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EE24BTECH11004 - ANKIT JAINAR

1) What is the maximum number of free independent real parameters specifying an n-dimensional orthogonal matrix?
   a) $n(n-2)$
   b) $(n-1)^2$
   c) $\frac{n(n-1)}{2}$
   d) $\frac{n(n+1)}{2}$
2) An excited state of Ca atom is $[\mathrm{Mg}]3p^5 4s^2 3d^1$. The spectroscopic terms corresponding to the total orbital angular momentum are
   a) S, P, and D
   b) P, D, and F
   c) P and D
   d) S and P
3) On the surface of a spherical shell enclosing a charge-free region, the electrostatic potential values are as follows: One quarter of the area has potential $\phi_0$, another quarter has potential $2\phi_0$, and the rest has potential $4\phi_0$. The potential at the centre of the shell is (You can use a property of the solution of Laplace's equation.)
   a) $\frac{11}{4}\phi_0$
   b) $\frac{11}{2}\phi_0$
   c) $\frac{7}{3}\phi_0$
   d) $\frac{7}{4}\phi_0$
4) A point charge $q$ is performing simple harmonic oscillations of amplitude $A$ at angular frequency $\omega$. Using Larmor's formula, the power radiated by the charge is proportional to
   a) $q\,\omega^2 A^2$
   b) $q\,\omega^4 A^2$
   c) $q^2\omega^2 A^2$
   d) $q^2\omega^4 A^2$
5) Which of the following relationships between the internal energy $U$ and the Helmholtz free energy $F$ is true?
   a) $U = -T^2\left[\frac{\partial}{\partial T}\left(\frac{F}{T}\right)\right]_V$
   b) $U = +T^2\left[\frac{\partial}{\partial T}\left(\frac{F}{T}\right)\right]_V$
   c) $U = +T\left[\frac{\partial F}{\partial T}\right]_V$
   d) $U = -T\left[\frac{\partial F}{\partial T}\right]_V$
6) If nucleons in a nucleus are considered to be confined in a three-dimensional cubical box, then the first four magic numbers are
   a) $2, 8, 20, 28$
   b) $2, 8, 16, 24$
   c) $2, 8, 14, 20$
   d) $2, 10, 16, 28$
7) Consider the ordinary differential equation $y'' - 2xy' + 4y = 0$ and its solution $y(x) = a + bx + cx^2$. Then

a) $a = 0,\ c = -2b \neq 0$
b) $c = -2a \neq 0,\ b = 0$
c) $b = -2a \neq 0,\ c = 0$
d) $c = 2a \neq 0,\ b = 0$

8) For an Op-Amp based negative feedback, non-inverting amplifier, which of the following statements are true?
a) Closed loop gain < Open loop gain
b) Closed loop bandwidth < Open loop bandwidth
c) Closed loop input impedance > Open loop input impedance
d) Closed loop output impedance < Open loop output impedance

9) From the pairs of operators given below, identify the ones which commute. Here $l$ and $j$ correspond to the orbital angular momentum and the total angular momentum, respectively.
a) $l^2, j^2$
b) $j^2, j_z$
c) $j^2, l_z$
d) $l_z, j_z$

10) For normal Zeeman lines observed $\|$ and $\perp$ to the magnetic field applied to an atom, which of the following statements are true?
a) Only $\pi$-lines are observed $\|$ to the field
b) $\sigma$-lines $\perp$ to the field are plane polarized
c) $\pi$-lines $\perp$ to the field are plane polarized
d) Only $\sigma$-lines are observed $\|$ to the field

11) Pauli spin matrices satisfy
a) $\sigma_\alpha\sigma_\beta - \sigma_\beta\sigma_\alpha = i\epsilon_{\alpha\beta\gamma}\sigma_\gamma$
b) $\sigma_\alpha\sigma_\beta - \sigma_\beta\sigma_\alpha = 2i\epsilon_{\alpha\beta\gamma}\sigma_\gamma$
c) $\sigma_\alpha\sigma_\beta + \sigma_\beta\sigma_\alpha = \epsilon_{\alpha\beta\gamma}\sigma_\gamma$
d) $\sigma_\alpha\sigma_\beta + \sigma_\beta\sigma_\alpha = 2\delta_{\alpha\beta}$

12) For the refractive index $n = n_r(\omega) + in_{im}(\omega)$ of a material, which of the following statements are correct?
a) $n_r$ can be obtained from $n_{im}$ and vice versa
b) $n_{im}$ could be zero
c) $n$ is an analytic function in the upper half of the complex $\omega$ plane
d) $n$ is independent of $\omega$ for some materials

13) Complex function $f(z) = z + |z - a|^2$ ($a$ is a real number) is
a) continuous at $(a, a)$
b) complex-differentiable at $(a, a)$
c) complex-differentiable at $(a, 0)$
d) analytic at $(a, 0)$