

# JEE-MAIN EXAMINATION – JANUARY, 2024

Thursday 01<sup>st</sup> February, 2024)

TIME : 9 : 00 AM to 12 : 00 NOON

## PHYSICS

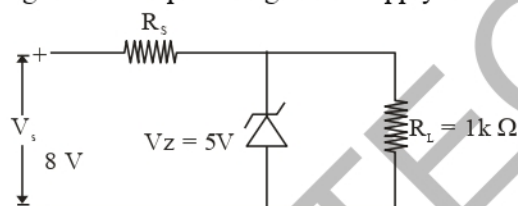
### SECTION-A

31. With rise in temperature, the Young's modulus of elasticity  
(1) changes erratically  
(2) decreases  
(3) increases  
(4) remains unchanged

32. If  $R$  is the radius of the earth and the acceleration due to gravity on the surface of earth is  $g = \pi^2 \text{ m/s}^2$ , then the length of the second's pendulum at a height  $h = 2R$  from the surface of earth will be,:

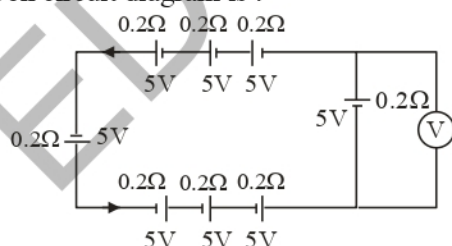
- (1)  $\frac{2}{9} \text{ m}$  (2)  $\frac{1}{9} \text{ m}$   
(3)  $\frac{4}{9} \text{ m}$  (4)  $\frac{8}{9} \text{ m}$

33. In the given circuit if the power rating of Zener diode is  $10 \text{ mW}$ , the value of series resistance  $R_s$  to regulate the input unregulated supply is :



- (1)  $5\text{k}\Omega$  (2)  $10\Omega$   
(3)  $1\text{k}\Omega$  (4)  $10\text{k}\Omega$

34. The reading in the ideal voltmeter (V) shown in the given circuit diagram is :



- (1)  $5\text{V}$  (2)  $10\text{V}$   
(3)  $0\text{V}$  (4)  $3\text{V}$

35. Two identical capacitors have same capacitance  $C$ . One of them is charged to the potential  $V$  and other to the potential  $2V$ . The negative ends of both are connected together. When the positive ends are also joined together, the decrease in energy of the combined system is :

- (1)  $\frac{1}{4} CV^2$  (2)  $2 CV^2$   
(3)  $\frac{1}{2} CV^2$  (4)  $\frac{3}{4} CV^2$

36. Two moles a monoatomic gas is mixed with six moles of a diatomic gas. The molar specific heat of the mixture at constant volume is :

- (1)  $\frac{9}{4} R$  (2)  $\frac{7}{4} R$   
(3)  $\frac{3}{2} R$  (4)  $\frac{5}{2} R$

37. A ball of mass  $0.5 \text{ kg}$  is attached to a string of length  $50 \text{ cm}$ . The ball is rotated on a horizontal circular path about its vertical axis. The maximum tension that the string can bear is  $400 \text{ N}$ . The maximum possible value of angular velocity of the ball in  $\text{rad/s}$  is,:

- (1)  $1600$  (2)  $40$   
(3)  $1000$  (4)  $20$

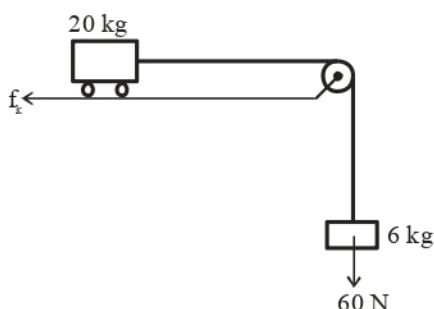
38. A parallel plate capacitor has a capacitance  $C = 200 \text{ pF}$ . It is connected to  $230 \text{ V}$  ac supply with an angular frequency  $300 \text{ rad/s}$ . The rms value of conduction current in the circuit and displacement current in the capacitor respectively are :

