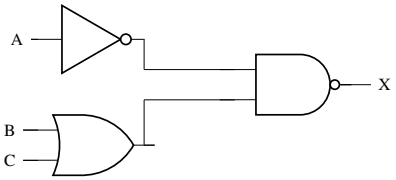
PH - 2016

EE24BTECH11064 - Harshil Rathan

1) Protons and α- particles of equal initial momenta are scattered off a gold foil in a Rutherford scattering experiment. The scattering for proton on gold and α-particle on gold are σ_p and σ_α respectively. The ratio $\frac{\sigma_\alpha}{\sigma_p}$ is _____.

2) For the digital circuit given below, the output X is



a) $\overline{\overline{A} + B \cdot C}$
b) $\overline{\overline{A} \cdot (B + C)}$
c) $\overline{A} \cdot (B + C)$
d) $A + \overline{(B \cdot C)}$

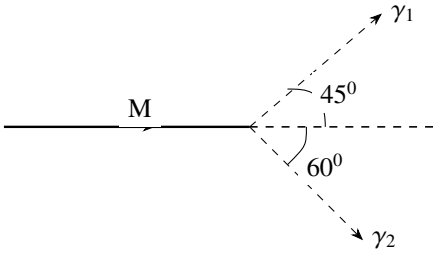
3) The Fermi energies of two metals $X$and Y are $5ev$ and $7ev$ and their Debye temperatues are 170K and 340K, respectively. The moalr specific heats of these metals at constant volume at low temparatues can be written ad $(C_v)\, x = \gamma_X T + A_X T^3$ and $(C_v)\, Y = \gamma_Y T + A_Y T^3$, where γ and A are constants. Assuming that the thermal effective mass of the elctrons in the two metals are same,which of the follwoing is correct ?

a) $\frac{\gamma_X}{\gamma_Y} = \frac{7}{5}, \frac{A_X}{A_Y} = 8$
b) $\frac{\gamma_X}{\gamma_Y} = \frac{5}{7}, \frac{A_X}{A_Y} = \frac{1}{8}$
c) $\frac{\gamma_X}{\gamma_Y} = \frac{7}{5}, \frac{A_X}{A_Y} = \frac{1}{8}$
d) $\frac{\gamma_X}{\gamma_Y} = \frac{5}{7}, \frac{A_X}{A_Y} = 8$

4) A two-level system has energies zero and E. The level with zero energy is non-degenerate, while the level with energy E is triply degenerate. The mean energy of a classical particle in this system at temperature T is

a) $\frac{Ee^{-E/k_bT}}{1+3e^{-E/k_bT}}$
b) $\frac{3Ee^{-E/k_bT}}{1+e^{-E/k_bT}}$
c) $\frac{Ee^{-E/k_bT}}{1+e^{-E/k_bT}}$
d) $\frac{3Ee^{-E/k_bT}}{1+3e^{-E/k_bT}}$

5) A partical of rest mass M is moving along the positive x-direction.It decays into two photons γ_1 and γ_2 as shown in the figure. The energy of γ_1 is $1GeV$ and the energy of γ_2 is $0.82GeV$. The value of M (in units of GeV/c^2 is _____. Give your answer upto two decimal places)



6) If x and p are the x components of the position and the momentum operators of a particle respectively, the commutator $[x^2, p^2]$ is

a) $ih(xp - px)$
b) $2ih(xp - px)$
c) $ih(xp + px)$
d) $2ih(xp + px)$

7) The x-y plane is the boundary between free space and a magnetic material with relative permeability μ_r. The magnetic field in the free space is $B_x\hat{i}+B_z\hat{k}$. The magnetic field in the magnetic material is

a) $B_x\hat{i} + B_z\hat{k}$
b) $B_x\hat{i} + \mu_r B_z\hat{k}$
c) $\frac{1}{\mu_r}B_x\hat{i} + B_z\hat{k}$
d) $\mu_r B_x\hat{i} + B_z\hat{k}$

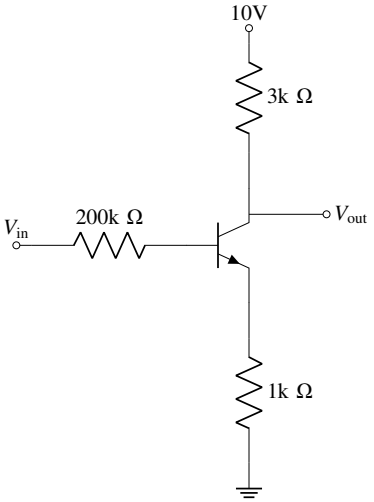
8) Let $|l, m\rangle$ be the simultaneous eigenstates of L^2 and L_z. Here $\mathbf{L}$ is the angular momentum operator with Cartesian components (L_x, L_y, L_z), l is the angular momentum quantum number and m is the azimuthal quantum number. The value of $\langle 1, 0|(L_x + iL_y)|1, -1\rangle$ is

(A) 0
(B) h
(C) $\sqrt{2}h$
(D) $\sqrt{3}h$

9) For the parity operator P, whoch of the following statements is NOT true?

a) $P^+ = P$
b) $P^2 = -P$
c) $P^2 = I$
d) $P^+ = P^{-1}$

10) For the transistor shown in the figure, assume $V_{BE} = 0.7V$ and $\beta_{dc} = 100$. If $V_{in} = 5V$, V_{out} (in Volts) is _____. (Give your answer upto one decimal place)



11) The state of a system is given by

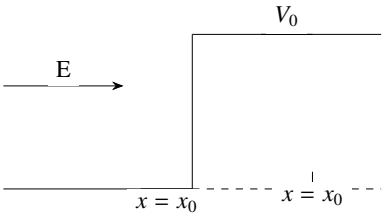
$$|\psi\rangle = |\phi_1\rangle + 2|\phi_2\rangle + 3|\phi_3\rangle$$

where $|\phi_1\rangle$, $|\phi_2\rangle$ and $|\phi_3\rangle$ form an orthonormal set. The probability of finding the system in the state $|\phi_2\rangle$ is _____. (Give your answer upto two decimal places)

12) According to the nuclear shee model, the respective groudn state spin-parity values of ${}^{15}_{8}O$ and ${}^{17}_{8}O$ nuclei are

a) $\frac{1^+}{2}, \frac{1^-}{2}$
b) $\frac{1^-}{2}, \frac{5^+}{2}$
c) $\frac{3^-}{2}, \frac{5^+}{2}$
d) $\frac{3^-}{2}, \frac{1^-}{2}$

13) A particle of mass m and energy E, moving in the positive x direction, is incident on a step potential at $x = 0$, as indicated in the figure. The height of the potential is V_0, where $V_0 > E$. At $x = x_0$, where $x_0 > 0$, the probability of finding the electron is $\frac{1}{e}$ times the probability of finding it at $x = 0$. If $\alpha = \sqrt{\frac{2m(V_0 - E)}{H^2}}$, the value of x_0 is



a) $\frac{2}{\alpha}$
b) $\frac{1}{\alpha}$
c) $\frac{1}{2\alpha}$
d) $\frac{1}{4\alpha}$