

Chapter 9

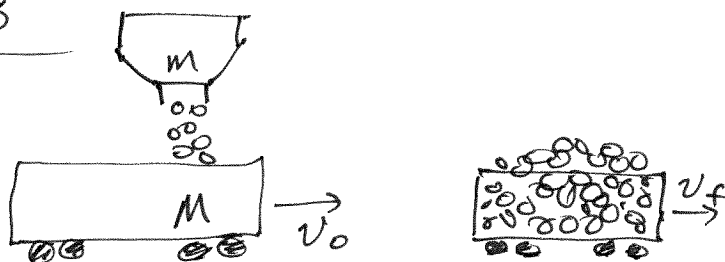
Problem 95

$$M = 30,000 \text{ kg}$$

$$v_0 = 2.2 \text{ m/s}$$

$$v_f = 1.5 \text{ m/s}$$

m - mass of gravel



What is the mass of gravel added to the freight car?

In the vertical direction the normal force of the ground has to support the freight car and also provide an impulse to the gravel to bring it to a halt.

However, in the horizontal direction there are no external forces, if we ignore the effect of friction.

The internal forces between gravel and freight car can be large, but they are equal and opposite of each other by Newton's 3rd Law.

Since there is no external force in the x -direction, we can use conservation of momentum to solve this problem.

x -direction

$$P_0 = P_f$$

$$Mv_0 + m \cdot 0 = (M+m)v_f$$

both freight car and gravel are moving together.

Solve for m .

$$Mv_0 = Mv_f + mv_f$$

$$Mv_0 - Mv_f = mv_f$$

$$m = \frac{M(v_0 - v_f)}{v_f} = \frac{(30,000 \text{ kg})(2.2 \text{ m/s} - 1.5 \text{ m/s})}{1.5 \text{ m/s}}$$

$$m = 14,000 \text{ kg}$$