

AIPMT 2011 Prelims — Physics Question Paper with Solutions

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

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1. The dimensions of $(\mu_0 \epsilon_0)^{-1/2}$ are

- (A) $[L^{(-1/2)} T^{(1/2)}]$
- (B) $[L^{(1/2)} T^{(-1/2)}]$
- (C) $[L^{-1} T]$
- (D) $[L T^{-1}]$

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2. The moment of inertia of a thin uniform rod of mass M and length L about an axis passing through its midpoint and perpendicular to its length is I_0 . Its moment of inertia about an axis passing through one of its ends and perpendicular to its length is

- (A) $I_0 + ML^2$
- (B) $I_0 + ML^2/2$
- (C) $I_0 + ML^2/4$
- (D) $I_0 + 2ML^2$

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3. A boy standing at the top of a tower of 20 m height drops a stone. Assuming $g = 10 \text{ m s}^{-2}$, the velocity with which it hits the ground is

- (A) 5.0 m/s
- (B) 10.0 m/s
- (C) 20.0 m/s
- (D) 40.0 m/s

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4. A person of mass 60 kg is inside a lift of mass 940 kg and presses the button on the control panel. The lift starts moving upwards with an acceleration 1.0 m/s^2 . If $g = 10 \text{ m s}^{-2}$, the tension in the supporting cable is

- (A) 1200 N
- (B) 8600 N
- (C) 9680 N
- (D) 11000 N

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5. The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta(t) = 2t^3 - 6t^2$. The torque on the wheel becomes zero at

- (A) $t = 2 \text{ s}$
- (B) $t = 1 \text{ s}$
- (C) $t = 0.2 \text{ s}$
- (D) $t = 0.25 \text{ s}$

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6. A particle moves in a circle of radius 5 cm with constant speed and time period $0.2\pi \text{ s}$. The acceleration of the particle is

- (A) 5 m/s^2
- (B) 15 m/s^2
- (C) 25 m/s^2
- (D) 36 m/s^2

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7. A body of mass M hits normally a rigid wall with velocity V and bounces back with the same velocity. The impulse experienced by the body is

- (A) Zero
- (B) MV
- (C) $1.5 MV$
- (D) $2 MV$

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8. A planet moving along an elliptical orbit is closest to the sun at a distance r_1 and farthest away at a distance of r_2 . If v_1 and v_2 are the linear velocities at these points respectively, then the ratio v_1/v_2 is

- (A) r_1/r_2
- (B) $(r_1/r_2)^2$
- (C) r_2/r_1
- (D) $(r_2/r_1)^2$

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9. A radioactive nucleus of mass M emits a photon of frequency ν and the nucleus recoils. The recoil energy will be

- (A) $h\nu$
- (B) $Mc^2 - h\nu$
- (C) $h^2\nu^2/(2Mc^2)$
- (D) Zero

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10. The potential energy of a system increases if work is done

- (A) Upon the system by a conservative force
- (B) Upon the system by a non-conservative force
- (C) By the system against a conservative force
- (D) By the system against a non-conservative force

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11. A body is moving with velocity 30 m/s towards east. After 10 seconds its velocity becomes 40 m/s towards north. The average acceleration of the body is

- (A) 5 m/s^2
- (B) 1 m/s^2
- (C) 7 m/s^2
- (D) $\sqrt{7} \text{ m/s}^2$

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12. A missile is fired for maximum range with an initial velocity of 20 m/s . If $g = 10 \text{ m/s}^2$, the range of the missile is

- (A) 20 m
- (B) 40 m
- (C) 50 m
- (D) 60 m

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13. A charge Q is enclosed by a Gaussian spherical surface of radius R . If the radius is doubled, then the outward electric flux will

- (A) Be doubled
- (B) Increase four times
- (C) Be reduced to half
- (D) Remain the same

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14. A parallel plate condenser has a uniform electric field E (V/m) in the space between the plates. If the distance between the plates is d (m) and area of each plate is A (m^2) the energy (joules) stored in the condenser is

- (A) $(1/2)\epsilon_0 E^2 A d$
- (B) $E^2 A d / \epsilon_0$
- (C) $(1/2)\epsilon_0 E^2$
- (D) $\epsilon_0 E A d$

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15. A current of 2 A flows through a $2\ \Omega$ resistor when connected across a battery. The same battery supplies a current of 0.5 A when connected across a $9\ \Omega$ resistor. The internal resistance of the battery is

