

AIPMT 2007 Prelims — Physics Question Paper with Solutions

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

AIPMT 2007 Prelims · Q2

1. A beam of electron passes undeflected through mutually perpendicular electric and magnetic fields. If the electric field is switched off, and the same magnetic field is maintained, the electrons move

- (A) in a circular orbit
- (B) along a parabolic path
- (C) along a straight line
- (D) in an elliptical orbit

AIPMT 2007 Prelims · Q3

2. The position x of a particle with respect to time t along x -axis is given by $x = 9t^2 - t^3$ where x is in metres and t in second. What will be the position of this particle when it achieves maximum speed along the +ve x direction?

- (A) 54 m
- (B) 81 m
- (C) 24 m
- (D) 32 m

AIPMT 2007 Prelims · Q4

3. A particle starting from the origin $(0, 0)$ moves in a straight line in the (x, y) plane. Its coordinates at a later time are $(\sqrt{3}, 3)$. The path of the particle makes with the x -axis an angle of

- (A) 45°
- (B) 60°
- (C) 0°
- (D) 30°

AIPMT 2007 Prelims · Q5

4. A car moves from X to Y with a uniform speed v_u and returns to X with a uniform speed v_d . The average speed for this round trip is

- (A) $\sqrt{v_u v_d}$
- (B) $v_d v_u / (v_d + v_u)$
- (C) $(v_u + v_d) / 2$
- (D) $2v_d v_u / (v_d + v_u)$

AIPMT 2007 Prelims · Q6

5. Two radioactive substances A and B have decay constants 5λ and λ respectively. At $t = 0$ they have the same number of nuclei. The ratio of number of nuclei of A to those of B will be $(1/e)^2$ after a time interval

- (A) 4λ
- (B) 2λ
- (C) $1/(2\lambda)$
- (D) $1/(4\lambda)$

AIPMT 2007 Prelims · Q8

6. In a radioactive decay process, the negatively charged emitted β -particles are

- (A) the electrons produced as a result of the decay of neutrons inside the nucleus
- (B) the electrons produced as a result of collisions between atoms
- (C) the electrons orbiting around the nucleus
- (D) the electrons present inside the nucleus

7. The phase difference between the instantaneous velocity and acceleration of a particle executing simple harmonic motion is

- (A) π
- (B) 0.707π
- (C) zero
- (D) 0.5π

8. In a mass spectrometer used for measuring the masses of ions, the ions are initially accelerated by an electric potential V and then made to describe semicircular path of radius R using a magnetic field B . If V and B are kept constant, the ratio (charge on the ion/mass of the ion) will be proportional to

- (A) $1/R^2$
- (B) R^2
- (C) R
- (D) $1/R$

9. A wheel has angular acceleration of 3.0 rad/sec^2 and an initial angular speed of 2.00 rad/sec . In a time of 2 sec it has rotated through an angle (in radian) of

- (A) 10
- (B) 12
- (C) 4
- (D) 6

10. The frequency of a light wave in a material is $2 \times 10^{14} \text{ Hz}$ and wavelength is $5000 \text{ \AA}$. The refractive index of material will be

- (A) 1.50
- (B) 3.00
- (C) 1.33
- (D) 1.40

11. A nucleus ${}^A_Z\text{X}$ has mass represented by $M(A, Z)$. If M_p and M_n denote the mass of proton and neutron respectively and B.E. the binding energy in MeV, then

- (A) B.E. = $[ZM_p + (A - Z)M_n - M(A, Z)]c^2$
- (B) B.E. = $[ZM_p + ZM_n - M(A, Z)]c^2$
- (C) B.E. = $M(A, Z) - ZM_p - (A - Z)M_n$
- (D) B.E. = $[M(A, Z) - ZM_p - (A - Z)M_n]c^2$

12. If the nucleus ${}^{27}_{13}\text{Al}$ has nuclear radius of about 3.6 fm , then ${}^{125}_{32}\text{Te}$ would have its radius approximately as

- (A) 9.6 fm
- (B) 12.0 fm
- (C) 4.8 fm
- (D) 6.0 fm

13. A block B is pushed momentarily along a horizontal surface with an initial velocity V . If μ is the coefficient of sliding friction between B and the surface, block B will come to rest after a time

