

Chapter 9 Energy

Gravitational Potential Energy

Calculate the increase in potential energy when a crane lifts a 2,000-kg car a vertical distance of 10 m. The acceleration due to gravity (g) is 10 m/s^2 .

1. Read and Understand

What information are you given?

Mass of the car, $m = 2,000 \text{ kg}$

Height of the car, $h = 10 \text{ m}$

2. Plan and Solve

What unknown are you trying to calculate?

Gravitational potential energy = PE

What mathematical equation can you use to calculate the unknown?

Gravitational potential energy, $PE = mgh$

Substitute the information you know into the equation.

$$\begin{aligned} PE &= mgh \\ &= (2,000 \text{ kg})(10 \text{ m/s}^2)(10 \text{ m}) \end{aligned}$$

Multiply to find the unknown.

$$PE = 200,000 \text{ J} = 200 \text{ kJ}$$

3. Look Back and Check

Is your answer reasonable?

The magnitude of the potential energy is 100 times the mass of the car.

This is reasonable because the car is lifted 10 m.

Math Practice

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

- A football player throws a ball with a mass of 0.34 kg. What is the gravitational potential energy of the ball when it is 5.0 m above the ground?
 $PE = mgh = (0.34 \text{ kg})(10 \text{ m/s}^2)(5.0 \text{ m}) = 17 \text{ J}$
- A 2.0-kg book is on a shelf that is 1.6 m high. What is the gravitational potential energy of the book relative to the ground?
 $PE = mgh = (2.0 \text{ kg})(10 \text{ m/s}^2)(1.6 \text{ m}) = 32 \text{ J}$
- A 36-kg girl walks to the top of stairs that are 2.0-m high. How much gravitational potential energy does the girl gain?
 $PE = mgh = (36 \text{ kg})(10 \text{ m/s}^2)(2.0 \text{ m}) = 720 \text{ J}$
- A can of soup has a mass of 0.35 kg. The can is moved from a shelf that is 1.2 m off the ground to a shelf that is 0.40 m off the ground. How does the gravitational potential energy of the can change?
 $\Delta PE = mgh = (0.35 \text{ kg})(10 \text{ m/s}^2)(0.40 \text{ m} - 1.2 \text{ m}) = -2.8 \text{ J}$