

AIPMT 2008 Prelims — Physics Question Paper with Solutions

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

AIPMT 2008 Prelims · Q1

1. Which two of the following five physical parameters have the same dimensions?

- (a) energy density
- (b) refractive index
- (c) dielectric constant
- (d) Young's modulus
- (e) magnetic field

- (A) (a) and (e)
- (B) (b) and (d)
- (C) (c) and (e)
- (D) (a) and (d)

AIPMT 2008 Prelims · Q2

2. If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be

- (A) 2%
- (B) 4%
- (C) 6%
- (D) 8%

AIPMT 2008 Prelims · Q3

3. The distance travelled by a particle starting from rest and moving with an acceleration $(4/3) \text{ m s}^{-2}$, in the third second is

- (A) $19/3 \text{ m}$
- (B) 6 m
- (C) 4 m
- (D) $10/3 \text{ m}$

AIPMT 2008 Prelims · Q4

4. A particle moves in a straight line with a constant acceleration. It changes its velocity from 10 m s^{-1} to 20 m s^{-1} while passing through a distance 135 m in t second. The value of t is

- (A) 9
- (B) 10
- (C) 1.8
- (D) 12

AIPMT 2008 Prelims · Q6

5. A particle of mass m is projected with velocity v making an angle of 45° with the horizontal. When the particle lands on the level ground the magnitude of the change in its momentum will be

- (A) zero
- (B) $2mv$
- (C) $mv/\sqrt{2}$
- (D) $mv\sqrt{2}$

AIPMT 2008 Prelims · Q7

6. Sand is being dropped on a conveyor belt at the rate of $M \text{ kg/s}$. The force necessary to keep the belt moving with a constant velocity of $v \text{ m/s}$ will be

- (A) Zero
- (B) Mv newton
- (C) $2 Mv$ newton
- (D) $Mv/2$ newton

7. Water falls from a height of 60 m at the rate of 15 kg/s to operate a turbine. The losses due to frictional forces are 10% of energy. How much power is generated by the turbine? ($g = 10 \text{ m/s}^2$)

- (A) 7.0 kW
- (B) 8.1 kW
- (C) 10.2 kW
- (D) 12.3 kW

8. A shell of mass 200 g is ejected from a gun of mass 4 kg by an explosion that generates 1.05 kJ of energy. The initial velocity of the shell is

- (A) 120 m s^{-1}
- (B) 100 m s^{-1}
- (C) 80 m s^{-1}
- (D) 40 m s^{-1}

9. The ratio of the radii of gyration of a circular disc to that of a circular ring, each of same mass and radius, around their respective axes is

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

10. A thin rod of length L and mass M is bent at its midpoint into two halves so that the angle between them is 90° . The moment of inertia of the bent rod about an axis passing through the bending point and perpendicular to the plane defined by the two halves of the rod is

- (A) $\sqrt{2} ML^2/24$
- (B) $ML^2/24$
- (C) $ML^2/12$
- (D) $ML^2/6$

11. If Q , E and W denote respectively the heat added, change in internal energy and the work done in a closed cycle process, then

- (A) $Q = 0$
- (B) $W = 0$
- (C) $Q = W = 0$
- (D) $E = 0$

12. On a new scale of temperature (which is linear) and called the W scale, the freezing and boiling points of water are $39^\circ W$ and $239^\circ W$ respectively. What will be the temperature on the new scale, corresponding to a temperature of $39^\circ C$ on the Celsius scale?

