Name:

Skill Sheet 3-A Newton's Second Law

As you work through the problems on this skill sheet, you will develop your understanding of Newton's second law of motion and how it relates to Newton's first law of motion. The second law states that the acceleration of an object is directly proportional to the force acting on the object and indirectly proportional to the mass of the object.

1. Newton's first law of motion

Newton's first law of motion (the law of inertia) states that the motion of an object will continue until an outside force changes this motion. The amount of force needed to change the motion of an object depends on the amount of *inertia* an object has. The inertia of an object is related to its mass. You need more force to move or stop an object with a lot of mass or inertia, than you need for an object with less mass or inertia.

In Newton's second law, the acceleration of an object is directly related to the force on an object, and inversely related to the mass of an object. This is shown the formula below.

$$\text{acceleration} = \frac{\text{Force}}{\text{mass}}$$

Units for acceleration are m/sec^2. Units for force are newtons (N). One newton is equivalent to 1 kg-m/sec^2. Units for mass are kilograms (kg). The equation for acceleration illustrates that acceleration is equal to the ratio of force to mass. This means that the force on an object causes it to accelerate, but the object's mass is a measure of how much it will resist acceleration.

2. Three ways to write Newton's second law of motion

In the formula for the second law of motion, acceleration equals force divided by mass. What does mass equal? What does force equal? Rearrange the equation to solve for mass. Then, rearrange the equation to solve for force.

What do you want to know?	What do you know?	The formula you will use
acceleration (a)	Force (F) and mass (m)	$\text{acceleration} = \frac{\text{Force}}{\text{mass}}$
mass (m)	acceleration (a) and Force (F)	
Force (F)	acceleration (a) and mass (m)	

3. Solving problems using Newton's second law

Solve the following problems using Newton's second law. The first two problems are done for you.

1. How much force is needed to accelerate a truck with a mass of 2,000 kg, at a rate of 3m/sec^2?

$$F = m \times a = 2{,}000\ \text{kg} \times \frac{3\ \text{m}}{\text{sec}^2} = 6{,}000\ \frac{\text{kg-m}}{\text{sec}^2} = 6{,}000\ \text{N}$$

2. What is the mass of an object that requires 15 N to accelerate it at a rate of 1.5 m/sec^2?

$$m = \frac{F}{a} = \frac{15\ \text{N}}{\frac{1.5\ \text{m}}{\text{sec}^2}} = \frac{\frac{15\ \text{kg-m}}{\text{sec}^2}}{\frac{1.5\ \text{m}}{\text{sec}^2}} = 10\ \text{kg}$$

3. What is the rate of acceleration of a 2,000.0-kilogram truck if a force of 4,200 N is used to make it start moving forward?

4. What is the acceleration of a 0.30-kilogram ball that is hit with a force of 25 N?

5. How much force is needed to accelerate a 68-kilogram skier at a rate of 1.2 m/sec^2?

6. What is the mass of an object that requires a force of 30 N to accelerate at a rate of 5 m/sec^2?

7. What is the force on a 1,000-kilogram elevator that is falling freely under the acceleration of gravity only?

8. What is the mass of an object that needs a force of 4,500 N to accelerate it at a rate of 5 m/sec^2?

9. What is the acceleration of a 6.4-kilogram bowling ball if a force of 12 N is applied to it?