

# FINAL JEE-MAIN EXAMINATION – JANUARY, 2024

(Held On Saturday 27<sup>th</sup> January, 2024)

TIME : 3 : 00 PM to 6 : 00 PM

## PHYSICS

### SECTION-A

31. The equation of state of a real gas is given by  $\left(P + \frac{a}{V^2}\right)(V - b) = RT$ , where  $P$ ,  $V$  and  $T$  are pressure, volume and temperature respectively and  $R$  is the universal gas constant. The dimensions of  $\frac{a}{b^2}$  is similar to that of :

- (1)  $PV$  (2)  $P$   
(3)  $RT$  (4)  $R$

Ans. (2)

32. Wheatstone bridge principle is used to measure the specific resistance ( $S_1$ ) of given wire, having length  $L$ , radius  $r$ . If  $X$  is the resistance of wire, then specific resistance is :  $S_1 = X \left( \frac{\pi r^2}{L} \right)$ . If the length of the wire gets doubled then the value of specific resistance will be :

- (1)  $\frac{S_1}{4}$  (2)  $2S_1$   
(3)  $\frac{S_1}{2}$  (4)  $S_1$

Ans. (4)

33. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).  
**Assertion (A) :** The angular speed of the moon in its orbit about the earth is more than the angular speed of the earth in its orbit about the sun.

**Reason (R) :** The moon takes less time to move around the earth than the time taken by the earth to move around the sun.

In the light of the above statements, choose the most appropriate answer from the options given below :

- (1) (A) is correct but (R) is not correct  
(2) Both (A) and (R) are correct and (R) is the correct explanation of (A)  
(3) Both (A) and (R) are correct but (R) is not the correct explanation of (A)  
(4) (A) is not correct but (R) is correct

Ans. (2)

## TEST PAPER WITH ANSWER

34. Given below are two statements :

**Statement (I) :** The limiting force of static friction depends on the area of contact and independent of materials.

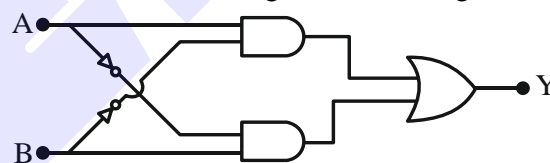
**Statement (II) :** The limiting force of kinetic friction is independent of the area of contact and depends on materials.

In the light of the above statements, choose the most appropriate answer from the options given below :

- (1) Statement I is correct but Statement II is incorrect  
(2) Statement I is incorrect but Statement II is correct  
(3) Both Statement I and Statement II are incorrect  
(4) Both Statement I and Statement II are correct

Ans. (2)

35. The truth table of the given circuit diagram is :



A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Ans. (2)



36. A current of  $200\ \mu\text{A}$  deflects the coil of a moving coil galvanometer through  $60^\circ$ . The current to cause deflection through  $\frac{\pi}{10}$  radian is :

- (1)  $30\ \mu\text{A}$  (2)  $120\ \mu\text{A}$   
(3)  $60\ \mu\text{A}$  (4)  $180\ \mu\text{A}$

Ans. (3)

37. The atomic mass of  ${}^6\text{C}^{12}$  is  $12.000000\ \text{u}$  and that of  ${}^6\text{C}^{13}$  is  $13.003354\ \text{u}$ . The required energy to remove a neutron from  ${}^6\text{C}^{13}$ , if mass of neutron is  $1.008665\ \text{u}$ , will be :

- (1)  $62.5\ \text{MeV}$   
(2)  $6.25\ \text{MeV}$   
(3)  $4.95\ \text{MeV}$   
(4)  $49.5\ \text{MeV}$

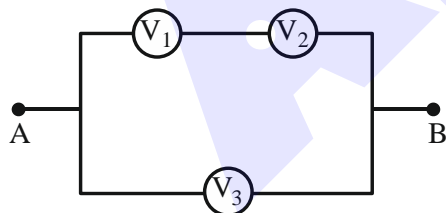
Ans. (3)

38. A ball suspended by a thread swings in a vertical plane so that its magnitude of acceleration in the extreme position and lowest position are equal. The angle ( $\theta$ ) of thread deflection in the extreme position will be :

- (1)  $\tan^{-1}(\sqrt{2})$  (2)  $2\tan^{-1}\left(\frac{1}{2}\right)$   
(3)  $\tan^{-1}\left(\frac{1}{2}\right)$  (4)  $2\tan^{-1}\left(\frac{1}{\sqrt{5}}\right)$

Ans. (2)

39. Three voltmeters, all having different internal resistances are joined as shown in figure. When some potential difference is applied across A and B, their readings are  $V_1$ ,  $V_2$  and  $V_3$ . Choose the correct option.