- (A) $1\ \Omega$
- (B) $0.5\ \Omega$
- (C) $1/3\ \Omega$
- (D) $1/4\ \Omega$

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16. The rate of increase of thermo e.m.f. with temperature at the neutral temperature of a thermocouple

- (A) Is negative
- (B) Is positive
- (C) Is zero
- (D) Depends upon the choice of the two materials of the thermocouple

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17. A current carrying closed loop in the form of a right angle isosceles triangle ABC (right angle at B) is placed in a uniform magnetic field acting along AB. If the magnetic force on the arm BC is F , the force on the arm AC is

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

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18. The power obtained in a reactor using U-235 disintegration is 1000 kW. The mass decay of U-235 per hour is

- (A) 1 microgram
- (B) 10 microgram
- (C) 20 microgram
- (D) 40 microgram

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19. There are four light-weight-rod samples, A, B, C, D separately suspended by threads. A bar magnet is slowly brought near each sample and the following observations are noted (i) A is feebly repelled (ii) B is feebly attracted (iii) C is strongly attracted (iv) D remains unaffected Which one of the following is true?

- (A) A is of a non-magnetic material
- (B) B is of a paramagnetic material
- (C) C is of a diamagnetic material
- (D) D is of a ferromagnetic material

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20. The electric and the magnetic field, associated with an e.m. wave, propagating along the +z-axis, can be represented by

- (A) $E = E_0\hat{j}$, $B = B_0\hat{k}$
- (B) $E = E_0\hat{i}$, $B = B_0\hat{j}$
- (C) $E = E_0\hat{k}$, $B = B_0\hat{i}$
- (D) $E = E_0\hat{j}$, $B = B_0\hat{i}$

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21. 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 left of direction of motion
- (B) Will turn towards right of direction of motion
- (C) Speed will decrease
- (D) Speed will increase

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22. In an ac circuit an alternating voltage $e = 200\sqrt{2} \sin 100t$ volts is connected to a capacitor of capacity $1 \mu\text{F}$. The r.m.s. value of the current in the circuit is

- (A) 20 mA
- (B) 10 mA
- (C) 100 mA
- (D) 200 mA

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23. An ac voltage is applied to a resistance R and inductor L in series. If R and the inductive reactance are both equal to 3Ω , the phase difference between the applied voltage and the current in the circuit is

- (A) Zero
- (B) $\pi/6$
- (C) $\pi/4$
- (D) $\pi/2$

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24. When 1 kg of ice at 0°C melts to water at 0°C , the resulting change in its entropy, taking latent heat of ice to be 80 cal/g , is

- (A) 293 cal/K
- (B) 273 cal/K
- (C) $8 \times 10^4 \text{ cal/K}$
- (D) 80 cal/K

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25. Two waves are represented by the equations $y_1 = a \sin(\omega t + kx + 0.57) \text{ m}$ and $y_2 = a \cos(\omega t + kx) \text{ m}$, where x is in metre and t in s. The phase difference between them is

- (A) 0.57 radian
- (B) 1.0 radian
- (C) 1.25 radian
- (D) 1.57 radian

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26. Out of the following functions representing motion of a particle which represents SHM?

(A) $y = \sin \omega t - \cos \omega t$

(B) $y = \sin^3 \omega t$

(C) $y = 5 \cos(3\pi/4 - 3\omega t)$

(D) $y = 1 + \omega t + \omega^2 t^2$

(A) Only $y = \sin \omega t - \cos \omega t$ and $y = \sin^3 \omega t$

(B) Only $y = \sin \omega t - \cos \omega t$

(C) Only $y = 1 + \omega t + \omega^2 t^2$ does not represent SHM

(D) Only $y = \sin \omega t - \cos \omega t$ and $y = 5 \cos(3\pi/4 - 3\omega t)$

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27. Sound waves travel at 350 m/s through warm air and at 3500 m/s through brass. The wavelength of a 700 Hz acoustic wave as it enters brass from warm air

(A) Decreases by a factor 20

(B) Decreases by a factor 10

(C) Increases by a factor 20

(D) Increases by a factor 10

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28. The decreasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is

(A) Infrared, microwave, ultraviolet, gamma rays

(B) Microwave, infrared, ultraviolet, gamma rays

(C) Gamma rays, ultraviolet, infrared, microwaves

(D) Microwaves, gamma rays, infrared, ultraviolet

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29. The wavelength of the first line of Lyman series for hydrogen atom is equal to that of the second line of Balmer series for a hydrogen like ion. The atomic number Z of hydrogen like ion is

(A) 2

(B) 3

(C) 4

(D) 1

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30. Which of the following is not due to total internal reflection?

