BOOKLET NO. 022

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

TBC : AP(ASH)PHYSICS-TE-2018

Time Allowed : 2 Hours] [Maximum Marks : 100

INSTRUCTIONS

1. **IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS BOOKLET DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.**
2. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. ***DO NOT*** write **anything** else on the Test Booklet.
3. This Test Booklet contains **100** items (questions). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose **ONLY ONE** response for each item.
4. You have to mark all your responses ONLY on the separate Answer Sheet provided. No erasing/correction fluid is allowed.
5. All items carry equal marks.
6. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
7. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator ***only the Answer Sheet***. You are permitted to take away with you the Test Booklet.
8. Sheets for rough work are appended in the Test Booklet at the end.
9. **Penalty for wrong answers :**
   THERE WILL BE PENALTY (NEGATIVE MARKING) FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBJECTIVE TYPE QUESTION PAPERS.
   (*i*) There are four alternatives for the answers to every question. For each question for which a wrong answer has been given by the candidate, **one-fourth (0.25)** of the marks assigned to that question will be deducted as penalty.
   (*ii*) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answer happen to be correct and there will be same penalty as above for that question.
   (*iii*) If a question is left blank i.e. no answer is given by the candidate, there will be **no penalty** for that question.
10. Use and carrying of Mobile Phone and Electronic Gadget is prohibited in the Examination Hall.

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1. Which of the following results is *not* connected with photoelectric effect ?

(A) The energy distribution of the photoelectrons is independent of the intensity of the incident light.

(B) The maximum kinetic energy of the photoelectrons is found to be independent of the frequency of the incident radiation.

(C) For a given frequency, the number of photoelectrons emitted is directly proportional to the intensity of the incident light.

(D) There seems to be no time lag between the onset of irradiation and the resulting photocurrent.

2. What potential difference must be applied to stop the fastest photoelectrons emitted by a surface when electromagnetic radiation of frequency 1.5×10^{15} Hz is allowed to fall on it ? The work function of the surface is 5.0 eV.

(A) 0.8 eV (B) 1.2 eV

(C) 3.1 eV (D) 5.0 eV

3. Estimate the width of a spectral line, if its life time is of the order of 10^{-8} s.

(A) 10^3 Hz (B) 10^5 Hz

(C) 10^8 Hz (D) 10^{10} Hz

4. The relativistic energy-momentum relation for a photon is :

(A) $E^2 = p^2c^2$ (B) $E^2 = p^2c^2 + m_0^2c^4$

(C) $E = p^2/2m$ (D) $E = p^2/2m + V$

5. Find the potential $V(x)$ for which the wave function :

$$\psi(r) = \left(\frac{x}{x_0}\right)^n e^{-x/x_0};\ n,\ x_0 \text{ are constants}$$

is an eigen function of the Hamiltonian with energy E. (Assume that $V(x) \to 0$ as $x \to \infty$) :

(A) $V(x) = \frac{\hbar^2}{2m}\left[\frac{n(n-1)}{x^2} - \frac{2n}{x_0 x}\right]$ (B) $V(x) = \frac{\hbar^2}{2m}\left[\frac{n(n+1)}{x^2} - \frac{n}{x_0 x}\right]$

(C) $V(x) = \frac{\hbar^2}{2m}\left[\frac{n^2}{x^2} - \frac{2n}{x_0 x}\right]$ (D) $V(x) = \frac{\hbar^2}{2m}\left[\frac{n(n-1)}{x_0 x} - \frac{2n}{x^2}\right]$

6. If ψ_n and ψ_m are the two eigen functions of a Hermitian operator corresponding to different eigen value a_n and a_m, respectively, then :

(A) $(\psi_n, \psi_m) = 1$ (B) $(\psi_n, \psi_m) = 0$

(C) $(\psi_n, \psi_m) = a_n + a_m$ (D) $(\psi_n, \psi_m) = a_n a_m$

7. The minimum energy of a particle of mass m, constrained to move in a box of size a, is :

(A) $\frac{\pi^2}{8ma^2}$ (B) $\frac{\pi^2\hbar^2}{4ma^2}$

(C) $\frac{\pi^2\hbar^2}{8ma^2}$ (D) Zero

8. For Pauli's matrices (σ_x, σ_y and σ_z) :

(A) $\sigma_x\sigma_y\sigma_z = i$ (B) $\sigma_x\sigma_y\sigma_z = 1$

(C) $\sigma_x\sigma_y\sigma_z = 0$ (D) $\sigma_x\sigma_y\sigma_z = \frac{1}{2}\sigma_x$

9. The energy levels of a symmetric top molecule with principal moments of inertia $I_1 = I_2 = I \neq I_3$, are given by (Take, $B = \frac{\hbar^2}{2I}$; $C = \frac{\hbar^2}{2I_3}$) :

(A) $Bl(l + 1)$ (B) $C(l + 1) + Bm^2$

(C) $Bl(l + 1) + (C - B)m^2$ (D) $Bl(l + 1) + Cm^2$

with $l = 0, 1, 2, \ldots \ldots \ldots$; $m = 0, \pm1, \pm2, \ldots \ldots \ldots \ldots$

10. A hydrogen atom in the $2p$ state is placed in a cavity. Find the temperature of the cavity at which the transition probabilities for stimulated and spontaneous emissions are equal :

(A) 7.2×10^{10} K (B) 9.6×10^{8} K

(C) 12.1×10^{6} K (D) 17.1×10^{4} K

11. Consider two non-interacting electrons described by the Hamiltonian :

$$H = \frac{p_1^2}{2m} + \frac{p_2^2}{2m} + V(x_1) + V(x_2),$$

where, $V(x) = 0$ for $0 < x < a$; $V(x) = \infty$ for $x < 0$ and for $x > 0$. If both the electrons are in the same spin state, find the lowest energy of the two electron system.

