FINAL JEE–MAIN EXAMINATION – APRIL, 2024

(Held On Monday 08th April, 2024) **TIME : 9 : 00 AM to 12 : 00 NOON**

PHYSICS

SECTION-A

31. Three bodies A, B and C have equal kinetic energies and their masses are 400 g, 1.2 kg and 1.6 kg respectively. The ratio of their linear momenta is :

(1) $1:\sqrt{3}:2$ (2) $1:\sqrt{3}:\sqrt{2}$

(3) $\sqrt{2}:\sqrt{3}:1$ (4) $\sqrt{3}:\sqrt{2}:1$

32. Average force exerted on a non-reflecting surface at normal incidence is 2.4×10^{-4}N. If 360 W/cm^2 is the light energy flux during span of 1 hour 30 minutes. Then the area of the surface is:

(1) 0.2 m^2 (2) 0.02 m^2

(3) 20 m^2 (4) 0.1 m^2

33. A proton and an electron are associated with same de-Broglie wavelength. The ratio of their kinetic energies is:

(Assume h = 6.63×10^{-34} J s, $m_e = 9.0 \times 10^{-31}$ kg and m_p = 1836 times m_e)

(1) 1 : 1836 (2) $1:\frac{1}{1836}$

(3) $1:\frac{1}{\sqrt{1836}}$ (4) $1:\sqrt{1836}$

34. A mixture of one mole of monoatomic gas and one mole of a diatomic gas (rigid) are kept at room temperature (27°C). The ratio of specific heat of gases at constant volume respectively is:

(1) $\frac{7}{5}$ (2) $\frac{3}{2}$

(3) $\frac{3}{5}$ (4) $\frac{5}{3}$

35. In an expression $a \times 10^b$:

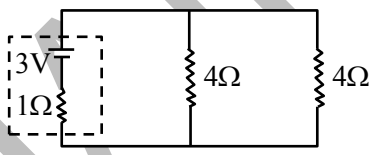
(1) a is order of magnitude for $b \le 5$

(2) b is order of magnitude for $a \le 5$

(3) b is order of magnitude for $5 < a \le 10$

(4) b is order of magnitude for $a \ge 5$

36. In the given circuit, the terminal potential difference of the cell is :



(1) 2 V (2) 4 V

(3) 1.5 V (4) 3 V

37. Binding energy of a certain nucleus is 18×10^8 J. How much is the difference between total mass of all the nucleons and nuclear mass of the given nucleus:

(1) 0.2 μg (2) 20 μg

(3) 2 μg (4) 10 μg

38. Paramagnetic substances:

A. align themselves along the directions of external magnetic field.

B. attract strongly towards external magnetic field.

C. has susceptibility little more than zero.

D. move from a region of strong magnetic field to weak magnetic field.

Choose the **most appropriate** answer from the options given below:

(1) A, B, C, D (2) B, D Only

(3) A, B, C Only (4) A, C Only

39. A clock has 75 cm, 60 cm long second hand and minute hand respectively. In 30 minutes duration the tip of second hand will travel x distance more than the tip of minute hand. The value of x in meter is nearly (Take $\pi = 3.14$) :

(1) 139.4 (2) 140.5

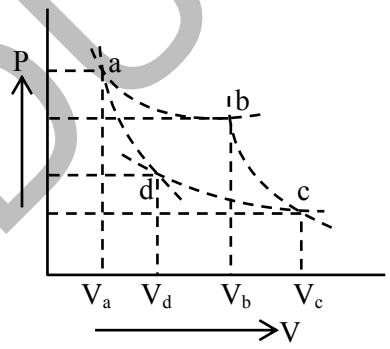
(3) 220.0 (4) 118.9

40. Young's modulus is determined by the equation given by $Y = 49000\frac{m}{\ell}\frac{dyne}{cm^2}$ where M is the mass and ℓ is the extension of wire used in the experiment. Now error in Young modules(Y) is estimated by taking data from M-ℓ plot in graph paper. The smallest scale divisions are 5 g and 0.02 cm along load axis and extension axis respectively. If the value of M and ℓ are 500 g and 2 cm respectively then percentage error of Y is :

