## Answer Key: Assistant Professor (Physics)

| Q No | Key |
|---|---|
| 1 | B |
| 2 | C |
| 3 | A |
| 4 | C |
| 5 | C |
| 6 | D |
| 7 | D |
| 8 | C |
| 9 | D |
| 10 | C |
| 11 | D |
| 12 | D |
| 13 | D |
| 14 | A |
| 15 | D |
| 16 | C |
| 17 | A |
| 18 | D |
| 19 | D |
| 20 | B |
| 21 | B |
| 22 | C |
| 23 | D |
| 24 | C |
| 25 | B |

| Q No | Key |
|---|---|
| 26 | B |
| 27 | D |
| 28 | B |
| 29 | B |
| 30 | A |
| 31 | A |
| 32 | C |
| 33 | C |
| 34 | D |
| 35 | D |
| 36 | B |
| 37 | C |
| 38 | D |
| 39 | D |
| 40 | B |
| 41 | A |
| 42 | C |
| 43 | D |
| 44 | B |
| 45 | B |
| 46 | C |
| 47 | D |
| 48 | B |
| 49 | A |
| 50 | C |

**Test Booklet Series**

**A**

**Test Booklet No.**

# Test Booklet for the Post of

## Assistant Professor Physics

Name of Applicant ..... Answer Sheet No. .....

Applicant ID/Roll No. : ..... Signature of Applicant : .....

Date of Examination: .....

Time of Examination : .....

Signature of the Invigilator(s)

1. .....

2. .....

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**Duration : 1½ Hours]** **[Maximum Marks : 50**

## IMPORTANT INSTRUCTIONS

(i) The question paper is in the form of Test-Booklet containing **50 (Fifty)** questions. All questions are compulsory. Each question carries four answers marked (A), (B), (C) and (D), out of which only one is correct. Choose the correct option or the most appropriate option.

(ii) On receipt of the Test-Booklet (Question Paper), the candidate should immediately check it and ensure that it contains all the pages, i.e., **50** questions. Discrepancy, if any, should be reported by the candidate to the invigilator immediately after receiving the Test-Booklet.

(iii) A separate Answer-Sheet is provided with the Test-Booklet/Question Paper. On this sheet there are **50** rows containing four circles each. One row pertains to one question.

(iv) The candidate should write his/her Application ID/Roll number at the places provided on the cover page of the Test-Booklet/Question Paper and on the Answer-Sheet and NOWHERE ELSE.

(v) No second Test-Booklet/Question Paper and Answer-Sheet will be given to a candidate. The candidates are advised to be careful in handling it and writing the answer on the Answer-Sheet.

(vi) For every correct answer of the question **One (1) mark will be awarded.** There will be negative marking and 1/4 (0.25) mark will be deducted for every incorrect answer.

(vii) Marking shall be done only on the basis of answers responded on the Answer-Sheet.

(viii) To mark the answer on the Answer-Sheet, candidate should **darken** the appropriate circle in the row of each question with Blue or Black pen.

(ix) For each question only **one** circle should be **darkened** as a mark of the answer adopted by the candidate. If more than one circle for the question are found darkened or with one black circle any other circle carries any mark, the answer will be treated as incorrect.

(x) The candidates should not remove any paper from the Test-Booklet/Question Paper. Attempting to remove any paper shall be liable to be punished for use of unfair means.

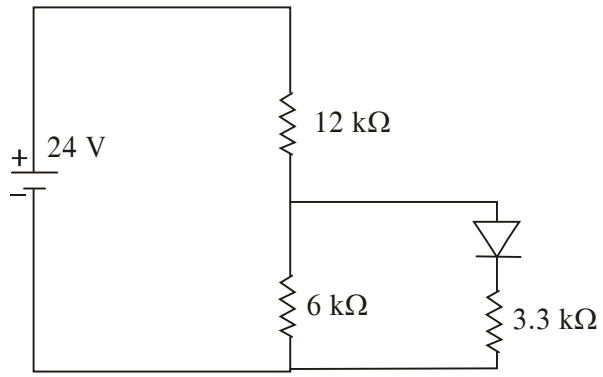
(xi) Rough work may be done on the blank space provided in the Test-Booklet/Question Paper only.

