FORCES, INERTIA AND LIFE SAVING DEVICES ANSWERS

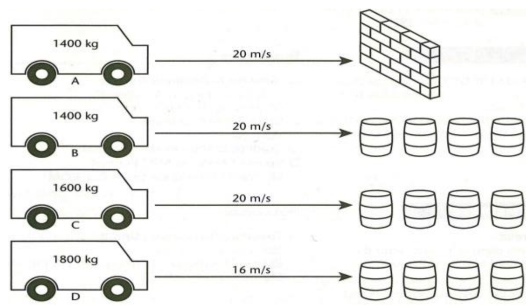
Back in the late 1960's, former racecar driver John Fitch invented a **force dispersion device** to protect people involved in car crashes. The Fitch Barriers he invented are commonly placed at freeway exit ramps, the base of freeway overpasses and where the road is divided (such as the gore point). These large, plastic, sand-filled (sometimes water filled) barrels have a lot of dispersible inertia that **reduce the amount of force** experienced by the driver at any point during a collision.

The barriers are designed to allow the vehicle to **accelerate (decelerate) over a larger distance** in a large period of time. This **reduces the amount of force** at any given point during the crash. This is the main principle behind why air bags, in conjunction with seat belts, work in saving lives (the barriers act like an "**air bag**" for the vehicle). The Fitch Barrier ability to protect the driver in a collision is based on **Newton's Second Law of Motion** **(F=MA)**.

The barriers **slowly absorb the momentum of a vehicle** as it crashes into them. Compare this to a car crashing into a solid concrete wall or a metal freeway divider and you can see (and calculate) the amount of force applied on the vehicle during the collision. The force of the collision is spread out over a longer amount of time and **not all at once**.

Dale Earnhardt was killed in a NASCAR race when his car hit a wall at close to 200 mph. He did not have the benefit of hitting the Fitch Barriers to slow down and minimize the force of the crash. This meant his car went from 200 mph to 0 mph almost instantly. The amount of acceleration experienced by him and his car in the collision was **huge**. If Earnhardt was able to hit the wall at an angle or if his car was able to flip over and roll he would probably still be alive today.

The picture below shows the **mass and velocity** of 4 trucks on a collision course with a concrete wall or Fitch Barriers. **Answer the questions that follow** **(show you work and include units).**



1. Calculate the momentum for each car (p=mv).
   Truck #1 p=mv = 1400 kg * 20 m/s = 28,000 kgm/s
   Truck #2 p=mv = 1400 kg * 20 m/s = 28,000 kgm/s
   Truck #3 p=mv = 1600 kg * 20 m/s = 32,000 kgm/s
   Truck #4 p=mv = 1800 kg * 16 m/s = 28,800 kgm/s

2. Of the trucks that hit the barriers which one will travel furthest after hitting the objects? Which will travel that shortest distance? Explain your reasoning. The furthest will be the Truck # 3 because it has the greatest momentum. Truck # 1 will travel the shortest distance because it has the least momentum, but more importantly it is hitting a solid concrete wall and not the Fitch safety barriers.

3. To get a sense of how much force each truck driver will experience take the velocity and divide it by the number of objects in front of the truck (that will represent the amount of time in seconds that the impact occurred). Use the mass and acceleration value and plug it into F=MA (or use F=mv/t where "m" is mass and "t" is time). Which truck experienced the greatest force? The one that hit the wall.
   Truck #1 f=mv/t = 1400 kg * 20 m/s / 1 s = 28,000 kgm/s^2 = 28,000 N = 28 Gs
   Truck #2 f=mv/t = 1400 kg * 20 m/s / 4s = 7000 kgm/s = 7000 N = 7 Gs
   Truck #3 f=mv/t = 1600 kg * 20 m/s / 4s = 8000 kgm/s = 8000 N = 8 Gs
   Truck #4 f=mv/t = 1800 kg * 16 m/s / 4s = 7200 kgm/s = 7200 N = 7.2 Gs

4. Explain why you should "roll" when you fall?
   It is so the force can be spread out over a great amount of time and distance so the force experienced at any point in time (impulse) will be less on your body.