(A) Brilliance of diamond

(B) Working of optical fibre

(C) Difference between apparent and real depth of a pond

(D) Mirage on hot summer days

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31. In photoelectric emission process from a metal of work function 1.8 eV, the kinetic energy of most energetic electrons is 0.5 eV. The corresponding stopping potential is

(A) 2.3 V

(B) 1.8 V

(C) 1.3 V

(D) 0.5 V

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32. Electrons used in an electron microscope are accelerated by a voltage of 25 kV. If the voltage is increased to 100 kV then the de-Broglie wavelength associated with the electrons would

- (A) Increase by 4 times
- (B) Increase by 2 times
- (C) Decrease by 2 times
- (D) Decrease by 4 times

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33. Light of two different frequencies whose photons have energies 1 eV and 2.5 eV respectively illuminate a metallic surface whose work function is 0.5 eV successively. Ratio of maximum speeds of emitted electrons will be

- (A) 1 : 5
- (B) 1 : 4
- (C) 1 : 2
- (D) 1 : 1

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34. In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by

- (A) Decreasing the potential difference between the anode and filament
- (B) Increasing the potential difference between the anode and filament
- (C) Increasing the filament current
- (D) Decreasing the filament current

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35. The half life of a radioactive isotope X is 50 years. It decays to another element Y which is stable. The two elements X and Y were found to be in the ratio of 1 : 15 in a sample of a given rock. The age of the rock was estimated to be

- (A) 100 years
- (B) 150 years
- (C) 200 years
- (D) 250 years

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36. Photoelectric emission occurs only when the incident light has more than a certain minimum

- (A) Frequency
- (B) Power
- (C) Wavelength
- (D) Intensity

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37. Fusion reaction takes place at high temperature because

- (A) Molecules break up at high temperature
- (B) Nuclei break up at high temperature
- (C) Atoms get ionised at high temperature
- (D) Kinetic energy is high enough to overcome the coulomb repulsion between nuclei

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38. A nucleus ${}^m_nX$ emits one α -particle and two β^- -particles. The resulting nucleus is

- (A) ${}^{m-4}_{n-2}Y$
- (B) ${}^{m-6}_{n-4}Z$
- (C) ${}^{m-6}_nZ$
- (D) ${}^{m-4}_nX$

39. A transistor is operated in common emitter configuration at $V_C = 2\text{ V}$ such that a change in the base current from $100\text{ }\mu\text{A}$ to $300\text{ }\mu\text{A}$ produces a change in the collector current from 10 mA to 20 mA . The current gain is

- (A) 25
- (B) 50
- (C) 75
- (D) 100

40. If a small amount of antimony is added to germanium crystal

- (A) Its resistance is increased
- (B) It becomes a p-type semiconductor
- (C) The antimony becomes an acceptor atom
- (D) There will be more free electrons than holes in the semiconductor

41. In forward biasing of the p-n junction

- (A) The positive terminal of the battery is connected to p-side and the depletion region becomes thin
- (B) The positive terminal of the battery is connected to p-side and the depletion region becomes thick
- (C) The positive terminal of the battery is connected to n-side and the depletion region becomes thin
- (D) The positive terminal of the battery is connected to n-side and the depletion region becomes thick

Answer key and explanations

1. Answer: (D) $[\text{LT}^{-1}]$

Since $c = 1/\sqrt{(\mu_0\epsilon_0)}$, the quantity $(\mu_0\epsilon_0)^{-1/2}$ is simply the speed of light and has dimensions $[\text{LT}^{-1}]$. The inverse $[\text{L}^{-1}\text{T}]$ would be the dimensions of $\sqrt{(\mu_0\epsilon_0)}$ itself, not its inverse root.

2. Answer: (C) $I_0 + \frac{ML^2}{4}$

By the parallel axis theorem, $I = I_0 + Md^2$, and the end of the rod is $d = L/2$ from the centre, so $I = I_0 + \frac{ML^2}{4}$. Using the full length L as the shift distance (giving $I_0 + ML^2$) is the usual mistake.

3. Answer: (C) 20.0 m/s

For a stone dropped from rest, $v^2 = 2gh = 2 \times 10 \times 20 = 400$, so $v = 20\text{ m/s}$. Forgetting the factor 2 under the root gives about 14 m/s , and $v = gh$ would give an unphysical 200 m/s .

