FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2020
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**

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

PART – II

Q. 2. **(a)** What is the curl of a vector field? Explain its physical significance. (10)

(b) What is vector triple product? Show that (6)

$$\vec{A}\times\left(\vec{B}\times\vec{C}\right)=\left(\vec{A}\cdot\vec{C}\right)\vec{B}-\left(\vec{A}\cdot\vec{B}\right)\vec{C}$$

(c) If $\phi = 2x^3y^2z^4$ then find the div grad Ø. (4) **(20)**

Q. 3. **(a)** State and explain Kelper's law of areas. (8)

(b) A spaceship of mass m = 4.50 × 103 kg is in a circular Earth orbit of radius $r = 8.00\times10^6$ m and period T_o = 118.6 min = 7.119 × 10^3 s when a thruster is fired in the forward direction to decrease the speed to 96.0% of the original speed. What is the period T of the resulting elliptical orbit? (6)

(c) Which has greater magnitude, the angular momentum of the Earth (relative to its center) associated with its rotation on its axis or the angular momentum of the Earth (relative to the center of its orbit) associated with its orbital motion around the Sun? (6) **(20)**

Q. 4. **(a)** Explain the equivalence of mass and energy. (6)

(b) Explain two tests of time dilation i.e microscopic and macroscopic clocks. (8)

(c) The mean lifetime of stationary muons is measured to be 2.2000 ms. The mean lifetime of high-speed muons in a burst of cosmic rays observed from Earth is measured to be 16.000 μs. To five significant figures, what is the speed parameter b of these cosmic-rays muons relative to Earth? (6) **(20)**

Q. 5. **(a)** What is viscosity? Explain in detail. What is the effect of temperature on viscosity? (8)

(b) Caster oil, which has a density of 0.96 × 10^3 kg/m^3 at room temperature, is forced through a pipe of circular cross section by a pump that maintains a gauge pressure of 950 Pa. The pipe has a diameter of 2.6 cm and a length of 65 cm. The castor oil emerging from the free end of the pipe at atmospheric pressure is collected. After 90 s, a total of 1.23 kg has been collected. What is the coefficient of viscosity of the castor oil at this temperature? (5)

(c) A liquid flows through a horizontal pipe whose inner radius is 2.52 cm. The pipe bends upward through a height of 11.5 m where it widens and joins another horizontal pipe of inner radius 6.14 cm. What must the volume flux be if the pressure in the two horizontal pipes is the same? (7) **(20)**

Q. 6. **(a)** What is damped harmonic oscillator? Write its equation of motion and find its solution. (10)

(b) The amplitude of a lightly damped oscillator decreases by 3.0% during each cycle. What percentage of the mechanical energy of the oscillator is lost in each cycle? (4)

(c) An insulating vessel containing 1.8 kg of water is placed on a hot plate, both the water and hot plate being initially at 20°C. The temperature of the hot plate is raised very slowly to 100°C, at which point the water begins to boil. What is the entropy change of the water during this process? (6) **(20)**

PHYSICS, PAPER-I

Q. 7. **(a)** What are travelling waves? Find the rate at which energy is transported by a wave travelling along a string. (5)

(b) A string has linear density μ = 525 g/m and is under tension T = 45 N. We send a sinusoidal wave with frequency f = 120 Hz and amplitude y_m = 8.5 mm along the string. At what average rate does the wave transport energy? (5)

(c) Two sinusoidal waves with the identical wavelengths and amplitudes travel in opposite directions along a string with a speed of 10 cm/s. If the time interval between instants when the string is flat is 0.50 s, what is the wavelength of the waves? (10) **(20)**

Q. 8. **(a)** Explain the volume and pressure corrections in ideal gas law as suggested by van der Waals. (10)

(b) For oxygen the van der Waals coefficients have been measured to be $a = 0.138\ J\ .m^3/mol^2$ and $b = 3.18 \times 10^{-5}\ m^3/mol$. Assume that 1.00 mol of oxygen at T = 50 K is confined to a box of volume 0.0224 m^3. What pressure does the gas exert according to (a) the ideal gas law and (b) the van der Waals equation? (5)

(c) State and explain the zeroth law of thermodynamics. (5) **(20)**

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