(xii) *Mobile phones (even in Switch-off mode) and such other communication/programmable devices are not allowed inside the examination hall.*

(xiii) No candidate shall be permitted to leave the examination hall before the expiry of the time.

**DO NOT OPEN THIS QUESTION BOOKLET UNTIL ASKED TO DO SO.**

1. In the following circuit, the voltage drop across the ideal diode in forward bias condition is 0.7V. The current passing through the diode is




(A) 0.5 mA (B) 1 mA

(C) 1.5 mA (D) 2.0 mA

2. In an NPN transistor, 90% of emitted electrons reach the collector. If the collector current is 18 mA, the base current will be

(A) 1.62 mA (B) 1.8 mA

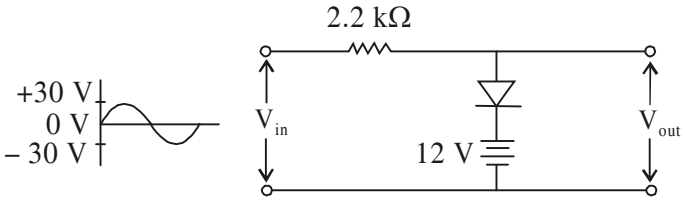
(C) 2.0 mA (D) 2.5 mA

3. The minimum number of flip-flops required to construct a modulo 75 counter is :

(A) 7 (B) 8

(C) 9 (D) 6

4. The peak-to-peak voltage for the following Si-based diode is :




(A) 17.3 V (B) 29.3 V

(C) 42.7 V (D) 47.0 V

5. Two batteries with EMFs 12 V and 13 V are connected in parallel to a 10 ohm load resistor. The internal resistances of the two batteries are 1 ohm and 2 ohms, respectively. The voltage across the load is :

(A) 5.3 V (B) 8.8 V

(C) 11.5 V (D) 14.2 V

6. Which one of the following is the weakest bond?

(A) Covalent bond (B) Ionic bond

(C) Metallic bond (D) Vander Waals bond

7. The fraction of electrons excited at room temperature (300 K) across the energy gap of silicon ($E_g$ = 1.1 eV) is :

(A) $4 \times 10^{-12}$ (B) $7 \times 10^{-18}$

(C) $1.7 \times 10^{-14}$ (D) $5.7 \times 10^{-10}$

8. For a three-dimensional crystal lattice having $N$ primitive unit cell with a basis of $p$ atoms, the number of optical phonon branches is :

(A) $3N - 3p$ (B) $3N - 3$

(C) $3p - 3$ (D) 3

9. The temperature dependence of the magnetic susceptibility ($\chi$) of a paramagnetic material with Curie temperature ($T_C$) is given by :

(A) $\frac{C}{T+T_C}$ for $T > T_C$ (B) $\frac{C}{T-T_C}$ for $T < T_C$

(C) $\frac{C}{T+T_C}$ for all temperatures (D) $\frac{C}{T-T_C}$ for $T > T_C$

10. The dependence of electronic specific heat on temperature is :

(A) $(C_v)_e \alpha T^{2/3}$ (B) $(C_v)_e \alpha T^3$

(C) $(C_v)_e \alpha T$ (D) $(C_v)_e \alpha T^2$

11. Which of the following atoms cannot exhibit Bose-Einstein condensation even in principle?

(A) $^{1}H_{1}$ (B) $^{4}H_{2}$

(C) $^{23}Na_{11}$ (D) $^{30}K_{19}$

12. A system of N-non-interacting and distinguishable particle of spin 1 is in thermodynamic equilibrium. The entropy of the system is :

(A) $2K_B \ln N$ (B) $3K_B \ln N$

(C) $NK_B \ln 2$ (D) $NK_B \ln 3$

13. For an ideal Fermi gas in three-dimensions, the electron velocity $V_F$ at the Fermi surface is related to the electron concentration $n$ as :