- (A) $139^\circ W$
- (B) $78^\circ W$
- (C) $117^\circ W$
- (D) $200^\circ W$

13. At 10°C the value of the density of a fixed mass of an ideal gas divided by its pressure is x. At 110°C this ratio is

- (A) $(283/383)x$
- (B) x
- (C) $(383/283)x$
- (D) $(10/110)x$

14. Two simple harmonic motions of angular frequency 100 and 1000 rad s⁻¹ have the same displacement amplitude. The ratio of their maximum accelerations is

- (A) 1 : 10⁴
- (B) 1 : 10
- (C) 1 : 10²
- (D) 1 : 10³

15. The wave described by $y = 0.25 \sin(10\pi x - 2\pi t)$, where x and y are in metres and t in seconds, is a wave travelling along the

- (A) -ve x direction with amplitude 0.25 m and wavelength $\lambda = 0.2$ m
- (B) -ve x direction with frequency 1 Hz
- (C) +ve x direction with frequency π Hz and wavelength $\lambda = 0.2$ m
- (D) +ve x direction with frequency 1 Hz and wavelength $\lambda = 0.2$ m

16. A point performs simple harmonic oscillation of period T and the equation of motion is given by $x = a \sin(\omega t + \pi/6)$. After the elapse of what fraction of the time period the velocity of the point will be equal to half of its maximum velocity?

- (A) $T/12$
- (B) $T/8$
- (C) $T/6$
- (D) $T/3$

17. Two points are located at a distance of 10 m and 15 m from the source of oscillation. The period of oscillation is 0.05 sec and the velocity of the wave is 300 m/sec. What is the phase difference between the oscillations of two points?

- (A) $\pi/6$
- (B) $\pi/3$
- (C) $2\pi/3$
- (D) π

18. The velocity of electromagnetic radiation in a medium of permittivity ϵ_0 and permeability μ_0 is given by

- (A) $\sqrt{(\mu_0/\epsilon_0)}$
- (B) $\sqrt{(\epsilon_0/\mu_0)}$
- (C) $\sqrt{(\mu_0\epsilon_0)}$
- (D) $1/\sqrt{(\mu_0\epsilon_0)}$

19. Two periodic waves of intensities I_1 and I_2 pass through a region at the same time in the same direction. The sum of the maximum and minimum intensities is

- (A) $2(I_1 + I_2)$
- (B) $I_1 + I_2$
- (C) $(\sqrt{I_1} + \sqrt{I_2})^2$
- (D) $(\sqrt{I_1} - \sqrt{I_2})^2$

20. Two thin lenses of focal lengths f_1 and f_2 are in contact and coaxial. The power of the combination is

- (A) $(f_1 + f_2)/(f_1 f_2)$
- (B) $\sqrt{(f_1/f_2)}$
- (C) $\sqrt{(f_2/f_1)}$
- (D) $(f_1 + f_2)/2$

21. A boy is trying to start a fire by focusing sunlight on a piece of paper using an equiconvex lens of focal length 10 cm. The diameter of the Sun is 1.39×10^9 m and its mean distance from the earth is 1.5×10^{11} m. What is the diameter of the Sun's image on the paper?

- (A) 12.4×10^{-4} m
- (B) 9.2×10^{-4} m
- (C) 6.5×10^{-4} m
- (D) 6.5×10^{-5} m

22. The energy required to charge a parallel plate condenser of plate separation d and plate area of cross-section A such that the uniform electric field between the plates is E , is

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

23. The electric potential at a point in free space due to a charge Q coulomb is $Q \times 10^{11}$ volts. The electric field at that point is

- (A) $12\pi\epsilon_0 Q \times 10^{22}$ volt/m
- (B) $4\pi\epsilon_0 Q \times 10^{22}$ volt/m
- (C) $12\pi\epsilon_0 Q \times 10^{20}$ volt/m
- (D) $4\pi\epsilon_0 Q \times 10^{20}$ volt/m

24. A wire of a certain material is stretched slowly by ten per cent. Its new resistance and specific resistance become respectively

- (A) 1.1 times, 1.1 times
- (B) 1.2 times, 1.1 times
- (C) 1.21 times, same
- (D) Both remain the same

25. An electric kettle takes 4 A current at 220 V. How much time will it take to boil 1 kg of water from temperature 20°C ? The temperature of boiling water is 100°C .