- (A) $g\mu/V$
- (B) g/V
- (C) V/g
- (D) $V/(g\mu)$

AIPMT 2007 Prelims · Q18

14. A particle moving along x-axis has acceleration f , at time t , given by $f = f_0(1 - t/T)$, where f_0 and T are constants. The particle at $t = 0$ has zero velocity. In the time interval between $t = 0$ and the instant when $f = 0$, the particle's velocity (v_x) is

- (A) $(1/2)f_0T^2$
- (B) f_0T^2
- (C) $(1/2)f_0T$
- (D) f_0T

AIPMT 2007 Prelims · Q19

15. A common emitter amplifier has a voltage gain of 50, an input impedance of 100Ω and an output impedance of 200Ω . The power gain of the amplifier is

- (A) 1000
- (B) 1250
- (C) 100
- (D) 500

AIPMT 2007 Prelims · Q20

16. Three resistances P , Q , R each of 2Ω and an unknown resistance S form the four arms of a Wheatstone bridge circuit. When a resistance of 6Ω is connected in parallel to S the bridge gets balanced. What is the value of S ?

- (A) 3Ω
- (B) 6Ω
- (C) 1Ω
- (D) 2Ω

AIPMT 2007 Prelims · Q23

17. A transformer is used to light a 100 W and 110 V lamp from a 220 V mains. If the main current is 0.5 amp, the efficiency of the transformer is approximately

- (A) 50%
- (B) 90%
- (C) 10%
- (D) 30%

AIPMT 2007 Prelims · Q24

18. Dimensions of resistance in an electrical circuit, in terms of dimension of mass M , of length L , of time T and of current I , would be

- (A) ML^2T^{-2}
- (B) $ML^2T^{-1}I^{-1}$
- (C) $ML^2T^{-3}I^{-2}$
- (D) $ML^2T^{-3}I^{-1}$

AIPMT 2007 Prelims · Q25

19. A uniform rod AB of length l , and mass m is free to rotate about point A . The rod is released from rest in the horizontal position. Given that the moment of inertia of the rod about A is $ml^2/3$, the initial angular acceleration of the rod will be

- (A) $mg/l/2$
- (B) $(3/2)gl$
- (C) $3g/(2l)$
- (D) $2g/(3l)$

20. A particle of mass m moves in the XY plane with a velocity v along the straight line AB . If the angular momentum of the particle with respect to origin O is LA when it is at A and LB when it is at B , then

- (A) $LA = LB$
- (B) the relationship between LA and LB depends upon the slope of the line AB
- (C) $LA < LB$
- (D) $LA > LB$

21. The particle executing simple harmonic motion has a kinetic energy $K_0 \cos^2 \omega t$. The maximum values of the potential energy and the total energy are respectively

- (A) $K_0/2$ and K_0
- (B) K_0 and $2K_0$
- (C) K_0 and K_0
- (D) 0 and $2K_0$

22. Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W. The number of photons emitted, on the average, by the sources per second is

- (A) 5×10^{16}
- (B) 5×10^{17}
- (C) 5×10^{14}
- (D) 5×10^{15}

23. Two satellites of earth, S_1 and S_2 are moving in the same orbit. The mass of S_1 is four times the mass of S_2 . Which one of the following statements is true?

- (A) The potential energies of earth satellites in the two cases are equal.
- (B) S_1 and S_2 are moving with the same speed.
- (C) The kinetic energies of the two satellites are equal.
- (D) The time period of S_1 is four times that of S_2 .

24. $\vec{A}$ and $\vec{B}$ are two vectors and θ is the angle between them, if $|\vec{A} \times \vec{B}| = \sqrt{3} (\vec{A} \cdot \vec{B})$, the value of θ is

- (A) 45°
- (B) 30°
- (C) 90°
- (D) 60°

25. A charged particle (charge q) is moving in a circle of radius R with uniform speed v . The associated magnetic moment μ is given by

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

26. The total energy of electron in the ground state of hydrogen atom is -13.6 eV. The kinetic energy of an electron in the first excited state is

- (A) 6.8 eV
- (B) 13.6 eV
- (C) 1.7 eV
- (D) 3.4 eV

27. A 5 watt source emits monochromatic light of wavelength $5000 \text{ \AA}$. When placed 0.5 m away, it liberates photoelectrons from a photosensitive metallic surface. When the source is moved to a distance of 1.0 m , the number of photoelectrons liberated will be reduced by a factor of

