

AIPMT 2012 Prelims — Physics Question Paper with Solutions

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

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1. In a CE transistor amplifier, the audio signal voltage across the collector resistance of $2\text{ k}\Omega$ is 2 V . If the base resistance is $1\text{ k}\Omega$ and the current amplification of the transistor is 100 , the input signal voltage is

- (A) 10 mV
- (B) 0.1 V
- (C) 1.0 V
- (D) 1 mV

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2. A coil of resistance $400\ \Omega$ is placed in a magnetic field. If the magnetic flux ϕ (Wb) linked with the coil varies with time t (s) as $\phi = 50t^2 + 4$, the current in the coil at $t = 2\text{ s}$ is

- (A) 1 A
- (B) 0.5 A
- (C) 0.1 A
- (D) 2 A

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3. A solid cylinder of mass 3 kg is rolling on a horizontal surface with velocity 4 m s^{-1} . It collides with a horizontal spring of force constant 200 N m^{-1} . The maximum compression produced in the spring will be

- (A) 0.2 m
- (B) 0.5 m
- (C) 0.6 m
- (D) 0.7 m

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4. An electric dipole of moment p is placed in an electric field of intensity E . The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when $\theta = 90^\circ$, the torque and the potential energy of the dipole will respectively be

- (A) $pE \cos \theta$, $-pE \sin \theta$
- (B) $pE \sin \theta$, $-pE \cos \theta$
- (C) $pE \sin \theta$, $-2pE \cos \theta$
- (D) $pE \sin \theta$, $2pE \cos \theta$

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5. The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectile is

- (A) $\theta = 45^\circ$
- (B) $\theta = \tan^{-1}(1/4)$
- (C) $\theta = \tan^{-1}(4)$
- (D) $\theta = \tan^{-1}(2)$

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6. If the nuclear radius of ^{27}Al is 3.6 fermi , the approximate nuclear radius of ^{64}Cu in fermi is

- (A) 3.6
- (B) 2.4
- (C) 1.2
- (D) 4.8

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7. Two similar coils of radius R are lying concentrically with their planes at right angles to each other. The currents flowing in them are I and $2I$, respectively. The resultant magnetic field induction at the centre will be

- (A) $\mu_0 I/R$
- (B) $\sqrt{5} \mu_0 I/(2R)$
- (C) $3\mu_0 I/(2R)$
- (D) $\mu_0 I/(2R)$

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8. When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index

- (A) less than that of glass
- (B) equal to that of glass
- (C) less than one
- (D) greater than that of glass

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9. A particle has initial velocity $(2\hat{i} + 3\hat{j})$ and acceleration $(0.3\hat{i} + 0.2\hat{j})$. The magnitude of velocity after 10 seconds will be

- (A) 9 units
- (B) $9\sqrt{2}$ units
- (C) $5\sqrt{2}$ units
- (D) 5 units

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10. The height at which the weight of a body becomes 1/16th of its weight on the surface of earth (radius R) is

- (A) $4R$
- (B) $5R$
- (C) $15R$
- (D) $3R$

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11. Four point charges $-Q$, $-q$, $2q$ and $2Q$ are placed, one at each corner of a square. The relation between Q and q for which the potential at the centre of the square is zero is

- (A) $Q = 1/q$
- (B) $Q = -q$
- (C) $Q = -1/q$
- (D) $Q = q$

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12. When a string is divided into three segments of length l_1 , l_2 and l_3 , the fundamental frequencies of these three segments are ν_1 , ν_2 and ν_3 respectively. The original fundamental frequency (ν) of the string is

- (A) $1/\nu = 1/\nu_1 + 1/\nu_2 + 1/\nu_3$
- (B) $\sqrt{\nu} = \sqrt{\nu_1} + \sqrt{\nu_2} + \sqrt{\nu_3}$
- (C) $\nu = \nu_1 + \nu_2 + \nu_3$
- (D) $1/\nu = 1/\nu_1 + 1/\nu_2 + 1/\nu_3$

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13. A ring is made of a wire having a resistance $R_0 = 12\ \Omega$. Points A and B on the ring divide it into two arcs of lengths l_1 and l_2 . At which points A and B should a current carrying conductor be connected so that the resistance R of the sub circuit between these points is equal to $8/3\ \Omega$?

