Week 8-Problems

8-1 Two objects have masses of M and 3M, respectively. If both have the same kinetic energy, which one has the larger linear momentum and by what factor? Why?

8-2 If the objects of problems 8-1 have the same linear momentum (magnitude), which will have the larger kinetic energy and by what factor? Why?

8-3 In order to conserve the total vector momentum of a many particle system, why is it necessary to have the external force equal to zero?

[*In all problems* 8 – 4 *through* 8 – 15 *assume that* $\underrightarrow{F_{ext}} = 0$]

8-4 What is the difference between a totally elastic and a totally inelastic two body collision?

8-5 Show that in a totally elastic head on collision the relative velocity reverses during the collision, that is, relatively velocity after is negative of the relative velocity before the collision?

8-6 You drop a ball of mass 1kg from a height of 2m. The collision with Earth lasts for about 10^{-4} seconds and on bouncing the ball rises to a height of 1.5m. is this collision totally elastic? Justify your answer.

8-7 When two objects of mass M_1 and M_2 with velocities $\underrightarrow{V_1}$ and $\underrightarrow{V_2}$ have a totally elastic head-on collision, the velocities after collision are given by:

$$\underrightarrow{V_1}' = \frac{M_1 - M_2}{M_1 + M_2}\underrightarrow{V_1} + \frac{2M_2\underrightarrow{V_2}}{M_1 + M_2}$$

$$\underrightarrow{V_2}' = \frac{M_2 - M_1}{M_1 + M_2}\underrightarrow{V_2} + \frac{2M_1\underrightarrow{V_1}}{M_1 + M_2}$$

Use these formulae to calculate to calculate $\underrightarrow{V_1}'$ and $\underrightarrow{V_2}'$ for the following cases.

i) $M_1 = M_2$, $\underrightarrow{V_1} = 5\text{m/s}\,\hat{x}$, $\underrightarrow{V_2} = 0$

ii) $M_1 << M_2$ (collision with a wall), $\underrightarrow{V_1} = 10\text{m/s}\,\hat{x}$, $\underrightarrow{V_2} = 0$

iii) $M_1 >> M_2$ (small object at rest, large object hits it), $\underrightarrow{V_1} = 10\text{m/s}\,\hat{x}$, $\underrightarrow{V_2} = 0$

iv) $M_1 = 10\text{kg}$ $\quad M_2 = 5\text{kg}$
$\underrightarrow{V_1} = 2\text{m/s}\,\hat{x}$ $\quad \underrightarrow{V_2} = -4m/s\,\hat{x}$

8-8 An object of mass M is sitting at rest when it is hit by another object of mass M traveling at $\underrightarrow{V_1}$. The collision is glancing and totally elastic. What is the relationship between their velocity $\underrightarrow{V_1}'$ and $\underrightarrow{V_2}'$ after the collision?

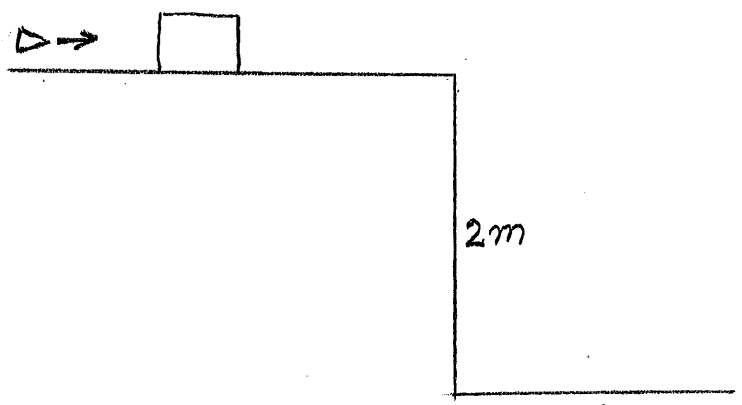
8-9 An object of mass 5kg traveling at 4m/s $\hat{x}$ collides with an object of mass 4kg traveling at $-5m/s\,\hat{y}$. After the collision they stick together. What is the magnitude and direction of the velocity after the collision?

8-10 If in Problem 8-7 (iv) the collision was totally inelastic, what would be the velocity after the collision?

8-11 The Earth has a mass which is 81 times the mass of the moon. The Earth-moon distance is 4×10^5km. Locate the center of mass of the Earth-moon system.

8-12 The puck $M_1 = 2$kg has a velocity of 3m/s $\hat{x}$ when it collides with a puck, $M_2 = 5$kg which has a velocity of $-6m/s\,\hat{y}$. What are their velocities after the collision?

8-13 A 2kg block is lying on a smooth horizontal table. A bullet of mass 0.01kg travelling of 100m/s $\hat{x}$ is fired into it and gets embedded. If the table is 2m high, where will the combination land on the ground?



8-14 A person of mass 50kg is standing at the end of a plank of mass 100kg and length 5m, and the plank rests on a horizontal smooth, icy surface. If the person walks from one end to the other, by how much will the plank move? Why?

8-15 (Ballistic Pendulum) Now the mass is hanging from a 1m long string when the bullet is fired. How high will the combination rise before falling back?