



FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2022
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT

Roll Number

PHYSICS, PAPER-I

TIME ALLOWED: THREE HOURS	PART-I (MCQS)	MAXIMUM MARKS = 20
PART-I(MCQS): MAXIMUM 30 MINUTES	PART-II	MAXIMUM MARKS = 80
<p>NOTE: (i) Part-II is to be attempted on the separate Answer Book.</p> <p>(ii) Attempt ONLY FOUR questions from PART-II. ALL questions carry EQUAL marks.</p> <p>(iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.</p> <p>(iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.</p> <p>(v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.</p> <p>(vi) Extra attempt of any question or any part of the question will not be considered.</p> <p>(vii) Use of Calculator is allowed.</p>		

PART – II

- Q. 2.**
- (a) A particle of unit mass moves in potential $V(x) = ax^2 + b/x^2$ where a & b are positive constants. Find the angular frequency of small oscillations? (08)
- (b) A hollow spherical shell carries charge density $\rho = k/r^2$ in region $a \leq r \leq b$. Find the electric field in three regions (i) $r < a$ (ii) $a < r < b$ (iii) $r > b$. (07)
- (c) A projectile is fired in such a way that its horizontal range is equal to three times its maximum height. Determine its angle of projection. (05) (20)
- Q. 3.**
- (a) Assume that a star has uniform density. Show that the gravitational pressure P is proportional to $V^{-3/4}$ where V is volume. (08)
- (b) Derive expressions for potential and electric field associated with point charge q located near an infinite grounded conducting plane. (07)
- (c) Determine equation of motion of masses attached to the string of at-wood machine by Lagrangian methods. (05) (20)
- Q. 4.**
- (a) $Q \text{ cm}^3$ of water flows per second through a horizontal tube of uniform bore of radius r & of length L . Another tube of half the length but radius $2r$ is connected in parallel to same pressure head. What will be the total quantity of water flowing / sec through these two tubes? (08)
- (b) A linear quadruple is an arrangement of a system of charges which consist of $-2Q$ at the origin and $+Q$ at the two point $(\pm d, 0, 0)$. Show that at distances much greater than (*i.e.* $r \gg d$), the potential may be written in the approximate form
- $$V = \frac{Qd^2}{4\pi\epsilon_0 r^3} (3 \cos^2 \theta - 1), r^2 \gg d^2$$
- (c) Two soap bubbles with radii r_1 and r_2 coalesce to form a bigger bubble of radii r . Show that $r = (r_1^2 + r_2^2)^{1/2}$. (05) (20)

PHYSICS, PAPER-I

- Q. 5.** (a) Explain wave function. Derive wave formula and explain phase and group velocity. (08)
- (b) Two semi-infinite grounded metal plates parallel to each other and to the xz -plane are located at $y = 0$ and $y = a$ planes, respectively. The left ends of these two plates at $x = 0$, are closed off by a strip of width a and extend to infinity in the z -direction. The strip is insulated from both the plates and is maintained at a specific potential $V_0(y)$. Find the potential distribution in the slot. (07)
- (c) A two level system has energies 0 & E . The level with zero energy is non-degenerate while the level with energy E is triply degenerate. Find the mean energy of a classical particle in this system at temperature T . (05) (20)
- Q. 6.** (a) Explain the particle in finite potential well with all possible cases and solutions and make a comparison with infinite potential well. (08)
- (b) The potential $V_0(\theta)$ is specified on the surface of a hollow sphere, of radius R . Find potential inside the sphere. (07)
- (c) A particle is confined to region $x > 0$ by a potential which increases linearly as $u(x) = u_0x$. Find the mean position of particle at temperature T . (05) (20)
- Q. 7.** (a) When a gas expands adiabatically its volume is doubled while its absolute temperature is decreased by a factor 1.32. Compute number of degree of freedom of gas molecule? (08)
- (b) State and prove Ampere's Law. (07)
- (c) Find the rms speed of oxygen molecules at 0°C ? (05) (20)
- Q. 8.** (a) An ensemble of non-interacting spin $-1/2$ particles is in contact with a heat bath at temperature T & is subjected to an external magnetic field. Each particle can be in one of the two quantum states of energies ϵ_0 . If the mean energy per particle is $-\epsilon_0/2$, then find free energy per particle? (08)
- (b) Derive the electromagnetic wave equation in vacuum and also describe the properties of monochromatic electromagnetic waves. (07)
- (c) Discuss adiabatic demagnetization using TDS equations mathematically in detail? (05) (20)
