Name: Key

Practice - 8.2 Impulse

1. A bullet is accelerated down the barrel of a gun by hot gases produced in the combustion of gun powder. What is the average force exerted on a 0.0300-kg bullet to accelerate it to a speed of 600 m/s in a time of 2.00 ms?

$$F_{NET} = \frac{\Delta p}{t} = \frac{m(v_f - v_i)}{t} = \frac{(0.0300\,kg)(600\,\frac{m}{s} - 0)}{2.00 \times 10^{-3}\,s}$$

$$= \boxed{9.00 \times 10^{3}\,N}$$

2. A car moving at 10 m/s crashes into a tree and stops in 0.26 s. Calculate the force the seat belt exerts on a passenger in the car to bring him to a halt. The mass of the passenger is 70 kg.

$$F_{NET} = \frac{\Delta p}{t} = \frac{m(v_f - v_i)}{t} = \frac{(70\,kg)(0 - 10\,\frac{m}{s})}{0.26\,s} = \boxed{-2.7 \times 10^{3}\,N}$$

F_{NET} is in the opposite direction of motion to slow the car down.

3. One hazard of space travel is debris left by previous missions. There are several thousand objects orbiting Earth that are large enough to be detected by radar, but there are far greater numbers of very small objects, such as flakes of paint. Calculate the force exerted by a 0.100-mg chip of paint that strikes a spacecraft window at a relative speed of 4.00 x 10^3 m/s, given the collision lasts 6.00 x 10^{-8} s.

$$F_{NET} = \frac{\Delta p}{t} = \frac{m(v_f - v_i)}{t} = \frac{(0.100 \times 10^{-3}\,g)\left(\frac{1\,kg}{10^3\,g}\right)(0 - 4.00 \times 10^{3}\,\frac{m}{s})}{6.00 \times 10^{-8}\,s}$$

$$= \boxed{-6.67 \times 10^{3}\,N}$$

4. A 75.0-kg person is riding in a car moving at 20.0 m/s when the car runs into a bridge abutment.

A. Calculate the average force on the person if he is stopped by a padded dashboard that compresses an average of 1.00 cm. [Hint: It will be easiest to use the kinematic equation $v_f^2 = v_0^2 + 2ax$.]

$$V_f^2 = V_0^2 + 2ax \Rightarrow a = \frac{V_f^2 - V_0^2}{2x} \Rightarrow F = ma = \frac{m(V_f^2 - V_0^2)}{2x}$$

$$F = \frac{(75.0\,kg)\left(0^2 - \left(20.0\frac{m}{s}\right)^2\right)}{2(1.00\times10^{-2}\,m)} = \boxed{-1.50\times10^6\,N}$$

B. Calculate the average force on the person if he is stopped by an air bag that compresses an average of 15.0 cm.

$$F = \frac{(75.0\,kg)\left(0^2 - \left(20.0\frac{m}{s}\right)^2\right)}{2(15.0\times10^{-2}\,m)} = \boxed{-1.00\times10^5\,N}$$

15X less

5. Calculate the final speed of a 110-kg rugby player who is initially running at 8.00 m/s but collides head-on with a padded goalpost and experiences a backward force of 1.76×10^4 N for 5.50×10^{-2} s.

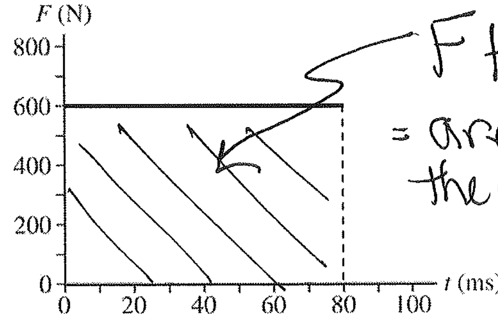
$$\Delta p = F_{NET}t \Rightarrow m(V_f - V_i) = F_{NET}t \Rightarrow V_f = \frac{F_{NET}t}{m} + V_i$$

$$V_f = \underbrace{\frac{(-1.76\times10^4\,N)(5.50\times10^{-2}\,s)}{110\,kg}}_{-8.80\,\frac{m}{s}} + 8.00\frac{m}{s} = \boxed{-0.80\frac{m}{s}}$$

in opposite direction as the initial motion

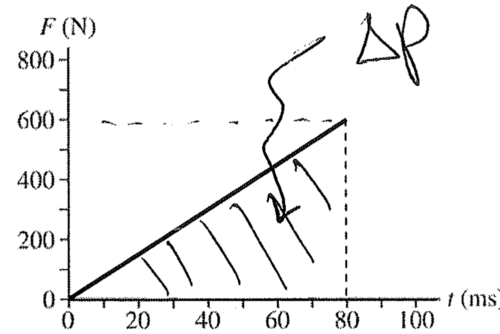
6. Find the impulse. (J)

$$J = Ft = (600\,N)(80\times10^{-3}\,s) = \boxed{48\,N\cdot s}$$



Ft = area under the curve

7. Find the change in momentum.



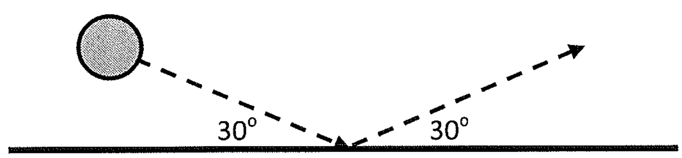
$$\Delta p = \frac{1}{2}(600\,N)(80\times10^{-3}\,s)$$

$$= \boxed{24\,\frac{kg\,m}{s}}$$

8. A 2.0-kg ball hits the floor with a downward speed of 10 m/s and then rebounds with an upward speed of 10 m/s. What impulse is delivered by the floor?

$$\Delta p = m(v_f - v_i) = (2.0\,kg)\left(10\frac{m}{s} - {-10}\frac{m}{s}\right) = \boxed{40\,\frac{kg\,m}{s}}$$

9. A 2.0-kg ball hits the floor with a speed of 10 m/s at an angle of 30° above the horizontal. The ball then rebounds with a speed of 10 m/s also at an angle of 30° above the horizontal. What impulse is delivered by the floor?



$$p_x = mv_x = mv\cos 30^\circ$$

$$p_{x_f} = p_{x_i} = mv\cos 30^\circ$$

$$\Rightarrow \Delta p_x = 0$$

$$p_y = mv_y = mv\sin 30^\circ$$

$$p_{y_f} = (2.0\,kg)(10\tfrac{m}{s})\sin 30^\circ = 10\tfrac{kg\,m}{s}$$

$$p_{y_i} = (2.0\,kg)(-10\tfrac{m}{s})\sin 30^\circ = -10\tfrac{kg\,m}{s}$$

$$\Rightarrow \Delta p_y (= \Delta p) = 10\frac{kg\,m}{s} - {-10}\frac{kg\,m}{s} = \boxed{20\,\frac{kg\,m}{s}}$$