Kinetic and potential energy

As a roller coaster races up and down, energy is transferred back and forth between its stores of kinetic energy (KE) and gravitational potential energy (GPE). The equations on these pages show you how to calculate both quantities.

Kinetic energy

A moving object stores kinetic energy. When it speeds up, energy is transferred to this store, and when it slows down, energy is transferred away. The faster the object moves, or the greater its mass, the greater its store of kinetic energy. The equation here shows how to calculate kinetic energy.

$$\text{kinetic energy (J)} = \frac{1}{2} \times \text{mass (kg)} \times \text{speed}^2\ (\text{m/s})^2$$

$$E_k = \frac{1}{2} \times m \times v^2$$

Key facts

- ✓ **The faster an object moves, or the greater its mass, the greater its store of kinetic energy (KE).**
- ✓ **The higher an object is, or the greater its mass, the greater its store of gravitational potential energy (GPE).**
- ✓ **When a roller coaster accelerates downhill, energy is transferred from its store of GPE to its store of KE.**

Calculating kinetic energy

Question

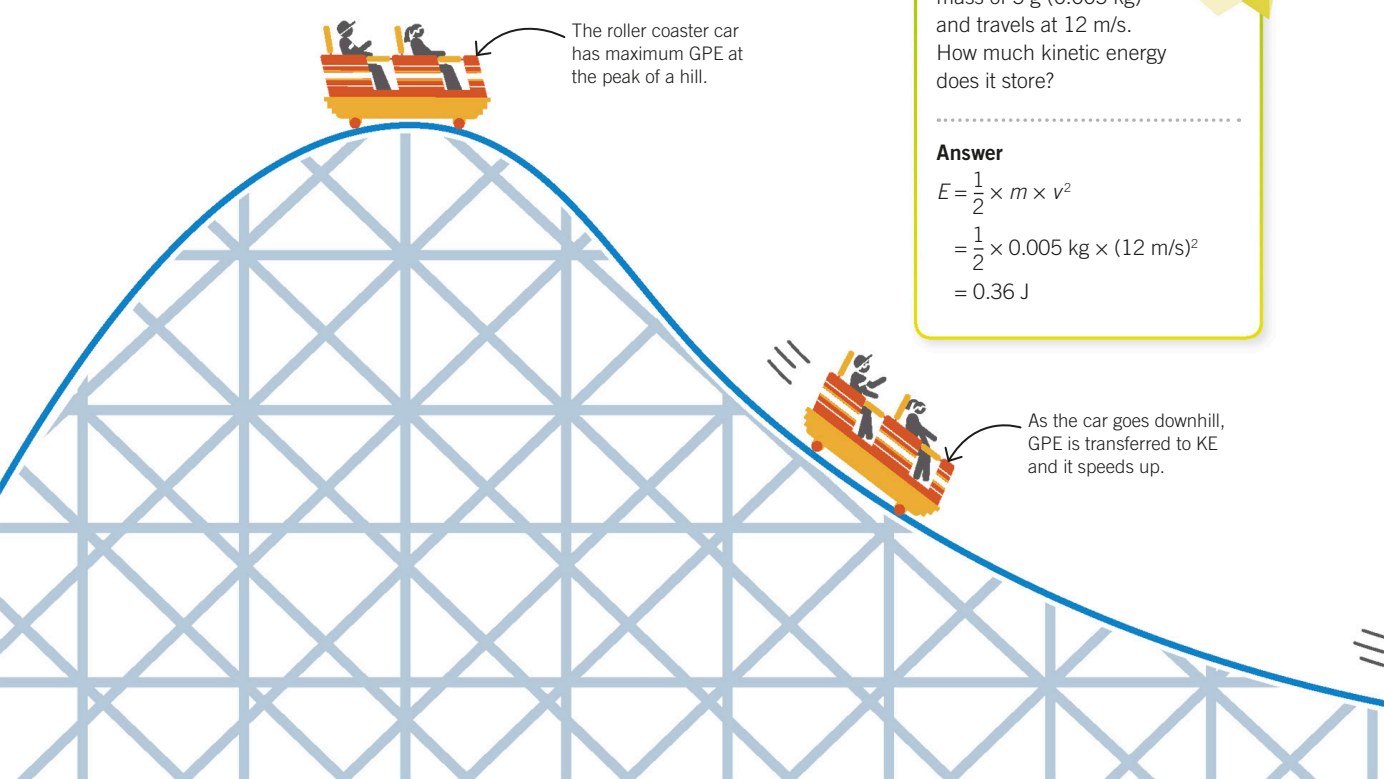
A paper plane has a mass of 5 g (0.005 kg) and travels at 12 m/s. How much kinetic energy does it store?

Answer

$$E = \frac{1}{2} \times m \times v^2$$

$$= \frac{1}{2} \times 0.005\ \text{kg} \times (12\ \text{m/s})^2$$

$$= 0.36\ \text{J}$$



Gravitational potential energy

When you raise an object, the lifting force does work and transfers energy to the object's store of gravitational potential energy (GPE). The higher an object is or the greater its mass, the greater its store of GPE. This equation shows how to calculate the change in an object's GPE from a change in its height.

On Earth, this figure is approximately 10 N/kg. On the Moon, it would be about a sixth of this figure.

$$\text{change in GPE (J)} = \text{mass (kg)} \times \text{gravitational field strength (N/kg)} \times \text{change in height (m)}$$

$$\Delta\text{GPE} = m \times g \times \Delta h$$

The Greek letter delta means "change in."

Calculating GPE

Question

A woman with a mass of 70 kg climbs 30 m up a cliff. How much gravitational potential energy does she gain?

Answer

$\Delta\text{GPE} = m \times g \times \Delta h$

$= 70\text{ kg} \times 10\text{ N/kg} \times 30\text{ m}$

$= 21\,000\text{ J}$