- (A) 8
- (B) 16
- (C) 2
- (D) 4

28. A particle executes simple harmonic oscillation with an amplitude a . The period of oscillation is T . The minimum time taken by the particle to travel half of the amplitude from the equilibrium position is

- (A) $T/8$
- (B) $T/12$
- (C) $T/2$
- (D) $T/4$

29. A black body is at 727°C . It emits energy at a rate which is proportional to

- (A) $(1000)^4$
- (B) $(1000)^2$
- (C) $(727)^4$
- (D) $(727)^2$

30. The resistance of an ammeter is 13Ω and its scale is graduated for a current upto 100 amps . After an additional shunt has been connected to this ammeter it becomes possible to measure currents upto 750 amperes by this meter. The value of shunt-resistance is

- (A) 2Ω
- (B) 0.2Ω
- (C) $2 \text{ k} \Omega$
- (D) 20Ω

31. An engine has an efficiency of $1/6$. When the temperature of sink is reduced by 62°C , its efficiency is doubled. Temperature of the source is

- (A) 37°C
- (B) 62°C
- (C) 99°C
- (D) 124°C

32. The electric and magnetic field of an electromagnetic wave are

- (A) in opposite phase and perpendicular to each other
- (B) in opposite phase and parallel to each other
- (C) in phase and perpendicular to each other
- (D) in phase and parallel to each other

33. What is the value of inductance L for which the current is maximum in a series LCR circuit with $C = 10 \mu\text{F}$ and $\omega = 1000 \text{ s}^{-1}$?

- (A) 1 mH
- (B) cannot be calculated unless R is known
- (C) 10 mH
- (D) 100 mH

34. Nickel shows ferromagnetic property at room temperature. If the temperature is increased beyond Curie temperature, then it will show

- (A) anti ferromagnetism
- (B) no magnetic property
- (C) diamagnetism
- (D) paramagnetism

35. Under the influence of a uniform magnetic field a charged particle is moving in a circle of radius R with constant speed v. The time period of the motion

- (A) depends on both R and v
- (B) is independent of both R and v
- (C) depends on R and not on v
- (D) depends on v and not on R

36. If the cold junction of a thermo-couple is kept at 0°C and the hot junction is kept at T°C then the relation between neutral temperature (T_n) and temperature of inversion (T_i) is

- (A) $T_n = 2T_i$
- (B) $T_n = T_i - T$
- (C) $T_n = T_i + T$
- (D) $T_n = T_i/2$

37. Assuming the sun to have a spherical outer surface of radius r, radiating like a black body at temperature t°C, the power received by a unit surface, (normal to the incident rays) at a distance R from the centre of the sun is (where σ is the Stefan's constant)

- (A) $r^2\sigma(t + 273)^4/(4\pi R^2)$
- (B) $16\pi^2 r^2\sigma t^4/R^2$
- (C) $r^2\sigma(t + 273)^4/R^2$
- (D) $4\pi r^2\sigma t^4/R^2$

Answer key and explanations

1. Answer: (A) in a circular orbit

With only the magnetic field, the force $qv \times B$ is always perpendicular to the velocity, which is itself perpendicular to B, so the electrons move in a circle. A parabolic path needs a constant force such as an electric field, which has been switched off.

2. Answer: (A) 54 m

$v = dx/dt = 18t - 3t^2$ and $a = 18 - 6t$; speed is maximum when $a = 0$, i.e. $t = 3$ s. Then $x = 9(9) - 27 = 54$ m. 81 m is just the $9t^2$ term without subtracting t^3 .

3. Answer: (B) 60°

For a straight line from the origin, $\tan \theta = y/x = 3/\sqrt{3} = \sqrt{3}$, so $\theta = 60^\circ$. 30° would be the angle with the y-axis instead.

4. Answer: (D) $2vd\,vu/(vd + vu)$

For equal distances d each way, total time = $d/v_u + d/v_d$, so average speed = $2d/(d/v_u + d/v_d) = 2v_u v_d/(v_u + v_d)$, the harmonic mean. The arithmetic mean $(v_u + v_d)/2$ is wrong because more time is spent at the lower speed.

5. Answer: (C) $1/(2\lambda)$

$N_A/N_B = e^{(-5\lambda t)}/e^{(-\lambda t)} = e^{(-4\lambda t)}$. Setting this equal to $e^{(-2)}$ gives $4\lambda t = 2$, so $t = 1/(2\lambda)$. Answers like 2λ have the wrong dimensions for a time.