(A) $\frac{5\pi^2\hbar^2}{2ma^2}$

(B) $\frac{3\pi^2\hbar^2}{ma^2}$

(C) $\frac{\pi^2\hbar^2}{3ma^2}$

(D) $\frac{2\pi^2\hbar^2}{5ma^2}$

12. For scattering by screened Coulomb potential, the differential cross-section behaves as (Take q as the momentum transfer) :

(A) $\sim q^4$

(B) $\sim 1/q^4$

(C) $\sim q$

(D) $\sim 1/q^2$

13. Which of the following symmetry relations for C-coefficients is *correct* ?

(A) $C(j_1 j_2 j_3; m_1 m_2 m_3) = (-1)^{j_1 + j_2 - j_3}\, C(j_2 j_1 j_3; -m_1, -m_2, -m_3)$

(B) $C(j_1 j_2 j_3; m_1 m_2 m_3) = (-1)^{j_1 + j_2 - j_3}\, C(j_1 j_3 j_2; -m_1, -m_2, -m_3)$

(C) $C(j_1 j_2 j_3; m_1 m_2 m_3) = (-1)^{j_1 + j_2 - j_3}\, C(j_2 j_1 j_3; m_2 m_1 m_3)$

(D) $C(j_1 j_2 j_3; m_1 m_2 m_3) = \left(\frac{2j_3 + 1}{2j_2 + 1}\right)^{1/2} C(j_1 j_3 j_2; m_1, -m_2, +m_3)$

14. The rotation operator in terms of Euler angles (α, β, γ) is given by :

(A) $R = e^{-i\alpha J_z} \cdot e^{-i\beta J_y} \cdot e^{-i\gamma J_z}$

(B) $R = e^{i\alpha J_z} \cdot e^{i\beta J_y} \cdot e^{i\gamma J_z}$

(C) $R = e^{i(\alpha + \beta + \gamma) J_x J_y J_z}$

(D) $R = e^{-i\gamma J_z} \cdot e^{-i\alpha J_y} \cdot e^{-i\beta J_z}$

15. Racah's definition of irreducible tensor operators T_{LM} of rank L is given by :

(A) $[J_x \pm iJ_y, T_{LM}] = [(L - M)(L + M + 1)]^{1/2} T_{LM + 1}$

(B) $[J_x \pm iJ_y, T_{LM}] = [(L + M)(L - M - 1)]^{1/2} T_{LM - 1}$

(C) $[J_x \pm iJ_y, T_{LM}] = [(L \mp M)(L \pm M + 1)]^{1/2} T_{LM \pm 1}$

(D) $[J_x \pm iJ_y, T_{LM}] = [(L \pm M)(L \mp M - 1)]^{1/2} T_{LM \pm 1}$

16. According to Wigner Eckart theorem :

(A) $(j'm' | T_{LM} | jm) = C(jLj'; mMm') (j' || T_L || j)$

(B) $(j'm' | T_{LM} | jm) = C(jjM; mLm') (j || T_L || j')$

(C) $(j'm' | T_{LM} | jm) = C(jLj'; mMm') (j || T_{LM} || j')$

(D) $(j'm' | T_{LM} | jm) = C(jLj'; mMm') (jm || T_{LM} || j'm')$

17. A tungsten wire of unknown composition emits 0.1 amp/cm^2 at a temperature of 1900 K. Find the work function of tungsten filament (Given $\log_e 4.6 = 1.52$; A = 60.2 amp/cm^2/K^2) :

(A) 6.3 eV

(B) 4.5 eV

(C) 3.5 eV

(D) 2.6 eV

18. A crystal diode having internal resistance 20 Ω is used for half-wave rectification. If the applied voltage $V = 50 \sin \omega t$ and load resistance $R_L = 800\ \Omega$, find the efficiency of rectification :

(A) 19%

(B) 24%

(C) 29.6%

(D) 39.5%

19. What value of series resistance is required to limit the current through a LED to 20 mA with a forward voltage drop of 1.6 V when connected to a 10 V supply ?

(A) 120 Ω

(B) 190 Ω

(C) 310 Ω

(D) 420 Ω

20. An $n - p - n$ transistor at room temperature has its emitter disconnected. A voltage of 5 V is applied between collector and base. With collector positive, a current of 0.2 μA flows. When the base is disconnected and the same voltage is applied between collector and emitter, the current is found to be 20 μA. Find the base current when collector current is 1 mA.

