

Answer Key For Ph.D Entrance Test in Physics

1. c
2. a
3. b
4. b
5. c
6. d
7. c
8. d
9. a
10. b
11. d
12. b
13. a
14. d
15. b
16. d
17. b
18. d
19. a
20. d
21. b
22. c
23. b
24. d
25. c
26. c
27. a
28. d
29. d
30. b
31. c
32. d
33. c
34. c
35. a
36. a
37. d
38. b
39. b
40. c

Revised
19/1/24

Ph.D. Entrance Examination of PHYSICS

1. The conservation law violated by the reaction $p \rightarrow \pi^0 + e^+$ is the conservation of
 - (a) charge.
 - (b) energy
 - (c) lepton number and baryon number.
 - (d) angular momentum.
2. The Lagrangian of a system is given by

$$L = \frac{1}{2} ml^2 [\dot{\theta}^2 + \sin^2 \theta \dot{\phi}^2] - mgl \cos \theta$$
 where m , l and g are constants. Which of the following is conserved?
 - a) $\dot{\phi} \sin^2 \theta$
 - b) $\dot{\phi} \sin \theta$
 - c) $\frac{\dot{\phi}}{\sin \theta}$
 - d) $\frac{\dot{\phi}}{\sin^2 \theta}$
3. The Lagrangian for a particle of mass m at a position \vec{r} moving with a velocity \vec{v} is given by

$$L = \frac{m}{2} \vec{v}^2 + C \vec{r} \cdot \vec{v} - V(r)$$
,
 where $V(r)$ is a potential and C is a constant. If \vec{p}_c is the canonical momentum, then its Hamiltonian is given by
 - a) $\frac{1}{2m} (\vec{p}_c + C \vec{r})^2 + V(r)$
 - b) $\frac{1}{2m} (\vec{p}_c - C \vec{r})^2 + V(r)$
 - c) $\frac{p_c^2}{2m} + V(r)$
 - d) $\frac{1}{2m} p_c^2 + C^2 r^2 + V(r)$
4. A particle with rest mass M is at rest and decays into two particles of equal rest masses $\frac{3}{10} M$ which move along the z axis. Their velocities are given by
 - a) $\vec{v}_1 = \vec{v}_2 = (0.8c)\hat{z}$
 - b) $\vec{v}_1 = -\vec{v}_2 = (0.8c)\hat{z}$
 - c) $\vec{v}_1 = -\vec{v}_2 = (0.6c)\hat{z}$
 - d) $\vec{v}_1 = (0.6c)\hat{z}; \vec{v}_2 = (-0.8c)\hat{z}$
5. An interstellar object has speed v at the point of its shortest distance R from a star of much larger mass M . Given $v^2 = 2GM/R$, the trajectory of the object is
 - a) Circle
 - b) Ellipse
 - c) Parabola
 - d) Hyperbola
6. The electric field component of a plane electromagnetic wave travelling in vacuum is given by

$$\vec{E}(z, t) = E_0 \cos(kz - \omega t)\hat{i}$$
.
 The Poynting vector for the wave is
 - a) $\left(\frac{c\epsilon_0}{2}\right) E_0^2 \cos^2(kz - \omega t)\hat{j}$
 - b) $\left(\frac{c\epsilon_0}{2}\right) E_0^2 \cos^2(kz - \omega t)\hat{k}$
 - c) $c\epsilon_0 E_0^2 \cos^2(kz - \omega t)\hat{j}$
 - d) $c\epsilon_0 E_0^2 \cos^2(kz - \omega t)\hat{k}$

