1. For a motion under the central force $-\frac{k}{r^2}$. If it starts on the +ve X-axis at a distance $a$ away from the origin and moves with speed $v_0$ in direction making an angle $\alpha$ with X-axis, the differential equation can be written as
   
   (i) $\frac{d^2r}{dt^2} = \frac{k-ma^2v_0^2\sin^2\alpha}{mr^3}$
   
   (ii) $\frac{d^2r}{dt^2} = \frac{k-ma^2v_0^2\sin^2\alpha}{mr^3}$
   
   (iii) $\frac{d^2r}{dt^2} = \frac{k+ma^2v_0^2\sin^2\alpha}{mr^3}$
   
   (iv) $\frac{d^2r}{dt^2} = \frac{k+ma^2v_0^2\sin^2\alpha}{mr^3}$

2. A particle is described by an attractive central force moves in an orbit given by $r = a\cos(\theta)$, the law of force is proportional to
   
   (i) $\frac{1}{r^2}$
   
   (ii) $\frac{1}{r^2}$
   
   (iii) $\frac{1}{r^3}$
   
   (iv) $\frac{1}{r^3}$

3. A particle describes an equiangular spiral $r = ae^\theta$ in such a manner that its acceleration has no radial component. Then
   
   (i) angular velocity is zero
   
   (ii) angular velocity is constant and magnitude of velocity is proportional to $r$
   
   (iii) angular velocity is constant and magnitude of velocity is proportional to $\frac{1}{r}$
   
   (iv) angular velocity and magnitude of velocity is proportional to $r$.

4. For attractive inverse square force field $f(R) = -\frac{k}{R^2}$, show that the velocity at any point of the for an hyperbolic path may be given as
   
   (i) $v^2 = \frac{k}{m}\left[\frac{2}{r} - \frac{1}{a}\right]$
   
   (ii) $v^2 = \frac{k}{m}\left[\frac{2}{r} + \frac{1}{a}\right]$
   
   (iii) $v^2 = \frac{k}{m}\left[\frac{2}{r} - \frac{1}{a}\right]$
   
   (iv) $v^2 = \frac{k}{m}\left[\frac{2}{r} + \frac{1}{a}\right]$
6. The central force necessary to make a particle describe the lemniscate \( r^2 = a^2 \cos 2\theta \) is
   (i) proportional to \( r^7 \)
   (ii) inversely proportional to \( r \)
   (iii) proportional to \( r \)
   (iv) inversely proportional to \( r^7 \)

7. If a particle describes a elliptic orbit under the influence of an attractive central force \( = -\frac{k}{r^2} \), then the period of revolution of the particle is
   (i) \( 2\pi a^{3/2} \sqrt{\frac{k}{m}} \)
   (ii) \( 2\pi a^{3/2} \sqrt{\frac{k}{m}} \)
   (iii) \( \pi a^{3/2} \sqrt{\frac{k}{m}} \)
   (iv) \( \pi a^{3/2} \sqrt{\frac{k}{m}} \)

8. Find the law of force to the pole when the orbit described by the cardioid \( r = a(1 - \cos \theta) \)
   (i) \( \propto r^{-1} \)
   (ii) \( \propto r^{-2} \)
   (iii) \( \propto r^{-3} \)
   (iv) \( \propto r^{-4} \)

9. Which one is the correct expression of areal velocity
   (i) \( \frac{1}{2} r^2 \dot{\theta} \)
   (ii) \( r^2 \dot{\theta} \)
   (iii) \( \frac{1}{2} r^2 \dot{\theta}^2 \)
   (iv) \( \frac{1}{2} r^2 \dot{\theta} \)

10. On the earth surface \( g \) can be expressed as
    (i) \( \sqrt{GM} \)
    (ii) \( \frac{GM}{R^2} \)
    (iii) \( \frac{GM}{R^2} \)
    (iv) \( \sqrt{\frac{GM}{R}} \)