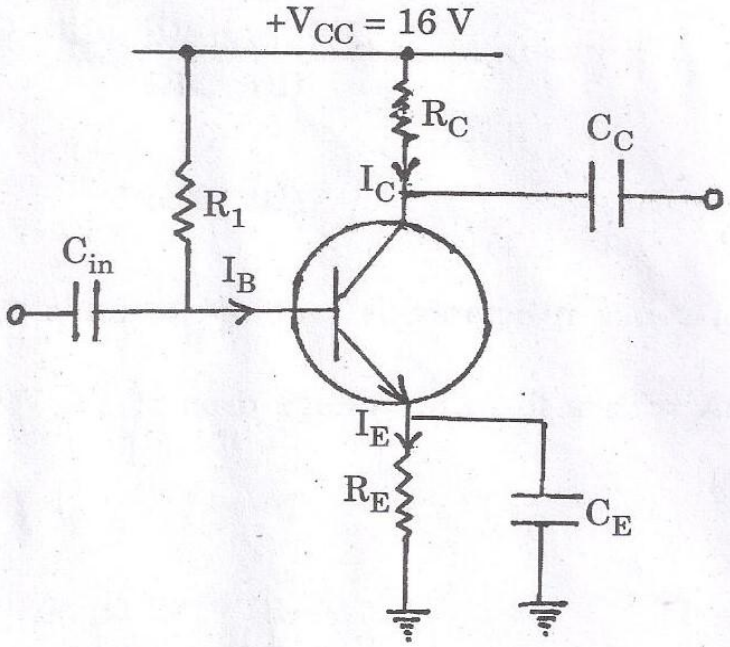
(A) 10 μA

(B) 8.2 μA

(C) 6.3 μA

(D) 5 μA

21. It is desired to design the biasing circuit of an amplifier (as shown) in such a way to have an operating point of 6 V, 1 mA. If transistor has $\beta = 150$, find R_1. Take, $V_{BE} = 0.7$ V :



(A) 140 kΩ (B) 260 kΩ

(C) 310 kΩ (D) 410 kΩ

22. A small signal germanium transistor operating at 25°C has $I_{CBO} = 5$ μA, $\beta = 40$ and zero signal collector current = 2 mA. Find the percentage change in zero signal collector current if the temperature rises to 55°C. Assume I_{CBO} doubles with every 10°C rise.

(A) 49% (B) 62%

(C) 73% (D) 82%

23. A class B push-pull amplifier with transformer coupled load uses two transistors rated 10 W each. What is the maximum power output one can obtain at the load from the circuit ?

(A) 59 W (B) 73 W

(C) 101 W (D) 120 W

24. The following readings were obtained from a JFET :

V_{GS} :	0 V	0 V	–0.2 V
V_{DS} :	7 V	15 V	15 V
I_D :	10 mA	10.25 mA	9.65 mA

Find the amplification factor :

(A) 37 (B) 49

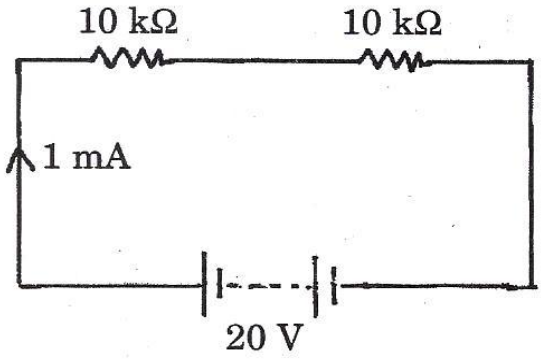
(C) 62 (D) 96

25. Power (brightness) of a 100 W, 110 V tungsten lamp is to be varied by controlling the firing angle of an SCR in a half-wave rectifier circuit supplied with 110 V a.c. What r.m.s. current is developed in the lamp at firing angle $\alpha = 60°$?

(A) 0.58 A (B) 0.43 A

(C) 0.31 A (D) 0.19 A

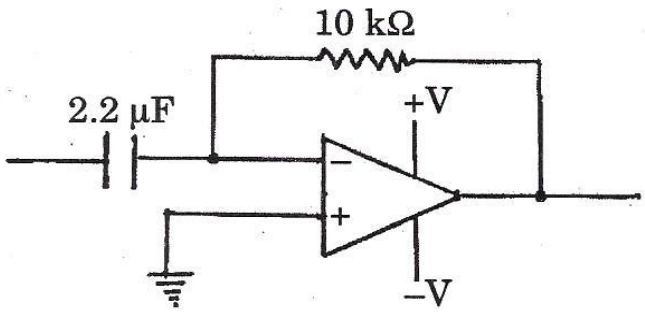
26. In the following circuit, it is desired to measure the voltage across 10 kΩ resistance. If a multimeter of sensitivity 4 kΩ/Volt and range 0-10 V is used for the purpose, what will be reading ?