7. An unpolarized light wave is incident from air on a glass surface at the Brewster angle. The angle between the reflected and the refracted wave is
- 0°
 - 45°
 - 90°
 - 120°
8. The electric and the magnetic field $\vec{E}(z, t)$ and $\vec{B}(z, t)$, respectively corresponding to the scalar potential $\varphi(z, t) = 0$ and vector potential $\vec{A}(z, t) = \hat{i}tz$ are
- $\vec{E} = \hat{i}z$ and $\vec{B} = -jt$
 - $\vec{E} = \hat{i}z$ and $\vec{B} = jt$
 - $\vec{E} = -\hat{i}z$ and $\vec{B} = -jt$
 - $\vec{E} = -\hat{i}z$ and $\vec{B} = jt$
9. A plane polarized electromagnetic wave in free space at time $t=0$ is given by $\vec{E}(x, y) = 10j \exp[i(6x + 8z)]$. The magnetic field $\vec{B}(x, z, t)$ is given by
- $\vec{B}(x, z, t) = \frac{1}{c}(6\hat{k} - 8\hat{i}) \exp[i(6x + 8z - 10ct)]$
 - $\vec{B}(x, z, t) = \frac{1}{c}(6\hat{k} + 8\hat{i}) \exp[i(6x + 8z - 10ct)]$
 - $\vec{B}(x, z, t) = \frac{1}{c}(6\hat{k} - 8\hat{i}) \exp[i(6x + 8z - ct)]$
 - $\vec{B}(x, z, t) = \frac{1}{c}(6\hat{k} + 8\hat{i}) \exp[i(6x + 8z + ct)]$
10. Which one of the following quantities is invariant under Lorentz transformation?
- Charge density
 - Charge
 - Current
 - Electric field
11. A conservation law that is not universal but applies only to certain kinds of interactions is the conservation of
- lepton number
 - baryon number
 - spin
 - strangeness
12. The direction of $\vec{\nabla}f$ for a scalar field $f(x, y, z) = \frac{1}{2}x^2 - xy + \frac{1}{2}z^2$ at the point $P(1, 1, 2)$ is
- $\frac{(-j-2\hat{k})}{\sqrt{5}}$
 - $\frac{(-j+2\hat{k})}{\sqrt{5}}$
 - $\frac{(j-2\hat{k})}{\sqrt{5}}$
 - $\frac{(j+2\hat{k})}{\sqrt{5}}$
13. Consider a complex function $f(z) = \frac{1}{z(z+\frac{1}{2})\cos(z\pi)}$, which one of the following statements is correct?
- $f(z)$ has simple poles at $z = 0$ and $z = -\frac{1}{2}$
 - $f(z)$ has second order pole at $z = -\frac{1}{2}$
 - $f(z)$ has infinite number of second order poles
 - $f(z)$ has all simple poles

14. In spherical polar coordinates (r, θ, φ) , the unit vector $\hat{\theta}$ at $(10, \frac{\pi}{4}, \frac{\pi}{2})$ is
- \hat{k}
 - $\frac{1}{\sqrt{2}}(\hat{j} + \hat{k})$
 - $\frac{1}{\sqrt{2}}(-\hat{j} + \hat{k})$
 - $\frac{1}{\sqrt{2}}(\hat{j} - \hat{k})$
15. The eigenvalues of the matrix $\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$ are
- 0,1,1
 - $0, -\sqrt{2}, \sqrt{2}$
 - $\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0$
 - $\sqrt{2}, \sqrt{2}, 0$
16. Which one of the following commutation relations is NOT CORRECT? Here, symbols have their usual meanings.
- $[L^2, L_z] = 0$
 - $[L_x, L_y] = i \frac{h}{2\pi} L_z$
 - $[L_z, L_+] = \frac{h}{2\pi} L_+$
 - $[L_z, L_-] = \frac{h}{2\pi} L_-$
17. If n be the number density and λ_D be the de-Broglie wavelength. Which of the following conditions should be satisfied for Bose-Einstein condensation to take place?
- $\lambda_D^3 n < 2.6$
 - $\lambda_D^3 n > 2.6$
 - $\lambda_D^3 n > 1/2.6$
 - $\lambda_D^3 n < 1/2.6$
18. The vapour pressure p (in mm Hg) of a solid, at temperature T , is expressed by $\ln p = 23 - 3863/T$ and that of its liquid phase by $\ln p = 19 - 3063/T$. the triple point (in kelvin) of the material is
- 185
 - 190
 - 195
 - 200
19. A quantity of heat ΔH is transferred from a large heat reservoir at temperature T_1 to another large heat reservoir at temp. T_2 , with $T_1 > T_2$ required for spontaneous transfer. The heat reservoir have such large capacities that there is no observable change in their temperature. The entropy of the entire system has
- Increased
 - decreased
 - remains unchanged
 - Zero
20. A heat pump working on the Carnot cycle maintains the inside temperature of a house at 22°C by supplying 450kJ/s . if the outside temperature is 0°C , the heat taken, in kJ/s , from the outside air is approximately
- 487
 - 470
 - 467
 - 417