- (A) $l_1/l_2 = 1/2$
- (B) $l_1/l_2 = 5/8$
- (C) $l_1/l_2 = 1/3$
- (D) $l_1/l_2 = 3/8$

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14. A geostationary satellite is orbiting the earth at a height of $5R$ above the surface of the earth, R being the radius of the earth. The time period of another satellite in hours at a height of $2R$ from the surface of the earth is

- (A) $6\sqrt{2}$
- (B) 5
- (C) 10
- (D) $6\sqrt{2}$

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15. If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q ? (σ stands for Stefan's constant)

- (A) $(Q/(4\pi R^2\sigma))^{1/4}$
- (B) $Q/(4\pi R^2\sigma)$
- (C) $(Q/(4\pi R^2\sigma))^{-1/2}$
- (D) $(4\pi R^2Q/\sigma)^{1/4}$

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16. When a mass is rotating in a plane about a fixed point, its angular momentum is directed along:

- (A) the tangent to the orbit
- (B) a line perpendicular to the plane of rotation
- (C) the line making an angle of 45° to the plane of rotation
- (D) the radius

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17. Two sources of sound placed close to each other are emitting progressive waves given by $y_1 = 4 \sin 600\pi t$ and $y_2 = 5 \sin 608\pi t$. An observer located near these two sources of sound will hear

- (A) 4 beats per second with intensity ratio 81 : 1 between waxing and waning
- (B) 4 beats per second with intensity ratio 25 : 16 between waxing and waning
- (C) 8 beats per second with intensity ratio 25 : 16 between waxing and waning
- (D) 8 beats per second with intensity ratio 81 : 1 between waxing and waning

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18. A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45° , the speed of the car is

- (A) 10 m s^{-1}
- (B) 20 m s^{-1}
- (C) 30 m s^{-1}
- (D) 5 m s^{-1}

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19. The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. The focal length of lenses are

- (A) 11 cm, 9 cm
- (B) 10 cm, 10 cm
- (C) 15 cm, 5 cm
- (D) 18 cm, 2 cm

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20. What is the flux through a cube of side a if a point charge of q is at one of its corners?

- (A) $(q/2\epsilon_0)6a^2$
- (B) $2q/\epsilon_0$
- (C) $q/(8\epsilon_0)$
- (D) q/ϵ_0

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21. An α -particle moves in a circular path of radius 0.83 cm in the presence of a magnetic field of 0.25 Wb/m^2 . The de Broglie wavelength associated with the particle will be

- (A) $0.01 \text{ \AA}$
- (B) $1 \text{ \AA}$
- (C) $0.1 \text{ \AA}$
- (D) $10 \text{ \AA}$

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22. A compass needle which is allowed to move in a horizontal plane is taken to a geomagnetic pole. It:

- (A) will stay in east-west direction only
- (B) will become rigid showing no movement
- (C) will stay in any position
- (D) will stay in north-south direction only

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23. A spherical planet has a mass M_p and diameter D_p . A particle of mass m falling freely near the surface of this planet will experience an acceleration due to gravity, equal to

- (A) $4GM_p m/D_p^2$
- (B) $4GM_p/D_p^2$
- (C) $GM_p m/D_p^2$
- (D) GM_p/D_p^2

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24. A 200 W sodium street lamp emits yellow light of wavelength $0.6 \mu\text{m}$. Assuming it to be 25% efficient in converting electrical energy to light, the number of photons of yellow light it emits per second is

- (A) 3×10^{19}
- (B) 1.5×10^{20}
- (C) 6×10^{18}
- (D) 62×10^{20}

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25. The potential energy of a particle in a force field is $U = A/r^2 - B/r$, where A and B are positive constants and r is the distance of particle from the centre of the field. For stable equilibrium the distance of the particle is

