Msc . Physics (481)

Set No. 1 | 15P/218/2 | Question Booklet No....................391

INSTRUCTIONS TO CANDIDATES

(Use only **blue/black ball-point pen** in the space above and on both sides of the Answer Sheet)

1. Within 10 minutes of the issue of the Question Booklet, check the Question Booklet to ensure that it contains all the pages in correct sequence and that no page/question is missing. In case of faulty Question Booklet bring it to the notice of the Superintendent/Invigilators immediately to obtain a fresh Question Booklet.

2. Do not bring any loose paper, written or blank, inside the Examination Hall *except the Admit Card without its envelope.*

3. A separate Answer Sheet is given. *It should not be folded or mutilated. A second Answer Sheet shall not be provided. Only the Answer Sheet will be evaluated.*

4. Write your *Roll Number and Serial Number of the Answer Sheet* by pen in the space provided above

5. **On the front page of the Answer Sheet, write by pen your Roll Number in the space provide at the top, and by darkening the circles at the bottom. Also, wherever applicable, write th Question Booklet Number and the Set Number in appropriate places.**

6. No overwriting is allowed in the entries of Roll No., Question Booklet No. and Set No. (if any) o OMR sheet and also Roll No. and OMR Sheet No. on the Question Booklet.

7. Any change in the aforesaid entries is to be verified by the invigilator, otherwise it will be taken a unfair means.

8. Each question in this Booklet is followed by four alternative answers. *For each question, you are t record the correct option on the Answer Sheet by darkening the appropriate circle* in the correspondin row of the Answer Sheet, by ball-point pen as mentioned in the guidelines given on the first pag of the Answer Sheet.

9. For each question, darken only one circle on the Answer Sheet. If you darken more than one circl or darken a circle partially, the answer will be treated as incorrect.

10. *Note that the answer once filled in ink cannot be changed. If you do not wish to attempt* a question leave all the circles in the corresponding row blank (such question will be awarded zero mark).

11. For rough work, use the inner back page of the title cover and the blank page at the end of thi Booklet.

12. Deposit *only the OMR Answer Sheet* at the end of the Test.

13. You are not permitted to leave the Examination Hall until the end of the Test.

14. If a candidate attempts to use any form of unfair means, he/she shall be liable to such punishment as the University may determine and impose on him/her.

[उपर्युक्त निर्देश हिन्दी में अन्तिम आवरण-पृष्ठ पर दिये गए हैं]   [No. of Printed Pages : 32+2

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No. of Questions/प्रश्नों की संख्या : 150

Time/समय : 2½ Hours/घण्टे   **Full Marks/पूर्णांक :** 450

Note :   (1) Attempt as many questions as you can. Each question carries **3** marks. **One** mark will be deducted for each incorrect answer. Zero mark will be awarded for each unattempted question.

अधिकाधिक प्रश्नों को हल करने का प्रयत्न करें। प्रत्येक प्रश्न **3** अंक का है। प्रत्येक गलत उत्तर के लिए **एक** अंक काटा जाएगा। प्रत्येक अनुत्तरित प्रश्न का प्राप्तांक शून्य होगा।

(2) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.

यदि एकाधिक वैकल्पिक उत्तर सही उत्तर के निकट प्रतीत हों, तो निकटतम सही उत्तर दें।

1. If the probability in a total number of N steps making n_1 steps to the right and n_2 steps to the let is described by a binomial distribution, the mean number $\langle n_1 \rangle$ is proportional to

(1) N (2) N^{-1}

(3) $N^{1/2}$ (4) None of these

2. The specific internal energy of an ideal gas is dependent on its

   (1) volume only   (2) temperature only

   (3) pressure only   (4) None of these

3. Which of the following best describes the relation between isothermal compressibility (κ_T) and adiabatic compressibility (κ_S) is

   (1) $\kappa_T > \kappa_S$ (2) $\kappa_S \leq \kappa_T$ (3) $\kappa_T < \kappa_S$ (4) $\kappa_T \leq \kappa_S$

4. $\left(\dfrac{\partial P}{\partial T}\right)_V$ can be given in terms of volume expansivity (β) and isothermal compressibility (κ_T) as

   (1) $\dfrac{\beta}{\kappa_T}$ (2) $\dfrac{-\beta}{\kappa_T}$ (3) $\dfrac{\kappa_T}{\beta}$ (4) $\dfrac{-\kappa_T}{\beta}$

5. In a throttling expansion of a real gas through a porus plug, the following quantity is the same in the initial and the final states of the gas

   (1) Temperature   (2) Pressure   (3) Entropy   (4) Enthalpy

6. One kilogram of water at 273 K is brought into contact with a heat reservoir at 373 K. When the temperature of water becomes 373 K, the change in the entropy (in SI units) of the Universe is (for water $C_p = 4200 \ \mathrm{J kg^{-1} K^{-1}}$)

   (1) 1310   (2) 185   (3) 0   (4) 1210

7. The change in entropy (in SI units) in an adiabatic free expansion of one mole of an ideal gas, to double its initial volume is

   (1) 5·762   (2) 0   (3) 8·314   (4) 1·38

8. Entropy has the same unit as

(1) heat capacity

(2) enthalpy

(3) temperature

(4) internal energy

9. The Clausius mathematical statement of the second law of thermodynamics, for an irreversible process is

(1) $\oint \frac{\delta Q}{T} \leq 0$

(2) $\oint \frac{\delta Q}{T} > 0$

(3) $\oint \frac{\delta Q}{T} < 0$

(4) $\oint \frac{\delta Q}{T} = 0$

10. In a gas at room temperature, the ratio of the root mean square velocity and the speed of sound in the gas is $\left(\text{for } \gamma = \frac{C_P}{C_V}\right)$