(A) $V_F \propto n^{2/3}$ (B) $V_F \propto n$

(C) $V_F \propto n^{1/2}$ (D) $V_F \propto n^{1/3}$

14. The energy density and pressure of a photon gas are given by $u = aT^4$ and $P = u/3$. Here, T represents the temperature and $a$ is the radiation constant. The entropy per unit volume is given by $\alpha aT^3$. The value of $\alpha$ is

(A) 1.33 (B) 1.25

(C) 0.75 (D) 1.00

15. If the electrostatic potential is given by $\phi = \phi_o (x^2 + y^2 + z^2)$, where $\phi_o$ is constant, then the charge density giving rise to the above potential would be :

(A) $-3\phi_o\varepsilon_0$ (B) $-4\phi_o\varepsilon_0$

(C) $-12\phi_o\varepsilon_0$ (D) $-6\phi_o\varepsilon_0$

16. A sphere of radius $a$ has a charge density which varies with $r$ as $\rho = Ar^{1/2}$. The electric field at distance $r < a$ varies as :

(A) $E \propto r^{-1/2}$ (B) $E \propto r^{-3/2}$

(C) $E \propto r^{3/2}$ (D) $E \propto r^{1/2}$

17. The magnetic field associated with the electric field vector $\mathbf{E} = E_0 \sin(kz - \omega t)\,\hat{j}$ is given by :

(A) $\mathbf{B} = -\dfrac{E_0 \sin(kz - \omega t)\hat{i}}{c}$ (B) $\mathbf{B} = \dfrac{E_0 \sin(kz - \omega t)\hat{i}}{c}$

(C) $\mathbf{B} = -\dfrac{E_0 \sin(kz - \omega t)\hat{k}}{c}$ (D) $\mathbf{B} = \dfrac{E_0 \sin(kz - \omega t)\hat{k}}{c}$

18. The magnetic field in a region is $\mathbf{B} = \beta t\hat{z}$ . The induced electric field due to this time-varying magnetic field is given by :

(A) $\dfrac{\beta r}{3}\hat{\phi}$ (B) $-\dfrac{\beta r}{3}\hat{\phi}$

(C) $\dfrac{\beta r}{2}\hat{\phi}$ (D) $-\dfrac{\beta r}{2}\hat{\phi}$

19. The electric and magnetic fields **E** and **B** respectively corresponding to the scalar potential $\phi = 0$ and vector potential $\mathbf{A} = tz\hat{x}$ are :

(A) $\mathbf{E} = z\hat{x}$ and $\mathbf{B} = -t\hat{y}$ (B) $\mathbf{E} = z\hat{x}$ and $\mathbf{B} = t\hat{y}$

(C) $\mathbf{E} = -z\hat{x}$ and $\mathbf{B} = -t\hat{y}$ (D) $\mathbf{E} = -z\hat{x}$ and $\mathbf{B} = t\hat{y}$

20. A stationary body explodes into two fragments of mass 1.0 kg each that move apart at a speed of 0.6c relative to the original body. Find the mass of the original body

(A) 3.0 kg (B) 2.5 kg

(C) 3.5 kg (D) 3.33 kg

21. At what value of kinetic energy is the de Broglie wavelength of a relativistic electron of rest mass $m_0$ equal to its Compton wavelength?

(A) $\sqrt{2}m_o c^2$ (B) $(\sqrt{2}-1)m_o c^2$

(C) $(\sqrt{2}+1)m_o c^2$ (D) $2m_o c^2$

22. An eigen function of operator $d^2/dx^2$ is $\varphi = e^{2x}$ . The corresponding eigenvalue is:

(A) 1 (B) 2

(C) 4 (D) Zero

23. Value of $[L_x, r^2]$ is :

(A) $i\hbar y$ (B) $i\hbar P_y$

(C) $-i\hbar x$ (D) zero

24. If $L_+$ and $L_-$ are angular momentum ladder operators, then the expectation value of $(L_+ L_- + L_- L_+)$ in the state $|l = 1, m = 1>$ of an atom is :

