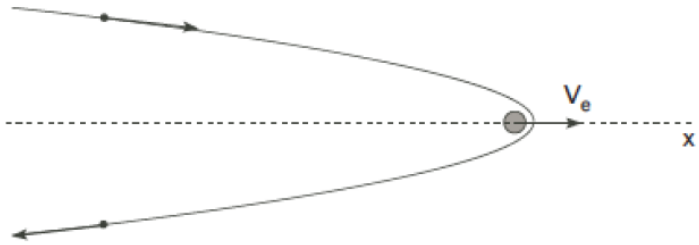
Assignment- Modern Physics-I

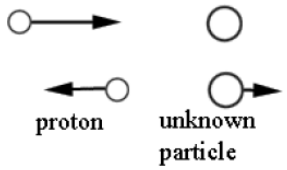
1. A particle has relativistic energy equal to three times its rest energy. Find its resulting speed and momentum. How do these results change if the total energy is six times its rest energy? Comment on the change in velocity

2.



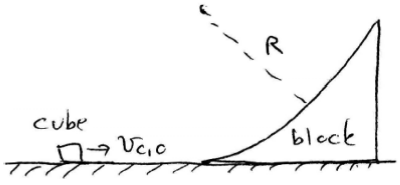
A satellite (with mass negligible compared to that of the Earth) is making a fly-by of the Earth. Let the velocity of the Earth be $\vec{\mathbf{v}}_e = v_e\hat{\mathbf{i}}$. The satellite's orbit is symmetric about a line through the center of the Earth that is parallel to x-axis. Far from the Earth the magnitude of the satellite's x-component of velocity is v_i when approaching and v_f when receding. For the case where $v_i = 4v_e$, (i) is the final speed v_f of the satellite greater, equal to, or less than the initial speed v_i of the satellite?, (ii) What is the final speed v_f of the satellite in terms of the speed of the earth v_e?

3.



A proton makes a head-on collision with an unknown particle at rest. The proton rebounds straight back with $4/9$ of its initial kinetic energy. Find the ratio of the mass of the unknown particle to the mass of the proton, assuming that the collision is elastic.

Problem 4 A block of mass m_b sits at rest on a frictionless table; the block has a circular surface of radius R as shown in the figure. A small cube of mass m_c and speed $v_{c,0}$ is incident upon the block; the cube moves frictionlessly on the table and the block.



a) What is the maximum height h above the table, attained by the cube (assume $v_{c,0}$ is small enough that $h < R$)?

b) The cube comes back down the block and when it leaves the block it is moving along the table in the opposite direction(to the left in the figure above). What is the final speed of the block when the cube is no longer on it? (Hint: think about the energy and momentum conditions.)