NEET 2023 Manipur — Physics Question Paper with Solutions

39 Physics questions as set in the paper · answers checked by RankUp

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1. A bullet of mass m hits a block of mass M elastically. The transfer of energy is the maximum, when :

(A) M = m
(B) M = 2m
(C) M << m
(D) M >> m

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2. The ground state energy of hydrogen atom is −13.6 eV. The energy needed to ionize hydrogen atom from its second excited state will be :

(A) 13.6 eV
(B) 6.8 eV
(C) 1.51 eV
(D) 3.4 eV

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3. The escape velocity of a body on the earth surface is 11.2 km/s. If the same body is projected upward with velocity 22.4 km/s, the velocity of this body at infinite distance from the centre of the earth will be:

(A) 11.2√2 km/s
(B) Zero
(C) 11.2 km/s
(D) 11.2√3 km/s

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4. The diameter of a spherical bob, when measured with vernier callipers yielded the following values : 3.33 cm, 3.32 cm, 3.34 cm, 3.33 cm and 3.32 cm. The mean diameter to appropriate significant figures is :

(A) 3.328 cm
(B) 3.3 cm
(C) 3.33 cm
(D) 3.32 cm

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5. On the basis of electrical conductivity, which one of the following materials has the smallest resistivity?

(A) Germanium
(B) Silver
(C) Glass
(D) Silicon

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6. The mechanical quantity, which has dimensions of reciprocal of mass (M^{-1}) is :

(A) angular momentum
(B) coefficient of thermal conductivity
(C) torque
(D) gravitational constant

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7. The position of a particle is given by
$\vec{r}(t) = 4t\,\hat{i} + 2t^2\,\hat{j} + 5\,\hat{k}$
where t is in seconds and r in metre. Find the magnitude and direction of velocity v(t), at t = 1 s, with respect to x-axis

(A) $4\sqrt{2}$ m s^{-1}, 45°
(B) $4\sqrt{2}$ m s^{-1}, 60°
(C) $3\sqrt{2}$ m s^{-1}, 30°
(D) $3\sqrt{2}$ m s^{-1}, 45°

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8. An ac source is connected in the given circuit. The value of φ will be :
[Circuit: an inductor of (1/π) H in series with a 100 Ω resistor across an ac source V = 220 sin(100πt + φ) Volt]

(A) 60°
(B) 90°
(C) 30°
(D) 45°

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9. The given circuit is equivalent to:
[Circuit: input A passes through a NOT gate and input B passes through a NOT gate; the two outputs are fed to a NOR gate, whose output is Y]

(A) NOR gate
(B) NAND gate
(C) OR gate
(D) AND gate

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10. A particle moves with a velocity $(5\hat{i} - 3\hat{j} + 6\hat{k})$ m s^{-1} horizontally under the action of constant force $(10\hat{i} + 10\hat{j} + 20\hat{k})$ N. The instantaneous power supplied to the particle is :

(A) 200 W
(B) Zero
(C) 100 W
(D) 140 W

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11. A certain wire A has resistance 81 Ω. The resistance of another wire B of same material and equal length but of diameter thrice the diameter of A will be :

(A) 81 Ω
(B) 9 Ω
(C) 729 Ω
(D) 243 Ω

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12. ε_0 and μ_0 are the electric permittivity and magnetic permeability of free space respectively. If the corresponding quantities of a medium are $2\varepsilon_0$ and $1.5\mu_0$ respectively, the refractive index of the medium will nearly be :

(A) $\sqrt{2}$
(B) $\sqrt{3}$
(C) 3
(D) 2

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13. The amount of elastic potential energy per unit volume (in SI unit) of a steel wire of length 100 cm to stretch it by 1 mm is (if Young's modulus of the wire = 2.0×10^{11} N m^{-2}) :

(A) 10^{11}
(B) 10^{17}
(C) 10^{7}
(D) 10^{5}

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14. The 4th overtone of a closed organ pipe is same as that of 3rd overtone of an open pipe. The ratio of the length of the closed pipe to the length of the open pipe is :

