NITESHPHYZICS

Nitesh Phyzics

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PHYSICS

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1. An atomic transition line with a wavelength 350 nm is observed to be split into three components in a spectrum of light from a sunspot. Adjacent components are separated by 1.7 pm. Determine the strength of the magnetic field in the sunspot
   A. 3T B. 0.03T C. 3.3T D. 0.3T ✔

2. Which one of the following is correct in respect of an electron and a proton having a same de-Broglie wavelength of 2Å

   A. Both have the same kinetic energy
   B. Both have the same velocity
   C. Both have the same momentum ✔
   D. The kinetic energy of the proton is more than that of the electron.

3. If r_p and r_H are the radius and E_p and E_H are the energy of an electron in the n^{th} orbit of positronium atom and hydrogen atom respectively, then

   A. $r_p = 2r_H$ and $E_p = E_H/2$ ✔
   B. $r_p = 2r_H$ and $E_p = 2E_H$
   C. $r_p = 2r_H$ and $E_p = E_H/4$
   D. $r_p = r_H$ and $E_p = 2E_H$

4. An X - ray beam of wavelength 0.16 nm is incident on a set of planes of a certain crystal. The first Bragg reflection is observed for an incidence angle of 30^o. What is the corresponding interplanar spacing?
   A. 0.16nm ✔ B. 0.67 nm C. 1.02 nm D. 0.89 nm

5. What is the velocity of conduction electron of silver having Fermi energy 5.52eV
   A. $1.39 \times 10^6 m/s$ ✔ B. $2.39 \times 10^6 m/s$ C. $0.89 \times 10^6 m/s$ D. 0

6. Given that a piece of n - type silicon contains $8 \times 10^{21} m^{-3}$ phosphorus impurity atoms, calculate the carrier concentration of silicon at room temperature. Given that the intrinsic electron concentration of silicon at room temperature is 1.6×10^{16}
   A. 3.2×10^{10} ✔ B. 2.3×10^{11} C. 1.5×10^{10} D. 3.2×10^{11}

7. The dispersion relation for a one-dimensional mono-atomic lattice chain is given by the equation $\omega = \frac{2}{a} v_s \left| sin\frac{ka}{2} \right|$, where, 'a' is the inter-atomic spacing, $K = \frac{2\pi}{\lambda}$ and v_s has the dimension of velocity. The relation between the phase velocity V_P and group velocity V_g in the long wavelength limit is given by
   A. $v_p = v_g$ ✔ B. $v_p = 2v_g$ C. $v_p = v_g/2$ D. $v_p \neq v_g$

8. The largest wavelength of light falling on double slits separated by $1.5\mu m$, for which there is a first-order maximum is in the
   A. ultraviolet range B. visible range C. infrared range ✔ D. X-ray range

9. In a multi-stage R - C coupled amplifier, the coupling capacitor
   A. limits the low-frequency response
   B. limits the high-frequency response
   C. reduces the amplitude of input signal
   D. blocks d.c. component without affecting the frequency response ✔

10. An AM transmitter is coupled to an aerial. The input current is found to be 5A. With modulation, the current value increases to 5.9 A. The depth of modulation is
   A. 83.4 % B. 88.6 % ✔ C. 78.2 % D. 74.3 %

11. Hexadecimal equivalent of a digital number 10011101 is
   A. H913 B. 9D ✔ C. AE D. 157

12. If the doping concentration in a Si - Zener diode is increased, the Zener breakdown voltage
   A. Decrease ✔ B. Increase C. Remains unchanged D. Becomes broader

13. Which one of the following is an example of doubly magic nuclei?
   A. ^{18}O B. ^{48}Ca ✔ C. ^{124}Sn D. ^{204}Pb

14. Which radiation has maximum ionization power?
   A. Alpha ✔ B. Beta C. Neutron D. Gamma

15. For beta-minus decay, which statement is TRUE?
   A. Daughter nuclide atomic mass (A_D) is more than that of the parent nuclide atomic mass (A_P).

B. Daughter nuclide atomic number (Z_D) is the same as that of the parent nuclide atomic number (Z_P).

C. Daughter nuclide neutron number ((N_D)) is less than that of the parent nuclide neutron number (N_P) ✔

D. Daughter nuclide neutron number ((N_D)) is the same as that of the parent nuclide neutron number (N_P).

16. The probability that student A solves the problem is 1/2, and that of B is 2/3. What is the probability that the problem is solved?