6. Answer: (A) the electrons produced as a result of the decay of neutrons inside the nucleus

In β^- decay a neutron inside the nucleus changes into a proton, emitting an electron (and an antineutrino). Electrons do not exist inside the nucleus beforehand, and orbital electrons are not involved.

7. Answer: (D) 0.5π

If $x = A \sin \omega t$, then $v = A\omega \cos \omega t$ and $a = -A\omega^2 \sin \omega t$, so acceleration leads velocity by $\pi/2 = 0.5\pi$. A phase difference of π exists between displacement and acceleration, not velocity and acceleration.

8. Answer: (A) $1/R^2$

$qV = \frac{1}{2}mv^2$ and $R = mv/(qB)$ give $R^2 = 2mV/(qB^2)$, so $q/m = 2V/(B^2R^2) \propto 1/R^2$. Answering $1/R$ ignores that v itself depends on q/m .

9. Answer: (A) 10

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2 = 2.0 \times 2 + \frac{1}{2} \times 3.0 \times 4 = 4 + 6 = 10$ rad. 4 rad counts only the initial-speed term.

10. Answer: (B) 3.00

Speed in the material $v = f\lambda = 2 \times 10^{14} \times 5 \times 10^{-7} = 1 \times 10^8$ m/s, so $n = c/v = 3 \times 10^8 / 1 \times 10^8 = 3.00$. 1.50 comes from a slip in the power of ten.

11. Answer: (A) B.E. = $[ZMp + (A - Z)Mn - M(A, Z)]c^2$

Binding energy is the mass defect times c^2 : B.E. = $[ZMp + (A - Z)Mn - M(A, Z)]c^2$. The expression without c^2 is a mass, not an energy, and the reversed sign would give a negative binding energy.

12. Answer: (D) 6.0 fm

$R \propto A^{1/3}$, so $R_{\text{Te}} = 3.6 \times (125/27)^{1/3} = 3.6 \times 5/3 = 6.0$ fm. Scaling the radius in proportion to A instead of its cube root would give a much larger value.

13. Answer: (D) $V/(\mu g)$

Friction gives a deceleration μg , so the block stops when $V - \mu g t = 0$, i.e. $t = V/(\mu g)$. V/g ignores the friction coefficient.

14. Answer: (C) $(1/2)f_0 T$

$f = 0$ at $t = T$. $v = \int_0^T f_0(1 - t/T) dt = f_0 T - f_0 T/2 = \frac{1}{2}f_0 T$. $f_0 T$ would be the velocity if the acceleration stayed at f_0 throughout.

15. Answer: (B) 1250

Voltage gain $A_v = \beta(R_{\text{out}}/R_{\text{in}})$, so $\beta = 50 \times 100/200 = 25$. Power gain = $A_v \times \beta = 50 \times 25 = 1250$. 1000 or 500 come from misusing the impedance ratio.

16. Answer: (A) 3Ω

Balance requires $P/Q = R/S'$, so the effective arm $S' = 2\Omega$. S in parallel with 6Ω : $6S/(S + 6) = 2$ gives $4S = 12$, so $S = 3\Omega$. Answering 2Ω forgets that S is in parallel with the 6Ω .

17. Answer: (B) 90%

Efficiency = output/input = $100/(220 \times 0.5) = 100/110 \approx 0.91$, i.e. about 90%. 50% comes from comparing the voltages instead of the powers.

18. Answer: (C) $ML^2T^{-3}I^{-2}$

$R = V/I$ and $V = W/q$ has dimensions $ML^2T^{-2}/(IT) = ML^2T^{-3}I^{-1}$, so $R = ML^2T^{-3}I^{-2}$. $ML^2T^{-3}I^{-1}$ is the dimension of potential difference, not resistance.

19. Answer: (C) $3g/(2l)$

Torque of gravity about A is $mg(l/2) = l\alpha = (ml^2/3)\alpha$, so $\alpha = 3g/(2l)$. $mg/l/2$ is the torque itself, not the angular acceleration.

20. Answer: (A) $LA = LB$

$L = mvd$, where d is the perpendicular distance from O to the line AB; this distance is the same for every point on the line, so $LA = LB$. The slope of AB changes d but not the equality between the two points.