(A) 8 : 9
(B) 9 : 7
(C) 9 : 8
(D) 7 : 9

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15. A long straight wire of length 2 m and mass 250 g is suspended horizontally in a uniform horizontal magnetic field of 0.7 T. The amount of current flowing through the wire will be (g = 9.8 m s^{-2}) :

(A) 2.45 A
(B) 2.25 A
(C) 2.75 A
(D) 1.75 A

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16. According to Gauss law of electrostatics, electric flux through a closed surface depends on :

(A) the area of the surface
(B) the quantity of charges enclosed by the surface
(C) the shape of the surface
(D) the volume enclosed by the surface

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17. Which of the following statements is not true?

(A) Coefficient of viscosity is a scalar quantity
(B) Surface tension is a scalar quantity
(C) Pressure is a vector quantity
(D) Relative density is a scalar quantity

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18. A uniform electric field and a uniform magnetic field are acting along the same direction in a certain region. If an electron is projected in the region such that its velocity is pointed along the direction of fields, then the electron:

(A) will turn towards right of direction of motion
(B) will turn towards left of direction of motion
(C) speed will decrease
(D) speed will increase

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19. A p-type extrinsic semiconductor is obtained when Germanium is doped with:

(A) Antimony
(B) Phosphorous
(C) Arsenic
(D) Boron

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20. The wavelength of Lyman series of hydrogen atom appears in:

(A) visible region
(B) far infrared region
(C) ultraviolet region
(D) infrared region

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21. The de Broglie wavelength associated with an electron, accelerated by a potential difference of 81 V is given by:

(A) 13.6 nm
(B) 136 nm
(C) 1.36 nm
(D) 0.136 nm

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22. The maximum power is dissipated for an ac in a/an:

(A) resistive circuit
(B) LC circuit
(C) inductive circuit
(D) capacitive circuit

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23. The maximum kinetic energy of the emitted photoelectrons in photoelectric effect is independent of:

(A) work function of material
(B) intensity of incident radiation
(C) frequency of incident radiation
(D) wavelength of incident radiation

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24. Two particles A and B initially at rest, move towards each other under mutual force of attraction. At an instance when the speed of A is v and speed of B is 3v, the speed of centre of mass is :

(A) 2v
(B) zero
(C) v
(D) 4v

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25. A charge Q μC is placed at the centre of a cube. The flux coming out from any one of its faces will be (in SI unit) :

(A) $(Q/\varepsilon_0) \times 10^{-6}$
(B) $(2Q/3\varepsilon_0) \times 10^{-3}$
(C) $(Q/6\varepsilon_0) \times 10^{-3}$
(D) $(Q/6\varepsilon_0) \times 10^{-6}$

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26. The viscous drag acting on a metal sphere of diameter 1 mm, falling through a fluid of viscosity 0.8 Pa s with a velocity of 2 m s^{-1} is equal to :

(A) 15×10^{-3} N
(B) 30×10^{-3} N
(C) 1.5×10^{-3} N
(D) 20×10^{-3} N

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27. If R is the radius of the earth and g is the acceleration due to gravity on the earth surface. Then the mean density of the earth will be :

(A) πRG/12g
(B) 3πR/4gG
(C) 3g/4πRG
(D) 4πG/3gR

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28. A copper wire of radius 1 mm contains 10^{22} free electrons per cubic metre. The drift velocity for free electrons when 10 A current flows through the wire will be (Given, charge on electron = 1.6×10^{-19} C) :

(A) $(6.25 \times 10^4/\pi)$ m s^{-1}
(B) $(6.25/\pi) \times 10^3$ m s^{-1}
(C) $(6.25/\pi)$ m s^{-1}
(D) $(6.25 \times 10^5/\pi)$ m s^{-1}

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29. An object is mounted on a wall. Its image of equal size is to be obtained on a parallel wall with the help of a convex lens placed between these walls. The lens is kept at distance x in front of the second wall. The required focal length of the lens will be :

(A) less than x/4
(B) more than x/4 but less than x/2
(C) x/2
(D) x/4

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30. If a conducting sphere of radius R is charged. Then the electric field at a distance r (r > R) from the centre of the sphere would be, (V = potential on the surface of the sphere)

