

SECTION-A

26. Match List-I with List-II.

List-I**List-II**

(A) Meter (L)

I. $\sqrt{\frac{hc}{G}}$

(B) Second (S)

II. $\sqrt{\frac{Gh}{c^5}}$

(C) Kilogram (M)

III. $\sqrt{\frac{K^2 L^2 c^3}{Gh}}$

(D) Kelvin (K)

IV. $\sqrt{\frac{Gh}{c^3}}$

where h (Planck's constant), G (gravitational constant) and c (speed of light in vacuum) as fundamental units.

Choose the correct answer from the options given below:

(1) A-II, B-IV, C-I, D-III

(2) A-IV, B-II, C-I, D-III

(3) A-IV, B-I, C-II, D-III

(4) A-III, B-I, C-II, D-IV

27. In an experiment to determine the resistance of a given wire using Ohm's law, the voltmeter and ammeter readings are noted as 10 V and 5 A, respectively. The least counts of voltmeter and ammeter are 500 mV and 200 mA, respectively. The estimated error in the resistance measurement is _____ Ω

(1) 0.25

(2) 2

(3) 2.5

(4) 0.18

28. A mass of 1 kg kept in a inclined plane with 30° inclination with respect to horizontal plane and it is at rest initially. Then the whole assembly is moved up with constant velocity of 4 m/s. The work done by the frictional force in time 2 s is _____ J. (Take $g = 10 \text{ m/s}^2$)

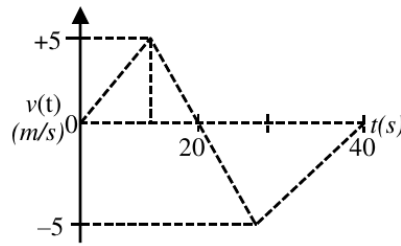
(1) 20

(2) 25

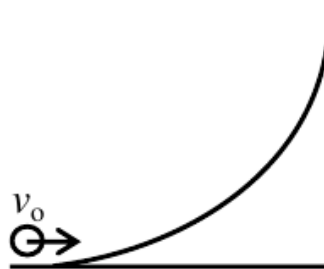
(3) 30

(4) 10

29. The velocity (v) versus time (t) plot of a particle is shown in the figure, for a time interval of 40 s. The total distance travelled by the particle and the average velocity during this period are, respectively ____



- (1) 25 m and zero
 (2) 50 m and zero
 (3) 100 m and zero
 (4) 100 m and 2.5 m/s
30. A wheel initially at rest is subjected to a uniform angular acceleration about its axis. In the first 2 s it rotates through an angle θ_1 and in the next 2 s it rotates through an angle θ_2 . The ratio θ_2/θ_1 is ____.
- (1) 6
 (2) 3
 (3) 4
 (4) 1/3
31. An object of uniform density rolls up the curved path with the initial velocity v_0 as shown in the figure. If the maximum height attained by an object is $7v_0^2/10g$ (g = acceleration due to gravity), the object is a ____.



- (1) solid cylinder
 (2) ring
 (3) disc
 (4) solid sphere
32. A body of mass m is taken from the surface of earth to a height equal to twice the radius of earth (R_e). The increase in potential energy will be _____. (g is acceleration due to gravity at the surface of earth)
- (1) $\frac{1}{2} mgR_e$
 (2) $\frac{3}{4} mgR_e$
 (3) $\frac{1}{4} mgR_e$
 (4) $\frac{2}{3} mgR_e$
33. Eight mercury drops, each of radius r , coalesce to form a bigger drop. The surface energy released in this process is _____. (S is the surface tension of mercury).
- (1) $8\pi r^2 S$
 (2) $16\pi r^2 S$
 (3) $64\pi r^2 S$
 (4) $4\pi r^2 S$
34. An ideal gas at pressure P and temperature T is expanding such that $PT^3 = \text{constant}$. The coefficient of volume expansion of the gas is ____.
- (1) $2/T$
 (2) $1/T$
 (3) $4/T$
 (4) $3/T$

