**Momentum, Conservation of Momentum & Impulse Practice**

**Mechanics:**

**Japanese Rail & the Shinkansen**

** **before =** ** **after**

** = *mv*

*Δ* = **f - **i

*Δ* = *FΔt*

1. Japan’s Shinkansen system includes several different versions of train. The 100-series trains consist of 16 steel cars that have a combined mass of 9.25 × 105 kg. The top speed of a regular 100-series train is 220 km/h. What would be the momentum of one of these trains?
2. A 15000 kg train engine traveling South at 13 m/s increases its velocity to 30 m/s. What is the trains:
   1. initial momentum?
   2. final momentum?
   3. change in momentum?
3. A freight train moves North with a speed of 8 m/s.  The mass of the train is 6x106 kg.  How fast would a 1500 kg car have to be moving North to have the same momentum as the train?
4. The high-speed 300-series Shinkansen trains consist of 16 aluminum cars with a combined mass of 7.10 × 105 kg. The reduction in mass from the 100-series trains enables the 300-series trains to reach a top speed of 270 km/h. What is the magnitude of a 300-series train’s momentum at its top speed?
5. A 42,000 kg train car travelling at 10 m/s toward another train car. After the two cars collide, they couple together and move along at 6 m/s. What is the mass of the second train car?
6. At a test centre in Nagoya a 10,000 kg train car coasts at 10 m/s and collides with a 2000kg car which was coasting at 30 m/s in the opposite direction. If the stick together after the impact how fast and in what direction will they be moving?



1. Two train cars approach each other, one of mass 113 000 kg traveling at 1.20 m/s East, the other of mass 75 000 kg is traveling at 2.30 m/s West. After the collision, the two cars lock together. Calculate:
   * 1. The momentum or each car
     2. The total momentum of the cars before the collision
     3. The total momentum of the cars after the collision
     4. The velocity of the cars after the collision
2. In a shunting yard a stationary flatcar of mass 4.0 x 104 kg is rammed by an engine with a mass of 6.0 x 104 kg and a velocity of 4.5 m/s. If they stick together, with what velocity will they continue to move at after the collision?
3. A freight car with a mass of 6.0 x 104 kg is rolling along a level track at 0.40 m/s, dragging a chain behind it. If the largest force that could be applied to the chain is 320.0 N, find:
   1. How long would it take to stop the freight car
   2. How far would the car move before it could be stopped (hint: use kinematics equations)
4. Considering impulse discuss why it is more comfortable travelling in a train that takes longer to slow down and stop at a station compared to one that stops much more suddenly.

