

Introduction to Gravitational Potential Energy

What is potential energy?

Potential energy is the energy associated with the relative positions of objects. There are a number of different forms of potential energy. Spring potential energy refers to the arrangement of coils in a spring. Chemical potential energy refers to the arrangement of chemical bonds. We are going to concentrate on gravitational potential energy, which is the energy related to the separation of two objects that have mass. Specifically, we are going to concentrate on the separation of objects from the Earth.

$$PE = mgh \text{ where } g \text{ is the acceleration due to gravity } (9.8 \frac{m}{s^2})$$

If we look at the units for the equation, we can see a joule in fundamental units:

$$J = (kg)(\frac{m}{s^2})(m)$$

Example Calculations:

Example 1: A 5 kg block is 3 meters above the ground. Calculate the potential energy.

$$PE = mgh$$

$$PE = (5)(9.8)(3)$$

$$PE = 147 J$$

Example 2: A ball has a 1.47 J of energy when it is 1.5 m above the ground. Determine the mass of the ball.

$$PE = mgh$$

$$m = \frac{PE}{gh}$$

$$m = \frac{1.47}{(9.8)(1.5)} = \frac{1.47}{14.7} = 0.1 \text{ kg}$$

Example 3: A 0.5 kg cart has 9.8 J of potential energy at the top of a hill. Determine the height of the hill.

$$PE = mgh$$

$$h = \frac{PE}{mg}$$

$$h = \frac{9.8}{(0.5)(9.8)} = 2 \text{ m}$$

Practice Calculations

Show your work as you complete the following calculations.

1. Calculate the gravitational potential energy of a 2.0 kg block that is 3.0 meters above the ground. (*ans 58.8 J*)
2. Calculate the gravitational potential energy of a 2.0 kg block that is 6.0 meters above the ground. (*ans 117.6 J*)
3. Calculate the gravitational potential energy of a 2.0 kg block that is 9.0 meters above the ground. (*ans 176.4 J*)
4. Calculate the gravitational potential energy of a 4.0 kg block that is 3.0 meters above the ground. (*ans 117.6 J*)
5. Calculate the gravitational potential energy of a 6.0 kg block that is 3.0 meters above the ground. (*ans 176.4 J*)

Questions

Show your work as you answer the following questions.

6. A 0.150 kg baseball has 45 J of gravitational potential energy. How high is the ball above the ground?

7. A roller coaster cart has 196000 J of gravitational potential energy when it is 20 meters above the ground. How high above the ground is the cart when it has 19600 J of gravitational potential energy?

Extension

8. Sketch the graph of potential energy vs. mass. From the graph, describe the relationship between potential energy and mass.

9. Sketch the graph of potential energy vs. height. From the graph, describe the relationship between potential energy and height.