- (A) 4.2 min
- (B) 6.3 min
- (C) 8.4 min
- (D) 12.6 min

26. A particle of mass m , charge Q and kinetic energy T enters a transverse uniform magnetic field of induction B . After 3 seconds the kinetic energy of the particle will be

- (A) $4T$
- (B) $3T$
- (C) $2T$
- (D) T

27. A circular disc of radius 0.2 metre is placed in a uniform magnetic field of induction $(1/\pi)$ Wb/m² in such a way that its axis makes an angle of 60° with B . The magnetic flux linked with the disc is

- (A) 0.01 Wb
- (B) 0.02 Wb
- (C) 0.06 Wb
- (D) 0.08 Wb

28. A galvanometer of resistance $50\ \Omega$ is connected to a battery of 3 V along with a resistance of $2950\ \Omega$ in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce this deflection to 20 divisions, the resistance in series should be

- (A) $4450\ \Omega$
- (B) $5050\ \Omega$
- (C) $5550\ \Omega$
- (D) $6050\ \Omega$

29. Curie temperature is the temperature above which

- (A) Ferromagnetic material becomes diamagnetic material
- (B) Ferromagnetic material becomes paramagnetic material
- (C) Paramagnetic material becomes diamagnetic material
- (D) Paramagnetic material becomes ferromagnetic material

30. A long solenoid has 500 turns. When a current of 2 ampere is passed through it, the resulting magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb. The self-inductance of the solenoid is

- (A) 4.0 henry
- (B) 2.5 henry
- (C) 2.0 henry
- (D) 1.0 henry

31. In an a.c. circuit the e.m.f. (e) and the current (i) at any instant are given respectively by

$$e = E_0 \sin \omega t$$

$$i = I_0 \sin(\omega t - \phi)$$

The average power in the circuit over one cycle of a.c. is

- (A) $E_0 I_0$
- (B) $E_0 I_0 / 2$
- (C) $(E_0 I_0 / 2) \sin \phi$
- (D) $(E_0 I_0 / 2) \cos \phi$

32. The work function of a surface of a photosensitive material is 6.2 eV. The wavelength of the incident radiation for which the stopping potential is 5 V lies in the

- (A) X-ray region
- (B) Ultraviolet region
- (C) Visible region
- (D) Infrared region

33. A particle of mass 1 mg has the same wavelength as an electron moving with a velocity of $3 \times 10^6 \text{ m s}^{-1}$. The velocity of the particle is (mass of electron = $9.1 \times 10^{-31} \text{ kg}$)

- (A) $2.7 \times 10^{-21} \text{ m s}^{-1}$
- (B) $2.7 \times 10^{-18} \text{ m s}^{-1}$
- (C) $9 \times 10^{-2} \text{ m s}^{-1}$
- (D) $3 \times 10^{-31} \text{ m s}^{-1}$

34. The ground state energy of hydrogen atom is -13.6 eV . When its electron is in the first excited state, its excitation energy is

- (A) 0
- (B) 3.4 eV
- (C) 6.8 eV
- (D) 10.2 eV

35. Two radioactive materials X_1 and X_2 have decay constants 5λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be $1/e$ after a time

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

36. Two nuclei have their mass numbers in the ratio of 1 : 3. The ratio of their nuclear densities would be

- (A) 1 : 1
- (B) 1 : 3
- (C) 3 : 1
- (D) $3^{1/3} : 1$

37. If $M(A, Z)$, M_p and M_n denote the masses of the nucleus ${}^A_ZX$, proton and neutron respectively in units of u ($1 \text{ u} = 931.5 \text{ MeV}/c^2$) and BE represents its binding energy in MeV, then

- (A) $M(A, Z) = ZM_p + (A - Z)M_n + BE/c^2$
- (B) $M(A, Z) = ZM_p + (A - Z)M_n - BE/c^2$
- (C) $M(A, Z) = ZM_p + (A - Z)M_n + BE$
- (D) $M(A, Z) = ZM_p + (A - Z)M_n - BE$

