# 2009-PH-1-12

AI24BTECH11023 - Tarun Reddy Pakala

1) The value of the contour integral, $\left|\int_C \vec{r} \times d\vec{\theta}\right|$, for a circle $C$ of radius $r$ with center at origin is
   a) $2\pi r$
   b) $r^2/2$
   c) $\pi r^2$
   d) $r$
2) An electrostatic field $\vec{E}$ exists in a given region R. Choose the WRONG statement.
   a) Circulation of $\vec{E}$ is zero
   b) $\vec{E}$ can always be expressed as the gradient of a scalar field
   c) The potential difference between any two arbitrary points in the region R is zero
   d) The work done in a closed path lying entirely in R is zero
3) The Lagrangian of a free particle in spherical polar co-ordinates is given by $L = \frac{1}{2}m\left(\dot{r}^2 + r^2\dot{\theta}^2 + r^2\dot{\phi}^2\sin^2\theta\right)$. The quantity that is conserved is
   a) $\frac{\partial L}{\partial \dot{r}}$
   b) $\frac{\partial L}{\partial \dot{\theta}}$
   c) $\frac{\partial L}{\partial \dot{\phi}}$
   d) $\frac{\partial L}{\partial \dot{\phi}} + \dot{r}\dot{\theta}$
4) A conducting loop $L$ of surface area $S$ is moving with a velocity $\vec{v}$ in a magnetic field $\vec{B}(\vec{r}, t)=\vec{B_0}t^2$, $B_o$ is a positive constant of suitable dimensions. The emf induced, $V_{emf}$, in the loop is given by
   a) $-\int_S \frac{\partial \vec{B}}{\partial t} \cdot d\vec{S}$
   b) $\oint_L (\vec{v} \times \vec{B}) \cdot d\vec{L}$
   c) $-\int_S \frac{\partial \vec{B}}{\partial t} \cdot d\vec{S} - \oint_L (\vec{v} \times \vec{B}) \cdot d\vec{L}$
   d) $-\int_S \frac{\partial \vec{B}}{\partial t} \cdot d\vec{S} + \oint_L (\vec{v} \times \vec{B}) \cdot d\vec{L}$
5) The eigenvalues of the matrix $A = \begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ are
   a) real and distinct
   b) complex and distinct
   c) complex and coinciding
   d) real and coinciding
6) $\sigma_i (i = 1, 2, 3)$ represent the Pauli spin matrices. Which one of the following is NOT true ?
   a) $\sigma_i\sigma_j + \sigma_j\sigma_i = 2\delta_{ij}$
   b) $Tr(\sigma_i) = 0$
   c) The eigenvalues of $\sigma_i$ are $\pm 1$
   d) $\det(\sigma_i) = 1$
7) Which one of the functions given below represents the bound state eigenfunction of the operator $-\frac{d^2}{dx^2}$ in the region, $0 \le x < \infty$ with the eigenvalue -4 ?
   a) $A_o e^{2x}$
   b) $A_o \cosh 2x$
   c) $A_o e^{-2x}$

d) $A_o \sinh 2x$

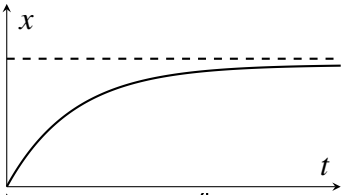
8) Pick the WRONG statement.
   a) The nuclear force is independent of electric charge
   b) The Yukawa potential is proportional to $r^{-1}\exp\left(\frac{mc}{\hbar}r\right)$, where $r$ is the separation between two nucleons
   c) The range of nuclear force is order of $10^{-15}m - 10^{-14}m$
   d) The nucleons interact among each other by the exchange of mesons

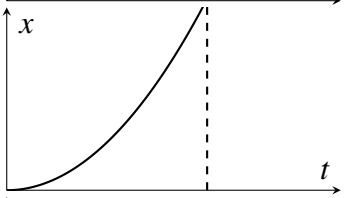
9) If $p$ and $q$ are the position and momentum variables, which one of the following is NOT a canonical transformation ?
   a) $Q = \alpha q$ and $P = \frac{1}{\alpha}p$, for $\alpha \neq 0$
   b) $Q = \alpha q + \beta p$ and $P = \beta q + \alpha p$ for $\alpha, \beta$ real and $\alpha^2 - \beta^2 = 1$
   c) $Q = p$ and $P = q$
   d) $Q = p$ and $P = -q$

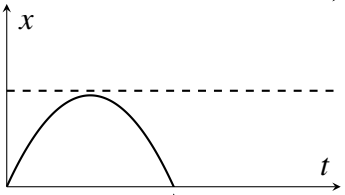
10) The Common Mode Rejection Ratio (CMRR) of a differential amplifier using an operational amplifier is 100 dB. The output voltage for a differential input of 200 $\mu$V is 2 V. The common mode gain is
   a) 10
   b) 0.1
   c) 30 dB
   d) 10 dB

11) In an insulating solid which one of the following physical phenomena is a consequence of Pauli's exclusion principle ?
   a) Ionic conductivity
   b) Ferromagnetism
   c) Paramagnetism
   d) Ferroelectricity

12) Which one of the following curves gives the solution of the differential equation $k_1\frac{dx}{dt} + k_2 x = k_3$, where $k_1, k_2$ and $k_3$ are positive constants with initial conditions $x = 0$ at $t = 0$ ?

a) 


b) 


c) 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