- (1)  $V_1 = V_2$   
(2)  $V_1 \neq V_3 - V_2$   
(3)  $V_1 + V_2 > V_3$   
(4)  $V_1 + V_2 = V_3$

Ans. (4)

40. The total kinetic energy of 1 mole of oxygen at  $27^\circ\text{C}$  is :

[Use universal gas constant ( $R$ ) =  $8.31\ \text{J/mole K}$ ]

- (1)  $6845.5\ \text{J}$   
(2)  $5942.0\ \text{J}$   
(3)  $6232.5\ \text{J}$   
(4)  $5670.5\ \text{J}$

Ans. (3)

41. Given below are two statements : one is labelled as Assertion(A) and the other is labelled as Reason (R).

**Assertion (A) :** In Vernier calliper if positive zero error exists, then while taking measurements, the reading taken will be more than the actual reading.

**Reason (R) :** The zero error in Vernier Calliper might have happened due to manufacturing defect or due to rough handling.

In the light of the above statements, choose the correct answer from the options given below :

- (1) Both (A) and (R) are correct and (R) is the correct explanation of (A)  
(2) Both (A) and (R) are correct but (R) is not the correct explanation of (A)  
(3) (A) is true but (R) is false  
(4) (A) is false but (R) is true

Ans. (2)

42. Primary side of a transformer is connected to  $230\ \text{V}$ ,  $50\ \text{Hz}$  supply. Turns ratio of primary to secondary winding is  $10 : 1$ . Load resistance connected to secondary side is  $46\ \Omega$ . The power consumed in it is :

- (1)  $12.5\ \text{W}$  (2)  $10.0\ \text{W}$   
(3)  $11.5\ \text{W}$  (4)  $12.0\ \text{W}$

Ans. (3)

43. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio of  $\frac{C_p}{C_v}$  for the gas is :

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

Ans. (2)



44. The threshold frequency of a metal with work function 6.63 eV is :

- (1)  $16 \times 10^{15}$  Hz
- (2)  $16 \times 10^{12}$  Hz
- (3)  $1.6 \times 10^{12}$  Hz
- (4)  $1.6 \times 10^{15}$  Hz

Ans. (4)

45. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R)

**Assertion (A) :** The property of body, by virtue of which it tends to regain its original shape when the external force is removed, is Elasticity.

**Reason (R) :** The restoring force depends upon the bonded inter atomic and inter molecular force of solid.

In the light of the above statements, choose the correct answer from the options given below :

- (1) (A) is false but (R) is true
- (2) (A) is true but (R) is false
- (3) Both (A) and (R) are true and (R) is the correct explanation (A)
- (4) Both (A) and (R) are true but (R) is not the correct explanation of (A)

Ans. (3 or 4)

46. When a polaroid sheet is rotated between two crossed polaroids then the transmitted light intensity will be maximum for a rotation of :

- (1)  $60^\circ$
- (2)  $30^\circ$
- (3)  $90^\circ$
- (4)  $45^\circ$

Ans. (4)

47. An object is placed in a medium of refractive index 3. An electromagnetic wave of intensity  $6 \times 10^8 \text{ W/m}^2$  falls normally on the object and it is absorbed completely. The radiation pressure on the object would be (speed of light in free space  $= 3 \times 10^8 \text{ m/s}$ ) :

- (1)  $36 \text{ Nm}^{-2}$
- (2)  $18 \text{ Nm}^{-2}$
- (3)  $6 \text{ Nm}^{-2}$
- (4)  $2 \text{ Nm}^{-2}$

Ans. (3)

48. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason(R)

**Assertion (A) :** Work done by electric field on moving a positive charge on an equipotential surface is always zero.

**Reason (R) :** Electric lines of forces are always perpendicular to equipotential surfaces.

In the light of the above statements, choose the most appropriate answer from the options given below :