- (1)  $1.38 \mu\text{A}$  and  $1.38 \mu\text{A}$   
(2)  $14.3 \mu\text{A}$  and  $143 \mu\text{A}$   
(3)  $13.8 \mu\text{A}$  and  $138 \mu\text{A}$   
(4)  $13.8 \mu\text{A}$  and  $13.8 \mu\text{A}$

39. The pressure and volume of an ideal gas are related as  $PV^{3/2} = K$  (Constant). The work done when the gas is taken from state A ( $P_1, V_1, T_1$ ) to state B ( $P_2, V_2, T_2$ ) is :
- $2(P_1V_1 - P_2V_2)$
  - $2(P_2V_2 - P_1V_1)$
  - $2(\sqrt{P_1}V_1 - \sqrt{P_2}V_2)$
  - $2(P_2\sqrt{V_2} - P_1\sqrt{V_1})$
40. A galvanometer has a resistance of  $50 \Omega$  and it allows maximum current of  $5 \text{ mA}$ . It can be converted into voltmeter to measure upto  $100 \text{ V}$  by connecting in series a resistor of resistance
- $5975 \Omega$
  - $20050 \Omega$
  - $19950 \Omega$
  - $19500 \Omega$
41. The de Broglie wavelengths of a proton and an  $\alpha$  particle are  $\lambda$  and  $2\lambda$  respectively. The ratio of the velocities of proton and  $\alpha$  particle will be :
- $1 : 8$
  - $1 : 2$
  - $4 : 1$
  - $8 : 1$
42. 10 divisions on the main scale of a Vernier calliper coincide with 11 divisions on the Vernier scale. If each division on the main scale is of 5 units, the least count of the instrument is :
- $\frac{1}{2}$
  - $\frac{10}{11}$
  - $\frac{50}{11}$
  - $\frac{5}{11}$
43. In series LCR circuit, the capacitance is changed from  $C$  to  $4C$ . To keep the resonance frequency unchanged, the new inductance should be :
- reduced by  $\frac{1}{4}L$
  - increased by  $2L$
  - reduced by  $\frac{3}{4}L$
  - increased to  $4L$
44. The radius ( $r$ ), length ( $l$ ) and resistance ( $R$ ) of a metal wire was measured in the laboratory as  
 $r = (0.35 \pm 0.05) \text{ cm}$   
 $R = (100 \pm 10) \text{ ohm}$   
 $l = (15 \pm 0.2) \text{ cm}$   
 The percentage error in resistivity of the material of the wire is :
- $25.6\%$
  - $39.9\%$
  - $37.3\%$
  - $35.6\%$
45. The dimensional formula of angular impulse is :
- $[M L^{-2} T^{-1}]$
  - $[M L^2 T^{-2}]$
  - $[M L T^{-1}]$
  - $[M L^2 T^{-1}]$
46. A simple pendulum of length  $1 \text{ m}$  has a wooden bob of mass  $1 \text{ kg}$ . It is struck by a bullet of mass  $10^{-2} \text{ kg}$  moving with a speed of  $2 \times 10^2 \text{ ms}^{-1}$ . The bullet gets embedded into the bob. The height to which the bob rises before swinging back is. (use  $g = 10 \text{ m/s}^2$ )
- $0.30 \text{ m}$
  - $0.20 \text{ m}$
  - $0.35 \text{ m}$
  - $0.40 \text{ m}$
47. A particle moving in a circle of radius  $R$  with uniform speed takes time  $T$  to complete one revolution. If this particle is projected with the same speed at an angle  $\theta$  to the horizontal, the maximum height attained by it is equal to  $4R$ . The angle of projection  $\theta$  is then given by :
- $\sin^{-1} \left[ \frac{2gT^2}{\pi^2 R} \right]^{\frac{1}{2}}$
  - $\sin^{-1} \left[ \frac{\pi^2 R}{2gT^2} \right]^{\frac{1}{2}}$
  - $\cos^{-1} \left[ \frac{2gT^2}{\pi^2 R} \right]^{\frac{1}{2}}$
  - $\cos^{-1} \left[ \frac{\pi R}{2gT^2} \right]^{\frac{1}{2}}$

