Name: ______________________ Date: __________

Skill and Practice

17A The Inverse Square Law

Read:

If you stand one meter away from a portable stereo blaring your favorite music, the intensity of the sound may hurt your ears. As you back away from the stereo, the sound's intensity decreases. When you are two meters away, the sound intensity is one-fourth its original value. When you are ten meters away, the sound intensity is one-one hundredth its original value.

The sound intensity decreases according to the **inverse square law**. This means that the intensity decreases as the square of the distance. If you triple your distance from the stereo, the sound intensity decreases by nine times its original value.

Many fields follow an inverse square law, including sound, light from a small source (like a match or light bulb), gravity, and electricity. Magnetic fields are the exception. They decrease much faster because there are two magnetic poles.

Examples:

Example 1: The light intensity one meter from a bulb is 2 W/m^2. What is the light intensity measured from a distance of four meters from the bulb?

Solution: The distance has increased to four times its original value. The light intensity will decrease by 42 or 16, times.

$$2 \times \frac{1}{16} = \frac{1}{8} \text{ or } 0.125 \text{ W/m}^2$$

Example 2: Mercury has a gravitational force of 3.7 N/kg. Its radius is 2,439 kilometers. How far away from the surface of Mercury would you need to move in order to experience a gravitational force of 0.925 N/kg?

Solution: For the gravitational force to be reduced to one-fourth its original value, the distance from Mercury's center must be doubled. Therefore you would have to move to a spot 2,439 kilometers away from Mercury's surface or 4,878 meters from its center.

Practice:

1. You stand 4 meters away from a light and measure the intensity to be 1 W/m^2. What will be the intensity if you move to a position 8 meters away from the bulb?

2. You are standing 1 meter from a squawking parrot. If you move to a distance three meters away, the sound intensity will be what fraction of its original value?

3. Venus has a gravitational force of 8.9 N/kg. Its radius is 6,051 kilometers. How far away from the surface of Mercury would you need to move in order to experience a gravitational force of 0.556 N/kg?

4. Earth's radius is 6,378 kilometers. If you weigh 500 newtons on Earth's surface, what would you weigh at a distance of 19,134 kilometers from Earth?

5. Compare the intensity of light 2 meters away from a lit match to the intensity 6 meters away from the match.

6. How does the strength of a sound field 1 meter from its source compare with its strength 4 meters away?