(1) $\sqrt{\frac{3}{\gamma}}$

(2) $\sqrt{\frac{\gamma}{3}}$

(3) $\sqrt{3\gamma}$

(4) None of these

11. The phase velocity v_p and group velocity v_g of an EM wave through a dispersive medium are given by

(1) $v_g = v_p + \lambda \, d v_p / d\lambda$

(2) $v_g = v_p - \lambda \, d v_p / d\lambda$

(3) $v_g = v_p - d v_p / d\lambda$

(4) $v_g = v_p - d^2 v_p / d\lambda^2$

12. curl $E = -\delta B/\delta t$ is representing

(1) Ampere's law

(2) Gauss's law

(3) Ohm's law

(4) Faraday's law

13. The pointing vector S of an electromagnetic wave is

(1) $S = E \times H$ (2) $S = E \times B$ (3) $S = E/B$ (4) $S = E/H$

14. The ratio of electric field vectors E and magnetic field vector H (i.e., E/H) has the dimensions of

(1) resistance

(2) inductance

(3) capacitance

(4) product of inductance and capacitance

15. Which one of the following Maxwell's equations implies the absence of magnetic monopole?

(1) div $D = \rho$ (2) div $B = 0$

(3) curl $E = -\delta B/\delta t$ (4) curl $H = J + \delta D/\delta t$

16. The displacement vector D and electric field strength E are related by

(1) $D = E/\varepsilon$ (2) $D = \varepsilon E$ (3) $D = \varepsilon E^2$ (4) $D = \varepsilon E^{1/2}$

17. The dimension of $E \times H$ is

(1) energy/area × time   (2) energy/time

(3) energy/area   (4) energy/length × time

18. Propagation of EM wave in a medium the dependence of phase velocity with frequency is called

(1) reflection   (2) refraction   (3) polarization   (4) dispersion

19. For a good conductor, the skin depth varies

    (1) inversely as frequency ω

    (2) directly as ω

    (3) inversely as $\sqrt{\omega}$

    (4) directly as $\sqrt{\omega}$

20. The relative dielectric constant ε_r of water is 80. This does not justify its refractive index $n = 1\cdot 33$ violating the expression $n^2 = \varepsilon_r$. This is because

    (1) the water molecule has no permanent dipole moment

    (2) the boiling point of water is 100 °C

    (3) the two quantities are measured by different experiments

    (4) water is transparent to visible light

21. An a.c. voltage is applied to a parallel plate capacitor. The ratio of displacement current and conduction current through the capacitor in the external circuit is

    (1) larger than 1

    (2) less than 1

    (3) equal to 1

    (4) None of the above

22. A plane EM wave travelled in a vacuum with a velocity is given by

    (1) $c = \sqrt{\varepsilon_0/\mu_0}$ (2) $c = 1/\sqrt{\varepsilon_0\mu_0}$ (3) $c = \sqrt{\mu_0/\varepsilon_0}$ (4) $c = \sqrt{\varepsilon_0\mu_0}$

23. What is the main parameter for determining whether a medium is free space, lossless dielectric, lossy dielectric or good conductor

    (1) attenuation constant

    (2) consecutive parameter $(\sigma, \varepsilon, \mu)$

    (3) loss tangent

    (4) reflection coefficient

(336)   5   (P.T.O.)

24. For a material medium characterized by conductivity σ and permittivity ε exposed to sinusoidally varying field E of frequency ω. The ratio of conduction current density to displacement current density is

    (1) $\sigma/E\varepsilon$ (2) $\sigma/\omega\varepsilon$ (3) $\varepsilon/(\omega\sigma)$ (4) $E\varepsilon/\omega$

25. For Cu $\sigma = 10^{-2}$ S/m and $\varepsilon = 3\varepsilon_0$. The conduction current and displacement current will be equal at the frequency

    (1) 160 Hz   (2) 60 kHz   (3) 60 MHz   (4) 160 MHz

26. For sinusoidally varying electric field the conduction current and the displacement current differ in phase by

    (1) 180 degrees   (2) 0 degree   (3) 90 degrees   (4) 45 degrees

27. In a dielectric material having $\varepsilon_r = 12$ the displacement current is 25 times greater than the conduction current at 100 MHz. The conductivity of the dielectric is

    (1) 0·00267 S/m   (2) 0·0267 S/m

    (3) 2·67 S/m   (4) 0·267 S/m

28. For a plane e.m. wave propagation in a non-conducting, non-magnetic medium, the square of index of refraction is given as

    (1) $1/(\varepsilon_r \mu_r)^{1/2}$ (2) $(\mu_r)^{1/2}$ (3) $(\varepsilon_r)^{1/2}$ (4) $1/(\varepsilon_r)^{1/2}$

29. A plane e.m. wave is travelling in an lossless dielectric medium having $\mu_r = 2$ $\varepsilon_r = 3$ and has peak value electric field intensity of 6 V/m. The velocity of wave is

    (1) 3×10^8 m/s   (2) $0·37 \times 10^8$ m/s

    (3) $1·73 \times 10^8$ m/s   (4) $1·5 \times 10^8$ m/s

30. A medium has conductivity $\sigma = 10^2$ mho/m $\mu_r = 2$ $\varepsilon_r = 3$. The depth of penetration at 2 MHz is

    (1) 115·7 mm   (2) 11·57 mm   (3) 1·157 mm   (4) 0·1157 mm

31. Bubbled (inputs inverted) OR gate is equivalent to

    (1) NOR gate   (2) NAND gate   (3) NOT gate   (4) XNOR gate

32. The minimum number of two input NAND gates required to realize the function of 3 input OR gate is

    (1) 4   (2) 5   (3) 6   (4) 3

33. Which one of the following is not the Boolean expression for XOR gate?

    (1) $A\bar{B} + \bar{A} \cdot B$

    (2) $(\bar{A} + \bar{B}) \cdot (A + B)$

    (3) $(\bar{A} + B) \cdot (A + \bar{B})$

    (4) $(A + B) \cdot (\overline{A \cdot B})$

34. The simplified Boolean expression for the given Boolean expression $AB + (A + B) \cdot (B + C)$ is

    (1) $B + AC$ (2) $C + AB$ (3) $A + BC$ (4) $AB + AC$

35. The Boolean expression $AB\bar{C} + BC\bar{A} + CA\bar{B} + ABC$ is equivalent to the simplified Boolean expression in POS form