(A) rV/R^2
(B) R^2V/r^3
(C) RV/r^2
(D) V/r

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31. A container of volume 200 cm^3 contains 0.2 mole of hydrogen gas and 0.3 mole of argon gas. The pressure of the system at temperature 200 K (R = 8.3 J K^{-1} mol^{-1}) will be :-

(A) 6.15×10^5 Pa
(B) 6.15×10^4 Pa
(C) 4.15×10^5 Pa
(D) 4.15×10^6 Pa

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32. To produce an instantaneous displacement current of 2 mA in the space between the parallel plates of a capacitor of capacitance 4 μF, the rate of change of applied variable potential difference (dV/dt) must be :-

(A) 800 V/s
(B) 500 V/s
(C) 200 V/s
(D) 400 V/s

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33. An emf is generated by an ac generator having 100 turn coil, of loop area 1 m^2. The coil rotates at a speed of one revolution per second and placed in a uniform magnetic field of 0.05 T perpendicular to the axis of rotation of the coil. The maximum value of emf is :-

(A) 3.14 V
(B) 31.4 V
(C) 62.8 V
(D) 6.28 V

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34. A constant torque of 100 N m turns a wheel of moment of inertia 300 kg m^2 about an axis passing through its centre. Starting from rest, its angular velocity after 3 s is :-

(A) 1 rad/s
(B) 5 rad/s
(C) 10 rad/s
(D) 15 rad/s

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35. The emf of a cell having internal resistance 1 Ω is balanced against a length of 330 cm on a potentiometer wire. When an external resistance of 2 Ω is connected across the cell, the balancing length will be :

(A) 220 cm
(B) 330 cm
(C) 115 cm
(D) 332 cm

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36. A 1 kg object strikes a wall with velocity 1 m s^{-1} at an angle of 60° with the wall and reflects at the same angle. If it remains in contact with wall for 0.1 s, then the force exerted on the wall is :

(A) $30\sqrt{3}$ N
(B) Zero
(C) $10\sqrt{3}$ N
(D) $20\sqrt{3}$ N

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37. The angular momentum of an electron moving in an orbit of hydrogen atom is 1.5 (h/π). The energy in the same orbit is nearly.

(A) −1.5 eV
(B) −1.6 eV
(C) −1.3 eV
(D) −1.4 eV

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38. A particle is executing uniform circular motion with velocity $\vec{v}$ and acceleration $\vec{a}$. Which of the following is true?

(A) $\vec{v}$ is a constant; $\vec{a}$ is not a constant
(B) $\vec{v}$ is not a constant; $\vec{a}$ is not a constant
(C) $\vec{v}$ is a constant; $\vec{a}$ is a constant
(D) $\vec{v}$ is not a constant; $\vec{a}$ is a constant

39. A simple pendulum oscillating in air has a period of √3 s. If it is completely immersed in non-viscous liquid, having density (1/4)th of the material of the bob, the new period will be :-

(A) 2√3 s
(B) 2/√3 s
(C) 2 s
(D) √3/2 s

Answer key and explanations

1. Answer: (A) M = m

In a head-on elastic collision with M at rest, the fraction of kinetic energy transferred is $4mM/(m + M)^2$. This equals 1 when M = m (the bullet stops and the block moves off with its velocity). A very heavy block barely moves and a very light block takes little energy, so both extremes give small transfer.

2. Answer: (C) 1.51 eV

The second excited state is n = 3, with $E_n = -13.6/n^2 = -13.6/9 = -1.51$ eV. Ionisation needs energy to raise it to 0, i.e. 1.51 eV. Taking the second excited state as n = 2 gives the trap value 3.4 eV.

3. Answer: (D) 11.2√3 km/s

Energy conservation: $\tfrac{1}{2}mv^2 - GMm/R = \tfrac{1}{2}mv_\infty^2$, and $GMm/R = \tfrac{1}{2}mv_e^2$. So $v_\infty^2 = v^2 - v_e^2 = (22.4)^2 - (11.2)^2 = 11.2^2(4 - 1) = 3 \times 11.2^2$, giving $v_\infty = 11.2\sqrt{3}$ km/s. Subtracting speeds directly (22.4 − 11.2 = 11.2) ignores that energies, not velocities, add.