21. Answer: (C) K_0 and K_0

Kinetic energy is maximum (K_0) at the mean position, where all energy is kinetic, so total energy = K_0 . Potential energy is maximum at the extremes and also equals K_0 . $2K_0$ wrongly adds the two maxima.

22. Answer: (D) 5×10^{15}

$n = P/(hf) = 2 \times 10^{-3}/(6.63 \times 10^{-34} \times 6.0 \times 10^{14}) = 2 \times 10^{-3}/3.98 \times 10^{-19} \approx 5 \times 10^{15}$ per second. 5×10^{16} is a power-of-ten slip.

23. Answer: (B) S_1 and S_2 are moving with the same speed.

Orbital speed $v = \sqrt{GM/r}$ depends only on the orbit radius, so both move with the same speed (and period). Potential and kinetic energies are proportional to the satellite mass, so they differ by a factor of 4.

24. Answer: (D) 60°

$AB \sin \theta = \sqrt{3} AB \cos \theta$ gives $\tan \theta = \sqrt{3}$, so $\theta = 60^\circ$. 30° would come from $\tan \theta = 1/\sqrt{3}$.

25. Answer: (D) $qvR/2$

The circulating charge is a current $I = q/T = qv/(2\pi R)$; $\mu = I \times \pi R^2 = qvR/2$. qvR misses the factor $1/2$.

26. Answer: (D) 3.4 eV

$E_n = -13.6/n^2$ eV, so in the first excited state ($n = 2$) $E = -3.4$ eV. For a Bohr orbit kinetic energy $= -E = 3.4$ eV. 13.6 eV is the ground-state value.

27. Answer: (D) 4

The number of photoelectrons is proportional to intensity, which falls as $1/r^2$. Doubling the distance from 0.5 m to 1.0 m reduces it by $2^2 = 4$. A factor of 2 assumes intensity $\propto 1/r$.

28. Answer: (B) $T/12$

$x = a \sin \omega t$; $x = a/2$ when $\omega t = \pi/6$, so $t = (\pi/6)/(2\pi/T) = T/12$. $T/4$ is the time to reach the full amplitude.

29. Answer: (A) $(1000)^4$

By Stefan's law the emitted power $\propto T^4$ with T in kelvin: $727 + 273 = 1000$ K, so rate $\propto (1000)^4$. Using 727 forgets to convert from Celsius.

30. Answer: (A) 2 Ω

The meter still carries 100 A, so the shunt carries 650 A at the same voltage: $S = 13 \times 100/650 = 2 \Omega$. 0.2 Ω would be a power-of-ten slip.

31. Answer: (C) 99°C

$1/6 = 1 - T_2/T_1$ and $1/3 = 1 - (T_2 - 62)/T_1$. Subtracting, $62/T_1 = 1/6$, so $T_1 = 372$ K = 99°C . 62°C confuses the temperature drop with the source temperature.

32. Answer: (C) in phase and perpendicular to each other

In a plane EM wave, E and B oscillate in phase (both reach maxima together) and are perpendicular to each other and to the direction of propagation.

33. Answer: (D) 100 mH

Current is maximum at resonance, $\omega^2 LC = 1$: $L = 1/(\omega^2 C) = 1/(10^6 \times 10 \times 10^{-6}) = 0.1$ H = 100 mH. R only sets the height of the peak, not where it occurs.

34. Answer: (D) paramagnetism

Above the Curie temperature thermal agitation destroys the domain alignment and a ferromagnet becomes paramagnetic. It does not become diamagnetic or lose all magnetic response.

35. Answer: (B) is independent of both R and v

$T = 2\pi R/v = 2\pi m/(qB)$; a larger speed gives a proportionally larger radius, so the period depends on neither R nor v .

36. Answer: (D) $T_n = T_i/2$

For a thermocouple with the cold junction at 0°C , the neutral temperature is the mean of the cold-junction and inversion temperatures, so $T_n = (0 + T_i)/2 = T_i/2$.

37. Answer: (C) $r^2\sigma(t + 273)^4/R^2$

The sun radiates $P = 4\pi r^2\sigma(t + 273)^4$. At distance R this spreads over $4\pi R^2$, giving $r^2\sigma(t + 273)^4/R^2$ per unit area. Options using t^4 forget to convert to kelvin, and dividing by an extra 4π is wrong.

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