4. Answer: (D) 11000 N

The cable accelerates the lift and the person together (total mass 1000 kg) upward at 1 m/s^2 , so $T - (M + m)g = (M + m)a$, giving $T = 1000 \times (10 + 1) = 11000\text{ N}$. Using only the lift's mass or ignoring the acceleration gives the smaller values.

5. Answer: (B) $t = 1\text{ s}$

Torque is zero when angular acceleration is zero: $\alpha = d^2\theta/dt^2 = 12t - 12 = 0$, so $t = 1\text{ s}$. Setting the angular velocity $6t^2 - 12t$ to zero instead gives $t = 2\text{ s}$, which is the trap.

6. Answer: (A) 5 m/s^2

$\omega = 2\pi/T = 2\pi/(0.2\pi) = 10\text{ rad/s}$, and the centripetal acceleration is $a = \omega^2 r = 100 \times 0.05 = 5\text{ m/s}^2$. Forgetting to convert 5 cm to metres gives a value 100 times too large.

7. Answer: (D) 2 MV

Impulse equals change in momentum: taking the initial direction as positive, $\Delta p = (-MV) - (MV) = -2MV$, so its magnitude is $2MV$. Zero would only be the change in speed, not in momentum.

8. Answer: (C) r_2/r_1

Gravity exerts no torque about the sun, so angular momentum is conserved; at perihelion and aphelion the velocity is perpendicular to the radius, so $mv_1r_1 = mv_2r_2$ and $v_1/v_2 = r_2/r_1$. The planet moves faster when closer, so the ratio must exceed 1, which rules out r_1/r_2 .

9. Answer: (C) $\frac{h^2v^2}{2Mc^2}$

The photon carries momentum $p = h\nu/c$, and the nucleus recoils with equal and opposite momentum. Its kinetic energy is $p^2/2M = h^2\nu^2/(2Mc^2)$. It is not $h\nu$, which is the photon's own energy.

10. Answer: (C) By the system against a conservative force

Potential energy is defined only for conservative forces: $\Delta U = -W(\text{conservative})$. When the system does work against a conservative force (the conservative force does negative work), its potential energy increases. Work by non-conservative forces does not change potential energy.

11. Answer: (A) 5 m/s²

The velocity changes from 30 m/s east to 40 m/s north; the change Δv has magnitude $\sqrt{30^2 + 40^2} = 50$ m/s. Average acceleration = $50/10 = 5$ m/s². Taking the difference of speeds (1 m/s²) ignores the change in direction.

12. Answer: (B) 40 m

Maximum range occurs at 45°, $R = u^2/g = 20^2/10 = 40$ m. The value 20 m is the range for $u^2/2g$, which is the maximum height formula at 90°, not the range.

13. Answer: (D) Remain the same

By Gauss's law, the total flux through any closed surface is $q(\text{enclosed})/\epsilon_0$. The enclosed charge is still Q when the radius doubles, so the flux remains the same; the field falls as $1/r^2$ but the area grows as r^2 .

14. Answer: (A) $(1/2)\epsilon_0 E^2 \Delta d$

The energy density in the field is $(1/2)\epsilon_0 E^2$ and the field fills a volume Δd , so $U = (1/2)\epsilon_0 E^2 \Delta d$. The expression $(1/2)\epsilon_0 E^2$ alone is just the energy per unit volume, not the total energy.

15. Answer: (C) 1/3 Ω

The emf is the same in both cases: $\epsilon = 2(2 + r) = 0.5(9 + r)$. So $4 + 2r = 4.5 + 0.5r$, giving $1.5r = 0.5$ and $r = 1/3 \Omega$ ($\epsilon = 4.67$ V). Checking $1/3 \Omega$: $2 \times 2.333 = 4.67$ and $0.5 \times 9.333 = 4.67$, consistent.

16. Answer: (C) Is zero

Thermo emf rises with temperature, reaches a maximum at the neutral temperature, and then falls. At a maximum the slope $dE/d\theta$ is zero. It does not depend on the materials at that point, although the neutral temperature itself does.

17. Answer: (C) $-F$

The field is along AB, so the force on arm AB is zero. The net magnetic force on any closed current loop in a uniform field is zero, so $F(BC) + F(AC) = 0$ and the force on AC is $-F$. A factor of $\sqrt{2}$ is the trap from the longer length of AC, but only the component of AC perpendicular to B (equal to BC) matters.