    (1) $(A + B) \cdot (B + C) \cdot (C + A)$

    (2) $(A + \bar{B}) \cdot (B + \bar{C}) \cdot (C + \bar{A})$

    (3) $(\bar{A} + \bar{B}) \cdot (\bar{B} + \bar{C}) \cdot (\bar{C} + \bar{A})$

    (4) $(\bar{A} + B) \cdot (\bar{B} + C) \cdot (\bar{C} + A)$

36. Indicate the false statement about doped semiconductors

(1) The product of majority and minority carriers is independent of doping concentration

(2) On heating these semiconductors, their conductivity always increases

(3) On heating these semiconductors, their conductivity initially increases but after reaching a maximum value it begins to decrease with increase of temperature

(4) The product of majority and minority carriers increases with increase in temperature

37. To obtain P type silicon, it must be doped with

(1) Barium   (2) Antimony   (3) Arsenic   (4) Indium

38. The conductivity of Ge doped with phosphorous with impurity concentration $4.41 \times 10^{14}/cm^3$. (Given that for Ge the intrinsic carrier concentration is $2.5 \times 10^{13}/cm^3$, electron mobility $\mu_e = 3800$ cm²/V-sec and hole mobility $\mu_p = 1800$ cm²/V-sec) is

(1) $0.27 \ (\Omega\text{-cm})^{-1}$

(2) $0.03 \ (\Omega\text{-cm})^{-1}$

(3) $0.05 \ (\Omega\text{-cm})^{-1}$

(4) $0.42 \ (\Omega\text{-cm})^{-1}$

39. The net current density in a p-type semiconductor, when both a potential gradient and concentration gradient exist simultaneously within the semiconductor is given by

(1) $J = -q\mu_p p \left(\dfrac{dV}{dx} \right) + qD_p \dfrac{dp}{dx}$

(2) $J = -q\mu_p p \left(\dfrac{dV}{dx} \right) - qD_p \dfrac{dp}{dx}$

(3) $J = qp\mu_p \dfrac{dV}{dx} - qD_p \dfrac{dp}{dx}$

(4) $J = pq\mu_p \dfrac{dV}{dx} + qD_p \dfrac{dp}{dx}$

(336)

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40. The value of the ideality factor η in the diode equation for current flowing in $P\text{-}N$ junction made from Si is

(1) $\eta = 1$ for all currents

(2) $\eta = 2$ for all currents

(3) $\eta = 1$ for small current but $\eta = 2$ for large current

(4) $\eta = 2$ for small current but $\eta = 1$ for large current

41. On heating the current in reverse biased $p\text{-}n$ junction diode increases because of

(1) increase in its carrier concentration and carrier mobilities both

(2) increase in its carrier concentration only

(3) increase in its carrier mobilities only

(4) decrease in its carrier concentration but increase in its carrier mobilities

42. $P\text{-}N$ junction diode cannot be used as

(1) modulator   (2) demodulator   (3) redefier   (4) amplifier

43. The frequency of second harmonic component in the output of full-wave rectifier (Given AC mains frequency is 50 Hz) is

(1) 50 Hz   (2) 100 Hz   (3) 200 Hz   (4) 25 Hz

44. Indicate the false statement from the following statements for a Zener diode whose breakdown voltage is 4·7 volts

(1) It has been constructed from highly doped materials to decrease the depletion width

(2) Breakdown is due to high velocity of minority carriers causing thermal ionization of impurities in the depletion region

(3) Breakdown is due to high electric field causing field ionization of impurities in depletion region

(4) Tunnelling of minority carriers from one side of the junction to the other side of junction

45. Why does the collector current increases with increasing collector to base reverse bias voltage V_{CB} for constant forward bias emitter base voltage V_{EB} in common base configurations?

(1) It is due to increase in effective base width

(2) It is due to decrease in concentration gradient of minority carriers in base region

(3) It is due to decrease in effective base width and increase in concentration gradient of minority carriers in base region

(4) It is due to increase in effective base width and decrease in concentration gradient of minority carriers in base region

46. For a given Ge transistor, the common base current gain is 0·98 and the reverse saturation current is 50 μA, then the collector current will be

(1) 2·45 mA   (2) 2·40 mA   (3) 2·50 mA   (4) 2·55 mA

47. Indicate the false statement about the common collector transistor amplifier

    (1) Its input impedance is very high

    (2) Its output impedance is very low

    (3) Its voltage gain is slightly less than 1

    (4) Its voltage gain is slightly more than 1

48. On increasing the value of bypass capacitor in RC coupled CE amplifier its

    (1) voltage gain increases but lower cutoff frequency decreases

    (2) voltage gain as well as lower cutoff frequency decreases

    (3) voltage gain as well as lower cutoff frequency increases

    (4) voltage gain decreases but lower cutoff frequency increases

49. A bridge rectifier is preferred over an ordinary full-wave rectifier because

    (1) it uses four diodes

    (2) it uses transformer which has no centre tap

    (3) it has higher rectification efficiency

    (4) it has lower ripple factor

50. In a series L-C-R circuit $R = 100\ \Omega$, $X_L = 300\ \Omega$ and $X_C = 200\ \Omega$ the current lags the applied voltage by an angle

    (1) 45°   (2) 60°   (3) 90°   (4) 0°

51. If $\vec{r}$ is position vector of a point, for what value of n, the vector $r^n \vec{r}$ is solenoidal?

    (1) 3   (2) 2   (3) 1   (4) 4

52. If $\vec{r}$ is position vector of a point, the vector $r^n \vec{r}$ is an irrotational vector for

    (1) $n = 3$ (2) any value of n

    (3) $n = 2$ (4) $n = 1$

53. Divergence of the vector $r^{n-1} \vec{r}$, where $\vec{r}$ is position vector of a point, vanishes for

    (1) $n = 3$ (2) $n = 2$ (3) $n = -2$ (4) $n = -3$

54. If $\vec{r}$ is position vector of a point and r is its magnitude, the value of $\vec{\nabla} \cdot \vec{\nabla}(r^n)$ vanishes for

