GATE
PH - 2012

EE24BTECH11061 - Rohith Sai

Single Correct 1 Mark each

1) Identify the CORRECT statement for the following vectors $\mathbf{a} = \mathbf{3i} + \mathbf{2j}$ and $\mathbf{b} = i + 2j$

a) The vectors **a** and **b** are linearly independent
b) The vectors **a** and **b** are linearly dependent
c) The vectors **a** and **b** are orthogonal
d) The vectors **a** and **b** are normalized

2) Two uniform thin rods of equal length, L, and masses M_1 and M_2 are joined together along the length. The moment of inertia of the combined rod of length $2L$ about an axis passing through the mid-point and perpendicular to the length of the rod is,

a) $(M_1 + M_2)\frac{L^2}{12}$
b) $(M_1 + M_2)\frac{L^2}{6}$
c) $(M_1 + M_2)\frac{L^2}{3}$
d) $(M_1 + M_2)\frac{L^2}{2}$

3) The space-time dependence of the electric field of a linearly polarized light in free space is given by $xE_0 \cos \omega t - kz$ where E_0, ω and k are the amplitude, the angular frequency and the wavevector, respectively. The time averaged energy density associated with the electric field is

a) $\frac{1}{4}\epsilon_0 E_0^2$
b) $\frac{1}{2}\epsilon_0 E_0^2$
c) $\epsilon_0 E_0^2$
d) $2\epsilon_0 E_0^2$

4) If the peak output voltage of a full wave rectifier is 10 V, its d.c. voltage is

a) 10.0 V
b) 7.07 V
c) 6.36 V
d) 3.18 V

5) A particle of mass m is confined in a two dimensional square well potential of dimension a. This potential $V(x, y)$ is given by

$$V(x, y) = 0 \text{ for } -a < x < a \text{ and } -a < y < a$$
$$= \infty \text{ elsewhere}$$

The energy of the first excited state for this particle is given by,

a) $\frac{\pi^2\hbar^2}{mq^2}$
b) $\frac{2\pi^2\hbar^2}{ma^2}$
c) $\frac{5\pi^2\hbar^2}{2ma^2}$
d) $\frac{4\pi^2\hbar^2}{ma^2}$

6) The isothermal compressibility, κ of an ideal gas at temperature T_0 and volume V_0, is given by

a) $-\frac{1}{V_0}\frac{\partial V}{\partial P}\Big|_{T_0}$
b) $\frac{1}{V_0}\frac{\partial V}{\partial P}\Big|_{T_0}$
c) $-V_0\frac{\partial P}{\partial V}\Big|_{T_0}$
d) $V_0\frac{\partial P}{\partial V}\Big|_{T_0}$

7) The ground state of sodium atom $\left({}^{11}Na\right)$ is a ${}^2S_{1/2}$ state. The difference in energy levels arising in the presence of a weak external magnetic field B, given in terms of Bohr magneton, μ_B, is

a) μ_B
b) $2\mu_B$
c) $4\mu_B$
d) $6\mu_B$

8) For an ideal Fermi gas in three dimensions, the electron velocity v_F at the Fermi surface is related to electron concentration n as,

a) $v_F \propto n^{2/3}$
b) $v_F \propto n$
c) $v_F \propto n^{1/2}$
d) $v_F \propto n^{1/3}$

9) Which one of the following sets corresponds to fundamental particles?

a) proton, electron and neutron
b) proton, electron and photon
c) electron, photon and neutrino
d) quark, electron and meson

10) In case of a Geiger-Muller (GM) counter, which one of the following statements is CORRECT?

a) Multiplication factor of the detector is of the order of 10^{10}
b) Type of the particles detected can be identified
c) Energy of the particles detected can be distinguished
d) Operating voltage of the detector is few tens of Volts

11) A plane electromagnetic wave traveling in free space is incident normally on a glass plate of refractive index $\frac{3}{2}$. If there is no absorption by the glass, its reflectivity is

a) 4%
b) 16%
c) 20%e
d) 50%

12) A Ge semiconductor is doped with acceptor impurity concentration of 10^{15} atoms/cm^3. For the given hole mobility of 1800 cm^2/V-s, the resistivity of this material is

a) 0.288Ω cm
b) 0.694Ω cm
c) 3.472Ω cm
d) 6.944Ω cm

13) A classical gas of molecules, each of mass m, is in thermal equilibrium at the absolute temperature, T. The velocity components of the molecules along the Cartesian axes are v_x, v_y and v_z. The mean value of $\left(v_x + v_y\right)^2$ is

a) $\frac{k_B T}{m}$
b) $\frac{3}{2}\frac{k_B T}{m}$
c) $\frac{1}{2}\frac{k_B T}{m}$
d) $2\frac{k_B T}{m}$