A. 4/6 B. 1/3 C. 5/6 ✔ D. none of these

17. Are the three points whose position vectors are $2\vec{i}+\vec{j}-4\vec{k}$, $\vec{i}-2\vec{j}+3\vec{k}$ and $-7\vec{j}+10\vec{k}$ collinear?

A. yes ✔ B. no C. cannot be determined D. none of these

18. The number of independent fundamental solutions in n-th order ordinary differential equation is

A. n-1 B. n ✔ C. n+1 D. 2n

19. If z_1= 2-3i and z_2= 4+i6 then find $\frac{z_1}{z_2}$ is

A. $-\frac{5}{26}-\frac{6i}{13}$ B. $-\frac{5}{26}+\frac{6i}{13}$ ✔ C. $8+18i$ D. $8+18i$

20. The rank of the following matrix $\begin{bmatrix} 1 & 5 & 1 \\ 2 & 1 & 1 \\ 3 & 6 & 2 \end{bmatrix}$ is

A. 1 B. 2 ✔ C. 3 D. 4

21. Two Carnot engines X and Y are operating in series. The engine X receives heat at 1200K and rejects to a reservoir at a temperature of T. The second engine Y receives the heat rejected by X and in turn rejects to a heat reservoir at 300K. Calculate the temperature T(in Kelvin) for the situation when the efficiency of the engines is same.

A. 600K ✔ B. 750K C. 0K D. 450K

22. A square conducting loop of mass m, side l and resistance R is dropped into a region with a uniform horizontal magnetic field B whose direction is perpendicular to the plane of the falling loop. The loop will reach a terminal velocity v given by

A. $v=\frac{mgR}{(Bl)^2}$ ✔ B. $v=\frac{2mgR}{(Bl)^2}$ C. $v=\frac{mgR}{2(Bl)^2}$ D. none of these

23. An ideal inductor, a resistor of resistance R Ohms and a capacitor with adjustable capacitance are connected in series to an alternating voltage with an effective value of V Volts and with the

frequency of f Hz. The current flowing through the circuit when the capacitance of the capacitor is set to C_1 is the same as when the capacitance of the capacitor is set to C_2. The inductance of the inductor L is given by

A. $\frac{1}{8\pi^2 f^2}\frac{C_1+C_2}{C_1C_2}$ ✔
B. $\frac{1}{8\pi^2 f^2}\frac{C_1C_2}{C_1+C_2}$
C. $\frac{1}{2\pi f}\frac{C_1C_2}{C_1-C_2}$
D. $\frac{1}{2\pi^2 f^2(C_1-C_2)}\frac{C_1C_2}{C_1+C_2}$

24. . A cylinder of length L is made up of an inner core of steel of radius r_1 and an outer r_1. The resistivities of steel and copper are ρ_1 ρ_2 respectively. The total resistance of the cylinder is

A. $\frac{(\rho_1\rho_2)L}{\pi r^2(3\rho_1+\rho_2)}$ ✔
B. $\frac{((3\rho_1+\rho_2)L}{\pi r^2}$
C. $\frac{(\rho_1+\rho_2)L}{4\pi r^2}$
D. Cannot be determined from the information provided above

25. A meter stick is at an angle of 45^o to the x - axis in its rest frame. The rod moves with a speed of $\frac{c}{\sqrt{2}}$ along the +x - direction w.r.t. a frame S . The length of the rod in S is

A. $\frac{\sqrt{3}}{2}$ meter ✔ B. $\frac{\sqrt{5}}{2}$ meter C. $\frac{\sqrt{2}}{3}$ meter D. $\frac{3}{2}$ meter

26. An AC generator with output and frequency f is connected to the plates of an air filled parallel plate capacitor of plate area A and plate separation d. The maximum value of the displacement current is

A. $\frac{2\pi\varepsilon_0 fVA}{d}$ ✔
B. $\frac{\varepsilon_0 fVA}{d}$
C. $\frac{2\pi\varepsilon_0 fA}{Vd}$
D. Cannot be determined from the information provided above

27. An electron enters a uniform magnetic field of flux density $1.2Wb/m^2$. Find the energy difference in (eV), between electrons having spins parallel and anti-parallel to the field. (Given:$\mu_B = 9.3 \times 10^{-24}$)

A. 3.95×10^{-5} eV B. 13.95×10^{-5} eV ✔ C. 23.95×10^{-5} eV D. 33.95×10^{-5} eV

28. Using the vector atom model, determine the possible values of the angular momentum of an electron in f - shell

A. $\frac{3\sqrt{7}}{2}\hbar, \frac{\sqrt{35}}{2}\hbar$ ✔ B. $\frac{2\sqrt{7}}{2}\hbar, \frac{\sqrt{25}}{2}\hbar$ C. $\frac{5\sqrt{7}}{2}\hbar, \frac{\sqrt{15}}{2}\hbar$ D. $\frac{\sqrt{7}}{2}\hbar, \frac{\sqrt{5}}{2}\hbar$