4. Answer: (C) 3.33 cm

Mean = (3.33 + 3.32 + 3.34 + 3.33 + 3.32)/5 = 16.64/5 = 3.328 cm. Each reading is given to two decimal places (least count 0.01 cm), so the mean is rounded to 3.33 cm. Writing 3.328 cm claims more precision than the instrument gives.

5. Answer: (B) Silver

Silver is a metal and the best electrical conductor, with resistivity about 1.6×10^{-8} Ω m. Germanium and silicon are semiconductors with resistivities many orders of magnitude higher, and glass is an insulator with the highest resistivity of all.

6. Answer: (D) gravitational constant

From $F = Gm_1m_2/r^2$, $G = Fr^2/m^2$, with dimensions $[M^{-1}L^3T^{-2}]$, so it contains M^{-1}. Angular momentum $[ML^2T^{-1}]$, torque $[ML^2T^{-2}]$ and thermal conductivity $[MLT^{-3}K^{-1}]$ all have mass to the power +1.

7. Answer: (A) 4√2 m s⁻¹, 45°

$\vec{v} = d\vec{r}/dt = 4\,\hat{i} + 4t\,\hat{j}$; at t = 1 s, $\vec{v} = 4\,\hat{i} + 4\,\hat{j}$ (the constant $5\,\hat{k}$ term gives no velocity). $|v| = \sqrt{(16 + 16)} = 4\sqrt{2}$ m s⁻¹, and tan θ = 4/4 = 1, so θ = 45° with the x-axis.

8. Answer: (D) 45°

ω = 100π rad s⁻¹, so $X_L = \omega L = 100\pi \times (1/\pi) = 100$ Ω. In the series LR circuit tan φ = X_L/R = 100/100 = 1, so φ = 45°. A value of 90° would apply only to a pure inductor.

9. Answer: (D) AND gate

The NOR gate receives $\bar{A}$ and $\bar{B}$, so Y = NOT($\bar{A}$ + $\bar{B}$). By De Morgan's theorem NOT($\bar{A}$ + $\bar{B}$) = A·B, which is the AND function. NAND would be the result if the final gate had been an OR with inverted inputs.

10. Answer: (D) 140 W

$P = \vec{F} \cdot \vec{v} = (10)(5) + (10)(-3) + (20)(6) = 50 - 30 + 120 = 140$ W. Ignoring the negative y-component (taking +30) would give the trap value 200 W.

11. Answer: (B) 9 Ω

$R = \rho L/A$ with $A = \pi d^2/4$, so for the same material and length $R \propto 1/d^2$. Tripling the diameter makes the area 9 times larger, so R = 81/9 = 9 Ω. Using $R \propto 1/d$ would give 27 Ω, and multiplying instead of dividing gives 729 Ω.

12. Answer: (B) √3

Speed in a medium $v = 1/\sqrt{(\mu\varepsilon)}$ and in vacuum $c = 1/\sqrt{(\mu_0\varepsilon_0)}$, so $n = c/v = \sqrt{(\mu_r\varepsilon_r)} = \sqrt{(1.5 \times 2)} = \sqrt{3}$. Forgetting the square root gives 3.

13. Answer: (D) 10^5

Strain = ΔL/L = 1×10^{-3} m / 1 m = 10^{-3}. Energy per unit volume = ½ Y (strain)² = ½ × 2.0×10^{11} × 10^{-6} = 10^5 J m⁻³. Using Y × strain (the stress) without the ½ × strain factor would give a much larger number.

14. Answer: (C) 9 : 8

A closed pipe has only odd harmonics; its 4th overtone is the 9th harmonic, f = 9v/4L_c. An open pipe has all harmonics; its 3rd overtone is the 4th harmonic, f = 4v/2L_o = 2v/L_o. Equating, 9/(4L_c) = 2/L_o, so L_c/L_o = 9/8. Inverting the ratio gives the trap 8 : 9.

