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B.Sc Part-II Intermediate Examination 2020

Subject: Physics (Advanced)

F.M – 50 Paper – IV Time – 2 hours

Answer Q.1 and any four questions from the rest.

Q.1. Answer any five questions. (2×5 = 10)

a) Prove that the slope of adiabatic curve through a point in P-V graph is ϒ (= C_p/C_v) times the slope of the isothermal curve through the same point.

b) By applying uncertainty principle, explain the non-existence of electrons in the atomic nucleus.

c) Calculate the maximum possible efficiency of a heat engine working between 30°C and 300°C.

d) X-rays of wavelength 0.144 Å are scattered from a carbon target. Find maximum shift in wavelength of it.

e) What is normalization of a wave function? How it is mathematically expressed?

f) Prove that for any substance $Tds = C_v\, dT + T\left(\frac{\partial P}{\partial T}\right)_v dv$ where the symbols have their usual meaning.

g) Find the amount of work done during an isothermal expansion of a perfect gas.

Q.2. a) What is Compton effect? Derive an expression for Compton shift of scattered photon.

b) Calculate de-Broglie wavelength of an electron whose kinetic energy is 50 eV.

c) What do you mean by photo-electric work function? and also write the Einstein's photo-electric equation.

$\{(1+4)+2+3\}$

Q.3.a) Define group velocity of a wave packet. Find the relation between phase velocity and group velocity.

b) An electron has a momentum 5.4×10^{-26} Kg.m.s^{-1} with an accuracy of 0.05%. Find the minimum uncertainty in the location of the electron.

c) Prove the relation $\frac{\partial P}{\partial t} + \vec{\nabla}.\vec{J} = 0$ where $\vec{J}$ is probability current density and P is the probability density.

d) What is Hermitian operator? Discuss briefly. $\{(1+2)+2+3+2\}$

Q.4.a) Show that the wave equation $\Psi(x,t) = A\cos(kx - wt)$ does not satisfy time dependent Schrodinger wave equation for a free particle.

b) What do you understand by superposition of states?

c) State the Ehrenfest theorem and prove that $\langle p_x \rangle = m\frac{d\langle x \rangle}{dt}$ where $\langle p_x \rangle$ and $\langle x \rangle$ are the expectation values of momentum and position.

d) Using commutator relation, prove that $[x, p_x] = i\hbar$ $\{2 + 2 + (1 + 3) + 2\}$

Q.5.a) Calculate the depression of melting point of ice produced by one atmosphere increase of pressure. Given, the latent heat of ice = 80 cal/gm and specific volume of ice and water at 0°C are 1.091 cm^3 and 1.0 cm^3 respectively.

b) Calculate the change in entropy of a system containing 1 Kg ice at 0°C which melts at the same temperature. Latent heat of ice 80 Kcal/Kg.

c) State Carnot's theorem.

d) State Zeroth law of thermodynamics and explain its significance.

$\{3 + 2 + 2 + (2 + 1)\}$

Q.6.a) What is thermal equilibrium? Explain why the temperature of a gas drops in adiabatic expansion?

b) Derive Clapeyron's equation $\frac{dP}{dT} = \frac{L}{T(v_2 - v_1)}$ from Maxwell's thermodynamical relations.

c) What is Joule-Thomson effect? Show that, the value of Joule-Thomson co-efficient is zero for a perfect gas.

$\{(2 + 2) + 3 + (1 + 2)\}$

Q.7.a) Prove that $F = U + T\left(\frac{dF}{dT}\right)_v$ where F is Helmholtz free energy and U and T are internal energy and temperature respectively.

b) A Carnot's engine takes in 800 Kcal of heat from a reservoir at 527°C and gives some heat to the sink at 27°C. What is the efficiency? How much work does it perform in joules?

c) What is the temperature of inversion in Joule-Thomson effect?

d) Use Maxwell's relation to obtain $C_p - C_v = R$ for an ideal gas where C_p and C_v are molar specific heats at constant pressure and constant volume respectively. $\{2 + 3 + 2 + 3\}$