Q- Suppose that a particle of mass m_1 approaches a stationary mass m_2 and that $m_2 >> m_1$.

a) Describe the velocity of m_2 after an elastic collision. Justify your answer mathematically.
b) What is the approximate momentum of m_1 after collision?

(a) As the mass m_2 of the resting body is very large as compared to m_1 and so the m_2 will move with very little velocity in the direction of motion of m_1 and m_1 itself will be rebound back with almost the same speed in opposite direction.

Let the velocity with which m_1 collides with m_2 is v_0. The velocity of m_1 after collision is v_1 and that of m_2 is v_2. Applying law of conservation of linear momentum we have

Total momentum before collision = total momentum after collision

Or $m_1v_0 + m_2*0 = m_1v_1 + m_2v_2$

Or $m_1v_0 = m_1v_1 + m_2v_2$ ----------------------- (1)

As the collision is perfectly elastic (e = 1)we have

Velocity of separation = velocity of approach

Or $v_2 - v_1 = v_0$

Gives $v_1 = v_2 - v_0$ ----------------------- (2)

Substituting value of v_1 from equation (2) into equation (1) we get

$m_1v_0 = m_1(v_2 - v_0) + m_2v_2$

or $2m_1v_0 = (m_1 + m_2)v_2$

Gives $v_2 = \frac{2m_1v_0}{(m_1+m_2)}$ ----------------------- (3)

Now as $m_2 >> m_1$ neglecting m_1 as compared to m_2 in denominator we get

$$v_2 = \frac{2m_1v_0}{m_2}$$

As the m_2 in denominator >> m_1 in numerator the magnitude of v2 will be very small as compared to v_0.

(b) Substituting value of v_2 from equation (3) in equation (2) we get

$$v_1 = v_2 - v_0 = \frac{2m_1v_0}{m_2} - v_0 = \frac{(2m_1-m_2)}{m_2}v_0$$

On approximation again we can neglect m_1 in numerator and gives

$$v_1 = -v_0$$

Means that the light particle will rebound with nearly the same speed