15. Answer: (D) 1.75 A

For the wire to stay suspended the magnetic force balances its weight: BIL = mg, so I = mg/(BL) = (0.25 × 9.8)/(0.7 × 2) = 2.45/1.4 = 1.75 A. The value 2.45 is the weight in newtons, not the current.

16. Answer: (B) the quantity of charges enclosed by the surface

Gauss's law states $\Phi = q_{enclosed}/\varepsilon_0$, so the total flux through a closed surface depends only on the net charge enclosed. The area, shape or volume of the surface can change without changing the flux as long as the enclosed charge is unchanged.

17. Answer: (C) Pressure is a vector quantity

Pressure at a point acts equally in all directions and has no particular direction of its own, so it is a scalar, even though the force it produces on a surface is a vector. Coefficient of viscosity, surface tension and relative density are also scalars, so only the statement calling pressure a vector is untrue.

18. Answer: (C) speed will decrease

Since $\vec{v}$ is parallel to $\vec{B}$, the magnetic force $q\vec{v} \times \vec{B}$ is zero, so the electron does not turn either way. The electric force on the negative electron is $-e\vec{E}$, opposite to its velocity, so it decelerates and its speed decreases. A positive charge would have speeded up.

19. Answer: (D) Boron

A p-type semiconductor needs a trivalent (acceptor) impurity, which creates holes. Boron is trivalent; antimony, phosphorus and arsenic are pentavalent donors and give n-type material.

20. Answer: (C) ultraviolet region

Lyman lines are transitions ending on n = 1, with wavelengths from about 91 nm to 122 nm, which lie in the ultraviolet. The visible lines belong to the Balmer series (ending on n = 2), and the Paschen, Brackett and Pfund series lie in the infrared.

21. Answer: (D) 0.136 nm

For an electron accelerated through V volts, $\lambda = h/\sqrt{(2meV)} \approx 1.227/\sqrt{V}$ nm. With V = 81 V, λ = 1.227/9 ≈ 0.136 nm. The other options are this value shifted by powers of ten.

22. Answer: (A) resistive circuit

Average power is $P = V_{rms} I_{rms} \cos\varphi$. In a purely resistive circuit φ = 0 and cos φ = 1, giving the maximum power. In purely inductive, capacitive or LC circuits φ = ±90°, so the average power dissipated is zero.

23. Answer: (B) intensity of incident radiation

Einstein's equation $K_{max} = h\nu - \varphi_0$ shows the maximum kinetic energy depends on the frequency (or wavelength) of the light and on the work function. Intensity only changes the number of photons, and hence the photocurrent, not K_{max}.

24. Answer: (B) zero

The only forces are internal (mutual attraction), so the total momentum stays at its initial value of zero and the centre of mass, initially at rest, stays at rest. The speeds v and 3v simply reflect a 3 : 1 mass ratio; averaging the speeds is the trap.

25. Answer: (D) $(Q/6\varepsilon_0) \times 10^{-6}$

Total flux through the closed cube is $q/\varepsilon_0 = Q \times 10^{-6}/\varepsilon_0$. By symmetry the six faces share it equally, so each face carries $(Q/6\varepsilon_0) \times 10^{-6}$. The 10^{-3} factor would be for millicoulombs, and the $1/\varepsilon_0$ version is the total, not one face.

26. Answer: (A) 15×10^{-3} N

Stokes' law: $F = 6\pi\eta rv$ with r = 0.5 mm = 5×10^{-4} m. $F = 6\pi \times 0.8 \times 5 \times 10^{-4} \times 2 = 4.8\pi \times 10^{-3} \approx 15 \times 10^{-3}$ N. Using the diameter instead of the radius doubles this to about 30×10^{-3} N.

27. Answer: (C) $3g/4\pi RG$

$g = GM/R^2$ with $M = (4/3)\pi R^3\rho$ gives $g = (4/3)\pi GR\rho$. Hence $\rho = 3g/(4\pi GR)$. The other expressions invert or misplace g, R or G.