35. Match List-I with List-II.

List-I	List-II
A. $\sin^2 \omega t$	I. Periodic with time period $T = \pi/\omega$ but not simple harmonic motion (SHM)
B. $\sin^3(2\omega t)$	II. Periodic with time period $T = 2\pi/\omega$ but Not SHM
C. $\sin(\omega t) + \cos(\pi\omega t)$	III. periodic with time period $T = \pi/\omega$ and SHM
D. $\cos \omega t + \cos 2\omega t$	IV. Non-periodic

Choose the correct answer from the options given below.

(1) A-III, B-I, C-IV, D-II

(2) A-II, B-I, C-III, D-IV

(3) A-III, B-II, C-IV, D-I

(4) A-II, B-I, C-IV, D-III

36. A metal rod of length L rotates about one end at origin with a uniform angular velocity ω . The magnetic field radially falls off as $B(r) = B_0 e^{-\lambda r}$; λ being a positive constant. The emf induced (neglecting the centripetal force on electrons in the rod) is:

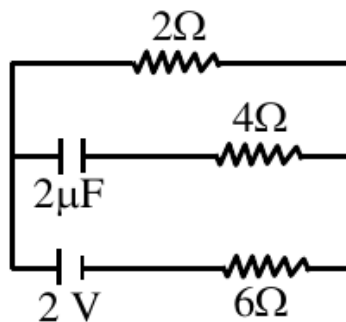
(1) $B_0 \omega \left[\frac{1}{\lambda^2} - e^{-\lambda L} \left(\frac{1}{\lambda^2} + \frac{L}{\lambda} \right) \right]$

(2) $B_0 \omega \left[\frac{1}{\lambda^2} + e^{-\lambda L} \left(\frac{1}{\lambda^2} + \frac{L}{\lambda} \right) \right]$

(3) $B_0 \omega \left[\frac{4}{\lambda^2} - e^{-2\lambda L} \left(\frac{1}{\lambda^2} + \frac{2L}{\lambda} \right) \right]$

(4) $B_0 \omega \left[\frac{3}{\lambda^2} - e^{-3\lambda L} \left(\frac{3}{\lambda^2} + \frac{L}{\lambda} \right) \right]$

37. Under steady state condition the potential difference across the capacitor in the circuit is ____ V.



(1) 0.5

(2) 1.5

(3) 0

(4) 2

38. A particle of charge q and mass m is projected from origin with an initial velocity

$$\vec{v} = \left(\frac{v_0}{\sqrt{2}} \hat{x} + \frac{v_0}{\sqrt{2}} \hat{y} \right)$$

There exists a uniform magnetic field $B = B_0 \hat{z}$ (along the z-axis) and a space varying electric field $E = E_0 e^{-\lambda x} \hat{x}$ within the region $0 \leq x \leq L$. After travelling a distance such that x-coordinate has changed from $x = 0$ to $x = L$, the change in the kinetic energy is _____.

- (1) $\frac{qE_0}{\lambda} [1 - e^{-\lambda L}]$
- (2) $\left(\frac{v_0 q B_0}{2\lambda} \right) [2 - e^{-2\lambda L}]$
- (3) $\frac{qE_0}{\lambda} [1 + e^{-\lambda L}]$
- (4) $q \left[\frac{E_0 + v_0 B_0}{\lambda} \right] [1 - e^{-\lambda L/2}]$

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

Assertion (A) : The electromagnetic wave exerts pressure on the surface on which they are allowed to fall.

Reason (R) : There is no mass associated with the electromagnetic waves.

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

- (1) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**
- (2) Both **(A)** and **(R)** are true 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

40. A thin convex lens and a thin concave lens are kept in contact and are co-axial. Which of the following statements is correct for this combination of two lenses?