18. Answer: (D) 40 microgram

Energy produced in one hour = $10^6 \text{ W} \times 3600 \text{ s} = 3.6 \times 10^9 \text{ J}$. Mass converted = $E/c^2 = 3.6 \times 10^9 / (9 \times 10^{16}) = 4 \times 10^{-8} \text{ kg} = 40 \mu\text{g}$. Forgetting the factor 3600 or using kW as W gives the smaller options.

19. Answer: (B) B is of a paramagnetic material

Feeble attraction towards a magnet is the signature of a paramagnetic material. Feeble repulsion indicates diamagnetic (so the first sample is diamagnetic, not non-magnetic), strong attraction indicates ferromagnetic, and the unaffected sample is non-magnetic, not ferromagnetic.

20. Answer: (B) $\mathbf{E} = E_0 \hat{i}$, $\mathbf{B} = B_0 \hat{j}$

An EM wave travels along $\mathbf{E} \times \mathbf{B}$, with $\mathbf{E}$ and $\mathbf{B}$ perpendicular to each other and to the propagation direction. With $\mathbf{E}$ along $\hat{i}$ and $\mathbf{B}$ along $\hat{j}$, $\hat{i} \times \hat{j} = \hat{k}$, i.e. $+z$. $\mathbf{E}$ along $\hat{j}$ with $\mathbf{B}$ along $\hat{i}$ gives $\hat{j} \times \hat{i} = -\hat{k}$, the reverse direction.

21. Answer: (C) Speed will decrease

Since the velocity is parallel to $\mathbf{B}$, the magnetic force $q\mathbf{v} \times \mathbf{B}$ is zero and there is no sideways turning. The electron's charge is negative, so the electric force is opposite to $\mathbf{E}$, i.e. opposite to its velocity, and it decelerates, so its speed decreases.

22. Answer: (A) 20 mA

$V(\text{rms}) = 200\sqrt{2}/\sqrt{2} = 200$ V and $\omega = 100$ rad/s, so $X_C = 1/(\omega C) = 1/(100 \times 10^{-6}) = 10^4 \Omega$. $I(\text{rms}) = 200/10^4 = 0.02 \text{ A} = 20 \text{ mA}$. Using the peak voltage $200\sqrt{2}$ V would give about 28 mA, which is not the rms value.

23. Answer: (C) $\pi/4$

For a series LR circuit $\tan \phi = X_L/R = 3/3 = 1$, so $\phi = \pi/4$ with voltage leading the current. $\pi/2$ would apply only for a pure inductor.

24. Answer: (A) 293 cal/K

Heat absorbed $Q = mL = 1000 \text{ g} \times 80 \text{ cal/g} = 8 \times 10^4 \text{ cal}$ at constant $T = 273 \text{ K}$. $\Delta S = Q/T = 80000/273 \approx 293 \text{ cal/K}$. Giving $8 \times 10^4 \text{ cal/K}$ forgets to divide by the temperature.

25. Answer: (B) 1.0 radian

Write $y_2 = a \cos(\omega t + kx) = a \sin(\omega t + kx + \pi/2)$. The phase difference is $\pi/2 - 0.57 = 1.57 - 0.57 = 1.0$ radian. 1.57 rad would be the phase of the cosine wave alone, ignoring the 0.57 in the first wave.

26. Answer: (D) Only $y = \sin \omega t - \cos \omega t$ and $y = 5 \cos(3\pi/4 - 3\omega t)$

$\sin \omega t - \cos \omega t = \sqrt{2} \sin(\omega t - \pi/4)$ and $5 \cos(3\pi/4 - 3\omega t)$ are single sinusoids, so both are SHM. $\sin^3 \omega t = (3 \sin \omega t - \sin 3\omega t)/4$ is periodic but a mix of two frequencies, so not SHM, and $1 + \omega t + \omega^2 t^2$ is not even periodic. So only the first and third functions are SHM; the claim that only the last function fails is wrong because $\sin^3 \omega t$ also fails.

27. Answer: (D) Increases by a factor 10

Frequency is unchanged when a wave enters a new medium, so $\lambda = v/f$ is proportional to speed. λ goes from $350/700 = 0.5$ m to $3500/700 = 5$ m, an increase by a factor of 10. It increases, not decreases, because sound is faster in brass.

