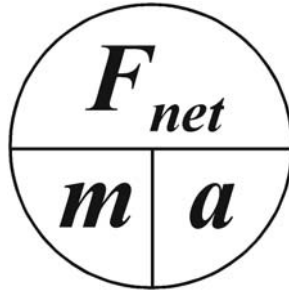


## Newton's Second Law of Motion

Newton's first law of motion says an object's state of motion will not change unless an unbalanced force is applied to it. This implies that if an unbalanced force *is* applied to an object, its state of motion *will* change. Any change in motion is acceleration. So, force causes acceleration. Now imagine, the same force is used to toss a softball into the air and to toss a bowling ball into the air. Which one will accelerate more? The one with the smaller mass accelerates more. This is essentially Newton's Second Law. Newton's Second Law of Motion says the acceleration of an object is equal to the net force divided by the mass.

$$\text{acceleration} = \frac{\text{net force}}{\text{mass}}$$

Any of the three variables, force ( $F_{\text{net}}$ ), mass ( $m$ ), or acceleration ( $a$ ), can be determined if the other two variables are known. Since the acceleration due to gravity is a constant  $9.8 \text{ m/s}^2$ , the weight of an object, which is the downward force of gravity on the object, can be calculated using the same formula if the mass is known. The units of force are newtons (N), where  $1 \text{ N} = 1 \text{ kg}\cdot\text{m/s}^2$ .



### Sample Problem 1

What is the acceleration of a 15 kg object that is pushed with a net force of 300. N?

$$a = \frac{F}{m} = \frac{300\text{N}}{15\text{kg}} = \frac{300.\text{kg}\cdot\text{m/s}^2}{15\text{kg}} = 20.\text{m/s}^2$$

### Sample Problem 2

What is the weight of a 65 kg object?

$$F = ma = (65\text{kg})(9.8\text{m/s}^2) = 637\text{kg}\cdot\text{m/s}^2 = 637\text{N}$$

### Sample Problem 3

What is the mass of an object that weighs 441 N?

$$m = \frac{F}{a} = \frac{425\text{N}}{9.8\text{m/s}^2} = \frac{441\text{kg}\cdot\text{m/s}^2}{9.8\text{m/s}^2} = 45\text{kg}$$

Answer the questions below using the formulas above.

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|--|--|
| 1. What is the mass of an object that accelerates at $20.0 \text{ m/s}^2$ as a result of a 15 N force? | 4. What is the acceleration of an 81 kg object that is pushed with a net force of 243 N? |
| 2. What is the acceleration of a 45 kg object that is pushed with a net force of 630. N?               | 5. What is the mass of an object that weighs 196 N?                                      |
| 3. What is the net force required to accelerate a 24 kg object at $18 \text{ m/s}^2$ ?                 | 6. What is the weight of a 27 kg mass?   |