- (A) B/A
- (B) $B/2A$
- (C) $2A/B$
- (D) A/B

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26. An electron of a stationary hydrogen atom passes from the fifth energy level to the ground level. The velocity that the atom acquired as a result of photon emission will be (m is the mass of the electron, R the Rydberg constant and h Planck's constant)

- (A) $24m/(25hR)$
- (B) $24hR/(25m)$
- (C) $25hR/(24m)$
- (D) $25m/(24hR)$

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27. Monochromatic radiation emitted when an electron in hydrogen atom jumps from first excited to the ground state irradiates a photosensitive material. The stopping potential is measured to be 3.57 V. The threshold frequency of the material is

- (A) 2.5×10^{15} Hz
- (B) 4×10^{15} Hz
- (C) 5×10^{15} Hz
- (D) 1.6×10^{15} Hz

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28. A mixture consists of two radioactive materials A_1 and A_2 with half lives of 20 s and 10 s respectively. Initially the mixture has 40 g of A_1 and 160 g of A_2 . The amount of the two in the mixture will become equal after

- (A) 40 s
- (B) 60 s
- (C) 80 s
- (D) 20 s

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29. If voltage across a bulb rated 220 V-100 W drops by 2.5% of its rated value, the percentage of the rated value by which the power would decrease is

- (A) 10%
- (B) 20%
- (C) 2.5%
- (D) 5%

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30. C and Si both have same lattice structure, having 4 bonding electrons in each. However, C is insulator where as Si is intrinsic semiconductor. This is because

- (A) The four bonding electrons in the case of C lie in the third orbit, whereas for Si they lie in the fourth orbit
- (B) In case of C the valance band is not completely filled at absolute zero temperature
- (C) In case of C the conduction band is partly filled even at absolute zero temperature
- (D) The four bonding electrons in the case of C lie in the second orbit, whereas in the case of Si they lie in the third

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31. Two persons of masses 55 kg and 65 kg respectively, are at the opposite ends of a boat. The length of the boat is 3.0 m and weighs 100 kg. The 55 kg man walks up to the 65 kg man and sits with him. If the boat is in still water the centre of mass of the system shifts by

- (A) 0.75 m
- (B) 3.0 m
- (C) 2.3 m
- (D) zero

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32. The motion of a particle along a straight line is described by equation $x = 8 + 12t - t^3$, where x is in metre and t in second. The retardation of the particle when its velocity becomes zero is

- (A) 12 m s^{-2}
- (B) 24 m s^{-2}
- (C) zero
- (D) 6 m s^{-2}

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33. A millivoltmeter of 25 millivolt range is to be converted into an ammeter of 25 ampere range. The value (in ohm) of necessary shunt will be

- (A) 0.05
- (B) 0.001
- (C) 0.01
- (D) 1

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34. The damping force on an oscillator is directly proportional to the velocity. The units of the constant of proportionality are

- (A) kg s
- (B) kg m s^{-1}
- (C) kg m s^{-2}
- (D) kg s^{-1}

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35. A ray of light is incident at an angle of incidence i on one face of a prism of angle A (assumed to be small) and emerges normally from the opposite face. If the refractive index of the prism is μ , the angle of incidence i is nearly equal to

- (A) $A/(2\mu)$
- (B) μA
- (C) $\mu A/2$
- (D) A/μ

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36. Electron in hydrogen atom first jumps from third excited state to second excited state and then from second excited to the first excited state. The ratio of the wavelengths $\lambda_1 : \lambda_2$ emitted in the two cases is

- (A) 20/7
- (B) 7/5
- (C) 27/20
- (D) 27/5

37. The electric field associated with an e.m. wave in vacuum is given by $E = \hat{i} 40 \cos(kz - 6 \times 10^8 t)$, where E , z and t are in volt/m, metre and seconds respectively. The value of wave vector k is

