Answer on Question #51469, Physics, Mechanics | Kinematics | Dynamics

Two balls having masses m and 2m are fastened to two light strings of same length l which is held horizontally[say x axis, with the mass 2m at (l,0) and mass m at (-l,0)]. The strings are kept fixed at origin. This system is released from rest. Collision between the balls is elastic in nature.

a- find the velocities of the balls just after their collision and

b- how high will the balls rise after collision ?

Solution:

As a ball begins moving, its potential energy is converted to kinetic energy.

$$mgl = \frac{mv^2}{2}$$

Thus, the velocity of first and second ball is the same and equal

$$v = \sqrt{2gl}$$

The equation that denotes the conservation of momentum is:

$$m_1v_{1i} - m_2v_{2i} = -m_1v_{1f} + m_2v_{2f}$$

where, m_1 =m mass of object or ball 1

m_2 =2m mass of ball 2

v_{1i} $=v$ initial velocity of ball 1

$v_{2i}$$=v$ initial velocity of ball 2

v_{1f} = final velocity of ball 1

v_{2f} = final velocity of ball 2

$$2mv - mv = 2mv_{2f} + mv_{1f}$$

$$v = v_{1f} + 2v_{2f}$$

The kinetic energy conservation formula is

$$\frac{mv^2}{2} + \frac{2mv^2}{2} = \frac{mv_{1f}^2}{2} + \frac{2mv_{2f}^2}{2}$$

$$3v^2 = v_{1f}^2 + 2v_{2f}^2$$

Substituting

$$v_{2f} = \frac{v - v_{1f}}{2}$$

$$3v^2 = v_{1f}^2 + 2\left(\frac{v - v_{1f}}{2}\right)^2$$

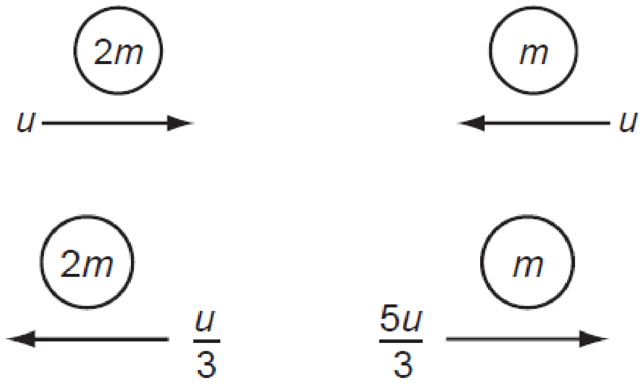
$$3v^2 = v_{1f}^2 + 2\left(\frac{v^2 - 2vv_{1f} + v_{1f}^2}{4}\right)$$

$$3v^2 = v_{1f}^2 + \frac{v^2}{2} - v_{1f} + \frac{v_{1f}^2}{2}$$

$$6v^2 = 2v_{1f}^2 + v^2 - 2vv_{1f} + v_{1f}^2$$

$$3v_{1f}^2 - 2vv_{1f} - 5v^2 = 0$$

$$v_{1f} = \frac{2v \pm \sqrt{4v^2 - 4 * 3 * (-5v^2)}}{6} = \frac{2v \pm v\sqrt{64}}{6} = \frac{5v}{3} \ or - v$$



$$v_{2f} = -\frac{1}{3}v \ \ or\ v$$

We choose set of solution

$$v_{1f} = \frac{5v}{3} = \frac{5}{3}\sqrt{2gl}$$

$$v_{2f} = -\frac{1}{3}\sqrt{2gl}$$

b.

$$h_1 = \frac{v_{1f}^2}{2g} = \frac{25 * 2gl}{9 * 2g} = \frac{25}{9}l$$

$$h_2 = \frac{v_{2f}^2}{2g} = \frac{2gl}{9 * 2g} = \frac{l}{9}$$

Answer: a. $v_{1f} = \frac{5}{3}\sqrt{2gl};\quad v_{2f} = - -\frac{1}{3}\sqrt{2gl}$

b. $h_1 = \frac{25}{9}l;\ \ h_2 = \frac{l}{9};$