(A) 1.1 V (B) 2.3 V

(C) 4.6 V (D) 8.9 V

27. For the differentiator circuit (shown below), find the output voltage if the input goes from 0 V to 10 V in 0.4 s :



(A) –0.55 V (B) +0.55 V

(C) –0.66 V (D) +0.66 V

28. Convert $(B2F)_{16}$ to octal :

(A) $(541)_8$ (B) $(5457)_8$

(C) $(2391)_8$ (D) $(3456)_8$

29. Using Boolean techniques, simplify the following expression :

$$Y = AB + A(B + C) + B(B + C)$$

(A) B + AC (B) A + BC

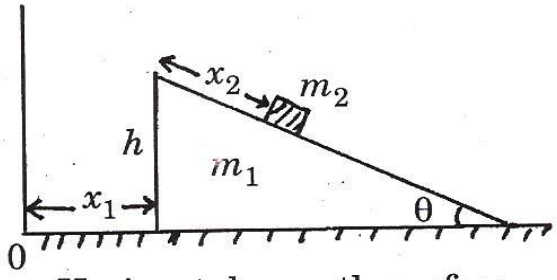
(C) C + AB (D) AB + C

30. A body is moved along a straight line by a machine delivering constant power. The distance d moved by the body in time t is proportional to :

(A) $t^{1/2}$ (B) $t^{3/4}$

(C) $t^{3/2}$ (D) t^2

31. Figure shows an inclined plane of mass m_1. It is sliding on a horizontal smooth surface and a body of mass m_2 is sliding on its smooth inclined surface. Find the equation of motion of the inclined plane :



Horizontal smooth surface

(A) $\ddot{x}_1 = \dfrac{-g\sin\theta\cos\theta}{\dfrac{m_1 + m_2}{m_2} - \cos^2\theta}$

(B) $\ddot{x}_1 = \dfrac{g\sin\theta\cos\theta}{\dfrac{m_1 - m_2}{m_2} + \cos^2\theta}$

(C) $\ddot{x}_1 = \dfrac{g\sin\theta}{\dfrac{m_1 + m_2}{m_2} + \sin^2\theta}$

(D) $\ddot{x}_1 = \dfrac{g\cos\theta}{\dfrac{m_1 - m_2}{m_2} + \cos^2\theta}$

32. The Lagrangian of a particle moving in a plane under the influence of a central potential is given by $L = \frac{1}{2}m\left(\dot{r}^2 + r^2\dot{\theta}^2\right) - V(r)$. The generalized momenta corresponding to r and θ are given by :

(A) $m\dot{r}^2$ and $mr^2\dot{\theta}^2$

(B) $m\dot{r}^2$ and $mr^2\dot{\theta}$

(C) $m\dot{r}$ and $mr\dot{\theta}$

(D) $m\dot{r}$ and $mr^2\dot{\theta}$

33. Which of the following is *not* connected with the uses of artificial satellite ?

(A) Distant transmission of radio and TV signals

(B) To study upper as well as lower regions of the atmosphere

(C) Weather forecasting

(D) Earth measurements (gravitational and magnetic fields)

34. Consider a homogeneous cube of uniform density ρ, mass M and side a. Taking the origin at one corner and axes along the edges of the cube, find the inertia tensor :

(A) $I = \frac{Ma^2}{12}\begin{pmatrix} 8 & -3 & -3 \\ -3 & 8 & -3 \\ -3 & -3 & 8 \end{pmatrix}$

(B) $I = \frac{Ma^2}{12}\begin{pmatrix} 4 & -2 & -2 \\ -2 & 4 & -2 \\ -2 & -2 & 4 \end{pmatrix}$

(C) $I = \frac{Ma^2}{6}\begin{pmatrix} 8 & -2 & -2 \\ -2 & 8 & -3 \\ -2 & -3 & 8 \end{pmatrix}$

(D) $I = \frac{Ma^2}{6}\begin{pmatrix} 8 & -3 & -3 \\ -3 & 8 & -3 \\ -3 & -3 & 8 \end{pmatrix}$

35. The relativistic Hamiltonian for a charged particle in electromagnetic field has the form :

(A) $H = \sqrt{(\vec{p} - q\vec{A})^2 c^2 + m_0^2 c^4} + q\phi$ (B) $H = \sqrt{(\vec{p} - \vec{A})^2 c^2 + m_0^2 c^4} - q\phi$

(C) $H = \sqrt{(\vec{p} - q\vec{A})^2 c^2} + m_0 c^2 + q\phi$ (D) $H = \sqrt{(\vec{p} - q\vec{A})^2 c^2} + q\phi$

36. Number of lattices in the orthorhombic system is :

(A) 1 (B) 2

(C) 3 (D) 4

37. Atomic packing factor of body centred cubic structure (bcc) is :

(A) 0.34 (B) 0.52

(C) 0.68 (D) 0.74

38. If E_C and E_V are the lowest and highest energies of the conduction band and valence band, respectively, and if the effective mass of a hole and a free electron are the same i, e, $m_h = m_e = m$, then the Fermi level E_F is given by :

(A) $\frac{E_C + E_V}{2}$ (B) $\frac{E_C - E_V}{2}$

(C) $\frac{E_C + E_V}{2} + \frac{3}{4} KT \log_e m$ (D) $\frac{E_C + E_V}{2} - \frac{3}{4} KT \log_e m$

39. Which of the following informations *can not* be provided by the Hall effect measurements ?

(A) The sign of the charge carrier is determined.

