the spectra of alkalies. 4+3=7

3. *(a)* Write down the rate equations for a three-level laser. 3

(b) Solve the rate equations under steady-state conditions and derive an expression for the population difference between the first and second energy levels for low laser powers. 4

Or

(a) What are the characteristic properties of laser light? 3

(b) Explain how the laser action can be produced by considering a three-level laser system. 4

4. *(a)* Give the general idea of Born-Oppenheimer approximation. 2

(b) Discuss the rotational spectra of polyatomic molecules. 5

Or

Considering vibrating diatomic molecule is a harmonic oscillator, obtain the expression for frequency, energy levels, and selection rules. 4+1+1+1=7

5. Explain the intensity variation of vibrational-electronic spectra using Franck-Condon principle. 7

Or

Write about the *P*, *R* and *Q* branches in the rotational fine structure of electronic-vibrational transitions of molecular spectra. Explain it by using appropriate diagram. 4+3=7

★★★

2015

(5th Semester)

PHYSICS

EIGHTH (A) PAPER

(Spectroscopy)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 5)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×5=5

1. The total energy of an electron in the first excited state of hydrogen atom is about $-3 \cdot 4$ eV. Its potential energy in this state is

(a) $3 \cdot 4$ eV ( )

(b) $6 \cdot 8$ eV ( )

(c) $-6 \cdot 8$ eV ( )

(d) $-3 \cdot 4$ eV ( )

2. In the doublet fine structure of hydrogen spectrum, which one of the following is not an allowed transition?

(a) $^2P_{3/2} \rightarrow {}^2D_{3/2}$ ( )

(b) $^2P_{3/2} \rightarrow {}^2D_{5/2}$ ( )

(c) $^2P_{1/2} \rightarrow {}^2D_{3/2}$ ( )

(d) $^2P_{1/2} \rightarrow {}^2D_{5/2}$ ( )

3. Laser is produced by

(a) stimulated emission ( )

(b) spontaneous emission ( )

(c) Both *(a)* and *(b)* ( )

(d) resonant scattering ( )

4. For a rigid diatomic molecule, the spectral lines are separated by a constant distance of

(a) $2B\ cm^{-1}$ ( )

(b) $3B\ cm^{-1}$ ( )

(c) $4B\ cm^{-1}$ ( )

(d) $5B\ cm^{-1}$ ( )

5. Stokes' lines in a Raman spectra are associated with

(a) frequency less than that of the incident radiation ( )

(b) frequency more than that of the incident radiation ( )

(c) frequency equal to that of the incident radiation ( )

(d) Independent of frequency of the incident radiation ( )

SECTION—II

(*Marks* : 15)

Give short answers of the following questions : 3×5=15

1. What is the highest state that unexcited hydrogen atoms can reach when they are bombarded with 12·6 eV electrons?

2. Derive an expression for the maximum number of electrons that can go into a shell with its principal quantum number *n*.

3. Write briefly about semiconductor laser.

4. State the transition rules for molecules as anharmonic oscillator.

5. What are the progressions in a vibrational coarse structure of molecular spectra?

***