Name _____ Class _____ Date _____

Skills Worksheet

Math Skills

Gravitational Potential Energy

After you study each sample problem and solution, work out the practice problems on a separate sheet of paper. Write your answers in the spaces provided.

PROBLEM

An automobile to be transported by ship is raised 7.0 m above the dock. If its gravitational potential energy is 6.6×10^4 J, what is the automobile's mass?

SOLUTION

Step 1: List the given and unknown values.

> **Given:** *gravitational potential energy, $PE = 6.6 \times 10^4$ J*
>
> *height, $h = 7.0$ m*
>
> *free-fall acceleration, $g = 9.8$ m/s^2*

> **Unknown:** *mass, $m = ?$ kg*

Step 2: Write the gravitational potential energy equation, and rearrange it to solve for mass.

> *gravitational potential energy = mass × free-fall acceleration × height*
>
> $PE = mgh$
>
> $\dfrac{PE}{gh} = \dfrac{m\cancel{g}\cancel{h}}{\cancel{g}\cancel{h}} = m$

Step 3: Insert the known values into the equation, and solve.

$$m = \frac{6.6 \times 10^4 \text{ J}}{9.8 \text{ m/s}^2 \times 7.0 \text{ m}} = \frac{6.6 \times 10^4 \text{ kg} \bullet \text{m}^2/\text{s}^2}{9.8 \text{ m/s}^2 \times 7.0 \text{ m}}$$

$$m = 9.6 \times 10^2 \text{ kg}$$

PRACTICE

1. The world record for pole vaulting is 6.15 m. If the pole vaulter's gravitational potential is 4,942 J, what is his mass?

_____

2. One of the tallest radio towers is in Fargo, North Dakota. The tower is 629 m tall, or about 44 percent taller than the Sears Tower in Chicago. If a bird lands on top of the tower, so that the gravitational potential energy associated with the bird is 2,033 J, what is its mass?

_____

Math Skills *continued*

PROBLEM

The largest sea turtle found in the United States had a mass of 860 kg. If the gravitational potential energy associated with the turtle, as it was being lifted onto a ship, was 2.0×10^4 J, how high above the water was the turtle?

SOLUTION

Step 1:   List the given and unknown values.

> **Given:**   *gravitational potential energy, $PE = 2.0 \times 10^4$ J*
> *mass, $m = 860$ kg*
>
> *free-fall acceleration, $g = 9.8$ m/s^2*

> **Unknown:**   *height, $h = ?$ m*

Step 2:   Write the gravitational potential energy equation, and rearrange it to solve for height.

> *gravitational potential energy =*
> *mass × free-fall acceleration × height*
>
> $PE = mgh$
>
> $\dfrac{PE}{mg} = \dfrac{\cancel{m}g h}{\cancel{m}g} = h$

Step 3:   Insert the known values into the equation, and solve.

$$h = \frac{2.0 \times 10^4 \text{ J}}{860 \text{ kg} \times 9.8 \text{ m/s}^2} = \frac{2.0 \times 10^4 \text{ kg} \bullet \text{m}^2/\text{s}^2}{860 \text{ kg} \times 9.8 \text{ m/s}^2}$$

$$h = 2.4 \text{ m}$$

PRACTICE

3. In 1993, Cuban athlete Javier Sotomayor set the world record for the high jump. The gravitational potential energy associated with Sotomayor's jump was 1,970 J. Sotomayor's mass was 82.0 kg. How high did Sotomayor jump?

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4. A 1,750 kg weather satellite moves in a circular orbit with a gravitational potential energy of 1.69×10^{10} J. At its location, free-fall acceleration is only 6.44 m/s^2. How high above Earth's surface is the satellite?

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Math Skills *continued*

PROBLEM

What is the gravitational potential energy associated with a 75 kg tourist at the top floor of the Sears Tower in Chicago, with respect to the street 436 m below?

SOLUTION

Step 1: List the given and unknown values.

> **Given:** *mass, m* $= 75$ kg
>
> *height, h* $= 436$ m
>
> *free-fall acceleration, g* $= 9.8$ m/s^2
>
> **Unknown:** *gravitational potential energy, PE* $= ?$ J

Step 2: Write the equation for gravitational potential energy.

> *gravitational potential energy =*
> *massÈ× free-fall acceleration × height*
>
> $PE = mgh$

Step 3: Insert the known values into the equation, and solve.

> $PE = (75$ kg$) \times (9.8$ m/s$^2) \times (436$ m$) = 3.2 \times 10^5$ kg • m^2/s^2
>
> $PE = 3.2 \times 10^5$ J

PRACTICE

5. With an elevation of 5,334 m above sea level, the village of Aucanquilca, Chile is the highest inhabited town in the world. What would be the gravitational potential energy associated with a 64 kg person in Aucanquilca?

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6. The peak of the extinct volcano Volcán Chimborazo in Ecuador is the farthest point on Earth from Earth's center. This is because Earth bulges outward due to its rotation, and this bulge is greatest at the Equator, which is only about 100 km north of Chimborazo. Volcán Chimborazo's summit is 6,267 m above sea level. If a mountain climber with a mass of 85 kg (climbing equipment included) reaches the mountain's peak, what is the gravitational potential energy associated with the climber with respect to sea level?

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MIXED PRACTICE

7. The Royal Gorge Bridge is situated 321 m above the Arkansas River in Colorado. If the gravitational potential energy associated with a tourist on the bridge is 1.73×10^5 J with respect to the river, what is the tourist's mass?

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