    (1) $n = 3$ (2) $n = -2$

    (3) $n = 0$ only   (4) $n = 0$ and $n = -1$

55. Eigenvalues of

$$\begin{pmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{pmatrix}$$

    are

    (1) $-1, 0, 2$ (2) $0, 1, 2$ (3) $-1, 1, 2$ (4) $-3, 1, 5$

56. The function $e^{\frac{x(t^2-1)}{2t}}$ is a generating function of

(1) Hermite polynomials   (2) Legendre polynomials

(3) Laguerre polynomials   (4) Bessel functions

57. The value of $J_{1/2}(x)$ is

(1) $\sqrt{\dfrac{2}{\pi x}}\cos x$ (2) $\sqrt{\dfrac{2}{\pi x}}\sin x$ (3) $\sqrt{\dfrac{\pi x}{2}}\cos x$ (4) $\sqrt{\dfrac{\pi x}{2}}\sin x$

58. Which of the following is true?

(1) $J_{5/2}(x)=\dfrac{3}{x}J_{3/2}(x)-J_{1/2}(x)$ (2) $J_{5/2}(x)=\dfrac{x}{3}J_{3/2}(x)-J_{1/2}(x)$

(3) $J_{5/2}(x)=\dfrac{3}{x}J_{3/2}(x)+J_{1/2}(x)$ (4) $J_{5/2}(x)=\dfrac{x}{3}J_{3/2}(x)+J_{1/2}(x)$

59. Legendre polynomial $P_n(x)$ for order $n=0$ has, for any value of x, value

(1) 0   (2) ∞ (3) 1   (4) None of these

60. For $P_n(x)$, which of the following is true?

(1) $P_n(x)=\dfrac{1}{2^n n!}\dfrac{d^n}{dx^n}(x^2+1)^n$ (2) $P_n(x)=\dfrac{1}{2^n n!}\dfrac{d^n}{dx^n}(1-x^2)^n$

(3) $P_n(x)=\dfrac{1}{2^n n!}\dfrac{d^n}{dx^n}(x^2-1)^n$ (4) $P_n(x)=\dfrac{1}{2^n n!}\dfrac{d^n}{dx^n}(x-1)^n$

61. The de Broglie wavelength associated with a photon of wavelength 6580 Å would be

    (1) 6000 Å   (2) 7000 Å   (3) 4580 Å   (4) 6580 Å

62. An atom absorbs and emits orange light whose frequency is $5 \cdot 00 \times 10^{14}$ Hz. The energy quantum of this light is

    (1) 2·08 keV   (2) 2·08 eV   (3) 2·08 MeV   (4) $2 \cdot 08 \times 10^2$ eV

63. A wave function has the form $\psi_1 = Ae^{-\alpha x}$ for $x > 0$ for the positive value of α. However, it has the form $\psi_2 = e^{+\alpha x}$ for $x < 0$. The normalized form of this function is

    (1) $\psi_1(x) = \sqrt{\alpha}\, e^{\alpha x}$ for $x > 0$
        $\psi_2(x) = \sqrt{\alpha}\, e^{-\alpha x}$ for $x < 0$

    (2) $\psi_1(x) = \sqrt{\alpha}\, e^{+\alpha x}$ for $x < 0$
        $\psi_2(x) = \sqrt{\alpha}\, e^{-\alpha x}$ for $x > 0$

    (3) $\psi_1(x) = \dfrac{1}{\sqrt{\alpha}}\, e^{\alpha x}$ for $x > 0$
        $\psi_2(x) = \dfrac{1}{\sqrt{\alpha}}\, e^{-\alpha x}$ for $x < 0$

    (4) $\psi_1(x) = \dfrac{1}{\sqrt{\alpha}}\, e^{-\alpha x}$ for $x > 0$
        $\psi_2(x) = \dfrac{1}{\sqrt{\alpha}}\, e^{+\alpha x}$ for $x < 0$

64. For a linear harmonic oscillator, the potential is $V = \frac{1}{2} m\omega^2 x^2$. Using Schrödinger equation with $\psi(x) = xe^{-m\omega x^2/2\hbar}$ one obtains the energy eigenvalue as

    (1) $E = \frac{5}{2}\hbar\omega$ (2) $E = \frac{3}{2}\hbar\omega$ (3) $E = \frac{1}{2}\hbar\omega$ (4) $E = \hbar\omega$

65. For a rigid rotator with moment of inertia (I) which is fixed in the XY-plane only, the Schrödinger equation would be

(1) $\dfrac{\partial^2 \psi}{\partial \varphi^2} + \dfrac{\partial^2 \psi}{\partial \theta^2} + \dfrac{2IE}{\hbar^2} \psi = 0$

(2) $\dfrac{\partial^2 \psi}{\partial \varphi^2} - \dfrac{\partial^2 \psi}{\partial \theta^2} + \dfrac{2IE}{\hbar^2} \psi = 0$

(3) $\dfrac{\partial^2 \psi}{\partial \varphi^2} + \dfrac{2IE}{\hbar^2} \psi = 0$

(4) $\dfrac{\partial^2 \psi}{\partial \varphi^2} - \dfrac{2IE}{\hbar^2} \psi = 0$

where the symbols carry their standard meanings.

66. For a rigid rotor fixed in the XY-plane, the energy eigenvalues change as

(1) $E_m = \dfrac{3}{2} \dfrac{\hbar^2}{2I} m^2, \quad m = 0, \pm 1, \pm 2, \cdots$

(2) $E_m = \dfrac{2}{3} \dfrac{\hbar^2 m^2}{2I}, \quad m = 0, \pm 1, \pm 2, \cdots$

(3) $E_m = \dfrac{m^2 \hbar^2}{2I}, \quad m = 0, \pm 1, \pm 2, \cdots$

(4) $E_m = \dfrac{\hbar^2}{2I}(1 + m^2), \quad m = 0, \pm 1, \pm 2, \cdots$

67. The ground state of the H-atom corresponds to the following quantum numbers

(1) $n = 0, \ m = 0, \ l = 0$

(2) $n = 1, \ m = 0, \ l = 0$

(3) $n = 2, \ m = 1, \ l = 1$

(4) $n = 1, \ m = 1, \ l = 1$

68. If the Hamiltonian is Hermitian, two degenerate eigenstates

(1) would be orthogonal to each other

(2) would be non-orthogonal to each other

(3) may not be orthogonal

(4) may not be non-orthogonal

69. The smallest possible uncertainty in the position of an electron moving with velocity 3×10^7 m/sec is given by

    (1) 0·048 Å   (2) 0·058 Å   (3) 0·038 Å   (4) 0·068 Å

70. An anti-Hermitian operator corresponds to the eigenvalue that is

    (1) complex   (2) real   (3) imaginary   (4) zero

71. Two photons A and B are moving in the opposite direction. The relative velocity of A w.r.t. B would be

    (1) $2c$ (2) 0   (3) c (4) $\frac{2}{3}c$

72. The inertial reference frame is used in the description of special theory of relativity. An example of an inertial reference frame is