(B) The carrier concentration (number of charge carrier per unit volume) can not be determined.

(C) The mobility of charge carriers is measured directly.

(D) It can be used to determine whether the given material is metal, insulator or semiconductor.

40. The saturation current density of a *p-n* junctions Ge diode is 200 mA/m^2 at 27°C. Find the voltage to be applied across the junctions to have a forward current density of 10^4 Amp/m^2 to flow :

(A) 0.11 Volt (B) 0.28 Volt

(C) 0.49 Volt (D) 0.61 Volt

41. Which of the following features of a tunnel diode is its drawback ?

(A) Extremely high frequency response

(B) Very wide temperature range of operations

(C) Instability due to negative resistance

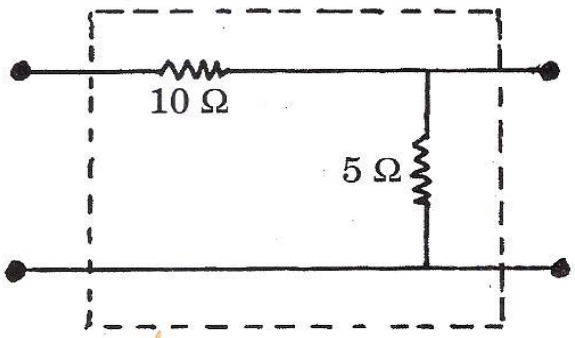
(D) Very low power consumptions

42. A full wave rectifier with a load resistance of 15 kΩ uses an inductance filter of 15 H. The peak value of the applied voltage is 250 volts and the frequency is 50 Hz. Find the r.m.s. value of a.c. component of output current :

(A) 1.12 mA (B) 2.34 mA

(C) 3.04 mA (D) 4.24 mA

43. Find the h parameters (h_{11}, h_{12}, h_{21} and h_{22}) of the following circuit :



(A) $h_{11} = 10\ \Omega$, $h_{12} = 1$, $h_{21} = -1$, $h_{22} = 0.2$ mhos

(B) $h_{11} = 5\ \Omega$, $h_{12} = -1$, $h_{21} = 1$, $h_{22} = 0.1$ mhos

(C) $h_{11} = 5\ \Omega$, $h_{12} = -1$, $h_{21} = 1$, $h_{22} = 0.3$ mhos

(D) $h_{11} = 5\ \Omega$, $h_{12} = 1$, $h_{21} = -1$, $h_{22} = 0.2$ mhos

44. An amplifier has a voltage gain of 50. If the gain is reduced by 10 by negative feedback, find the percentage of feedback :

(A) 2% (B) 8%

(C) 18% (D) 25%

45. Perform binary addition of 11101 and 10111 :

(A) 110100 (B) 101100

(C) 010110 (D) 001010

46. Find the pinch-off voltage for n-channel silicon FET with a channel width of 5.6×10^{-4} cm and a donor concentration of 10^{15} cm^{-3}. Given, dielectric constant for Si = 12.

(A) 1.3 Volt (B) 2.4 Volt

(C) 3.9 Volt (D) 5.9 Volt

47. A box of sides L_x, L_y and L_z has N_x gas molecules each of mass M moving in X-direction with speed v_x, N_y molecules moving with speed v_y in Y-direction and N_z molecules with speed v_z in Z-direction. In the case when pressures are same on all sides and $N_x = N_y = N_z$, find the relation between r.m.s. speed v_{rms} and v_x.

(A) $v_{rms} = \sqrt{3}\, v_x$ (B) $v_{rms} = 3v_x$

(C) $v_{rms} = \sqrt{2}\, v_x$ (D) $v_{rms} = v_x$

48. A hollow spherical chamber of radius R is filled with an ideal gas at temperature T. What fraction of the gas molecules with hit the portion of the chamber wall defined by $\theta = 30°$, $d\theta = 0.5°$, $\phi = 45°$ and $d\phi = 0.5°$?

(A) 3×10^{-6} (B) 2×10^{-7}

(C) 1.8×10^{-8} (D) 2.3×10^{-10}

49. On reducing the temperature of a fixed amount of an ideal gas, the value of the most probable velocity and the total area of the velocity distribution curve, respectively :

(A) increases, decreases (B) remains same, decreases

(C) decreases, increases (D) decreases, remains same

50. Which of the following equations leads to :

$$\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$$

(A) $dU = TdS - PdV$ (B) $dF = -PdV - SdT$

(C) $dG = VdP - SdT$ (D) $dH = TdS + VdP$

51. A system contained in volume V at temperature T has internal energy given by $U = aVT^4$ and pressure given by $P = \frac{1}{3}aT^4$, where a is a constant. Find the entropy for the system :

(A) $\frac{4U}{T}$ (B) $\frac{3}{2}\frac{U}{T}$

(C) $\frac{1}{3}\frac{U}{T}$ (D) $\frac{U}{T}$

52. A distant galaxy is receding from the earth at 6.12×10^7 m/s. By how much is a green spectral line of wavelength 500 nm emitted by this galaxy shifted toward the red end of the spectrum ?

