FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION FOR RECRUITMENT TO POSTS IN BPS-17 UNDER THE FEDERAL GOVERNMENT, 2009
PHYSICS, PAPER-I

S.No.	
R.No.	

TIME ALLOWED:	**(PART-I) 30 MINUTES**	**MAXIMUM MARKS:20**
	(PART-II) 2 HOURS & 30 MINUTES	**MAXIMUM MARKS:80**

NOTE: (i) First attempt **PART-I (MCQ)** on separate **Answer Sheet** which shall be taken back after **30 minutes.**
(ii) Overwriting/cutting of the options/answers will not be given credit.
(iii) Use of Scientific Calculator is allowed.

PART – I (MCQ)
(COMPULSORY)

Q.1. Select the best option/answer and fill in the appropriate box on the Answer Sheet. (20)

(i) A body is moving northward and the force applied is eastward, the acceleration produced is:
(a) Northward (b) At 45° East of North (c) Eastward (d) None of these

(ii) The correct form for the dimension of Power is:
(a) $[ML^2T^{-3}]$ (b) $[ML^3T^{-2}]$ (c) ML^2T^{-4} (d) None of these

(iii) The work done by the force $\vec{F} = 4\hat{a}_x - 3\hat{a}_y - 2\hat{a}_z$ N in giving a 1nC charge a displacement of $10\hat{a}_x + 2\hat{a}_y - 7\hat{a}_z m$ is:
(a) 10 nJ (b) 15 nJ (c) 20 nJ (d) None of these

(iv) Three masses are placed on the x-axis; 200g at x = 0, 500g at x = 30cm, and 400g at x = 70cm. The center of mass will be at:
(a) 0.89 m (b) 0.69 m (c) 0.39 m (d) None of these

(v) A 60 kg woman stands on a light, cubical box that is 5.0cm on each edge. The box sits on the floor. What pressure does the box exerts on the floor?
(a) 2.4×10^5 N/m^2 (b) 5×10^5 N/m^2 (c) 3×10^5 N/m^2 (d) None of these

(vi) SI unit of stress is same as that of:
(a) Force (b) Momentum (c) Pressure (d) None of these

(vii) What is the maximum speed at which a car can round a curve of 25m radius on a level road if the coefficient of static friction between the tires and the road is 0.80?
(a) 25 m/s (b) 14 m/s (c) 10 m/s (d) None of these

(viii) The equation of a simple harmonic motion with amplitude 5m and time period 0.5s is:
(a) $y = 5\sin(4\pi t)$ (b) $y = 0.5\sin(2\pi t/5)$ (c) $y = 5\sin(2\pi t)$ (d) None of these

(ix) Two particles each of mass 5.0kg are mounted 4.0m apart on a mass-less light rod which is capable of rotation about its center? The moment of inertia is:
(a) 1.25 kgm^2 (b) 20 kgm^2 (c) 40 kgm^2 (d) None of these

(x) The time period of mass of 1kg attached to a spring of spring constant of 100N/m is:
(a) 0.2π (b) π (c) 2π (d) None of these

(xi) A 14cm inner diameter water main furnishes water (through intermediate pipes) to a 1.00cm inner diameter faucet pipe. If the average speed in the faucet pipe is 3.0 cm/s, what will be the average speed it causes in the water main?
(a) 0.015 cm/s (b) 0.15 m/s (c) 0.5 m/s (d) None of these

(xii) What is the tension T in the rope if a 10N weight is being pulled upward by it with a constant velocity of 2m/s?
(a) 12N (b) 8N (c) 5N (d) None of these

(xiii) The ratio of linear Stress/Linear Strain is called:
(a) Young's Modulus (b) Bulk Modulus (c) Deformation (d) None of these

(xiv) A body is moving with constant speed in a circle, its velocity vector:
(a) Remains constant (b) Changes its magnitude (c) Changes its direction
(d) None of these

(xv) When a constant torque is acting on a rotating system, which of the following is constant?
(a) Angular velocity (b) Angular acceleration (c) Angular momentum
(d) None of these

(xvi) A planet has a mass four times and diameter twice that of the earth. What is the value of g on the planet?
(a) 19.6 m/s^2 (b) 9.8 m/s^2 (c) 4.9 m/s^2 (d) None of these

(xvii) A geo-stationary satellite revolves around the earth from:
(a) East to west (b) West to east (c) North to south (d) None of these

(xviii) According to Einstein, with the great increase in the speed of a body, the relativistic is:
(a) Length remains constant (b) Time decreases
(c) Mass increases (d) None of these

(xix) If graph between 1/m and a is a straight line, then:
(a) $m \propto a$ (b) $m \propto 1/a$ (c) $m \propto 1/a^2$ (d) None of these

(xx) The frequency of rotation ω of a spaceship about its own axis to create gravity like earth is the square root of:
(a) g/r (b) r^2/g (c) g/r^2 (d) None of these

PART – II

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)** Extra attempt of any question or any part of the attempted question will not be considered. **(iv)** Use of Scientific calculator is allowed.