    (1) rotating frame with a uniform angular velocity w.r.t. a stationary frame

    (2) two frames stationary with respect to each other

    (3) A freely falling frame under uniform gravitation

    (4) two frames having uniform acceleration with respect to each other

73. An electron is moving with a speed of 0·85c in a direction opposite to that of a photon. The relative velocity of the electron w.r.t. the photon is

    (1) 0·85c   (2) 0·65c   (3) 0·75c   (4) c

74. The energy equivalent of the rest mass of an electron is

    (1) 1·12 MeV   (2) 0·51 MeV   (3) 0·91 MeV   (4) 0·85 MeV

75. The Lorentz invariant length between two space-time points (x, y, z, ct) and (x', y', z', ct') is as follows

(1) $(x' - x)^2 + (y' - y)^2 + (z' - z)^2 - c^2(t' - t)^2$

(2) $(x' - x)^2 + (y' - y)^2 - (z' - z)^2 + c^2(t' - t)^2$

(3) $(x' - x)^2 - (y' - y)^2 + (z' - z)^2 + c^2(t' - t)^2$

(4) $(x' - x)^2 + (y' - y)^2 + (z' - z)^2 + c^2(t' - t)^2$

76. Total energy of a relativistic particle, (which is the sum of kinetic energy and rest mass energy) is

(1) $m_0 c^2$

(2) $\dfrac{m_0 c^2}{\sqrt{1 - \dfrac{v^2}{c^2}}}$

(3) $m_0 c^2 \sqrt{1 - \dfrac{v^2}{c^2}}$

(4) $\dfrac{m_0 v^2}{\sqrt{1 - \dfrac{v^2}{c^2}}}$

where m_0 is the rest mass if the particle moving with velocity v and c is the speed of light.

77. In the laboratory frame of reference, a particle moving with speed $2 \cdot 8 \times 10^{10}$ cm/sec, has the life-time $2 \cdot 5 \times 10^{-7}$ sec. The proper life-time of the particle is

(1) $\approx 5 \times 10^{-10}$ sec

(2) $\approx 6 \times 10^{-11}$ sec

(3) $\approx 7 \times 10^{-8}$ sec

(4) $\approx 7 \times 10^{12}$ sec

78. The proper length of a rod is 100 cm. If the rod starts moving with speed $0.8c$, its length would be

(1) 110 cm   (2) 90 cm   (3) 60 cm   (4) 120 cm

79. A monochromatic light beam falls on a glass surface at Brewster's angle, then

(1) the refracted beam is partially polarized

(2) the refracted beam is completely polarized

(3) the reflected ray is partially polarized

(4) reflected and refracted rays both are completely polarized

80. A 0.25 mm thick crystal plate cut parallel to optic axis serves as a quarter wave plate for refractive index difference $n_e - n_0 = 0.009$, constant for all wavelengths. The number of wavelengths for which the plate behaves as a quarter wave plate in the visible region is

(1) 6   (2) 3   (3) 2   (4) 1

81. On applying electric field to certain materials, their refractive index changes. If change in refractive index Δn is proportional to the electric field E, the effect is called

(1) Faraday effect

(2) Pockels effect

(3) Kerr effect

(4) birefringence

82. Kerr effect is the change in refractive index Δn on application of electric field $\vec{E}$. The change Δn is given by

(1) $\Delta n \propto E^2$ (2) $\Delta n \propto E^3$ (3) $\Delta n \propto E$ (4) $\Delta n \propto E^{1/2}$

83. An optically inactive crystal becomes optically active under the application of magnetic field. The effect is known as

(1) Kerr effect

(2) Faraday effect

(3) Pockels effect

(4) birefringence

84. Which of the molecules given below will show optical activity?

(1) Methane

(2) Chloroform

(3) Carbon tetrachloride

(4) Chloro-bromo methanol

85. An optically active material

(1) rotates the direction of the light beam passing through it

(2) rotates the direction of polarization of the plane polarized beam passing through it

(3) splits the unpolarized beam passing through it into two linearly polarized beams with directions of polarization perpendicular to each other

(4) splits the unpolarized beam passing through it into two unpolarized light beams of equal intensity

86. Typical white light has range 4000–7000 Å. The coherence length for such a light beam is of the order of

(1) 100 Å (2) 100 mm (3) 100 cm (4) 100 m

87. He-Ne Laser emits light of wavelength 6328 Å with spectral width $\Delta\lambda = 10^{-7}$ Å. Its coherence time and coherence length are

(1) 133 µs and 40 m

(2) 133 µs and 40 km

(3) 133 ms and 40 m

(4) 133 ms and 40 km

88. A perfectly monochromatic light wave

    (1) cannot be observed

    (2) can be observed with special device

    (3) has finite coherence length

    (4) has finite coherence time

89. Anti-reflection coating is based on the principle of

    (1) polarization   (2) diffraction

    (3) interference   (4) total internal reflection

90. Resolving power of Fabry-Perot interferometer depends on

    (1) plate separation only

    (2) reflectivity of plates only

    (3) wavelength of light only

    (4) plate separation, reflectivity of plates and wavelength of light

91. The gyromagnetic ratio for electron spin is r times the corresponding ratio for the electron orbital motion, where r is

    (1) $\frac{1}{2}$ (2) $\frac{1}{3}$ (3) 2   (4) 3

92. Ground state of K is

    (1) $^1S_0$ (2) $^3S_0$ (3) $^1P_1$ (4) $^2S_{1/2}$

93. According to spin-relativity quantum-mechanical theory, the number of components of H_α line of H-atom is

    (1) 3   (2) 2   (3) 3   (4) 5

94. When S level is lower level out of the transitions $^2P_{1/2} \to {}^2S_{1/2}$ and $^2P_{3/2} \to {}^2S_{1/2}$

    (1) former is always weaker

    (2) latter is always weaker

    (3) both are equally strong

    (4) former is forbidden while latter is allowed

95. Spin-orbit interaction in one valence electron atom causes each energy level of a given l to split into

    (1) $2l+1$ components   (2) 2 components

    (3) $2j+1$ components   (4) 3 components

96. The fine structure levels $^3D_1$, $^3D_2$, $^3D_3$ have separations $^3D_1 - {}^3D_2$ and $^3D_2 - {}^3D_3$ in the ratio

