# 2011-PH-'1-13'

## EE24BTECH11009-Mokshith

1) Two matrices $A$ and $B$ are said to be similar if $B = P^{-1}AP$ for some invertible matrix $P$. Which of the following statements is NOT TRUE?

   a) Det $A$ = Det $B$

   b) Trace of $A$ = Trace of $B$

   c) $A$ and $B$ have the same eigenvectors

   d) $A$ and $B$ have the same eigenvalues

2) If a force $F$ is derivable from a potential function $V(r)$, where $r$ is the distance from the origin of the coordinate system, it follows that

   a) $\overrightarrow{\nabla} \times \overrightarrow{F} = 0$

   b) $\overrightarrow{\nabla} \cdot \overrightarrow{F} = 0$

   c) $\overrightarrow{\nabla} V = 0$

   d) $\nabla^2 V = 0$

3) The quantum mechanical operator for the momentum of a particle moving in one dimension is given by

   a) $i\hbar \frac{d}{dx}$

   b) $-i\hbar \frac{d}{dx}$

   c) $i\hbar \frac{\partial}{\partial t}$

   d) $-\frac{\hbar^2}{2m} \frac{d^2}{dx^2}$

4) A Carnot cycle operates on a working substance between two reservoirs at temperatures $T_1$ and $T_2$, with $T_1 > T_2$. During each cycle, an amount of heat $Q_1$ is extracted from the reservoir at $T_1$ and an amount $Q_2$ is delivered to the reservoir at $T_2$. Which of the following statements is INCORRECT?

   a) work done in one cycle is $Q_1 - Q_2$

   b) $\frac{Q_1}{T_1} = \frac{Q_2}{T_2}$

   c) entropy of the hotter reservoir decreases

   d) entropy of the universe (consisting of the working substance and the two reservoirs) increases

5) In a first order phase transition, at the transition temperature, specific heat of the system

   a) diverges and its entropy remains the same

   b) diverges and its entropy has finite discontinuity

   c) remains unchanged and its entropy has finite discontinuity

   d) has finite discontinuity and its entropy diverges

6) The semi-empirical mass formula for the binding energy of nucleus contains a surface correction term. This term depends on the mass number $A$ of the nucleus as

   a) $A^{-1/3}$

b) $A^{1/3}$

c) $A^{2/3}$

d) $A$

7) The population inversion in a two level laser material CANNOT be achieved by optical pumping because

a) the rate of upward transitions is equal to the rate of downward transitions

b) the upward transitions are forbidden but downward transitions are allowed

c) the upward transitions are allowed but downward transitions are forbidden

d) the spontaneous decay rate of the higher level is very low

8) The temperature ($T$) dependence of magnetic susceptibility ($\chi$) of a ferromagnetic substance with a Curie temperature ($T_c$) is given by

a) $\frac{C}{T-T_c}$, for $T < T_c$

b) $\frac{C}{T-T_c}$, for $T > T_c$

c) $\frac{C}{T+T_c}$, for $T > T_c$

d) $\frac{C}{T+T_c}$, for all temperatures

where $C$ is constant.

9) The order of magnitude of the energy gap of a typical superconductor is

a) $1 MeV$

b) $1 KeV$

c) $1 eV$

d) $1 meV$

10) Which of the following statements is CORRECT for a common emitter amplifier circuit?

a) The output is taken from the emitter

b) There is 180° phase shift between input and output voltages

c) There is no phase shift between input and output voltages

d) Both $p$-$n$ junctions are forward biased

11) A $3 \times 3$ matrix has elements such that its trace is 11 and its determinant is 36. The eigenvalues of the matrix are all known to be positive integers. The largest eigenvalue of the matrix is

a) 18

b) 12

c) 9

d) 6

12) A heavy symmetrical top is rotating about its own axis of symmetry (the $z$-axis). If $I_1$, $I_2$ and $I_3$ are the principal moments of inertia along $x$, $y$ and $z$ axes respectively, then

a) $I_2 = I_3;\ I_1 \neq I_2$

b) $I_1 = I_3;\ I_1 \neq I_2$

c) $I_1 = I_2;\ I_1 \neq I_3$

d) $I_1 \neq I_2 \neq I_3$

13) An electron with energy $E$ is incident from left on a potential barrier, given by

$$V(x) = \begin{cases} 0 & \text{for } x < 0 \\ V_0 & \text{for } x > 0 \end{cases}$$

as shown in the figure.
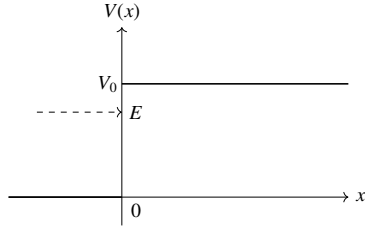


For $E < V_0$, the space part of the wave function for $x > 0$ is of the form

a) $e^{\alpha x}$

b) $e^{-\alpha x}$

c) $e^{i\alpha x}$

d) $e^{-i\alpha x}$

where $\alpha$ is a real positive quantity.