29. The two eigenvalues of the matrix $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$

A. 2,0 ✔ B. 1,1 C. 1,2 D. 0,1

30. The commutator, $\pi[x^2, p_x]$, is equal to

A. ihx ✔ B. $2ihx$ C. ihp_x D. 0

31. A particle of mass m is confined in the ground state of a one dimensional box extending from x=-2L to x=+2L. The wave function of the particle in this state is $psi(x) = \psi_o cos\left(\frac{\pi x}{4L}\right)$, where ψ_o is a constant. The energy eigenvalue corresponding to this state is

A. $\frac{\hbar^2\pi^2}{32mL^2}$ ✔ B. $\frac{\hbar^2\pi^2}{2mL^2}$ C. $\frac{\hbar^2\pi^2}{4mL^2}$ D. $\frac{\hbar^2\pi^2}{16mL^2}$

32. The normalized wave functions psi_1 and psi_2, correspond to the ground state and the first excited states of particle in a potential. The operator $\hat{A}$ acts on the wave functions as $\hat{A}\psi_1 = \psi_2$ and $\hat{A}\psi_2 = \psi_1$ The expectation value of the operator $\hat{A}$ for the state $\psi = (3\psi_1 + 4\psi_2)/5$ is

A. 0.96 ✔ B. -0.32 C. 0 D. 0.75

33. The primitive translation vector of a two-dimensional lattice are $\vec{a} = 2\vec{i} + \vec{j}, \vec{b} = 2\vec{j}$ The primitive translation vector of its reciprocal lattice in x - direction is given by

A. $a^* = \pi\vec{i}$ ✔ B. $a^* = 2\pi\vec{i}$ C. $a^* = \vec{i}$ D. $a^* = \pi\vec{j}$

34. The mean drift speed v_d of an electron in an applied electric field E with electron density 'n' can be expressed as

A. $v_d = |\frac{\sigma E}{ne}|$ ✔ B. $v_d = |\frac{\sigma E}{e}|$ C. $v_d = |\frac{\sigma e}{nE}|$ D. None of these

35. An un-damped oscillator has time period τ_o =1.0 sec. Now a little damping is added so that its time period changes to τ_1=1.001sec. By what factor will the amplitude of oscillation decrease after 10 cycles?

A. ≈ 17 ✔ B. ≈ 1 C. $\approx \frac{1}{17}$ D. None of these

36. A kilogram of water has a constant heat capacity of 4.2kJ/K/kg over the temperature range 0^oC to 100^oC. The water was initially at 0^oC and is brought into contact with a heat reservoir at 100^oC When the water is in thermal equilibrium with the heat reservoir, calculate the change in entropy

of the universe (Water + Reservoir).

A. $184.8J/K$ ✔ B. $2437.8J/K$ C. $0J/K$ D. $1310.8J/K$

37. Two identical finite bodies of constant volume and of constant heat capacity at constant volume C_V, are used to drive a heat engine. Their initial temperatures are T_1 and T_2. The maximum amount of work which can be obtained from the system is

    A. $C_V(2(T_1T_2)^{1/2} - (T_1+T_2))$ ✔
    B. $C_V(T_1+T_2)$
    C. $C_V(T_1T_2)^{1/2}$
    D. 0

38. For a system of bosons, we can write the Bose-Einstein distribution function as $f(E_i) = \frac{1}{exp(a+\beta E_i)-1}$, where $\beta = \frac{1}{K_BT}$ and $\alpha = \frac{\mu}{K_BT}$ (K_B is Boltzmann constant). If μ represents the chemical potential, then which one of the following is true?

    A. $\mu \leq 0$ B. $\mu \geq 0$ ✔ C. $\mu \leq 1$ D. $\mu \geq 1$

39. An ideal capacitor C is charged to a voltage V_o and connected at t = 0 across an ideal inductor L (The circuit now consists of a capacitor and an inductor only). If the resonant frequency $\omega_0 = \frac{1}{\sqrt{LC}}$ the voltage across the capacitor at time t > 0 is given by

    A. V_o B. $V_o cos(\omega_o t)$ ✔ C. $V_o sin(\omega_o t)$ D. $V_o e^{-\omega_o t} cos(\omega_o t)$

40. Magnetic moment of proton (μ_p) in terms of nuclear magneton (μ_N) is A. $\mu_p = 1.9\mu_N$ B. $\mu_p = 2.7\mu_N$ ✔ C. $\mu_p = 3.8\mu_N$ D. $\mu_p = 5.4\mu_N$