    (1) 1:2   (2) 1:3   (3) 2:3   (4) 1:1

97. The total number of terms arising due to one $4p$ and one $4d$ electrons i.e., outer configuration of an atom as $4p\,4d$ is

    (1) 6   (2) 12   (3) 9   (4) 3

98. The sodium lines 5890 Å and 5896 Å originate due to transitions, respectively

    (1) $^2P_{3/2} \to {}^2S_{1/2}$ and $^2P_{1/2} \to {}^2S_{1/2}$

    (2) $^2P_{1/2} \to {}^2S_{1/2}$ and $^2P_{3/2} \to {}^2S_{1/2}$

    (3) $^2S_{1/2} \to {}^2P_{3/2}$ and $^2S_{1/2} \to {}^2P_{1/2}$

    (4) $^2S_{1/2} \to {}^2P_{1/2}$ and $^2S_{1/2} \to {}^2P_{3/2}$

99. The number of components due to transition $^1D_2 \to {}^1P_1$ on account of Zeeman splitting is

    (1) 9   (2) 3   (3) 2   (4) 6

100. A Laser beam is passed through a strong magnetic field. One observes

    (1) Zeeman splitting   (2) Paschen-Back splitting

    (3) Stark splitting   (4) No splitting

101. Principal series arises due to transitions

    (1) $nf \to 3d$, $n > 3$ (2) $nd \to 3p$, $n > 2$

    (3) $ns \to 3p$, $n > 3$ (4) $np \to 3s$, $n > 2$

102. Which of the following is true?

    (1) Principal series appears in emission and absorption both

    (2) Sharp series appears in emission and absorption both

    (3) Diffuse series appears in emission and absorption both

    (4) Fundamental series appears in emission and absorption both

103. A metal surface has work function equivalence to energy of wavelength of light 4500 Å. When a beam of light with λ 4000 Å falls on it

(1) photoelectrons will not be emitted

(2) photoelectrons will be emitted with certain speeds

(3) photoelectrons will be emitted with zero speeds

(4) photoelectrons may or may not be emitted

104. Due to Compton scattering, the change in wavelength is

(1) dependent on electron charge

(2) dependent on electron mass and charge

(3) dependent on electron mass and scattering angle both

(4) dependent on scattering angle only

105. Which of the following is true?

(1) Dirac's theory explains fine structure of H-atom Balmer series lines

(2) The $2\,{}^2S_{1/2}$ level and $2\,{}^2P_{1/2}$ levels of H-atom have different energies due to Dirac

(3) $2\,{}^2S_{1/2}$ level of H-atom is a metastable level

(4) $2\,{}^2P_{1/2}$ level of H-atom is a metastable level

106. What is the shortest wavelength emitted by an X-ray tube if 40 kilovolts is applied across it?

(1) ·0496   (2) ·0310   (3) ·0248   (4) ·0155

107. X-ray spectrum of a cobalt larget ($Z = 27$) contains strong k_α line of wavelength 0.1785 nm and a weak line having wavelength of 0.1537 nm due to impurities. The atomic number of impurity element is

    (1) 29   (2) 24   (3) 23   (4) 30

108. For a simple cubic lattice, the ratio of $d_{100} : d_{110} : d_{111}$ is

    (1) $\sqrt{2} : \sqrt{3} : \sqrt{6}$ (2) $\sqrt{6} : \sqrt{3} : \sqrt{2}$ (3) $\sqrt{2} : \sqrt{6} : \sqrt{3}$ (4) $\sqrt{3} : \sqrt{2} : \sqrt{6}$

109. Given that the cube edge of diamond is 0.356 nm. The number of atoms per metre cube is

    (1) 0.88×10^{29} (2) 5.31×10^{29} (3) 2.77×10^{29} (4) 1.77×10^{29}

110. Sodium chloride has the following crystal structure

    (1) hexagonal   (2) face-centred cubic

    (3) simple cubic   (4) body-centred cubic

111. The spacing d_{hkl} of the planes (hkl) in a hexagonal crystal is

    (1) $\left[\dfrac{4}{3}\left(\dfrac{h^2 + hk + k^2}{a^2} \right) + \dfrac{l^2}{c^2} \right]^{-1/2}$ (2) $a\left[h^2 + k^2 + l^2 \right]^{-1/2}$

    (3) $\left[\dfrac{h^2}{a^2} + \dfrac{k^2}{b^2} + \dfrac{l^2}{c^2} \right]^{-1/2}$ (4) $\left[\dfrac{h^2 + k^2}{a^2} + \dfrac{l^2}{c^2} \right]^{-1/2}$

112. A crystal system whose unit cell is specified by $a = b \neq c$, $\alpha = \beta = \gamma = 90$ is known as

    (1) simple cubic   (2) hexagonal   (3) monoclinic   (4) tetragonal

113. In the periodic potential model, discontinuities in E versus k curve occur for

(1) $k = \dfrac{n\pi}{a}$ (2) $k = \dfrac{8n\pi}{a}$ (3) $k = \dfrac{n^2\pi}{a}$ (4) $k = \dfrac{n\pi}{4a}$

114. Which of the following statements is true about the velocity of electron in an energy band?

  (1) It is constant throughout the band

  (2) It is maximum at the bottom of the band

  (3) It is maximum at the inflection point of the $E(k)$ curve

  (4) It is maximum at the top of the band

115. The Miller indices of a set of parallel planes which makes intercepts in the ratio of $1:\frac{1}{2}:\frac{1}{4}$ is given by

(1) (421)   (2) (124)   (3) (122)   (4) (142)

116. The angle of diffracted X-rays is 90° from the incident direction of X-rays. The interplaner separation of the planes responsible for the diffraction is given by