(A) 85 nm (B) 115 nm

(C) 145 nm (D) 195 nm

53. An aircraft A is moving at $0.90c$ with respect to the earth. If aircraft B is to pass A at a relative speed of $0.50c$ in the same directions, what speed much B have with respect to the earth ?

(A) $0.90c$ (B) $0.92c$

(C) $0.94c$ (D) $0.97c$

54. A body is a black hole if all its mass (M) is inside a sphere of radius :

(A) $\frac{2GM}{c^2}$ (B) $\frac{GM}{c^2}$

(C) $\frac{GM}{2c^2}$ (D) $\frac{3}{2}\frac{GM}{c^2}$

55. Find the minimum energy of an electron confined in a box of width 0.10 nm. The particle is assumed to move back and forth along a straight line between the walls of the box :

(A) 16 eV (B) 28 eV

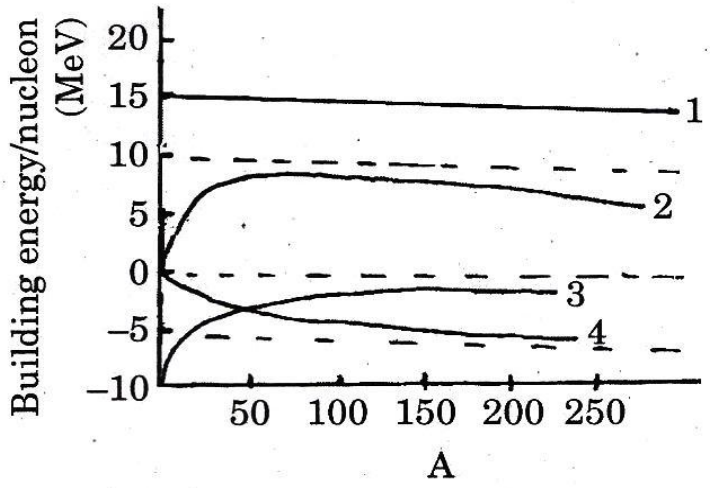
(C) 38 eV (D) 49 eV

56. If P_1 and P_2 are the probabilities of finding is 1*s* electron in a hydrogen atom at the distance r_0 and $r_0/2$, respectively, find P_1/P_2. (r_0 is the radius of the Bohr's first orbit) :

(A) 0.97 (B) 1.02

(C) 1.23 (D) 1.47

57. Which of the following curves represents the surface energy of the nucleus ?



(A) 1 (B) 2

(C) 3 (D) 4

58. The atomic ratio between the uranium isotopes ^{238}U and ^{234}U in a mineral sample is found to be 1.8×10^4. The half-life of ^{234}U is 2.5×10^5 yrs. Find the half-life of ^{238}U.

(A) 3.1×10^5 yrs (B) 5.4×10^7 yrs

(C) 4.5×10^9 yrs (D) 1.9×10^{11} yrs

59. Find the value of beta function $\beta\left(\frac{1}{2}, \frac{1}{2}\right)$:

(A) π (B) $\pi/2$

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

60. Round off the number 16.73117 to four decimal figures, and compute the percentile error :

(A) 16.73; 8.93×10^{-3} (B) 16.73; 6.99×10^{-3}

(C) 16.7311; 6.99×10^{-3} (D) 16.7311; 8.93×10^{-3}

61. A particle falls under gravity in a resisting medium whose resistance varies with velocity. Find the relation between distance (x) and velocity (v) if initially the particle starts from rest. (In the following expressions, k is a constant) :

(A) $x = -\frac{v}{k} - \frac{g}{k^2}\log\left(\frac{g - kv}{g}\right)$ (B) $x = \frac{v}{k} + \frac{g}{k^2}\log\left(\frac{g + kv}{g}\right)$

(C) $x = \sqrt{\frac{v^2}{k}} + \frac{g}{k}\log\left(\frac{kv}{g}\right)$ (D) $x = \frac{v}{k} + \frac{g}{k^2}\log(g + kv)$

62. Fcr Bessel functions $J_0(x)$ and $J_3(x)$, find the values of the constants a, b and c which gives :

$$aJ_3(x) + bJ_0'(x) + cJ_0'''(x) = 0$$

(A) $a = 4, b = 3, c = 1$ (B) $a = 3, b = 4, c = 1$

(C) $a = 1, b = 3, c = 4$ (D) $a = b = 3, c = 2$

63. Find a matrix P which transforms the matrix $A = \begin{pmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{pmatrix}$ to a diagonal matrix.