(A) $4\hbar^2$ (B) $\hbar^2$

(C) $2\hbar^2$ (D) $\hbar^2/2$

25. A normalized ground state wave function of a hydrogen atom is given by $= \frac{1}{\sqrt{\pi a^3}}\left(e^{-r/a}\right)$, where $a$ is the Bohr radius and $r$ is the distance of the electron from the nucleus, located at the origin. The expectation value of $1/r^2$ is

(A) $4/a^2$ (B) $2/a^2$

(C) $4\pi/a^2$ (D) $8\pi/a^2$

26. If Hamiltonian and wave function are $H = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$ and $\varphi = \frac{1}{\sqrt{2}}\begin{bmatrix} i \\ -i \end{bmatrix}$ then its eigen value is :

(A) 5 (B) 3

(C) 2 (D) 0

27. According to Fermi-Golden Rule, the transition rate is proportional to $n^{th}$ power of the matrix element of the perturbation connecting these states and proportional to the $m^{th}$ power of the density of final states. Here $n$ and $m$ are respectively :

(A) 1 and 2 (B) 2 and 2

(C) 1 and 4 (D) 2 and 1

28. How does the total angular quantum number $j$ change when the transition $Cr(3d^6)$ atom ionizes to $Cr^{2+}(3d^4)$?

(A) Increased by 2 (B) Decreased by 4

(C) Increased by 4 (D) Doesn't change

29. The magnitude of the spin magnetic dipole moment of an electron ($\mu_s$) in terms of the Bohr magneton ($\mu_B$) is :

(A) $\mu_s = \mu_B$

(B) $\mu_s = \sqrt{3}\mu_B$

(C) $\mu_s = \frac{\mu_B}{\sqrt{3}}$

(D) $\mu_s = 3\mu_B$

30. In a normal Zeeman effect experiment, a spectral splitting of a line at 5000 Å is to be observed. The spectrometer has a resolution of $1.1 \times 10^{-3}$ Å. The minimum magnetic field needed is :

(A) 9.42 mT

(B) 9.42 T

(C) 9.42 kT

(D) 5.2 T

31. The ratio of energies required to excite a diatomic molecule to the first vibrational and to the first rotational level is given by :

(Here $\mu$ is the reduced mass, $\omega$ is the natural angular vibrational frequency, and $d$ is the distance between nuclei).

(A) $\frac{\omega\mu d^2}{\hbar}$

(B) $\frac{2\omega\mu d^2}{\hbar}$

(C) $\frac{\omega\mu d^2}{2\hbar}$

(D) $\frac{\omega\mu d^2}{4\hbar}$

32. In the Stern-Gerlach experiment, as atoms moving along the $x$-direction enter in the region between magnetic poles, the magnetic field must be :

(A) Constant

(B) Have a gradient along the $x$-direction

(C) Have a gradient in the perpendicular direction

(D) Oscillate with time

33. In radioactive decay, ${}^{200}_{90}X \rightarrow {}^{168}_{80}Y$ number of $\alpha$ and $\beta$ particles emitted are respectively :

(A) 6, 6

(B) 4, 6

(C) 8, 6

(D) 6, 4

34. The probability of finding the neutron and proton within the range of nuclear force in a deuteron is :

(A) 70%
(B) 60%
(C) 40%
(D) 30%

35. Which of the following elementary particle processes doesn't conserve strangeness?

(A) $\pi^0 + p \rightarrow \Lambda^0 + K^+$
(B) $\pi^- + p \rightarrow \Lambda^0 + K^0$
(C) $\Delta^0 \rightarrow \pi^0 + n$
(D) $K^0 \rightarrow \pi^+ + \pi^-$

36. The dead time of a GM counter is 300 μs. If the counting rate is 1000 per minute, find the true counting rate.

(A) 1006.7/min
(B) 1005/min
(C) 905/min
(D) 1205/min

37. The binding energies of nuclei $A$ and $B$ are $E_a$ and $E_b$ respectively. If three nuclei of $B$ fuse to give one nucleus of $A$, and this fusion process is accompanied by the release of energy $E$, then $E_a$ and $E_b$ are related to each other as :

(A) $E_a + E = 3E_b$
(B) $E_a = 3E_b$
(C) $E_a - E = 3E_b$
(D) $E_a + 3E_b + E = 0$

