

2013-PH-1-13

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- 1) $f(x)$ is a symmetric periodic function of x i.e. $f(x) = f(-x)$. Then, in general, the Fourier series of the function $f(x)$ will be of the form (2013)
 - a) $f(x) = \sum_{n=1}^{\infty} (a_n \cos(nkx) + b_n \sin(nkx))$
 - b) $f(x) = a_0 + \sum_{n=1}^{\infty} (a_n \cos(nkx))$
 - c) $f(x) = \sum_{n=1}^{\infty} (b_n \sin(nkx))$
 - d) $f(x) = a_0 + \sum_{n=1}^{\infty} (b_n \sin(nkx))$
- 2) In the most general case, which one of the following quantities is NOT a second order tensor? (2013)
 - a) Stress
 - b) Strain
 - c) Moment of inertia
 - d) Pressure
- 3) An electron is moving with a velocity of $0.85c$ in the same direction as that of a moving photo. The relative velocity of the electron with respect to photon is (2013)
 - a) c
 - b) $-c$
 - c) $0.15c$
 - d) $-0.15c$
- 4) If Planck's constant were zero, then the total energy contained in a box filled with radiation of all frequencies at temperature T would be (k is the Boltzmann constant and T is nonzero) (2013)
 - a) Zero
 - b) Infinite
 - c) $\frac{3}{2}kT$
 - d) kT
- 5) Across a first order phase transition, the free energy is (2013)
 - a) proportional to the temperature
 - b) a discontinuous function of the temperature
 - c) a continuous function of the temperature but its first derivative is discontinuous
 - d) such that the first derivative with respect to temperature is continuous
- 6) Two gases separated by an impermeable but movable partition are allowed to freely exchange energy. At equilibrium, the two sides will have the same (2013)
 - a) pressure and temperature
 - b) volume and temperature
 - c) pressure and volume
 - d) volume and energy
- 7) The entropy function of a system is given by $S(E) = aE(E_0 - E)$ where a and E_0 are positive constants. The temperature of the system is (2013)
 - a) negative for some energies
 - b) increases monotonically with energy
 - c) decreases monotonically with energy
 - d) Zero
- 8) Consider a linear collection of N independent spin $\frac{1}{2}$ particles, each at a fixed location. The entropy of this system is (k is the Boltzmann constant) (2013)

- a) Zero
- b) Nk
- c) $\frac{1}{2}Nk$
- d) $Nk \ln(2)$

9) The decay process $n \rightarrow p^+ + e^- + \bar{\nu}_e$ violates (2013)

- a) baryon number
- b) lepton number
- c) isospin
- d) strangeness

10) The isospin (I) and baryon number (B) of the up quark is (2013)

- a) $I = 1, B = 1$
- b) $I = 1, B = \frac{1}{3}$
- c) $I = \frac{1}{2}, B = 1$
- d) $I = \frac{1}{2}, B = \frac{1}{3}$

11) Consider the scattering of neutrons by protons at very low energy due to a nuclear potential of range r_0 . Given that,

$$\cot(kr_0 + \delta) \approx -\frac{\gamma}{k}$$

where δ is the phase shift, k the wave number and $(-\gamma)$ the logarithmic derivative of the deuteron ground state wave function, the phase shift is (2013)

- a) $\delta \approx -\frac{k}{\gamma} - kr_0$
- b) $\delta \approx -\frac{\gamma}{k} - kr_0$
- c) $\delta \approx \frac{\pi}{2} - kr_0$
- d) $\delta \approx -\frac{\pi}{2} - kr_0$

12) In the β decay process, the transition $2^+ \rightarrow 3^+$, is (2013)

- a) allowed both by Fermi and Gamow-Teller selection rule
- b) allowed by Fermi and but not by Gamow-Teller selection rule
- c) not allowed by Fermi but allowed by Gamow-Teller selection rule
- d) not allowed both by Fermi and Gamow-Teller selection rule

13) At a surface current, which one of the magnetostatic boundary condition is NOT CORRECT? (2013)

- a) Normal component of the magnetic field is continuous.
- b) Normal component of the magnetic vector potential is continuous.
- c) Tangential component of the magnetic vector potential is continuous.
- d) Tangential component of the magnetic vector potential is not continuous.