Name: ______________________ Date: ______________

SKILL and PRACTICE 4.1

Gravity Problems

READ

In this skill sheet, you will practice using proportions as you learn more about the strength of gravity on different planets.

PRACTICE

Comparing the strength of gravity on the planets

Table 1 lists the strength of gravity on each planet in our solar system. We can see more clearly how these values compare to each other using proportions. First, we assume that Earth's gravitational strength is equal to "1." Next, we set up the proportion where x equals the strength of gravity on another planet (in this case, Mercury) as compared to Earth.

$$\frac{1}{\text{Earth gravitational strength}} = \frac{x}{\text{Mercury gravitational strength}}$$

$$\frac{1}{9.8\text{ N/kg}} = \frac{x}{3.7\text{ N/kg}}$$

$$(1 \times 3.7\text{ N/kg}) = (9.8\text{ N/kg} \times x)$$

$$\frac{3.7\text{ N/kg}}{9.8\text{ N/kg}} = x$$

$$0.38 = x$$

Note that the units cancel. The result tells us that Mercury's gravitational strength is a little more than a third of Earth's. Or, we could say that Mercury's gravitational strength is 38% as strong as Earth's.

Now, calculate the proportions for the remaining planets.

Table 1: The strength of gravity on planets in our solar system

Planet	Strength of gravity (N/kg)	Value compared to Earth's gravitational strength
Mercury	3.7	0.38
Venus	8.9	
Earth	9.8	1
Mars	3.7	
Jupiter	23.1	
Saturn	9.0	
Uranus	8.7	
Neptune	11.0	
Pluto	0.6	

How much does it weigh on another planet?

Use your completed Table 1 to solve the following problems.

Example:

- A bowling ball weighs 15 pounds on Earth. How much would this bowling ball weigh on Mercury?

$$\frac{\text{Weight on Earth}}{\text{Weight on Mercury}} = \frac{1}{0.38}$$

$$\frac{1}{0.38} = \frac{15\text{ pounds}}{x}$$

$$0.38 \times 15\text{ pounds} = x$$

$$x = 5.7\text{ pounds}$$

1. A cat weighs 8.5 pounds on Earth. How much would this cat weigh on Neptune?
2. A baby elephant weighs 250 pounds on Earth. How much would this elephant weigh on Saturn? Give your answer in newtons (4.48 newtons = 1 pound).
3. On Pluto, a baby would weigh 2.7 newtons. How much does this baby weigh on Earth? Give your answer in newtons and pounds.
4. Imagine that it is possible to travel to each planet in our solar system. After a space "cruise," a tourist returns to Earth. One of the ways he recorded his travels was to weigh himself on each planet he visited. Use the list of these weights on each planet to figure out the order of the planets he visited. On Earth he weighs 720 newtons. List of weights: 655 N; 1,872 N; 792 N; 36 N; and 661 N.

Challenge: Using the Universal Law of Gravitation

Here is an example problem that is solved using the equation for Universal Gravitation.

Equation of Universal Gravitation:

Mass 1 (kg) Mass 2 (kg)

Force (N)

$$F = G\frac{m_1 m_2}{R^2}$$

Gravitational constant (6.67×10^{-11} N-m²/kg²)

Distance between mass 1 and mass 2 (m)

Example

What is the force of gravity between Pluto and Earth? The mass of Earth is 6.0×10^{24} kg. The mass of Pluto is 1.3×10^{22} kg. The distance between these two planets is 5.76×10^{12} meters.

$$\text{Force of gravity between Earth and Pluto} = \left(\frac{6.67 \times 10^{-11}\text{N-m}^2}{\text{kg}^2}\right)\frac{(6.0 \times 10^{24}\text{kg}) \times (1.3 \times 10^{22}\text{kg})}{(5.76 \times 10^{12}\text{m})^2}$$

$$\text{Force of gravity} = \frac{52.0 \times 10^{35}}{33.2 \times 10^{24}} = 1.57 \times 10^{11}\text{N}$$

Now use the equation for Universal Gravitation to solve this problem:

5. What is the force of gravity between Jupiter and Saturn? The mass of Jupiter is 6.4×10^{24} kg. The mass of Saturn is 5.7×10^{26} kg. The distance between Jupiter and Saturn is 6.52×10^{11} m.