

# 2014-PH-14-26

EE24BTECH11003 - Akshara Sarma Chennubhatla

- 1) If the half-life of an elementary particle moving with speed  $0.9c$  in the laboratory frame is  $5 \times 10^{-8}$  s, then the proper half-life is \_\_\_\_\_  $\times 10^{-8}$  s. ( $c = 3 \times 10^8$  m/s) (2014)
- 2) An unpolarized light wave is incident from air on a glass surface at the Brewster angle. The angle between the reflected and the refracted wave is (2014)
  - a)  $0^\circ$
  - b)  $45^\circ$
  - c)  $90^\circ$
  - d)  $120^\circ$
- 3) Two masses  $m$  and  $3m$  are attached to the two ends of a massless spring with force constant  $K$ . If  $m = 100$  g and  $K = 0.3$  N/m, then the natural angular frequency of oscillation is \_\_\_\_\_ Hz. (2014)
- 4) The electric field of a uniform plane wave propagating in a dielectric, non-conducting medium is given by,

$$\mathbf{E} = \mathbf{x}10 \cos(6\pi \times 10^7 t - 0.4\pi z) \text{ V/m.}$$

The phase velocity of the wave is \_\_\_\_\_  $\times 10^8$  m/s. (2014)

- 5) The matrix  $A = \frac{1}{\sqrt{3}} \begin{pmatrix} 1 & 1+i \\ 1-i & -1 \end{pmatrix}$  is (2014)
  - a) orthogonal
  - b) symmetric
  - c) anti-symmetric
  - d) unitary
- 6) The recoil momentum of an atom is  $p_A$  when it emits an infrared photon of wavelength 1500 nm, and it is  $p_B$  when it emits a photon of visible wavelength 500 nm. The ratio  $\frac{p_A}{p_B}$  is (2014)
  - a) 1 : 1
  - b) 1 :  $\sqrt{3}$
  - c) 1 : 3
  - d) 3 : 2
- 7) For a gas under isothermal conditions, its pressure  $P$  varies with volume  $V$  as  $P \propto V^{-\frac{5}{3}}$ . The bulk modulus  $B$  is proportional to (2014)
  - a)  $V^{-\frac{1}{2}}$
  - b)  $V^{-\frac{2}{3}}$
  - c)  $V^{-\frac{3}{5}}$
  - d)  $V^{-\frac{5}{3}}$
- 8) Which one of the following high energy processes is allowed by conservation laws? (2014)
  - a)  $p + \bar{p} \rightarrow \Lambda^0 + \Lambda^0$
  - b)  $\pi^- + p \rightarrow \pi^0 + n$
  - c)  $n \rightarrow p + e^- + \nu_e$
  - d)  $\mu^+ \rightarrow e^+ + \gamma$
- 9) The length element  $ds$  of an arc is given by,  $(ds)^2 = 2(dx^2)^2 + \sqrt{3}dx^1 dx^2$ . The metric tensor  $g_g$  is (2014)

- a)  $\begin{pmatrix} 2 & \sqrt{3} \\ \sqrt{3} & 1 \end{pmatrix}$   
 b)  $\begin{pmatrix} 2 & \sqrt{\frac{3}{2}} \\ \sqrt{\frac{3}{2}} & 1 \end{pmatrix}$   
 c)  $\begin{pmatrix} 2 & 1 \\ \sqrt{\frac{3}{2}} & \sqrt{\frac{3}{2}} \end{pmatrix}$   
 d)  $\begin{pmatrix} 1 & \sqrt{\frac{3}{2}} \\ \sqrt{\frac{3}{2}} & 2 \end{pmatrix}$

10) The ground state and the first excited state wave functions of a one dimensional infinite potential well are  $\psi_1$  and  $\psi_2$ , respectively. When two spin-up electrons are placed in this potential, which one of the following, with  $x_1$  and  $x_2$  denoting the position of the two electrons, correctly represents the space part of the ground state wave function of the system? (2014)

- a)  $\frac{1}{\sqrt{2}} [\psi_1(x_1)\psi_2(x_1) - \psi_1(x_2)\psi_2(x_2)]$   
 b)  $\frac{1}{\sqrt{2}} [\psi_1(x_1)\psi_2(x_2) + \psi_1(x_2)\psi_2(x_1)]$   
 c)  $\frac{1}{\sqrt{2}} [\psi_1(x_1)\psi_2(x_1) + \psi_1(x_2)\psi_2(x_2)]$   
 d)  $\frac{1}{\sqrt{2}} [\psi_1(x_1)\psi_2(x_2) - \psi_1(x_2)\psi_2(x_1)]$

11) If the vector potential

$$\mathbf{A} = \alpha x\mathbf{x} + 2y\mathbf{y} - 3z\mathbf{z},$$

satisfies the Colomb gauge, the value of the constant  $\alpha$  is \_\_\_\_\_ (2014)

12) At a given temperature,  $T$ , the average energy per particle of a non-interacting gas of two-dimensional classical harmonic oscillators is \_\_\_\_\_  $k_B T$  ( $k_B$  is the Boltzmann constant). (2014)

13) Which of the following is a fermion? (2014)

- a)  $\alpha$  particle  
 b)  $Be_4^7$  nucleus  
 c) Hydrogen atom  
 d) Deuteron