- (1) Both (A) and (R) are correct but (R) is not the correct explanation of (A)
- (2) ((A) is correct but (R) is not correct
- (3) (A) is not correct but (R) is correct
- (4) Both (A) and (R) are correct and (R) is the correct explanation of (A)

Ans. (4)

49. A heavy iron bar of weight 12 kg is having its one end on the ground and the other on the shoulder of a man. The rod makes an angle  $60^\circ$  with the horizontal, the weight experienced by the man is :

- (1) 6 kg
- (2) 12 kg
- (3) 3 kg
- (4)  $6\sqrt{3}$  kg

Ans. (3)

50. A bullet is fired into a fixed target loses one third of its velocity after travelling 4 cm. It penetrates further  $D \times 10^{-3} \text{ m}$  before coming to rest. The value of D is :

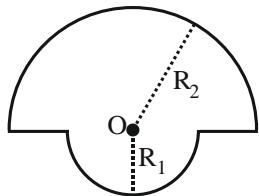
- (1) 2
- (2) 5
- (3) 3
- (4) 4

Ans. (Bonus)



SECTION-B

51. The magnetic field at the centre of a wire loop formed by two semicircular wires of radii  $R_1 = 2\pi$  m, and  $R_2 = 4\pi$  m carrying current  $I = 4$  A as per figure given below is  $\alpha \times 10^{-7}$  T. The value of  $\alpha$  is \_\_\_\_\_. (Centre O is common for all segments)



Ans. (3.00)

52. Two charges of  $-4 \mu\text{C}$  and  $+4 \mu\text{C}$  are placed at the points  $A(1, 0, 4)$  m and  $B(2, -1, 5)$  m located in an electric field  $\vec{E} = 0.20 \hat{i}$  V/cm. The magnitude of the torque acting on the dipole is  $8\sqrt{\alpha} \times 10^{-5}$  Nm, Where  $\alpha =$  \_\_\_\_\_.

Ans. (2.00)

53. A closed organ pipe 150 cm long gives 7 beats per second with an open organ pipe of length 350 cm, both vibrating in fundamental mode. The velocity of sound is \_\_\_\_\_ m/s.

Ans. (294.00)

54. A body falling under gravity covers two points A and B separated by 80 m in 2s. The distance of upper point A from the starting point is \_\_\_\_\_ m (use  $g = 10 \text{ ms}^{-2}$ )

Ans. (45.00)

55. The reading of pressure metre attached with a closed pipe is  $4.5 \times 10^4 \text{ N/m}^2$ . On opening the valve, water starts flowing and the reading of pressure metre falls to  $2.0 \times 10^4 \text{ N/m}^2$ . The velocity of water is found to be  $\sqrt{V}$  m/s. The value of V is \_\_\_\_\_

Ans. (50)

56. A ring and a solid sphere roll down the same inclined plane without slipping. They start from rest. The radii of both bodies are identical and the ratio of their kinetic energies is  $\frac{7}{x}$  where x is \_\_\_\_\_.

Ans. (7.00)

57. A parallel beam of monochromatic light of wavelength  $5000 \text{ \AA}$  is incident normally on a single narrow slit of width  $0.001 \text{ mm}$ . The light is focused by convex lens on screen, placed on its focal plane. The first minima will be formed for the angle of diffraction of \_\_\_\_\_ (degree).

Ans. (30.00)

58. The electric potential at the surface of an atomic nucleus ( $z = 50$ ) of radius  $9 \times 10^{-13} \text{ cm}$  is \_\_\_\_\_  $\times 10^6 \text{ V}$ .

Ans. (8.00)

59. If Rydberg's constant is R, the longest wavelength of radiation in Paschen series will be  $\frac{\alpha}{7R}$ , where  $\alpha =$  \_\_\_\_\_.

Ans. (144.00)

60. A series LCR circuit with  $L = \frac{100}{\pi} \text{ mH}$ ,  $C = \frac{10^{-3}}{\pi} \text{ F}$  and  $R = 10 \Omega$ , is connected across an ac source of  $220 \text{ V}$ ,  $50 \text{ Hz}$  supply. The power factor of the circuit would be \_\_\_\_\_.

Ans. (1.00)

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