10. Find the values of the magnitude of the angular momentum $J$ for which a finite motion is possible in a central conservative force field given by the potential energy
(i) $V(r) = -\frac{\alpha}{r}e^{-\kappa r}$,
(ii) $V(r) = -V_0 e^{-\kappa^2 r^2}$.

11. A particle of mass $m$ moves under an isotropic harmonic oscillator force with potential energy $V(r) = \frac{1}{2}k r^2$. Initially it is moving in a circle of radius $a$.
Find the orbital velocity $v$.
The particle is then given a blow of impulse $m v$ (in the plane of motion, $v$ is the found orbital velocity) in a direction making an angle $\alpha$ with its original velocity.
Use the conservation laws to determine its minimum and maximum distances from the origin during the subsequent motion. Explain your results physically for the two limiting cases $\alpha = 0$ and $\alpha = \pi$.

12. The minimum distance of a comet from the sun is observed to be half the radius of the earth’s orbit (assumed circular), and its velocity at that point is twice the orbital velocity of the earth around the sun. (The orbits of the earth and of the comet are in the same plane.)
Using conservation laws, check analytically whether the comet will subsequently escape from the solar system (neglecting the influence of the planets). What kind of orbit does it follow?
Find its velocity when it crosses the earth’s orbit, and the angle at which the orbits of the comet and the earth cross.