(A) $\begin{pmatrix} 1 & -2 & -1 \\ -1 & 1 & 1 \\ 0 & 2 & 2 \end{pmatrix}$ (B) $\begin{pmatrix} 1 & 2 & 1 \\ -1 & -1 & 1 \\ 0 & 2 & -2 \end{pmatrix}$

(C) $\begin{pmatrix} -1 & -2 & 1 \\ -1 & 1 & -1 \\ 0 & -2 & 2 \end{pmatrix}$ (D) $\begin{pmatrix} -1 & -2 & 1 \\ 1 & 1 & -1 \\ 2 & 2 & 0 \end{pmatrix}$

64. According to the shell model, the ground state spin and parity of ^{11}Li nucleus is :

(A) $\frac{7^-}{2}$ (B) $\frac{1^+}{2}$

(C) $\frac{3^+}{2}$ (D) $\frac{3^-}{2}$

65. A particle, consists of a quark and an antiquark, is bound by a potential :

$$V(r) = ar + \frac{b}{r}$$

where a = 200 MeV fm^{-1} and b = 100 MeV fm. If the masses of the quark and antiquark are negligible, the mass of the particle is :

(A) 141 MeV/c^2 (B) 283 MeV/c^2

(C) 353 MeV/c^2 (D) 425 MeV/c^2

66. In deep inelastic scattering electrons are scattered by protons to determine if a proton has any internal structure. The energy of the electrons for this reaction must be at least :

(A) 1.25×10^6 eV (B) 1.25×10^{10} eV

(C) 1.25×10^{12} eV (D) 1.25×10^{14} eV

67. The charm quark is assigned a charm quantum number c = 1. How should the Gellmann-Nishijima formula for electric charge be modified for four favours of quarks ?

(A) $I_3 + \frac{1}{2}(B - S - C)$ (B) $I_3 + \frac{1}{2}(B - S + C)$

(C) $I_3 + \frac{1}{2}(B + S - C)$ (D) $I_3 + \frac{1}{2}(B + S + C)$

68. A radioactive element A decays to B, which in turn decays to a stable element C. The decay constant from A $\rightarrow$ B is λ_1 and that from B $\rightarrow$ C is λ_2. If there are only N_0 atoms of A at $t = 0$, at short time ($t << 1/\lambda_1$ as well as $1/\lambda_2$) the number of atoms of C will be :

(A) $\frac{1}{2}\lambda_1\lambda_2 N_0 t^2$

(B) $\frac{\lambda_1\lambda_2}{2(\lambda_1 + \lambda_2)} N_0 t$

(C) $(\lambda_1 + \lambda_2)^2 N_0 t^2$

(D) $(\lambda_1 + \lambda_2) N_0 t$

69. According to the shell model, the nuclear magnetic moment of the $^{17}_{13}Al$ nucleus is (Given, for a proton $g_l = 1$, $g_s = 5.586$, and for a neutron $g_l = 0$, $g_s = -3.826$) :

(A) 0

(B) 4.793 μ_N

(C) 14.414 μ_N

(D) $-1.913\ \mu_N$

70. A particle, which is composed of three quarks u, d and s, has electric charge, spin and strangeness, respectively :

(A) $1, \frac{1}{2}, -1$

(B) $0, 0, -1$

(C) $0, \frac{1}{2}, -1$

(D) $-1, -\frac{1}{2}, 1$

71. The range of the potential between two hydrogen atoms is ~4 Å. For a gas in thermal equilibrium, find the temperature below which the atom-atom scattering is essentially s-wave :

(A) 1.01 K (B) 1.37 K

(C) 1.63 K (D) 2.09 K

72. For Zn, the X-ray absorption edges have the following values in KeV :

k 9.67, L_I 1.21, L_{II} 1.05, L_{III} 1.03.

Find the wavelengths of K_α lines (K_{α_1} and K_{α_2}) :

(A) 1.132 Å, 1.146 Å (B) 1.235 Å, 1.246 Å

(C) 1.313 Å, 1.333 Å (D) 1.436 Å, 1.440 Å

73. Which of the following experiments analyzed the Fraunhofer lines of the solar spectrum ?

(A) Barkla's experiment on scattering of X-rays.

(B) Lamb-Rutherford experiment.

(C) Geiger and Marsdens experiment on scattering of α particles

(D) Bunsen and Kirchhoff's experiment.

74. A beam of hydrogen molecules travel in the z-direction with a kinetic energy of 1 eV. The molecules are in an excited state, from which they decay and dissociate into two hydrogen atoms. When one of the dissociation atoms moves perpendicular to the z-directions with kinetic energy 0.8 eV, find the energy released in the dissociative reaction :

(A) 0.2 eV (B) 1.8 eV

(C) 2.6 eV (D) 0

75. A unit vector $\hat{n}$ on the xy-plane is at an angle of 120° with respect to $\hat{i}$. The angle between the vectors $\vec{A} = a\hat{i} + b\hat{n}$ and $\vec{B} = a\hat{n} + b\hat{i}$ will be 60° if :

(A) $b = \sqrt{3}a/2$ (B) $b = 2a/\sqrt{3}$

(C) $b = a/2$ (D) $b = a$

76. Two particles of identical masses move in circular orbits under a central potential $V(r) = \frac{1}{2}kr^2$. Let L_1 and L_2 are the angular momenta and r_1 and r_2 are the radii of the orbits, respectively. If $L_1/L_2 = 2$, the value of r_1/r_2 is :