- (A) 3 m^{-1}
- (B) 2 m^{-1}
- (C) 0.5 m^{-1}
- (D) 6 m^{-1}

38. An alternating electric field, of frequency ν , is applied across the dees (radius = R) of a cyclotron that is being used to accelerate protons (mass = m). The operating magnetic field (B) used in the cyclotron and the kinetic energy (K) of the proton beam, produced by it, are given by

- (A) $B = m\nu/e$ and $K = m^2\pi\nu R^2$
- (B) $B = m\nu/e$ and $K = 2m\pi^2\nu^2 R^2$
- (C) $B = 2\pi m\nu/e$ and $K = m^2\pi\nu R^2$
- (D) $B = 2\pi m\nu/e$ and $K = 2m\pi^2\nu^2 R^2$

39. In an electrical circuit R , L , C and an a.c. voltage source are all connected in series. When L is removed from the circuit, the phase difference between the voltage and the current in the circuit is $\pi/3$. If instead, C is removed from the circuit, the phase difference is again $\pi/3$. The power factor of the circuit is

- (A) $\sqrt{3}/2$
- (B) $1/2$
- (C) $1/\sqrt{2}$
- (D) 1

Answer key and explanations

1. Answer: (A) 10 mV

Voltage gain of a CE amplifier = $\beta(R_C/R_B) = 100 \times (2 \text{ k}\Omega/1 \text{ k}\Omega) = 200$. Input voltage = output/gain = $2 \text{ V}/200 = 0.01 \text{ V} = 10 \text{ mV}$. Taking 0.1 V comes from using only the resistance ratio or only β instead of their product.

2. Answer: (B) 0.5 A

Induced emf $e = d\phi/dt = 100t$, which is 200 V at $t = 2 \text{ s}$. Current = $e/R = 200/400 = 0.5 \text{ A}$. The constant 4 in ϕ does not contribute to the emf.

3. Answer: (C) 0.6 m

A rolling solid cylinder has $KE = \frac{1}{2}mv^2 + \frac{1}{2}(\frac{1}{2}mR^2)(v/R)^2 = \frac{3}{4}mv^2 = \frac{3}{4} \times 3 \times 16 = 36 \text{ J}$. Setting $\frac{1}{2}kx^2 = 36$ gives $x^2 = 72/200 = 0.36$, so $x = 0.6 \text{ m}$. Ignoring rotational KE gives 24 J and $x \approx 0.49 \text{ m}$, which leads to the 0.5 m trap.

4. Answer: (B) $pE \sin \theta$, $-pE \cos \theta$

Torque on a dipole is $\tau = pE \sin \theta$, and with U taken as zero at $\theta = 90^\circ$, the potential energy is $U = -pE \cos \theta$. The forms with $2pE \cos \theta$ wrongly double the energy, and $pE \cos \theta$ is not the torque.

5. Answer: (C) $\theta = \tan^{-1}(4)$

Range $R = u^2 \sin 2\theta/g = 2u^2 \sin \theta \cos \theta/g$ and maximum height $H = u^2 \sin^2 \theta/(2g)$. Setting $R = H$ gives $2 \cos \theta = \sin \theta/2$, i.e. $\tan \theta = 4$, so $\theta = \tan^{-1} 4$. An angle of 45° gives maximum range, not $R = H$.

6. Answer: (D) 4.8

Nuclear radius $R \propto A^{(1/3)}$, so $R_{\text{Cu}} = 3.6 \times (64/27)^{(1/3)} = 3.6 \times 4/3 = 4.8 \text{ fermi}$. A heavier nucleus must have a larger radius, which rules out the smaller values.

7. Answer: (B) $\sqrt{5} \mu_0 I/(2R)$

The coils give fields $\mu_0 I/(2R)$ and $\mu_0(2I)/(2R) = \mu_0 I/R$ at the centre, and these are perpendicular because the coil planes are perpendicular. Resultant $B = \sqrt{[(\mu_0 I/2R)^2 + (\mu_0 I/R)^2]} = \sqrt{5} \mu_0 I/(2R)$. Simply adding them ($3\mu_0 I/2R$) ignores that the fields are at right angles.