- (1) behaves as concave lens if $|f_{\text{convex}}| > |f_{\text{concave}}|$
- (2) behaves as concave lens if $|f_{\text{convex}}| < |f_{\text{concave}}|$
- (3) behaves as convex lens if $|f_{\text{convex}}| > |f_{\text{concave}}|$
- (4) Focal length of the lens system will change if the position of two lenses are interchanged

41. An object AB is placed 15 cm on the left of a convex lens P of focal length 10 cm. Another convex lens Q is now placed 15 cm right of lens P. If the focal length of lens Q is 15 cm, the final image is _____

- (1) virtual, formed at 7.5 cm right of lens Q, with a size bigger than that of AB
- (2) real, formed at 7.5 cm right of lens Q, with a size same than that of AB
- (3) formed at infinity.
- (4) real, formed at 7 cm right of lens Q, with a size smaller than that of AB

42. The maximum intensity in a Young's double slit experiment is I_0 . Distance between the slits (d) is 5λ , where λ is the wavelength of light used. The intensity of the fringe, exactly opposite to one of the slits on the screen, placed at $D = 10d$ is _____

- | | |
|-------------|--------------|
| (1) $I_0/4$ | (2) $I_0/2$ |
| (3) I_0 | (4) $3I_0/4$ |

43. An electron is travelling with a velocity v in free space and when it enters a medium, its velocity is reduced by 20%. The de Broglie wavelength of electron in the medium is $\alpha\lambda_0$, where λ_0 is its de Broglie wavelength in free space. The value of α is _____
- (1) 1.20 (2) 1.0
(3) 1.25 (4) 0.75
44. Assuming the experimental mass of $^{12}_6\text{C}$ as 12u, the mass defect of $^{12}_6\text{C}$ atom is _____ MeV/c^2 . (Mass of proton = 1.00727u, mass of neutron = 1.00866 u, 1 u = 931.5 MeV/c^2 and c is the speed of the light in vacuum.)
- (1) 127.5 (2) 89.03
(3) 272.0 (4) 92.0
45. In a semiconductor p-n diode, the doping concentrations on p-side and n-side are 10^{15} atoms/ cm^3 and 10^{18} atoms/ cm^3 , respectively. Which one of the following statement is true?
- (1) Widths of depletion region on either side of the interface are equal
(2) The depletion region width is more on p-side compared to that in n-side
(3) The depletion region width is more on n-side compared to that in p-side
(4) No depletion region forms because of unequal doping concentrations on p and n-sides

SECTION-B

46. A copper wire of length 3 m is stretched by 3 mm by applying an external force. The volume of the wire is $600 \times 10^{-6} \text{ m}^3$. The elastic potential energy stored in the wire in stretched condition would be _____ J. (Given Young modulus of copper = $1.1 \times 10^{11} \text{ N/m}^2$)
47. The heat extracted out of x gram of water initially at 50°C to cool it down to 0°C is sufficient to evaporate $(1000 - x)$ gram of water also initially at 50°C . The value of x (closest integer) is _____. (Take latent heat of water 2256 kJ/kg. K, specific heat capacity of water 4200 J/kg. K)
48. A series LCR circuit with $R = 20 \Omega$, $L = 1.6 \text{ H}$ and $C = 40 \mu\text{F}$ is connected to a variable frequency a.c. source. The inductive reactance at resonant frequency is _____ Ω .
49. When an external resistance of 5Ω is connected across terminals of a cell, a current of 0.25 A flows through it. When the 5Ω resistor is replaced by a 2Ω resistor, a current of 0.5 A flows through it. The internal resistance of the cell is _____ Ω .
50. A circular loop of radius 20 cm and resistance 2Ω is placed in a time varying magnetic field
- $$\vec{B} = (2t^2 + 2t + 3) \text{ T}$$
- At $t = 0$, for the plane of the loop being perpendicular to the magnetic field and, the induced current in the loop at $t = 3 \text{ s}$ is $(\alpha/50) \text{ A}$. The value of α is _____ (Take $\pi = 22/7$)