41. Find the eigenvalues of $A+4I$, where I is identity matrix and A $\begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$

    A. 1,3 B. 5,7 ✔ C. 4,4 D. none of these

42. The limit

$$\lim_{x\to\infty} \left(\frac{1}{n}\right)^{\frac{1}{n}}$$

    is

    A. $\frac{1}{e}$ B. 1 ✔ C. 0 D. e

43. $\left(\frac{1+i}{\sqrt{2}}\right)^{49}$ is equal to

    A. $\left(\frac{1+i}{\sqrt{2}}\right)$ ✔ B. $\left(\frac{2+98i}{\sqrt{2^{49}}}\right)$ C. $\left(\frac{1-i}{\sqrt{2}}\right)$ D. $\left(\frac{2-98i}{\sqrt{2^{49}}}\right)$

44. $sin(\frac{\pi}{4}+i)$ is equal to

A. $\frac{\sqrt{2}}{4}(e-\frac{1}{e})+\frac{\sqrt{2}}{4}(e-\frac{1}{e})i$
B. $\frac{\sqrt{2}}{4}(e+\frac{1}{e})+\frac{\sqrt{2}}{4}(e-\frac{1}{e})i$ ✔
C. $\frac{\sqrt{2}}{4}(e+\frac{1}{e})+\frac{\sqrt{2}}{4}(e+\frac{1}{e})i$
D. $\frac{\sqrt{2}}{4}(e-\frac{1}{e})+\frac{\sqrt{2}}{4}(e+\frac{1}{e})i$

45. Two students are working on a math problem. The first student has probability $\frac{1}{2}$ of solving it and the second student has probability $\frac{3}{4}$ of solving it. What is the probability that at least one of them solves the problem?

A. $\frac{3}{8}$ B. $\frac{5}{8}$ C. $\frac{7}{8}$ ✔ D. $\frac{9}{8}$

46. Expansion of the function $f(z)=\frac{1}{z^2-3z+2}$ in the region defined by z > 2 is

A. $z^{-2}+3z^{-4}+7z^{-6}+......$
B. $z^{-2}+3z^{-3}+7z^{-4}+......$ ✔
C. $z^{-1}+3z^{-2}+7z^{-3}+......$
D. $z^{-3}+3z^{-4}+7z^{-5}+......$

47. The Fourier transformation of the function for

$$f(x)=\begin{cases}1 & |x|<a\\ 0 & |x|>a\end{cases}$$

is

A. $\sqrt{\frac{2}{\pi}}\frac{sin\quad sa}{s}$ ✔ B. $\sqrt{\frac{2}{\pi}}\frac{cos\quad sa}{s}$ C. $\sqrt{pi}\frac{sin\quad sa}{s}$ D. $\sqrt{\frac{\pi}{2}}\frac{cos\quad sa}{s}$

48. The Laplace transformation of the function $f(t)=2^t$

A. $\frac{ln2}{s-ln2}$ B. $\frac{1}{s-ln2}$ ✔ C. $\frac{1}{sln2-1}$ D. $\frac{ln2}{sln2-1}$

49. Consider a collection of non-interacting particles, each of mass m in a volume where the gravitational force is a negative (z-direction). Consider the system is in thermal equilibrium at a temperature T. Find the partition function

A. $Q_N=\left[\frac{(KT)^3}{2\pi mg\hbar^2}\right]^{N/2}$ ✔ B. $Q_N=\left[\frac{(KT)^3}{2\pi mg\hbar^2}\right]^{N/2}$ C. $Q_N=\left[\frac{(KT)^3}{2\pi mg\hbar^2}\right]^{N}$ D. $Q_N=\left[\frac{(\pi mg\hbar^2}{(KT)^3}\right]^{N}$

50. The quantum distribution function for any gas atom which follows MB, BE, and FD statistics is given as a generalized single form

$$f_i = \frac{g_i}{exp(\varepsilon_i - \mu)/(kT + J)}$$

If the distribution function follows the MB statistics in a classical limit then what will be the condition of the following? Symbols have their usual meanings

A. $\frac{f_i}{g_i} = 1; J = 1$ B. $\frac{f_i}{g_i} = 1; J = 0$ ✔ C. $\frac{g_i}{f_i} = 1; J = 1$ D. $\frac{g_i}{f_i} = 1; J = -1$