8. Answer: (B) equal to that of glass

By the lens maker's formula $1/f = (\mu_g/\mu_l - 1)(1/R_1 - 1/R_2)$. The lens behaves like a plane sheet (no power) only when $\mu_g/\mu_l = 1$, i.e. the liquid has the same refractive index as glass, 1.47. A liquid of smaller index would leave it a converging lens.

9. Answer: (C) $5\sqrt{2}$ units

$v = u + at = (2 + 0.3 \times 10)\hat{i} + (3 + 0.2 \times 10)\hat{j} = 5\hat{i} + 5\hat{j}$. Magnitude $= \sqrt{(25 + 25)} = 5\sqrt{2}$ units. Adding the components as scalars (5 + 5 or 9) is the trap.

10. Answer: (D) 3R

$g_h = g/(1 + h/R)^2$. For $g_h = g/16$, $1 + h/R = 4$, so $h = 3R$. $4R$ is the distance from the centre of the earth, not the height above the surface.

11. Answer: (B) $Q = -q$

All four charges are at the same distance from the centre, so the potential is proportional to the sum of charges: $-Q - q + 2q + 2Q = Q + q$. For zero potential, $Q = -q$. $Q = q$ would make the sum $2q$, not zero.

12. Answer: (D) $1/v = 1/v_1 + 1/v_2 + 1/v_3$

For the same string (same tension and linear density) the fundamental frequency $v = v/(2l)$ is inversely proportional to length. Since $l = l_1 + l_2 + l_3$, $1/v = 1/v_1 + 1/v_2 + 1/v_3$. Adding frequencies directly would wrongly treat v as proportional to length.

13. Answer: (A) $l_1/l_2 = 1/2$

The two arcs have resistances R_1 and R_2 with $R_1 + R_2 = 12 \Omega$, and they are in parallel between A and B: $R_1 R_2 / 12 = 8/3$, so $R_1 R_2 = 32$. Then $R_1 = 4 \Omega$ and $R_2 = 8 \Omega$, and since resistance is proportional to length, $l_1/l_2 = 1/2$.

14. Answer: (D) $6\sqrt{2}$

Orbit radii are $6R$ (geostationary, $T = 24$ h) and $3R$ (height $2R$). By Kepler's law $T \propto r^{3/2}$: $T = 24 \times (3R/6R)^{3/2} = 24/(2\sqrt{2}) = 6\sqrt{2}$ h. Using heights ($5R$ and $2R$) instead of orbital radii gives a wrong value.

15. Answer: (A) $(Q/(4\pi R^2 \sigma))^{1/4}$

For a black body, power radiated $= \sigma T^4 \times \text{area} = 4\pi R^2 \sigma T^4$. In steady state this equals the energy production rate Q , so $T = (Q/(4\pi R^2 \sigma))^{1/4}$. The expression without the fourth root gives T^4 , not T .

16. Answer: (B) a line perpendicular to the plane of rotation

Angular momentum $L = r \times p$, and both r and p lie in the plane of rotation, so L is perpendicular to that plane. The tangent is the direction of linear momentum, and the radius is the direction of r .

17. Answer: (A) 4 beats per second with intensity ratio 81 : 1 between waxing and waning

$\omega_1 = 600\pi$ gives $f_1 = 300$ Hz and $\omega_2 = 608\pi$ gives $f_2 = 304$ Hz, so beat frequency $= 4$ per second.

Intensity ratio $I_{\max}/I_{\min} = (A_1 + A_2)^2/(A_1 - A_2)^2 = 9^2/1^2 = 81 : 1$. 25 : 16 is just the ratio of individual intensities, and 8 beats comes from using $\omega/2\pi$ wrongly.