28. Answer: (B) Microwave, infrared, ultraviolet, gamma rays

In the EM spectrum wavelength falls from microwaves (mm-cm) to infrared (μm) to ultraviolet (~ 100 nm) to gamma rays (< 0.01 nm). The order starting with gamma rays is increasing, not decreasing, wavelength.

29. Answer: (A) 2

Lyman first line: $1/\lambda = R(1 - 1/4) = 3R/4$. Balmer second line ($n = 4 \rightarrow 2$) for the ion: $1/\lambda = Z^2 R(1/4 - 1/16) = 3Z^2 R/16$. Equating gives $Z^2 = 4$, $Z = 2$ (He^+). Using $n = 3 \rightarrow 2$ as the second Balmer line gives a non-integer Z .

30. Answer: (C) Difference between apparent and real depth of a pond

The pond looking shallower than it is comes from ordinary refraction at the water surface, not total internal reflection. Sparkle of diamond, light guidance in optical fibres and mirages all rely on total internal reflection.

31. Answer: (D) 0.5 V

The stopping potential satisfies $eV_0 = K(\text{max}) = 0.5$ eV, so $V_0 = 0.5$ V. The work function is irrelevant once $K(\text{max})$ is given; adding it (2.3 V) gives the photon energy, not the stopping potential.

32. Answer: (C) Decrease by 2 times

For electrons accelerated through V , $\lambda = h/\sqrt{2meV}$, so $\lambda \propto 1/\sqrt{V}$. Increasing V from 25 kV to 100 kV (4 times) reduces λ by $\sqrt{4} = 2$ times. 'Decrease by 4 times' wrongly takes $\lambda \propto 1/V$.

33. Answer: (C) 1 : 2

$K(\text{max}) = h\nu - \phi$ gives $1 - 0.5 = 0.5$ eV and $2.5 - 0.5 = 2.0$ eV. Since $v \propto \sqrt{K}$, $v_1 : v_2 = \sqrt{0.5} : \sqrt{2} = 1 : 2$. Taking the ratio of photon energies (1 : 2.5) or of kinetic energies (1 : 4) are the traps.

34. Answer: (B) Increasing the potential difference between the anode and filament

The electrons gain kinetic energy eV from the accelerating potential difference between filament and anode, so increasing that potential difference increases their speed. Filament current only changes how many electrons are emitted, not their speed.

35. Answer: (C) 200 years

If $X : Y = 1 : 15$, the fraction of X remaining is $1/16 = (1/2)^4$, so four half-lives have passed: $4 \times 50 = 200$ years. Taking $1/15$ as the remaining fraction or counting 3 half-lives gives the wrong ages.

36. Answer: (A) Frequency

Photoelectric emission requires the frequency to exceed the threshold frequency of the metal, whatever the intensity. Intensity or power only changes the number of electrons once emission occurs; a minimum wavelength is the wrong sense since there is a maximum wavelength.

37. Answer: (D) Kinetic energy is high enough to overcome the coulomb repulsion between nuclei

Fusing nuclei are positively charged and repel each other; only at very high temperatures ($\sim 10^7$ K) do they have enough kinetic energy to overcome this Coulomb barrier. Ionisation of atoms or breaking of molecules is not the reason fusion needs high temperature.

38. Answer: (D) ${}^{m-4}_{n-2}\text{X}$

Alpha emission lowers mass number by 4 and atomic number by 2; each β^- raises atomic number by 1 with no mass change. Net: mass number $m - 4$, atomic number $n - 2 + 2 = n$, so the product is an isotope of X , ${}^{m-4}_{n}\text{X}$.

39. Answer: (B) 50

Common-emitter current gain $\beta = \Delta I_C / \Delta I_B = (20 - 10) \text{ mA} / (300 - 100) \mu\text{A} = 10 \text{ mA} / 0.2 \text{ mA} = 50$. Using the final values $I_C / I_B = 20 \text{ mA} / 300 \mu\text{A} \approx 67$ or initial values 100 is the trap.

40. Answer: (D) There will be more free electrons than holes in the semiconductor

Antimony is pentavalent; in germanium it donates an extra electron, making an n-type semiconductor with free electrons as majority carriers. It is a donor, not an acceptor, and doping lowers the resistance rather than increasing it.

41. Answer: (A) The positive terminal of the battery is connected to p-side and the depletion region becomes thin

In forward bias, the p-side is connected to the positive terminal; this opposes the built-in field and narrows the depletion region, letting current flow. Connecting the positive terminal to the n-side is reverse bias, which widens the depletion layer.

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