38. The voltage gain of an amplifier with 9% negative feedback is 10. The voltage gain without feedback will be

- (A) 100
- (B) 90
- (C) 10
- (D) 1.25

39. A p-n photodiode is made of a material with a band gap of 2.0 eV. The minimum frequency of the radiation that can be absorbed by the material is nearly

- (A) 20×10^{14} Hz
- (B) 10×10^{14} Hz
- (C) 5×10^{14} Hz
- (D) 1×10^{14} Hz

40. With which one of the following elements silicon should be doped so as to give p-type of semiconductor?

- (A) Boron
- (B) Germanium
- (C) Arsenic
- (D) Selenium

Answer key and explanations

1. Answer: (D) (a) and (d)

Energy density is energy per unit volume, $[ML^2T^{-2}]/[L^3] = [ML^{-1}T^{-2}]$, and Young's modulus is stress/strain, also $[ML^{-1}T^{-2}]$. Refractive index and dielectric constant are both dimensionless, but the magnetic field $[MT^{-2}A^{-1}]$ matches neither of them.

2. Answer: (C) 6%

$V = (4/3)\pi r^3$, so $\Delta V/V = 3(\Delta r/r) = 3 \times 2\% = 6\%$. Taking 8% would wrongly cube the error itself instead of multiplying it by the power 3.

3. Answer: (D) 10/3 m

Distance in the n th second from rest $= (a/2)(2n - 1) = (2/3)(2 \times 3 - 1) = 10/3$ m. 6 m is the total distance covered in the first three seconds, $(1/2)(4/3)(3^2)$, not the distance in the third second alone.

4. Answer: (A) 9

For uniform acceleration $s = (u + v)t/2$, so $135 = (10 + 20)t/2$ and $t = 9$ s. Check: $a = (20^2 - 10^2)/(2 \times 135) = 10/9 \text{ m s}^{-2}$, and $(20 - 10)/(10/9) = 9$ s.

5. Answer: (D) $mv\sqrt{2}$

The horizontal momentum $mv \cos 45^\circ$ is unchanged, while the vertical component $mv \sin 45^\circ$ reverses. The change is $2mv \sin 45^\circ = \sqrt{2} mv$. The answer is not zero, because momentum is a vector and its direction has changed even though the speed is the same.

6. Answer: (B) Mv newton

Each second a mass M of sand must be brought from zero to speed v , so $F = v(dm/dt) = Mv$ newton. The force is not zero: even at constant belt speed, the momentum of the system keeps increasing as sand is added.

7. Answer: (B) 8.1 kW

Input power $= (dm/dt)gh = 15 \times 10 \times 60 = 9000$ W. With 10% lost, the output is $0.9 \times 9000 = 8100$ W $= 8.1$ kW. 9 kW without the loss is not offered; adding the loss instead of subtracting it would give about 9.9 kW.

8. Answer: (B) 100 m s^{-1}

Momentum conservation: $0.2v = 4V$, so the gun recoils with $V = v/20$. Energy: $(1/2) \times 0.2 \times v^2 + (1/2) \times 4 \times (v/20)^2 = 0.1v^2 + 0.005v^2 = 0.105v^2 = 1050$, so $v^2 = 10^4$ and $v = 100 \text{ m s}^{-1}$. Ignoring the gun's recoil energy would give about 102 m s^{-1} , so the recoil share must be included.

9. Answer: (C) $1 : \sqrt{2}$

About the central axis, $I(\text{disc}) = MR^2/2$ gives $k = R/\sqrt{2}$, and $I(\text{ring}) = MR^2$ gives $k = R$. So $k(\text{disc}) : k(\text{ring}) = 1 : \sqrt{2}$. $\sqrt{2} : 1$ is the inverted ratio (ring to disc).

