Newton's Second Law

A large mining dump truck has a mass of 40,000 kg. If its engine produces 20,000 N of force, how fast will the truck accelerate?

1. Read and Understand

What information are you given?

Mass of truck = 40,000 kg

Force applied = 20,000 N

2. Plan and Solve

What unknown are you trying to calculate?

Acceleration of truck = ?

What formula contains the given quantities and the unknown?

$$\text{Acceleration} = \frac{\text{force}}{\text{mass}} \text{ or } a = \frac{F}{m}$$

Replace each variable with its known value and solve.

$$a = \frac{20,000\ \text{N}}{40,000\ \text{kg}} = \frac{20,000\ \text{kg} \cdot \text{m/s}^2}{40,000\ \text{kg}} = 0.5\ \text{m/s}^2$$

3. Look Back and Check

Is your answer reasonable?

Yes, the number calculated is the quotient of force and mass and the units are those of acceleration.

Math Practice

On a separate sheet of paper, solve the following problems.

1. The truck described above dumps its load and its mass is reduced to 10,000 kg. What is the acceleration of the truck? Assume its engine still produces the same amount of force.

$a = \frac{F}{m} = \frac{20,000\ \text{kg} \cdot \text{m/s}^2}{10,000\ \text{kg}} = 2\ \text{m/s}^2$

2. How much force must the engine of the dump truck described above develop to achieve an acceleration of 3.5 m/s^2?

$F = ma = 10,000\ \text{kg} \times 3.5\ \text{m/s}^2 = 35,000\ \text{kg} \cdot \text{m/s}^2 = 35,000\ \text{N}$

3. A toy car has a mass of 1500 g. If a 3-N force is applied to the car, what will its acceleration be?

$a = \frac{F}{m} = \frac{3\ \text{kg} \cdot \text{m/s}^2}{1.5\ \text{kg}} = 2\ \text{m/s}^2$