18. Answer: (C) 30 m s^{-1}

On a frictionless banked road, $\tan \theta = v^2/(rg)$. With $\theta = 45^\circ$, $v = \sqrt{rg} = \sqrt{(90 \times 10)} = 30 \text{ m s}^{-1}$ ($g = 10 \text{ m s}^{-2}$). The mass of the car does not enter the result.

19. Answer: (D) 18 cm, 2 cm

For normal adjustment, magnifying power $= f_o/f_e = 9$ and tube length $= f_o + f_e = 20$ cm. Solving, $f_e = 2$ cm and $f_o = 18$ cm. 15 cm and 5 cm add to 20 cm but give a magnification of only 3.

20. Answer: (C) $q/(8\epsilon_0)$

A charge at a corner can be enclosed symmetrically by 8 identical cubes, so each cube receives $1/8$ of the total flux q/ϵ_0 , i.e. $q/(8\epsilon_0)$. q/ϵ_0 would apply only if the charge were inside the cube.

21. Answer: (A) 0.01 Å

In a magnetic field, momentum $p = qBr$ with $q = 2e$ for an α -particle. $\lambda = h/(2eBr) = 6.63 \times 10^{-34}/(2 \times 1.6 \times 10^{-19} \times 0.25 \times 0.83 \times 10^{-2}) \approx 1.0 \times 10^{-12} \text{ m} = 0.01 \text{ Å}$. Taking the charge as e instead of $2e$ doubles the wavelength.

22. Answer: (C) will stay in any position

At a geomagnetic pole the earth's field is vertical, so its horizontal component is zero. A needle free to move only in a horizontal plane experiences no directing torque and stays in any position it is placed. It does not lock into north-south because there is no horizontal field to align it.

23. Answer: (B) $4GM_p/D_p^2$

$g = GM/R^2$ and $R = D_p/2$, so $g = GM_p/(D_p/2)^2 = 4GM_p/D_p^2$. Acceleration does not depend on the particle's mass m , so expressions containing m are forces, not accelerations.

24. Answer: (B) 1.5×10^{20}

Light power = 25% of 200 W = 50 W. Energy per photon = $hc/\lambda = (6.63 \times 10^{-34} \times 3 \times 10^8)/(0.6 \times 10^{-6}) \approx 3.3 \times 10^{-19}$ J. Number per second = $50/3.3 \times 10^{-19} \approx 1.5 \times 10^{20}$. Using the full 200 W gives about 6×10^{20} , ignoring the efficiency.

25. Answer: (C) $2A/B$

Equilibrium needs $dU/dr = -2A/r^3 + B/r^2 = 0$, giving $r = 2A/B$. At this r , $d^2U/dr^2 = 6A/r^4 - 2B/r^3 = B^4/(8A^3) > 0$, so U is a minimum and the equilibrium is stable. A/B is where U itself is zero, not where the force is zero.

26. Answer: (B) $24hR/(25m)$

The photon energy for $n = 5 \rightarrow 1$ is $E = hcR(1 - 1/25) = (24/25)hcR$. Its momentum $p = E/c = (24/25)hR$, and the atom recoils with equal momentum, so $v = p/m = 24hR/(25m)$. The inverted forms have wrong dimensions for velocity.

27. Answer: (D) 1.6×10^{15} Hz

The $n = 2 \rightarrow 1$ transition in hydrogen emits a 10.2 eV photon. Work function = $10.2 - 3.57 = 6.63$ eV = $6.63 \times 1.6 \times 10^{-19}$ J. Threshold frequency $\nu_0 = \phi/h = (6.63 \times 1.6 \times 10^{-19})/(6.63 \times 10^{-34}) = 1.6 \times 10^{15}$ Hz. Using the full 10.2 eV gives about 2.5×10^{15} Hz, which is the photon frequency, not the threshold.

28. Answer: (A) 40 s

After t seconds, $A_1 = 40(1/2)^{t/20}$ and $A_2 = 160(1/2)^{t/10}$. Equating: $4 = 2^{t/10 - t/20} = 2^{t/20}$, so $t/20 = 2$ and $t = 40$ s. Check: both become 10 g at 40 s.