38. The unit vector normal to the surface $x^2 + y^2 - z = 1$ at the point $P(1, 1, 1)$ is :

(A) $\frac{i+j-k}{\sqrt{3}}$
(B) $\frac{2i+j-k}{\sqrt{6}}$
(C) $\frac{i+2j-k}{\sqrt{6}}$
(D) $\frac{2i+2j-k}{3}$

39. The solution of the differential equation $\frac{d^2y}{dx^2} - y = 0$; subject to the boundary conditions $y(0) = 1$ and $y(\infty) = 0$, is :

(A) $\cos t + \sin t$
(B) $\cosh t + \sinh t$
(C) $\cos t - \sin t$
(D) $\cosh t - \sinh t$

40. The relation between the shift operator E and the difference operator $\Delta$ is :

(A) $\Delta = E + 1$ (B) $\Delta = E - 1$

(C) $\Delta = -E + 1$ (D) $1 + \Delta = -E$

41. In how many ways can 7 people be seated at a round table?

(A) 720 (B) 480

(C) 120 (D) 128

42. The phase of the complex number $(1 + i)i$ in the polar representation is :

(A) $\pi/4$ (B) $\pi/2$

(C) $3\pi/4$ (D) $5\pi/4$

43. The magnitude of the resultant of two vectors of magnitude 3 and 4 units is 1 unit. The magnitude of their cross product is :

(A) 5 (B) 1

(C) 12 (D) zero

44. A rocket is set for vertical firing. Its exhaust velocity is 750 m/s, and fuel is consumed at the rate of 2 kg/s. The initial acceleration of the rocket (in the upward direction) is :

(A) 12 $m/s^2$ (B) 5 $m/s^2$

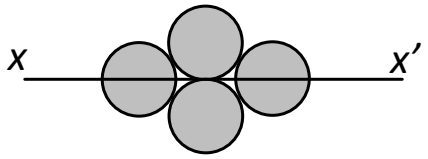
(C) 3 $m/s^2$ (D) 10 $m/s^2$

45. In the inertial coefficient of a rigid body are the components of symmetric tensor of rank :

(A) One (B) Two

(C) Three (D) Four

46. The moment of inertia of a solid sphere about its diameter is *I*. The moment of inertia about the axis *XX'* will be (shown figure all sphere to be identical) :




(A) $4I$ (B) $6I$

(C) $9I$ (D) $14I$

47. A central force $F = -k\frac{\dot{r}}{r^3}$ acts on a particle of mass $m$. If the total energy of the particle is $E$, then its speed $v$ is given by :

(A) $\sqrt{\left(\frac{k}{mr^2} - \frac{E}{m}\right)}$ (B) $\sqrt{\left(\frac{k}{mr^2} - \frac{2E}{m}\right)}$

(C) $\sqrt{\left(\frac{k}{2mr^2} + \frac{2E}{m}\right)}$ (D) $\sqrt{\left(\frac{k}{mr^2} + \frac{2E}{m}\right)}$

48. If the eccentricity of a planet's orbit is $e$, then the ratio of the maximum speed to the minimum speed of the planet in its orbit is :

(A) $\frac{1-e}{1+e}$ (B) $\frac{1+e}{1-e}$

(C) $\frac{1-e}{e}$ (D) $\frac{e}{1+e}$

49. The value of $\alpha$ and $\beta$ for which the equations $Q = q^{\alpha} \cos \beta p$, $P = q^{\alpha} \sin \beta p$ represent a canonical transformation are :

(A) $\alpha = 1/2, \beta = 2$ (B) $\alpha = 1, \beta = 1$

(C) $\alpha = 2, \beta = 2$ (D) $\alpha = 2, \beta = 1$

50. In Newton's ring experiment, rings are observed between a spherical surface having the radius of curvature 100 cm and the glass plate. The diameters of the $5^{th}$ and $15^{th}$ bright rings are 0.32 cm and 0.58 cm, respectively. What will be the diameter of $25^{th}$ ring?

(A) 0.80 cm (B) 0.70 cm

(C) 0.75 cm (D) 0.65 cm

## ROUGH WORK