10. Answer: (C) $ML^2/12$

Each half has mass $M/2$ and length $L/2$ and rotates about its own end: $I = 2 \times (1/3)(M/2)(L/2)^2 = ML^2/12$. The bend angle does not matter, because each element stays at the same distance from the axis, so the $\sqrt{2}$ factor is a trap.

11. Answer: (D) $E = 0$

Internal energy is a state function, so after a complete cycle its change E is zero. From $Q = E + W$ this gives $Q = W$, but neither heat nor work need be zero: a heat engine running in a cycle does net work.

12. Answer: (C) 117° W

For a linear scale, $(W - 39)/(239 - 39) = (C - 0)/(100 - 0)$. With $C = 39$: $W = 39 + 200 \times 0.39 = 39 + 78 = 117^\circ \text{ W}$. 78° W forgets to add the offset of the freezing point.

13. Answer: (A) $(283/383)x$

From $PV = (m/M)RT$, $\rho/P = M/(RT)$, so the ratio is inversely proportional to absolute temperature. At 383 K it becomes $x \times 283/383$. Using Celsius temperatures $(10/110)$ is wrong because gas laws need kelvin.

14. Answer: (C) $1 : 10^2$

Maximum acceleration $= \omega^2 A$. For equal amplitudes the ratio is $(100/1000)^2 = 1 : 10^2$. $1 : 10$ is the ratio of maximum velocities (ωA), not accelerations.

15. Answer: (D) +ve x direction with frequency 1 Hz and wavelength $\lambda = 0.2 \text{ m}$

Compare with $y = A \sin(kx - \omega t)$: $k = 10\pi$ gives $\lambda = 2\pi/k = 0.2 \text{ m}$, and $\omega = 2\pi$ gives $f = 1 \text{ Hz}$. The minus sign between the kx and ωt terms means the wave moves along $+x$. Reading $\omega = 2\pi$ as 'frequency $\pi \text{ Hz}$ ' confuses ω with $2\pi f$.

16. Answer: (A) $T/12$

$v = a\omega \cos(\omega t + \pi/6)$. Setting $v = a\omega/2$ gives $\omega t + \pi/6 = \pi/3$, so $\omega t = \pi/6$ and $t = (\pi/6)/(T/2\pi) = T/12$. $T/6$ would be the answer if the initial phase $\pi/6$ were ignored.

17. Answer: (C) $2\pi/3$

Wavelength $\lambda = vT = 300 \times 0.05 = 15 \text{ m}$. Path difference $= 15 - 10 = 5 \text{ m}$, so phase difference $= (2\pi/\lambda) \times 5 = 2\pi/3$. Using $\lambda = 5 \text{ m}$ by mistake would give 2π , not one of the options.

18. Answer: (D) $1/\sqrt{(\mu_0 \epsilon_0)}$

Maxwell's equations give the wave speed $v = 1/\sqrt{(\mu\epsilon)}$; with ϵ_0 and μ_0 this is $c = 1/\sqrt{(\mu_0 \epsilon_0)} \approx 3 \times 10^8 \text{ m/s}$. $\sqrt{(\mu_0 \epsilon_0)}$ is its inverse, with dimensions of time per length, and $\sqrt{(\mu_0/\epsilon_0)}$ is the impedance of free space (in ohms), not a speed.

19. Answer: (A) $2(I_1 + I_2)$

On superposition, $I_{\max} = (\sqrt{I_1} + \sqrt{I_2})^2$ and $I_{\min} = (\sqrt{I_1} - \sqrt{I_2})^2$. Adding them, the cross terms $\pm 2\sqrt{I_1 I_2}$ cancel, leaving $2(I_1 + I_2)$. $(\sqrt{I_1} + \sqrt{I_2})^2$ is only the maximum, not the sum.

