2017-PH-1-13

AI24BTECH11002 - K. Akshay Teja

1) Identical charges q are placed at five vertices of a regular hexagon of side a. Find the electric field and electrostatic potential at the center of the hexagon.

a) $0, 0$ b) $\frac{q}{4\pi\epsilon_o a^2}, \frac{q}{4\pi\epsilon_o a^2}$ c) $\frac{q}{4\pi\epsilon_o a^2}, \frac{5q}{4\pi\epsilon_o a^2}$ d) $\frac{\sqrt{5}q}{4\pi\epsilon_o a^2}, \frac{\sqrt{5}q}{4\pi\epsilon_o a^2}$

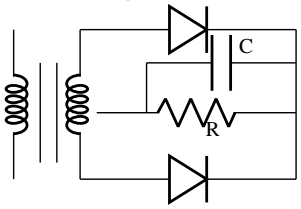
2) A parallel plate capacitor with square plates of side 1 m, separated by 1 micrometer is filled with a medium of dielectric constant 10If the charges on two plates are 1 C and -1 C, the voltage across the capacitor is _____ kV.(up to two decimal places). ($\epsilon_0 = 8.854 \times 10^{-12}$F/m)

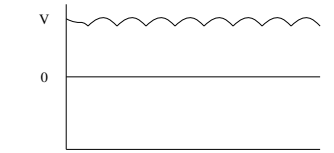
3) Light is incident from a medium of refractive index $n = 1.5$ onto vacuum. Find the smallest angle of incidence for which the light is not transmitted into the vacuum is _____ degrees.(up to two decimal places).

4) A monochromatic plane wave in free space with an electric field amplitude of 1 V/m is normally incident on a fully reflecting mirror. The pressure exerted on the mirror is _____$\times 10^{-12}$ Pa.(up to two decimal places). ($\epsilon_0 = 8.854 \times 10^{-12}$F/m)

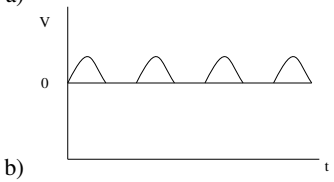
5) The best resolution that a 7-bit A/D converter with a 5 V full scale can achieve is _____ mV.(up to two decimal places).

6) In the figure given below, the input to the primary of the transformer is a voltage varying sinusoidally with time. The resistor R is connected to the center tap of the secondary. Which on of the following plots represents the voltage across the resistor R as a function of time?

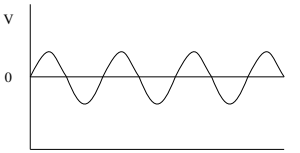




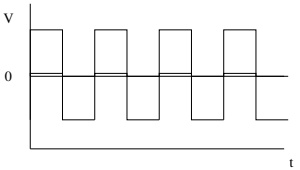
a)



b)



c)



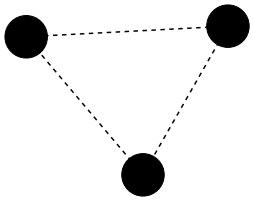
d)

7) The atomic mass and mass density of Sodium are 23 and 0.968 g/cm^3, respectively. The number density of valence electrons is _____$\times 10^{22}$cm^3.(up to two decimal places). (Avagadro number, $N_A = 6.023 \times 10^{23}$).

8) Consider a one-dimensional lattice with a weak periodic potential $U(x) = U_0 \cos\left(\frac{2\pi x}{a}\right)$ and a gap at the edge of the Brillouin zone where $\left(k = \frac{\pi}{a}\right)$ is:

a) U_0 b) $\frac{U_0}{2}$ c) $2U_0$ d) $\frac{U_0}{4}$

9) Consider a triatomic molecule of the shape shown in the figure below in three dimensions. The heat capacity of this molecule at high temperature (temperature much higher than the vibrational and rotational energy scales of the molecule but lower than its bond dissociation energies) is:



a) $\frac{3}{2}k_B$ b) $2k_B$ c) $\frac{9}{2}k_B$ d) $6k_B$

10) If the Lagrangian $L_0 = \frac{1}{2}m\left(\frac{dq}{dt}\right)^2 - \frac{1}{2}m\omega^2 q^2$ is modified to $L = L_0 + \alpha q\left(\frac{dq}{dt}\right)$, which one of the following is TRUE?

a) Both the canonical momentum and equation of motion do not change
b) Canonical momentum changes, equation of motion does not change
c) Canonical momentum does not change, equation of motion changes
d) Both the canonical momentum and equation of motion change

11) Two identical masses of 10 g each are connected by a massless spring of spring constant 1 N/m. The non-zero angular eigenfrequency of the system is _____ rad/s. (up to two decimal places).

12) The phase space trajectory of an otherwise free particle bouncing between two hard walls elastically in one dimension is a

a) straight line b) parabola c) rectangle d) circle

13) The Poisson bracket $\left[x, xp_y + yp_x\right]$ is equal to:

a) $-x$ b) y c) $2p_x$ d) p_y