(1) 0.2 % (2) 0.02 %

(3) 2 % (4) 0.5 %

41. Two different adiabatic paths for the same gas intersect two isothermal curves as shown in P-V diagram. The relation between the ratio $\frac{V_a}{V_d}$ and the ratio $\frac{V_b}{V_c}$ is:



(1) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^{-1}$ (2) $\frac{V_a}{V_d} \neq \frac{V_b}{V_c}$

(3) $\frac{V_a}{V_d} = \frac{V_b}{V_c}$ (4) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^2$

42. Two planets A and B having masses m_1 and m_2 move around the sun in circular orbits of r_1 and r_2 radii respectively. If angular momentum of A is L and that of B is 3L, the ratio of time period $\left(\frac{T_A}{T_B}\right)$ is:

(1) $\left(\frac{r_2}{r_1}\right)^{\frac{3}{2}}$ (2) $\left(\frac{r_1}{r_2}\right)^3$

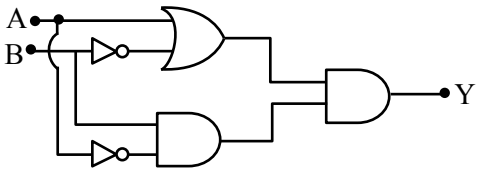
(3) $\frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$ (4) $27\left(\frac{m_1}{m_2}\right)^3$

43. A LCR circuit is at resonance for a capacitor C, inductance L and resistance R. Now the value of resistance is halved keeping all other parameters same. The current amplitude at resonance will be now:

(1) Zero (2) double

(3) same (4) halved

44. The output Y of following circuit for given inputs is :



(1) A•B(A + B)

(2) A • B

(3) 0

(4) $\bar{A}$•B

45. Two charged conducting spheres of radii a and b are connected to each other by a conducting wire. The ratio of charges of the two spheres respectively is:

(1) $\sqrt{ab}$ (2) ab

(3) $\frac{a}{b}$ (4) $\frac{b}{a}$

46. Correct Bernoulli's equation is (symbols have their usual meaning) :

(1) $P + mgh + \frac{1}{2}mv^2 = \text{constant}$

(2) $P + \rho gh + \frac{1}{2}\rho v^2 = \text{constant}$

(3) $P + \rho gh + \rho v^2 = \text{constant}$

(4) $P + \frac{1}{2}\rho gh + \frac{1}{2}\rho v^2 = \text{constant}$

47. A player caught a cricket ball of mass 150 g moving at a speed of 20 m/s. If the catching process is completed in 0.1 s, the magnitude of force exerted by the ball on the hand of the player is:

(1) 150 N (2) 3 N

(3) 30 N (4) 300 N

48. A stationary particle breaks into two parts of masses m_A and m_B which move with velocities v_A and v_B respectively. The ratio of their kinetic energies ($K_B : K_A$) is :

(1) $v_B : v_A$ (2) $m_B : m_A$

(3) $m_B v_B : m_A v_A$ (4) 1 : 1

49. Critical angle of incidence for a pair of optical media is 45°. The refractive indices of first and second media are in the ratio:

(1) $\sqrt{2}:1$ (2) 1 : 2

(3) $1:\sqrt{2}$ (4) 2 : 1

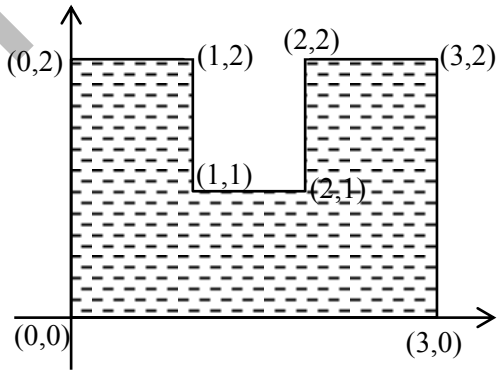
50. The diameter of a sphere is measured using a vernier caliper whose 9 divisions of main scale are equal to 10 divisions of vernier scale. The shortest division on the main scale is equal to 1 mm. The main scale reading is 2 cm and second division of vernier scale coincides with a division on main scale. If mass of the sphere is 8.635 g, the density of the sphere is:

(1) 2.5 g/cm^3 (2) 1.7 g/cm^3

(3) 2.2 g/cm^3 (4) 2.0 g/cm^3

SECTION-B

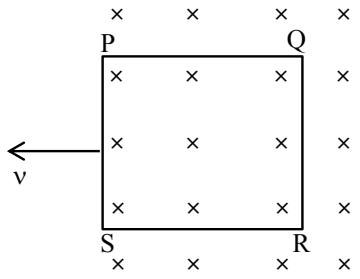
51. A uniform thin metal plate of mass 10 kg with dimensions is shown. The ratio of x and y coordinates of center of mass of plate in $\frac{n}{9}$ .The value of n is_____.



52. An electron with kinetic energy 5 eV enters a region of uniform magnetic field of 3 μT perpendicular to its direction. An electric field E is applied perpendicular to the direction of velocity and magnetic field. The value of E, so that electron moves along the same path, is_____ NC^{-1}.

(Given, mass of electron = 9×10^{-31} kg, electric charge = 1.6×10^{-19}C)

53. A square loop PQRS having 10 turns, area 3.6 × 10^{-3} m^2 and resistance 100 Ω is slowly and uniformly being pulled out of a uniform magnetic field of magnitude B = 0.5 T as shown. Work done in pulling the loop out of the field in 1.0 s is _____× 10^{-6} J.



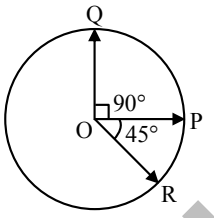
54. Resistance of a wire at 0 °C, 100 °C and t °C is found to be 10 Ω, 10.2 Ω and 10.95 Ω respectively. The temperature t in Kelvin scale is_____.

55. An electric field, $\vec{E} = \frac{2\hat{i} + 6\hat{j} + 8\hat{k}}{\sqrt{6}}$ passes through the surface of 4 m^2 area having unit vector $\hat{n} = \left(\frac{2\hat{i} + \hat{j} + \hat{k}}{\sqrt{6}}\right)$. The electric flux for that surface is _____ V m.

56. A liquid column of height 0.04 cm balances excess pressure of soap bubble of certain radius. If density of liquid is 8 × 10^3 kg m^{-3} and surface tension of soap solution is 0.28 Nm^{-1}, then diameter of the soap bubble is_____cm.
(if g = 10 ms^{-2})

57. A closed and an open organ pipe have same lengths. If the ratio of frequencies of their seventh overtones is $\left(\frac{a-1}{a}\right)$ then the value of a is _____.

58. Three vectors $\overrightarrow{OP}, \overrightarrow{OQ}$ and $\overrightarrow{OR}$ each of magnitude A are acting as shown in figure. The resultant of the three vectors is $A\sqrt{x}$. The value of x is _____.



59. A parallel beam of monochromatic light of wavelength 600 nm passes through single slit of 0.4 mm width. Angular divergence corresponding to second order minima would be _____×10^{-3} rad.

60. In an alpha particle scattering experiment distance of closest approach for the α particle is 4.5×10^{-14} m. If target nucleus has atomic number 80, then maximum velocity of α-particle is _____× 10^5 m/s approximately.
($\frac{1}{4\pi\epsilon_0} = 9\times10^9$ SI unit, mass of α particle = 6.72×10^{-27}kg