48. Consider a block and trolley system as shown in figure. If the coefficient of kinetic friction between the trolley and the surface is 0.04, the acceleration of the system in  $\text{ms}^{-2}$  is :

(Consider that the string is massless and unstretchable and the pulley is also massless and frictionless) :



- (1) 3                                      (2) 4  
(3) 2                                      (4) 1.2
49. The minimum energy required by a hydrogen atom in ground state to emit radiation in Balmer series is nearly :
- (1) 1.5 eV  
(2) 13.6 eV  
(3) 1.9 eV  
(4) 12.1 eV
50. A monochromatic light of wavelength  $6000\text{\AA}$  is incident on the single slit of width 0.01 mm. If the diffraction pattern is formed at the focus of the convex lens of focal length 20 cm, the linear width of the central maximum is :
- (1) 60 mm  
(2) 24 mm  
(3) 120 mm  
(4) 12 mm

## SECTION-B

51. A regular polygon of 6 sides is formed by bending a wire of length  $4\pi$  meter. If an electric current of  $4\pi\sqrt{3}$  A is flowing through the sides of the polygon, the magnetic field at the centre of the polygon would be  $x \times 10^{-7}$  T. The value of x is \_\_\_\_.
52. A rectangular loop of sides 12 cm and 5 cm, with its sides parallel to the x-axis and y-axis respectively moves with a velocity of 5 cm/s in the positive x axis direction, in a space containing a variable magnetic field in the positive z direction. The field has a gradient of  $10^{-3}\text{ T/cm}$  along the negative x direction and it is decreasing with time at the rate of  $10^{-3}\text{ T/s}$ . If the resistance of the loop is  $6\text{ m}\Omega$ , the power dissipated by the loop as heat is \_\_\_\_  $\times 10^{-9}\text{ W}$ .
53. The distance between object and its 3 times magnified virtual image as produced by a convex lens is 20 cm. The focal length of the lens used is \_\_\_\_ cm.
54. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle  $\theta$  with each other. When suspended in water the angle remains the same. If density of the material of the sphere is 1.5 g/cc, the dielectric constant of water will be \_\_\_\_ (Take density of water = 1 g/cc)
55. The radius of a nucleus of mass number 64 is 4.8 fermi. Then the mass number of another nucleus having radius of 4 fermi is  $\frac{1000}{x}$ , where x is \_\_\_\_.
56. The identical spheres each of mass  $2M$  are placed at the corners of a right angled triangle with mutually perpendicular sides equal to 4 m each. Taking point of intersection of these two sides as origin, the magnitude of position vector of the centre of mass of the system is  $\frac{4\sqrt{2}}{x}$ , where the value of x is \_\_\_\_.

57. A tuning fork resonates with a sonometer wire of length 1 m stretched with a tension of 6 N. When the tension in the wire is changed to 54 N, the same tuning fork produces 12 beats per second with it. The frequency of the tuning fork is \_\_\_\_\_ Hz.
58. A plane is in level flight at constant speed and each of its two wings has an area of  $40 \text{ m}^2$ . If the speed of the air is 180 km/h over the lower wing surface and 252 km/h over the upper wing surface, the mass of the plane is \_\_\_\_\_ kg. (Take air density to be  $1 \text{ kg m}^{-3}$  and  $g = 10 \text{ ms}^{-2}$ )
59. The current in a conductor is expressed as  $I = 3t^2 + 4t^3$ , where I is in Ampere and t is in second. The amount of electric charge that flows through a section of the conductor during  $t = 1 \text{ s}$  to  $t = 2 \text{ s}$  is \_\_\_\_\_ C.
60. A particle is moving in one dimension (along x axis) under the action of a variable force. It's initial position was 16 m right of origin. The variation of its position (x) with time (t) is given as  $x = -3t^3 + 18t^2 + 16t$ , where x is in m and t is in s. The velocity of the particle when its acceleration becomes zero is \_\_\_\_\_ m/s.