28. Answer: (B) $(6.25/\pi) \times 10^3$ m s^{-1}

$v_d = I/(neA)$ with $A = \pi(10^{-3})^2 = \pi \times 10^{-6}$ m^2. $v_d = 10/(10^{22} \times 1.6 \times 10^{-19} \times \pi \times 10^{-6}) = 10/(1.6\pi \times 10^{-3}) = (6.25/\pi) \times 10^3$ m s^{-1}. (The unusually small electron density given makes the value large, but it follows from the data.)

29. Answer: (C) x/2

A real image of the same size as the object forms when u = v = 2f. The image is on the second wall at distance x from the lens, so v = x = 2f and f = x/2. The value x/4 would apply if x were the distance between the two walls (4f).

30. Answer: (C) RV/r²

Outside, the sphere acts as a point charge: E = kQ/r². On the surface V = kQ/R, so kQ = VR and E = VR/r². The expression V/r would be correct only at the surface (r = R).

31. Answer: (D) 4.15 × 10⁶ Pa

Total moles n = 0.2 + 0.3 = 0.5 mol and V = 200 cm³ = 2 × 10⁻⁴ m³. P = nRT/V = 0.5 × 8.3 × 200/(2 × 10⁻⁴) = 830/(2 × 10⁻⁴) = 4.15 × 10⁶ Pa. Leaving the volume in litres instead of m³ shifts the power of ten.

32. Answer: (B) 500 V/s

Displacement current $I_d = \varepsilon_0 \, d\Phi_E/dt = C \, dV/dt$. So $dV/dt = I_d/C = 2 \times 10^{-3}/(4 \times 10^{-6}) = 500$ V s⁻¹. Multiplying instead of dividing gives a meaningless value.

33. Answer: (B) 31.4 V

$\varepsilon_0 = NBA\omega$ with $\omega = 2\pi \times 1$ rev s⁻¹ $= 2\pi$ rad s⁻¹. $\varepsilon_0 = 100 \times 0.05 \times 1 \times 2\pi = 10\pi \approx 31.4$ V. Using $\omega = 1$ rad s⁻¹ (forgetting 2π) gives 5 V, and using π alone gives 15.7 V.

34. Answer: (A) 1 rad/s

$\alpha = \tau/I = 100/300 = 1/3$ rad s⁻². Starting from rest, $\omega = \alpha t = (1/3) \times 3 = 1$ rad s⁻¹.

35. Answer: (A) 220 cm

Open-circuit balance gives E ∝ 330 cm. With the 2 Ω resistor, the terminal voltage is $V = E \, R/(R + r) = E \times 2/3$, so the new balancing length is 330 × 2/3 = 220 cm. Expecting no change ignores the drop across the internal resistance.

36. Answer: (C) 10√3 N

Only the component perpendicular to the wall reverses. The angle with the wall is 60°, so the normal component is v sin 60° = √3/2 m s⁻¹. Δp = 2mv sin 60° = 2 × 1 × √3/2 = √3 kg m s⁻¹, and F = Δp/Δt = √3/0.1 = 10√3 N. Using cos 60° (as if the angle were with the normal) would give 10 N.

37. Answer: (A) −1.5 eV

Bohr quantisation: L = nh/2π. Here 1.5 h/π = 3h/2π, so n = 3. $E_3 = -13.6/9 \approx -1.51$ eV, i.e. nearly −1.5 eV.

38. Answer: (B) $\vec{v}$ is not a constant; $\vec{a}$ is not a constant

In uniform circular motion the speed and the magnitude of acceleration are constant, but the velocity keeps changing direction along the tangent and the centripetal acceleration keeps changing direction toward the centre. So neither vector is constant.

39. Answer: (C) 2 s

Buoyancy reduces the effective weight: $g_{eff} = g(1 - \rho_{liquid}/\rho_{bob}) = g(1 - 1/4) = 3g/4$. T ∝ 1/√g, so T' = T/√(3/4) = √3 × 2/√3 = 2 s. Multiplying instead of dividing gives 3/2 s, which is not offered.

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