Q.2. (a) Define gradient. Find the gradient of the magnitude of a position vector **r**. What conclusion do you derive from your result? **(4,4,2)**

(b) Sketch a function **V = -yx^ + xy^**. Find curl **V.** What would be its divergence? **(4,4,2)**

Q.3. (a) What is theory of relativity? Consider two inertial frames, A and B, with axes parallel and origins O,O' coinciding at t = t' = 0 and B moving with uniform velocity **v** along x-axis of A. Letting $\gamma = 1/\sqrt{[1-(v^2c^2)]}$, the Lorenz transformation A → B is x' = γ(x – vt), y' = y, z' = z, t'= γ(t – vx/c^2). From the principle of equivalence of inertial frames infer the inverse Lorenz transformation B → A. **(8,4)**

(b) We can write one of Maxwell's equation of **B** in inertial frame 1 as

$$\mathbf{B}.\, d\mathbf{1}_1 = \mu_0 (\varepsilon_0 \partial\phi_{E1}/\partial t_1 = i_1).$$

Write it in inertial frame 2 according to Einstein's principle of relativity. Does $\mathbf{B}_1 = \mathbf{B}_2$? **(4,4)**

Q.4. (a) State and prove Bernoulli's Theorem. **(12)**

(b) If the speed of flow past the lower surface of an airplane wing is 110 m/s. What speed of flow over the upper surface will give a pressure difference of 900 Pa between upper and lower surface? Take the density of air to be 1.3×10^{-3} g/cm^3. **(8)**

Q.5. (a) Describe waves and its types. Derive an expression for speed of wave on a stretched string by Newton's second law. **(4,8)**

(b) The equation of a transverse wave on a string is

$$\mathbf{Y = (2mm)\ \sin\ [(20m^{-1})x - (600s^{-1})t].}$$

The tension in the string is 15N.
(i) What is the wave speed?
(ii) Find the linear density of this string in grams/meter. **(4,4)**

Q.6. (a) What is interference of waves? Describe all the necessary conditions for constructive and destructive interference. Explain one interferometer. **(2,6,4)**

(b) Two sound waves from two coherent sources with same frequency 450 Hz are traveling in the same direction at 330 m/s. What is the phase difference of the waves at a point that is 4.4m from one source and 4m from the other source. **(8)**

Q.7. (a) State and explain Second Law of Thermodynamics. Prove that Clausius and Kelvin-Plank statements of it are equivalent. **(6,6)**

(b) A Carnot engine operates between the temperatures 850 K and 300 K. The engine performs 1200 J of work each cycle, which takes 0.25 s. Calculate its efficiency and its average power. What are the rates of heat input and heat exhaust per cycle? **(8)**

Q.8. Write short notes on **ANY TWO** of the followings: **(10,10)**
(i) Laser and its applications (ii) Classical Maxwell-Boltzmann Statistics
(iii) Dynamics of rigid bodies

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PHYSICS, PAPER-II

S.No.	
R.No.	

TIME ALLOWED:	(PART-I) 30 MINUTES	MAXIMUM MARKS:20
	(PART-II) 2 HOURS & 30 MINUTES	MAXIMUM MARKS:80

NOTE: (i) First attempt **PART-I (MCQ)** on separate **Answer Sheet** which shall be taken back after **30 minutes.**
(ii) Overwriting/cutting of the options/answers will not be given credit.
(iii) Use of Scientific Calculator is allowed.

PART – I (MCQ)
(COMPULSORY)

Q.1. Select the best option/answer and fill in the appropriate box on the Answer Sheet. (20)

(i) The impedance of RLC series resonance circuit at resonant frequency is:
(a) Greater than R (b) Equal to R (c) Zero (d) None of these

(ii) An electron has a velocity of 10km/s normal to a magnetic field of 0.1 T flux density. If the radius of the path is 569nm then the frequency is:
(a) 2.79 GHz (b) 3.1 MHz (c) 2.8 KHz (d) None of these

(iii) If a current of 10 A flows through an electric heater for an hour and converts 8.64 MJ of electrical energy into heat energy. Then the potential difference across the heater is:
(a) 864 V (b) 240 V (c) 100 V (d) None of these

(iv) An alpha particle is accelerated to a velocity *v* in a particle accelerator by a potential difference of 1200 V. Which of the following potential differences would be needed to double the velocity of the alpha particle?
(a) 2400 V (b) 3600 V (c) 4800 V (d) None of these

(v) Two thin parallel wires carry currents along the same direction. The force experienced by one due to the other is:
(a) Parallel to the lines (b) perpendicular to the lines and attractive
(c) perpendicular to the lines and repulsive (d) None of these

(vi) If 300 mA current is passing through an electric bulb, then the number of electrons passing through in one minute will be:
(a) 1.12×10^{20} (b) 1.6×10^{19} (c) 6.02×10^{18} (d) None of these

