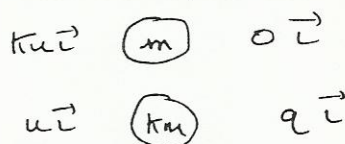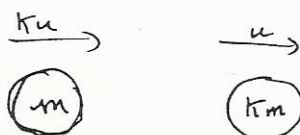5. (a)

5. (a) A smooth sphere P, of mass m, moving with speed ku collides directly with a smooth sphere Q, of mass km, moving in the same direction with speed u. P is brought to rest by the impact.

    (i)   Find the velocity of Q after the collision in terms of u.

    (ii)   Prove that $k \geq 3$.

$ku \rightarrow$ $u \rightarrow$ $ku\vec{\imath}$ (m) $0\vec{\imath}$

(m) (km) $u\vec{\imath}$ (km) $q\vec{\imath}$

COM ① $kmu + kmu = kmq$

         $2u = q$

NEL ② $\dfrac{0 - q}{ku - u} = -e \implies \dfrac{-2u}{ku - u} = -e$

       $\implies e = \dfrac{2u}{(k-1)u}$ $(k-1) > 0$ since $e > 0$

Now $0 \leq e \leq 1 \implies 0 \leq \dfrac{2u}{(k-1)u} \leq 1$

               $\implies 0 \leq 2u \leq (k-1)u$

               $\implies 0 \leq 2 \leq k - 1$

               $\implies 1 \leq 3 \leq k$

                $\therefore k \geq 3$

                 $\boxed{QED}$