9. An observer is sitting on a horizontal platform which is rotating with a constant angular velocity. He puts an object on the smooth frictionless floor of the platform, away from the axis of rotation, with zero initial velocity with respect to him. Let the time at this instant be $t = 0$. In the frame of the platform, the object would

(A) remain at rest for all $t > 0$

(B) accelerate purely in a radial direction outwards for all $t > 0$

(C) accelerate purely in a tangential direction for all $t > 0$

(D) accelerate radially in the outward direction at $t = 0$, however the direction of acceleration changes for $t > 0$

10. Which of the following is ***INCORRECT*** for the matrix $M = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$?

(A) It is its own inverse

(B) It is its own transpose

(C) It is non-orthogonal

(D) It has eigen values ± 1

11. A combination of two thin convex lenses of equal focal lengths, is kept separated along the optic axes by a distance of 20 cm between them. The combination behaves as a lens system of infinite focal length. If an object is kept at 10 cm from the first lens, its image will be formed on the other side at a distance x from the second lens. The value of x is

(A) 10 cm

(B) 20 cm

(C) 6.67 cm

(D) infinite

12. Two point charges $+q_1$ and $+q_2$ are fixed with a finite distance d between them. It is desired to put a third charge q_3 in between these two charges on the line joining them so that the charge q_3 is in equilibrium. This is

(A) possible only if q_3 is positive

(B) possible only if q_3 is negative

(C) possible irrespective of the sign of q_3

(D) not possible at all

13. A periodic function can be expressed in a Fourier series of the form, $f(x) = \sum_{n=0}^{\infty} \left(a_n \cos(nx) + b_n \sin(nx)\right)$. The functions $f_1(x) = \cos^2 x$ and $f_2(x) = \sin^2 x$ are expanded in their respective Fourier series. If the coefficients for the first series are $a_n^{(1)}$ and $b_n^{(1)}$, and the coefficients for the second series are $a_n^{(2)}$ and $b_n^{(2)}$, respectively, then which of the following is correct?

(A) $a_2^{(1)} = \frac{1}{2}$ and $b_2^{(2)} = \frac{-1}{2}$

(B) $b_2^{(1)} = \frac{1}{2}$ and $a_2^{(2)} = \frac{-1}{2}$

(C) $a_2^{(1)} = \frac{1}{2}$ and $a_2^{(2)} = \frac{-1}{2}$

(D) $b_2^{(1)} = \frac{1}{2}$ and $b_2^{(2)} = \frac{-1}{2}$

14. Which of the following statements is correct for NaCl crystal structure?

(A) It is a simple cubic lattice with one atom basis

(B) It is a face-centered cubic lattice with one atom basis

(C) It is a simple cubic lattice with two atom basis

(D) It is a face-centered cubic lattice with two atom basis

15. Which of the following statements is ***INCORRECT*** ?

(A) Indistinguishable particles obey Maxwell-Boltzmann statistics

(B) All particles of an ideal Bose gas occupy a single energy state at $T = 0$

(C) The integral spin particles obey Bose-Einstein statistics

(D) Protons obey Fermi-Dirac statistics

16. (a) Consider a constant vector field $\vec{v} = v_o \hat{k}$. Find any one of the many possible vectors $\vec{u}$, for which $\vec{\nabla} \times \vec{u} = \vec{v}$.

(b) Using Stoke's theorem, evaluate the flux associated with the field $\vec{v}$ through the curved hemispherical surface defined by $x^2 + y^2 + z^2 = r^2, z > 0$.