20. Answer: (A) $(f_1 + f_2)/(f_1 f_2)$

For thin lenses in contact, powers add: $P = 1/f_1 + 1/f_2 = (f_1 + f_2)/(f_1 f_2)$. $(f_1 + f_2)/2$ has dimensions of length, so it cannot be a power.

21. Answer: (B) $9.2 \times 10^{-4} \text{ m}$

The image forms in the focal plane, and the Sun and its image subtend the same angle at the lens: $d = f \times D/u = 0.10 \times 1.39 \times 10^9 / 1.5 \times 10^{11} \approx 9.3 \times 10^{-4} \text{ m}$, closest to $9.2 \times 10^{-4} \text{ m}$. $6.5 \times 10^{-4} \text{ m}$ would come from wrongly halving or mis-scaling the angular size.

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

Energy $= (1/2)CV^2$ with $C = \epsilon_0 A/d$ and $V = Ed$, giving $(1/2)(\epsilon_0 A/d)(Ed)^2 = (1/2)\epsilon_0 E^2 A d$, i.e. energy density $(1/2)\epsilon_0 E^2$ times the volume Ad . $\epsilon_0 E^2 A d$ misses the factor $1/2$, and the forms divided by Ad have the wrong dimensions.

23. Answer: (B) $4\pi\epsilon_0 Q \times 10^{22} \text{ volt/m}$

$V = Q/(4\pi\epsilon_0 r) = Q \times 10^{11}$ gives $r = 1/(4\pi\epsilon_0 \times 10^{11})$. Then $E = V/r = Q \times 10^{11} \times 4\pi\epsilon_0 \times 10^{11} = 4\pi\epsilon_0 Q \times 10^{22} \text{ V/m}$. The 10^{20} forms come from mishandling the power of ten.

24. Answer: (C) 1.21 times, same

The volume stays constant, so $R = \rho l/A = \rho l^2/V$ is proportional to l^2 . A 10% stretch gives $R' = (1.1)^2 R = 1.21R$. Specific resistance (resistivity) depends only on the material and temperature, so it stays the same.

25. Answer: (B) 6.3 min

Heat needed $= mc\Delta\theta = 1 \times 4200 \times 80 = 3.36 \times 10^5 \text{ J}$; power $= VI = 220 \times 4 = 880 \text{ W}$. $t = 3.36 \times 10^5 / 880 \approx 382 \text{ s} \approx 6.4 \text{ min}$, closest to 6.3 min. Heating from 0°C to 100°C instead of 20°C would give about 8 min.

26. Answer: (D) T

The magnetic force $qv \times B$ is always perpendicular to the velocity, so it does no work. The particle moves in a circle at constant speed and its kinetic energy stays T. The 3 seconds is a distractor: the elapsed time does not matter.

27. Answer: (B) 0.02 Wb

The disc's area vector lies along its axis, so $\phi = BA \cos 60^\circ = (\pi)(\pi \times 0.2^2)(1/2) = 0.02 \text{ Wb}$. Using $\sin 60^\circ$ (treating the angle as being with the plane of the disc) would give about 0.035 Wb.

28. Answer: (A) 4450 Ω

Full-scale current = $3/(50 + 2950) = 1 \text{ mA}$ for 30 divisions. For 20 divisions $I = (2/3) \text{ mA}$, so total resistance = $3/(2/3 \times 10^{-3}) = 4500 \Omega$ and the series resistance = $4500 - 50 = 4450 \Omega$. 4500 Ω would forget to subtract the galvanometer's own resistance.

29. Answer: (B) Ferromagnetic material becomes paramagnetic material

Above the Curie temperature, thermal agitation destroys the alignment of the domains, and a ferromagnet behaves as a paramagnet. It does not become diamagnetic, because the atoms still carry permanent magnetic moments.

30. Answer: (D) 1.0 henry

Total flux linkage $N\phi = LI$, so $L = 500 \times 4 \times 10^{-3}/2 = 1.0 \text{ H}$. 2.0 H would forget to divide by the current.