(1) $\dfrac{\lambda}{\sqrt{2}}$ (2) $\dfrac{\lambda}{2}$ (3) $\sqrt{2}\,\lambda$ (4) $\dfrac{\sqrt{3}}{2}\lambda$

117. Which of the statements about the spectrum of continuous X-rays is false?

  (1) There is no long wavelength cutoff limit

  (2) Continuous X-rays are produced due to deceleration of electrons

  (3) The maximum intensity of continuous X-rays depends upon potential difference across the X-ray tube

  (4) Short wavelength limit of X-rays depends upon the nature of filament

118. The de Broglie wavelength λ, mass m and charge e of an electron are related to the accelerating potential V by

(1) $V = \dfrac{\lambda^2}{2meh^2}$ (2) $V = \dfrac{h}{2me\lambda^2}$ (3) $V = \dfrac{h^2}{2me\lambda^2}$ (4) $V = \dfrac{h^2\lambda^2}{2me}$

119. The number of ions in the unit cell of NaCl crystal is

(1) 1   (2) 2   (3) 4   (4) 8

120. According to the Wiedemann-Franz law, the ratio of thermal to electrical conductivity of any metal is given by

(1) $\left(\dfrac{\pi kT}{2e}\right)^2$ (2) $\dfrac{\pi^2}{3}\left(\dfrac{k}{e}\right)^2 T$ (3) $\dfrac{\pi^2}{3}\left(\dfrac{kT}{e}\right)^2$ (4) $\left(\dfrac{\pi k}{e}\right)^2 T$

121. The number of lattice points in a BCC unit cell is

(1) 1   (2) 2   (3) 3   (4) 4

122. The lattice specific heat at constant volume C_V of a solid at lower temperatures depends on temperature T as

(1) $C_V \propto T$ (2) $C_V \propto T^3$ (3) $C_V \propto T^2$ (4) $C_V \propto \dfrac{1}{T}$

123. The reciprocal lattice of an FCC crystal is

(1) orthorhombic   (2) simple cubic

(3) hexagonal   (4) BCC

(336)   26

124. Because of which property of the crystals X-rays can be diffracted from the crystals

   (1) colour of the crystals

   (2) sharp edges of the crystals

   (3) periodic array of atoms

   (4) random arrangement of atoms

125. Indicate the false statement about the semiconductors

   (1) All intrinsic semiconductors are insulators at $T = 0$ °K

   (2) At very high temperatures all semiconductors become intrinsic semiconductors

   (3) The conductivity of all semiconductors always increases with temperature

   (4) N-type semiconductors are obtained by doping phosphorus into silicon

126. The density of carriers in a pure semiconductor is proportional to

   (1) $\exp\left[-\dfrac{E_g}{kT}\right]$ (2) $\exp\left[-\dfrac{2E_g}{kT}\right]$ (3) $\exp\left[-\dfrac{E_g}{kT^2}\right]$ (4) $\exp\left[-\dfrac{E_g}{2kT}\right]$

127. The reverse saturation current in germanium p-n diode is of the order of

   (1) nA   (2) μA   (3) mA   (4) ampere

128. The Fermi level in an n-type semiconductor at 0 °K

   (1) lies below the donor level

   (2) lies in the conduction band

   (3) lies half-way between the conduction band and donor level

   (4) coincides with the intrinsic Fermi level

129. If the Fermi energy of a metal at 0 °K, 10 eV, the mean energy of the electrons in the metal at 0 °K is

    (1) 6 eV   -   (2) 5 eV   (3) 1·5 eV   (4) 2 eV

130. X-rays can be deflected by

    (1) magnetic field only

    (2) electric field only

    (3) simultaneously applying electric and magnetic field

    (4) Neither by electric nor magnetic field

131. A nuclear reaction is exoergic if the Q-value of the reaction process is

    (1) negative

    (2) zero

    (3) positive

    (4) positive as well as negative depending on the nature of reacting nuclei

132. Nuclear fusion reaction is the one where light nuclei combine to form a heavy nucleus. The mass number of the light nuclei should have the limits

    (1) $A \geq 10$ (2) $A \geq 15$ (3) $A \leq 8$ (4) $A \geq 8$

133. For carbon dating, the isotope of the carbon that is used is

    (1) carbon-12   (2) carbon-13   (3) carbon-14   (4) carbon-15

134. The Q-value of an endoergic nuclear reaction process is

   (1) positive

   (2) negative

   (3) zero

   (4) zero as well as positive depending the nature of participating nuclei

135. Nuclear fission can be explained by one of the following models of nucleus

   (1) shell model

   (2) deformed-shell model

   (3) liquid-drop model

   (4) rotating model (rotor)

136. Binding energy curve of nuclei with respect to their mass number can be explained by

   (1) shell model of nucleus

   (2) rotating model of nucleus

   (3) deformed rotating model

   (4) liquid-drop model

137. Nucleus is approximately 10^5 times smaller than the size of an atom because of

   (1) universal electromagnetic interaction

   (2) short-range nuclear interaction

   (3) quantum effects of gravity

   (4) van der Waals interaction

(336)

(P.T.O.)

138. The helium isotope $_2^6He$ is unstable. The possible decay mode of it is

    (1) positive β-decay

    (2) negative β-decay

    (3) γ-decay

    (4) α-decay

139. The unit of activity in the process of radioactive decay is Becquerel (Bq). One unit of Bq is

    (1) 10 decays/sec

    (2) 5 decays/sec

    (3) 100 decays/sec

    (4) 1 decay/1 sec

140. In the nuclear reactors, the process that is controlled is

    (1) nuclear fusion reaction

    (2) nuclear fission

    (3) natural radioactive decay

    (4) artificial nuclear transmutation

141. α-decay of radioactive nuclei can be explained by exploiting the concepts of

    (1) classical theory of particles

    (2) electromagnetic theory

    (3) quantum tunnelling

    (4) weak interactions

142. The range of energy carried by the γ-rays is of the order of

    (1) keV (kilo electron volt)

    (2) MeV (Mega electron volt)

    (3) eV (Electron volt)

    (4) GeV (Giga electron volt)