21. A perfect gas is expanded from 10 m^3 to 20 m^3 at a constant pressure of 10^5 N/m^2 . The temperature before the expansion was 100°C . Temperature after expansion is
- 473K
 - 473°C
 - 200°C
 - 746°C
22. Two identical Zener diodes having specifications 12V, 1/4W are connected in series. If the breakdown voltage of each diode is 5V, then what is the breakdown voltage in series combination of diodes?
- 2.5V
 - 5V
 - 10V
 - 12 V
23. In a transistor, the change in base current from $100\mu\text{A}$ - $125\mu\text{A}$ causes a change in collector current from 5mA to 7.5 mA, keeping collector-to-emitter voltage constant at 10V. what is the current gain of transistor?
- 200
 - 100
 - 50
 - 25
24. A half-adder is a digital circuit with
- Three inputs and one output
 - Three inputs and two output
 - Two inputs and one output
 - Two inputs and two output
25. A certain op-amp has an open-loop voltage gain of 1,00,000 and a common mode gain of 0.2. the CMRR is
- 500000
 - 114dB
 - Both (a) and (b)
 - None of the above
26. An ammeter with range 0-10 A has a guaranteed accuracy of 1% of full scale deflection. The limiting error while reading 2.5 A is
- 1%
 - 2%
 - 4%
 - None of the above
27. The d_1 and d_2 lines of $\text{Na}(3^2 p_{1/2} \rightarrow 3^2 S_{1/2}, 3^2 p_{3/2} \rightarrow 3^2 S_{1/2})$ will split on the application of a weak magnetic field into
- 4 and 6 lines respectively
 - 3 lines each
 - 6 and 4 lines respectively
 - 6 lines each
28. The separation between the first Stokes and corresponding Anti-stokes lines of the rotational Raman spectrum in terms of the rotational constant B is
- 2B
 - 4B
 - 6B
 - 12B

29. In Ruby laser, population inversion is achieved by applying
- Magnetic field
 - Electrostatic field
 - Both magnetic and electrostatic field
 - Optical pumping
30. The number of photons emitted per second from a 1W Ar-ion laser operating at 488.0 nm is approximately
- 10.23×10^{19}
 - 2.46×10^{18}
 - 10.23×10^{17}
 - 2.46×10^{15}
31. The short wavelength cut-off of the continuous X-ray spectrum from nickel target is 0.0825 nm. The voltage required to be applied on an X-ray tube is
- 0.15kV
 - 1.5kV
 - 15kV
 - 150kV
32. Which of the following lattices has the highest void fraction?
- Hexagonal close-packed
 - Body-centered cubic
 - Face-centered cubic
 - Primitive cubic
33. The Fermi temperature of a metal is 24600K. Calculate the Fermi velocity.
- 0.5m/s
 - 1.38m/s
 - 0.8633×10^6 m/s
 - 9.11×10^{-3} m/s
34. When current flows along the length of the semiconductor slab and the magnetic field applied is perpendicular the length to Hall voltage developed is
- Along the length
 - Along the thickness
 - Along the width of
 - Along the edges from where the current enters
35. Which is the correct ordering of the band gaps energy?
- Diamond > silicon > copper
 - Diamond < silicon < copper
 - Diamond < silicon > copper
 - Diamond < silicon < copper
36. Ideal superconductors completely become _____ at the superconducting state
- Diamagnetic
 - Ferromagnetic
 - Ferri magnetic
 - Para magnetic
37. Type-I superconductors can produce a magnetic field of the order of.....
- 100 Tesla
 - 10 Tesla
 - 5 Tesla
 - 0.1 Tesla
38. The electron pairs in a superconductor are called.....
- Bardeen pair
 - Cooper pair
 - BCS Pair
 - Josephson Pair

39. What is the energy released in a nuclear reaction called?
- (a) R-value
 - (b) Q value
 - (c) P-value
 - (d) Nuclear energy
40. Which of the following forms the basis of a nuclear reactor?
- (a) Uncontrolled chain reaction
 - (b) Fast nuclear reaction
 - (c) Controlled chain reaction
 - (d) Catalyst-controlled nuclear reaction