31. Answer: (D) $(E_0 I_0/2) \cos \phi$

Average power = $E_{\text{rms}} \times I_{\text{rms}} \times \cos \phi = (E_0/\sqrt{2})(I_0/\sqrt{2}) \cos \phi = (E_0 I_0/2) \cos \phi$. $E_0 I_0/2$ holds only when current and emf are in phase ($\phi = 0$), and the $\sin \phi$ form gives the wattless (reactive) component.

32. Answer: (B) Ultraviolet region

Photon energy = $\phi + eV_0 = 6.2 + 5 = 11.2 \text{ eV}$, so $\lambda = 12400/11.2 \text{ eV} \cdot \text{\AA} \approx 1100 \text{ \AA}$ (about 110 nm). This lies in the ultraviolet; visible light is only about 1.8 to 3.1 eV, and X-rays need wavelengths below about 100 $\text{\AA}$.

33. Answer: (B) $2.7 \times 10^{-18} \text{ m s}^{-1}$

Equal de Broglie wavelengths ($\lambda = h/mv$) mean equal momenta. $1 \text{ mg} = 10^{-6} \text{ kg}$, so $v = (9.1 \times 10^{-31} \times 3 \times 10^6)/10^{-6} \approx 2.7 \times 10^{-18} \text{ m s}^{-1}$. Taking 1 mg as 10^{-3} kg gives $2.7 \times 10^{-21} \text{ m s}^{-1}$.

34. Answer: (D) 10.2 eV

The first excited state is $n = 2$ with energy $-13.6/4 = -3.4 \text{ eV}$. Excitation energy = $-3.4 - (-13.6) = 10.2 \text{ eV}$. 3.4 eV is the energy needed to ionise from $n = 2$, not the excitation energy from the ground state.

35. Answer: (D) $1/(4\lambda)$

$N_1/N_2 = e^{(-5\lambda t)}/e^{(-\lambda t)} = e^{(-4\lambda t)}$. Setting this to $1/e$ gives $4\lambda t = 1$, so $t = 1/(4\lambda)$. λ and $\lambda/2$ cannot be times, since λ has units of inverse time.

36. Answer: (A) 1 : 1

Nuclear radius $R = R_0 A^{(1/3)}$, so volume is proportional to A , just as mass is. Their ratio, the density, is the same for all nuclei, 1 : 1. The $3^{(1/3)}$ form is the ratio of radii, not of densities.

37. Answer: (B) $M(A, Z) = ZM_p + (A - Z)M_n - BE/c^2$

A bound nucleus is lighter than its free nucleons by the mass defect, and the mass defect equals BE/c^2 . So $M(A, Z) = ZM_p + (A - Z)M_n - BE/c^2$. The plus sign would make the nucleus heavier than its parts, and subtracting BE without c^2 mixes energy with mass units.

38. Answer: (A) 100

With negative feedback, $A_f = A/(1 + \beta A)$ with $\beta = 0.09$. Then $10 = A/(1 + 0.09A)$ gives $10 + 0.09A = A$, so $0.1A = 10$ and $A = 100$. A gain of 10 without feedback is impossible, because negative feedback always lowers the gain.

39. Answer: (C) $5 \times 10^{14} \text{ Hz}$

The photon must at least bridge the band gap: $\nu = E_g/h = (2.0 \times 1.6 \times 10^{-19})/(6.63 \times 10^{-34}) \approx 4.8 \times 10^{14} \text{ Hz} \approx 5 \times 10^{14} \text{ Hz}$. $10 \times 10^{14} \text{ Hz}$ would correspond to a 4 eV gap.

40. Answer: (A) Boron

A trivalent dopant such as boron has one electron too few to complete the four bonds with silicon, which creates holes, the majority carriers in a p-type semiconductor. Arsenic is pentavalent and gives n-type, while germanium is tetravalent like silicon and creates no extra carriers.

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