(vii) An electric iron of resistance 20 Ω takes a current of 5.0 A. The thermal energy developed in 30s is:
(a) 15 kJ (b) 100 J (c) 10 J (d) None of these

(viii) An ideal gas has a volume of exactly 1 liter at 1.00 atm and –20°C. To how many atmospheres pressure must it be subjected to be compressed to 0.500 liter at 40°C?
(a) 5.2 atm (b) 2.47 atm (c) 1.5 atm (d) None of these

(ix) In Bohr's model the lowest orbit corresponds to:
(a) Maximum energy (b) Minimum energy (c) Zero energy (d) None of these

(x) The diffusion of the free electrons across the unbiased p-n junction produces:
(a) Forward bias (b) Reverse bias (c) Depletion region (d) None of these

(xi) The P-N junction, on forward biasing acts like a:
(a) Capacitor (b) Inductor (c) Insulator (d) None of these

(xii) The impedance at the resonant frequency of a series RLC circuits with L = 15 mH, C=0.015 F, and R = 80 Ω:
(a) 0 KΩ (b) 30 Ω (c) 80 Ω (d) None of these

(xiii) Weber is a unit of:
(a) Magnetic field intensity (b) Magnetic Flux
(c) Magnetic Flux Density (d) None of these

(xiv) The magnetic flux through an element of area **A** in a uniform magnetic field **B** is expressed as:
(a) AB (b) **B. A** (c) **A x B** (d) None of these

(xv) In an electric circuit, currents flowing towards a node having four branches are 2A, -3A and 4A, then the current in the fourth branch is:
(a) 2A (b) -3 A (c) 4 A (d) None of these

(xvi) With the passage of time, the rate of decay of a radioactive element will:
(a) Increase exponentially (b) Decrease linearly
(c) Becomes zero in two half-life time (d) None of these

(xvii) The place where controlled fission chain reaction is carried is?
(a) A black hole (b) A star (c) A reactor (d) None of these

(xviii) In 19th century, Faraday and Maxwell worked on the unification of two forces named as:
(a) Gravitational and Weak forces (b) Electric and magnetic forces
(c) Weak and Strong forces (d) None of these

(xix) Electromagnetic wave theory of light was proposed by:
(a) Newton (b) Michelson (c) Maxwell (d) None of these

(xx) The concept of field theory was put forward by:
(a) Franklin (b) Kepler (c) Orsted (d) None of these

PART – II

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)** Extra attempt of any question or any part of the attempted question will not be considered. **(iv)** Use of Scientific calculator is allowed.

Q.2. (a) State and prove Gauss law. Compare it with Coulomb's law for calculating electric field. **(4+4+2)**

(b) Determine the **E** field caused by a spherical cloud of electrons with a volume charge density $\rho = \rho_0$ for $0 \le R \le b$ (both ρ_0 and b are positive) and $\rho = 0$ for R > b. Sketch the charge distribution and electric field for this charge. **(6+4)**

Q.3. (a) Explain Maxwell's equations. Write the fundamental relations for electrostatic and magnetostatic models. How these were modified to Maxwell's equations? What is the main contribution of Maxwell in this regard? **(4+2+4+2)**

(b) Derive Maxwell's two divergence equations from its two curl equations and the equation of continuity. **(4+4)**

Q.4. (a) What are P-type and N-type semiconductors? Draw ampere-volt characteristic of a PN junction. Why there is sudden increase in the small reverse saturation current at the breakdown voltage? Write the uses of zener diode. **(4+2+4+2)**

(b) What are transistors? Draw the three common transistor circuits. Explain the function of transistor in the saturation mode. **(2+2+4)**

Q.5. What is Compton Effect? Derive an expression for Compton shift. How it depends upon the scattering angle? What do you mean by Red Shift? **(2+8+6+4)**

Q.6. (a) Describe Schrodinger's wave equation. Normalize $\Psi = \mathbf{A}e^{-\alpha x}$, where A and α are real constants, A has units of (length)$^{-1/2}$ and α with units of (length)$^{-2}$. **(6+4)**

(b) What is the probability of finding the particle described by this wave function between x = 0.99 and x = 1.01 units? Also find the possible solution for E andV.

[Given the integration from -∞ to +∞ $\int_e^{-2x} dx = \sqrt{(\pi/2)}$] **(4+6)**

Q.7. (a) Explain Radioactive decay. Find an expression for decay rate. Relate half life to the disintegration constant. What are the units for the measurement of radioactivity? **(4+6+2+2)**

(b) A 2.71g sample of radioactive KCI is decaying at a constant rate of 440 Bq into the isotope ^{40}K, which constitutes 1.17% of the normal potassium. Calculate the half-life of this nuclide. **(6)**

Q.8. Write short notes on **ANY TWO** of the followings: **(10,10)**
(i) Poynting theorem and Poynting vectors
(ii) Elementary particles and their properties
(iii) Unification of forces.

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