(A) $\sqrt{2}$ (B) $\frac{1}{\sqrt{2}}$

(C) 2 (D) $\frac{1}{2}$

77. Two events, separated by a (spatial) distance 9×10^9 m, are simultaneous in one inertial frame. The time interval between these two events in a frame moving with a constant speed $0.8\ c$ is :

(A) 60 s (B) 40 s

(C) 20 s (D) 0 s

78. The Hamiltonian of a simple pendulum of a mass m attached to a massless string of length l is $H = \frac{p_\theta^2}{2ml^2} + mgl(1 - \cos\theta)$. If L denotes the Lagrangian, the value of $\frac{dL}{dt}$ is :

(A) $-\frac{2g}{l} p_\theta \sin\theta$ (B) $-\frac{g}{l} p_\theta \sin^2\theta$

(C) $\frac{g}{l} p_\theta \cos\theta$ (D) $lp_\theta^2 \cos\theta$

79. The muon has mass 105 MeV/c^2 and mean life time 2.2 μs in its rest frame. The mean distance traversed by a muon of energy 315 MeV before decaying is :

(A) 3×10^5 km (B) 2.2 cm

(C) 6.6 μm (D) 1.9 km

80. Let A, B and C be the functions of phase space variables (coordinates and momenta of a mechanical system). If {,} represents the Poisson bracket, the value of :

$$\{A, \{B, C\}\} - \{\{A, B\}, C\}$$

is given by :

(A) 0 (B) {B, {C, A}}

(C) {A, {C, B}} (D) {{C, A}, B}

81. By which treaty after the Anglo-Nepali war hilly areas like Kumaon and Garhwal were snatched from the Gurkhas ?

(A) Treaty of Aliwal
(B) Treaty of Sabraon
(C) Treaty of Sagauli
(D) Treaty of Rawingarh

82. By which name is Kinnaur called by the Tibetans ?

(A) Kurpa
(B) Maon
(C) Khunu
(D) Khasia

83. Which of the following streams is a tributary of the Ravi river ?

(A) Harla
(B) Awa
(C) Gaj
(D) Tant Giri

84. With which region of H.P. is Philli dance associated ?

(A) Sirmaur
(B) Kinnaur
(C) Kullu
(D) Lahaul-Spiti

85. In which building did Mahatma Gandhi stay during his visit to Shimla in 1945 ?

(A) Curzon Cottage
(B) Grass House
(C) Manor Ville
(D) Del Ville

86. Who was the leader of secret society set up in Sirmaur princely state around 1920 A.D. ?

(A) Vaid Surat Singh
(B) Shiva Nand Ramaul
(C) Mian Chu Chu
(D) Chaudhary Sher Jang

87. Girls of which age-group are covered in H.P. under Kishori Shakti Yojna ?

(A) 10 to 16 years
(B) 10 to 18 years
(C) 11 to 17 years
(D) 11 to 18 years

88. Which of the following is grown in H.P. during the Rabi season ?

(A) Rajmah
(B) Urd
(C) Moong
(D) Lentil

89. Among the following, at which place is packing house of the H.P. MC ?

(A) Nadaun
(B) Parwanoo
(C) Rohru
(D) Patlikuhal

90. SC students of which classes belonging to IRDP/BPL families in H.P. are being provided cash assistance for buying writing material ?

(A) Class I to V
(B) Class I to VIII
(C) Class I to X
(D) Class I to 10+2

91. How many MPs voted for Meira Kumar in the 2017 Presidential Elections ?

(A) 225 (B) 235

(C) 245 (D) 255

92. What is the name of the programme launched by the Government of India for telecasting high quality educational programmes ?

(A) Prabha Bharti (B) Swayam Siddhi

(C) Prabha Siddhi (D) Swayam Prabha

93. Which week is to be observed as Hindi Week in India in 2017 ?

(A) November 01 to 07 (B) October 21 to 27

(C) September 14 to 20 (D) December 23 to 29

94. Where is Satish Dhawan Space Centre ?

(A) Sriharikota (B) Mumbai

(C) Pune (D) Baripada

95. In the five Judge Supreme Court bench which two Judges ruled that instant tripple talaq has been a part of Muslim personal law for 1400 years and is hence valid ?

(A) J.S. Khehar and Abdul Nazeer

(B) Rohinton Nariman and U.U. Lalit

(C) U.U. Lalit and Kurian Joseph

(D) Kurian Joseph and Abdul Nazeer

96. Which of the following is *not* a member of the world forum for economic cooperation named G-20 ?

(A) Saudi Arabia
(B) Turkey
(C) UAE
(D) South Africa

97. What is unique about Japan's Okinoshima island ?

(A) Entry of women is banned
(B) Unmarried males are not allowed
(C) There is no priest in the temple on the island
(D) Males aged 80 years and above are not allowed

98. In which field was Liu Xiaobo of China, who died recently, was given nobel prize for ?

(A) Literature
(B) Physics
(C) Peace
(D) Medicine

99. How many super clusters are there in the recently discovered massive super cluster of galaxies called Saraswati ?

(A) 4
(B) 24
(C) 36
(D) 42

100. Which U.S. state faced fierce hurricane in the last week of August 2017 ?

(A) Texas
(B) Virginia
(C) Ohio
(D) Missouri