29. Answer: (D) 5%

For a fixed resistance, $P = V^2/R$, so $\Delta P/P \approx 2\Delta V/V = 2 \times 2.5\% = 5\%$. (Exactly, $(0.975)^2 = 0.951$, a 4.9% drop.) 2.5% wrongly assumes power proportional to voltage.

30. Answer: (D) The four bonding electrons in the case of C lie in the second orbit, whereas in the case of Si they lie in the third

Carbon's four bonding electrons are in the second shell ($n = 2$) and silicon's in the third ($n = 3$). The more tightly bound carbon electrons give a much larger band gap (about 5.5 eV vs 1.1 eV), so diamond is an insulator. A partly filled band at absolute zero would make carbon a conductor, not an insulator.

31. Answer: (D) zero

The man, the other man and the boat form an isolated system with no external horizontal force (still water, friction-free), so the centre of mass of the system cannot move. The boat moves back as the man walks, but the common centre of mass shifts by zero.

32. Answer: (A) 12 m s^{-2}

$v = dx/dt = 12 - 3t^2$, which is zero at $t = 2$ s. $a = dv/dt = -6t = -12 \text{ m s}^{-2}$ at $t = 2$ s, so the retardation is 12 m s^{-2} . Zero is wrong because velocity being zero does not make acceleration zero.

33. Answer: (B) 0.001

The meter gives full deflection at 25 mV across it; with the shunt carrying almost all 25 A, the shunt resistance is $S \approx V/I = 25 \times 10^{-3}/25 = 10^{-3} \Omega = 0.001 \Omega$. 0.01Ω would pass only 2.5 A at 25 mV.

34. Answer: (D) kg s^{-1}

$F = bv$, so $b = F/v$ with units $(\text{kg m s}^{-2})/(\text{m s}^{-1}) = \text{kg s}^{-1}$. kg m s^{-2} is the unit of force itself, not of the constant.

35. Answer: (B) μA

Normal emergence means $r_2 = 0$, so $r_1 = A - r_2 = A$. Snell's law at the first face: $\sin i = \mu \sin A$. For small angles, $i \approx \mu A$. A/μ would come from inverting Snell's law.

36. Answer: (A) 20/7

Third excited state $n = 4 \rightarrow$ second excited $n = 3$: $1/\lambda_1 = R(1/9 - 1/16) = 7R/144$. Second excited $n = 3 \rightarrow$ first excited $n = 2$: $1/\lambda_2 = R(1/4 - 1/9) = 5R/36 = 20R/144$. Ratio $\lambda_1/\lambda_2 = 20/7$. Taking excited state numbers as n values directly gives a wrong ratio.

37. Answer: (B) 2 m^{-1}

From $E = E_0 \cos(kz - \omega t)$, $\omega = 6 \times 10^8 \text{ rad s}^{-1}$. In vacuum $c = \omega/k$, so $k = 6 \times 10^8/(3 \times 10^8) = 2 \text{ m}^{-1}$. 0.5 m^{-1} comes from inverting the ratio.

38. Answer: (D) $B = 2\pi m v / e$ and $K = 2\pi m^2 v^2 R^2$

The dee voltage frequency must equal the cyclotron frequency $\nu = eB/(2\pi m)$, so $B = 2\pi m v / e$. At the dee radius R , $v = eBR/m = 2\pi \nu R$, so $K = \frac{1}{2}mv^2 = \frac{1}{2}m(2\pi \nu R)^2 = 2\pi^2 m v^2 R^2$. $B = mv/e$ misses the 2π factor between ν and angular frequency.

39. Answer: (D) 1

Removing L : $\tan(\pi/3) = X_C/R$; removing C : $\tan(\pi/3) = X_L/R$. So $X_L = X_C = \sqrt{3}R$ and with all three present the circuit is at resonance: $Z = R$, power factor $\cos \phi = 1$. $1/2$ is the power factor of each reduced circuit, not of the full RLC circuit.

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