

Ch 6 HW 6, 15, 24, 55

6. Use the impulse-momentum theorem to find how long a stone falling straight down takes to increase its speed from 5.5 m/s to 10.4 m/s .

$$\begin{aligned} \circ \downarrow 5.5 \text{ m/s} \quad F \cdot \Delta t &= m \Delta v \leftarrow \text{impulse-momentum theorem} \\ \circ \downarrow 10.4 \text{ m/s} \quad \Delta t &= \frac{m \Delta v}{F} = \frac{m(v_f - v_i)}{m a} = \frac{v_f - v_i}{a} \end{aligned}$$

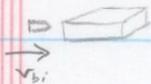
$$\Delta t = \frac{10.4 \text{ m/s} - 5.5 \text{ m/s}}{-9.8 \text{ m/s}^2} = \boxed{0.50 \text{ s}}$$

15. A 2.7 kg block of wood sits on a table. A 3.0 g bullet, fired horizontally at a speed of 500 m/s , goes completely through the block, emerging at a speed of 220 m/s . What is the speed of the block immediately after the bullet exits?

$$m_b = 3.0 \text{ g} \quad v_{bi} = 500 \text{ m/s} \quad v_{bf} = 220 \text{ m/s}$$

$$m_w = 2.7 \text{ kg} \quad v_{wi} = 0 \text{ m/s} \quad v_{wf} = ?$$

before



$$m_b v_{bi} + m_w v_{wi} = m_b v_{bf} + m_w v_{wf}$$

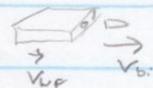
$$0.003 \text{ kg} \cdot 500 \text{ m/s} + 2.7 \text{ kg} \cdot 0 = 0.003 \text{ kg} \cdot 220 \text{ m/s} + 2.7 \text{ kg} \cdot v_{wf}$$

$$1.5 \text{ kg} \cdot \text{m/s} + 0 = 0.66 \text{ kg} \cdot \text{m/s} + 2.7 \text{ kg} \cdot v_{wf}$$

$$1.5 \text{ kg} \cdot \text{m/s} - 0.66 \text{ kg} \cdot \text{m/s} = 2.7 \text{ kg} \cdot v_{wf}$$

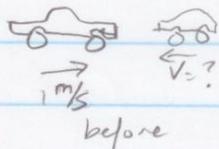
$$\frac{0.84 \text{ kg} \cdot \text{m/s}}{2.7 \text{ kg}} = v_{wf}$$

$$\boxed{v_{wf} = 0.31 \text{ m/s}}$$

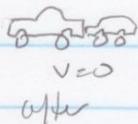


after

24. The parking brake on a 2000 kg Cadillac has failed, and it is rolling slowly, at 1 mph, toward a group of small children. Seeing the situation, you realize you have just enough time to drive your 1000 kg Volkswagen head-on into the Cadillac and save the children. With what speed should you impact the Cadillac to bring it to a halt?



$$\begin{array}{lll}
 m_c = 2000 \text{ kg} & v_{ci} = 1.0 \text{ m/s} & v_{cf} = 0 \text{ m/s} \\
 m_v = 1000 \text{ kg} & v_{vi} = ? & v_{vf} = 0 \text{ m/s}
 \end{array}$$



$$m_c v_{ci} + m_v v_{vi} = m_c v_{cf} + m_v v_{vf}$$

$$2000 \text{ kg} \cdot 1 \text{ m/s} + 1000 \text{ kg} v_{vi} = 0 + 0$$

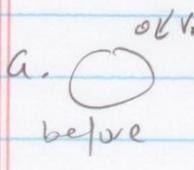
$$2000 \text{ kg} \cdot 1 \text{ m/s} = -1000 \text{ kg} v_{vi}$$

$$\frac{2000 \text{ kg} \cdot 1 \text{ m/s}}{-1000 \text{ kg}} = v_{vi}$$

$$\boxed{-2 \text{ m/s} = v_{vi}}$$

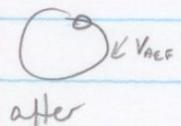
55. Most geologists believe the dinosaurs became extinct 65 million years ago when a large cometary asteroid struck the earth, throwing up so much dust that the sun was blocked out for a period of many months. Suppose an asteroid with a diameter of 2.0 km and a mass of 1.0×10^{13} kg hits the earth with an impact speed of 4.0×10^4 m/s.

- a) What is the earth's recoil speed after such a collision? (Use a reference frame in which the earth was initially at rest.)
- b) What percentage is this of the earth's speed around the sun? (Use the data inside the back cover of your text.)

a.  before

$$m_A = 1.0 \times 10^{13} \text{ kg} \quad v_{Ai} = 4.0 \times 10^4 \text{ m/s} \quad v_{AE} = ?$$

$$m_E = 5.98 \times 10^{24} \text{ kg} \quad v_{Ei} = 0 \text{ m/s} \quad v_{EF} = ?$$

 after

$$m_A v_{Ai} + m_E v_{Ei} = m_A v_{AEF} + m_E v_{EF}$$

$$1.0 \times 10^{13} \text{ kg} \cdot 4.0 \times 10^4 \text{ m/s} + 0 = (m_A + m_E) v_{AEF}$$

$$4.0 \times 10^{17} \text{ kg m/s} = (1.0 \times 10^{13} \text{ kg} + 5.98 \times 10^{24} \text{ kg}) v_{AEF}$$

$$\frac{4.0 \times 10^{17} \text{ kg m/s}}{5.98 \times 10^{24} \text{ kg}} = v_{AEF}$$

$$v_{AEF} = 6.7 \times 10^{-8} \text{ m/s}$$

b. Find speed of earth around the sun. Cause $v = \sqrt{\frac{GM}{r}}$ or $v = \frac{2\pi r}{T}$

$$v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2 \cdot 1.99 \times 10^{30} \text{ kg}}{1.5 \times 10^{11} \text{ m}}}$$

$$= 29,750 \text{ m/s}$$

or $v = \frac{2\pi r}{T} = \frac{2\pi \cdot 1.5 \times 10^{11} \text{ m}}{(86,400 \text{ s} \cdot 365 \text{ days})} = 29,890 \text{ m/s}$

$$\% = \frac{v_{AEF}}{v_E} \cdot 100\%$$

$$= \frac{6.7 \times 10^{-8} \text{ m/s}}{29,890 \text{ m/s}} \cdot 100\%$$

$$= \boxed{2.2 \times 10^{-10} \%}$$