143. Given that ^{113}Cd has density $n = 5.58 \times 10^{27}$ atoms/m^3 and its capture cross-section $\sigma = 2 \times 10^{-24}$ m^2 for thermal neutrons, the mean-free path of these neutrons in ^{113}Cd is

(1) 8.93×10^{-7} m

(2) 8.93×10^{-5} m

(3) 8.93×10^{-9} m

(4) 8.93×10^{-10} m

144. In an atomic bomb, the energy released cannot be controlled. The process involved in the making of an atomic bomb is

(1) atomic chain reaction

(2) nuclear chain reaction

(3) thermal chain reaction

(4) chemical chain reaction

145. Existence of magic numbers can be explained by

(1) liquid-drop model of nucleus

(2) shell model of nucleus

(3) rotating model of nucleus

(4) deformed model of nucleus

146. One of the isotopes of hydrogen is radioactive. This isotope is known as

(1) deuterium   (2) tritium   (3) charmonium   (4) positronium

147. The relationship between Bohr magneton and nuclear magneton is

(1) nuclear magneton is always greater than Bohr magneton

(2) Bohr magneton may be equal to the nuclear magneton in specific limit

(3) nuclear magneton is always less than Bohr magneton

(4) nuclear magneton can be less, equal and greater than Bohr magneton depending on the physical situation

(P.T.O.)

(336)

148. For the even-odd or odd-even nuclei, the pairing energy is always

   (1) positive

   (2) negative

   (3) zero

   (4) sometimes negative and sometimes positive

149. The binding energy of the neon isotope $^{20}_{10}$Ne is $160 \cdot 65$ MeV. Thus, its atomic mass, in atomic unit (u), would be

   (1) $19 \cdot 99\,u$ (2) $18 \cdot 99\,u$ (3) $17 \cdot 99\,u$ (4) $16 \cdot 99\,u$

150. Nuclear Magnetic Resonance (NMR) is used to determine

   (1) mass of the nucleon

   (2) magnetic moment of the nucleon

   (3) charge of the nucleon

   (4) quadrupole moment of the nucleon

★ ★ ★

अभ्यर्थियों के लिए निर्देश

(इस पुस्तिका के प्रथम आवरण-पृष्ठ पर तथा उत्तर-पत्र के दोनों पृष्ठों पर केवल नीली या काली बाल-प्वाइंट पेन से ही लिखें)

1. प्रश्न पुस्तिका मिलने के 10 मिनट के अन्दर ही देख लें कि प्रश्नपत्र में सभी पृष्ठ मौजूद हैं और कोई प्रश्न छूटा नहीं है। पुस्तिका दोषयुक्त पाये जाने पर इसकी सूचना तत्काल कक्ष-निरीक्षक को देकर सम्पूर्ण प्रश्नपत्र की दूसरी पुस्तिका प्राप्त कर लें।

2. परीक्षा भवन में *लिफाफा रहित प्रवेश-पत्र के अतिरिक्त*, लिखा या सादा कोई भी खुला कागज साथ में न लायें।

3. उत्तर-पत्र अलग से दिया गया है। *इसे न तो मोड़ें और न ही विकृत करें। दूसरा उत्तर-पत्र नहीं दिया जायेगा, केवल उत्तर-पत्र का ही मूल्यांकन किया जायेगा।*

4. अपना *अनुक्रमांक तथा उत्तर-पत्र का क्रमांक प्रथम आवरण-पृष्ठ* पर पेन से निर्धारित स्थान पर लिखें।

5. उत्तर-पत्र के प्रथम पृष्ठ पर पेन से अपना अनुक्रमांक निर्धारित स्थान पर लिखें तथा नीचे दिये वृत्तों को गाढ़ा कर दें। जहाँ-जहाँ आवश्यक हो वहाँ प्रश्न-पुस्तिका का क्रमांक तथा सेट का नम्बर उचित स्थानों पर लिखें।

6. ओ० एम० आर० पत्र पर अनुक्रमांक संख्या, प्रश्न-पुस्तिका संख्या व सेट संख्या (यदि कोई हो) तथा प्रश्न-पुस्तिका पर अनुक्रमांक सं० और ओ० एम० आर० पत्र सं० की प्रविष्टियों में उपरिलेखन की अनुमति नहीं है।

7. उपर्युक्त प्रविष्टियों में कोई भी परिवर्तन कक्ष निरीक्षक द्वारा प्रमाणित होना चाहिये अन्यथा यह एक अनुचित साधन का प्रयोग माना जायेगा।

8. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार वैकल्पिक उत्तर दिये गये हैं। *प्रत्येक प्रश्न के वैकल्पिक उत्तर के लिये आपको उत्तर-पत्र की सम्बन्धित पंक्ति के सामने दिये गये वृत्त को उत्तर-पत्र के प्रथम पृष्ठ पर दिये गये निर्देशों के अनुसार पेन से गाढ़ा करना है।*

9. प्रत्येक प्रश्न के उत्तर के लिये केवल एक ही वृत्त को गाढ़ा करें। एक से अधिक वृत्तों को गाढ़ा करने पर अथवा एक वृत्त को अपूर्ण भरने पर वह उत्तर गलत माना जायेगा।

10. ध्यान दें कि एक बार स्याही द्वारा अंकित उत्तर बदला नहीं जा सकता है। यदि आप किसी प्रश्न का *उत्तर नहीं देना चाहते हैं,* तो सम्बन्धित पंक्ति के सामने दिये गये सभी वृत्तों को खाली छोड़ दें। ऐसे प्रश्नों पर शून्य अंक दिये जायेंगे।

11. रफ़ कार्य के लिये प्रश्न-पुस्तिका के मुखपृष्ठ के अन्दर वाले पृष्ठ तथा अंतिम पृष्ठ का प्रयोग करें।

12. परीक्षा के उपरान्त केवल *ओ०एम०आर० उत्तर-पत्र* परीक्षा भवन में जमा कर दें।

13. परीक्षा समाप्त होने से पहले परीक्षा भवन से बाहर जाने की अनुमति नहीं होगी।

14. यदि कोई अभ्यर्थी परीक्षा में अनुचित साधनों का प्रयोग करता है, तो वह विश्वविद्यालय द्वारा निर्धारित दंड का/की, भागी होगा/होगी।