Physics IA **Solutions for Impulse and Momentum**

1. Impulse is either F(t) or MΔV, depending on what you want to do. Since we know that impulse = 100 kgm / s this = F(t)

   therefore, $F = \dfrac{100\ \text{kgm / s}}{0.1\ \text{s}} = 1{,}000\text{N}$

2. In this one, we need to find time: so take F(t) = MΔV and rearrange it for time:

   $$t = \frac{M\Delta V}{F} = \frac{1{,}000{,}000\text{kg} \times (-10\text{m / s})}{-8000\text{N}} = 1250\,\text{sec}$$

3. This is an explosion question, and since they mention two objects in the example, we want to think about using the conservation of momentum formula to solve it. Before the explosion, nothing is moving, so we have:

   $$2000\text{kg}(0\text{m / s}) + 100\text{kg}(0\text{m / s}) = 2000\text{kg}(x) + 100\text{kg}(500\text{m / s})$$

   therefore, we get *x* = -25 m / s - pretty fast, so don't stand in back of a howitzer when it's in the act of firing !

4. This is another conservation of momentum question, but in this case, both objects get stuck together after the collision. Before the collision, the can's not moving, so conservation looks like this:

   $$0.002\text{kg}(x) + 0.06\text{kg}(0\text{m / s}) = 0.002\text{kg}(5\text{m / s}) + 0.06\text{kg}(5\text{m / s})$$

   therefore, x = 155m / s

5. Another collision, but unlike the previous example, in which both objects got stuck together afterwards, this example is an *elastic* collision, where both objects remain separate after the collision. Here's the conservation formula:

   $$1.2\text{kg}(20\text{m / s}) + .102\text{kg}(0\text{m / s}) = (1.2\text{kg})(17\text{m / s}) + 0.102\text{kg}(x)$$

   therefore, x = 35m / s

6. This is lots of little thinking questions in one: Remember Newton's third law, which says that *all* interactions happen so that the forces of action and reaction are equal and opposite.
   a. the change in momentum for the hammer will be F(t) = (50 N)(.2sec) = 10 N•s.
   b. The impulse given to the nail *must be the opposite*, because of Newton's third.
   c. The nail experiences the same force, also by Newton's third law
   d. finally, the impulse of 10 N•s works on both hammer and nail, so that:
   hammer: $10\text{N} \bullet \text{s} = 2\text{kg}(x)$ therefore, x = 5 m / s

   nail: $-10\text{N} \bullet \text{s} = 0.01\text{kg}(x)$ for the nail, x = -1,000 m / s.

7. An elastic collision - watch out for the signs of velocity - a negative velocity is the *opposite* of a positive velocity !

$\Delta P = M\Delta V$, so $\Delta P = (80kg)(-6m/s - 7m/s) = 1040\ N \bullet s$

8. This is really just an impulse question. You want to find impulse, and the problem gives you enough information to do it right off the top; then find the force that is applied:

$\Delta P = M\Delta V$, so $\Delta P = 95kg(8m/s - -5m/s) = 95kg(13m/s) = 1235 kgm/s.$

Therefore, the Force applied to Deion will be $\frac{1235\ kgm/s}{0.2\ sec} = 6175N$

9. This is another impulse question - here's the layout:

$F(t) = m\Delta v$, so $F(1sec) = 70kg(5m/s - 0m/s)$,

Therefore, $F = 350\ N$.

To determine the bouncer's speed after the toss, you can use conservation of momentum, or the fact that the impulse for both guys will be equal and opposite. Here's the conservation angle:

$70kg(0m/s) + 150kg(0m/s) = 70kg(5m/s) + 150kg(x)$

Therefore, x = -2.3 m/s