

## Potential Energy

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### Recap

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Additional

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## Practice

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(a) How much gravitational potential energy (relative to the ground on which it is built) is stored in the Great Pyramid of Cheops, given that its mass is about  $7 \times 10^9$  kg and its center of mass is 36.5 m above the surrounding ground?

A  $5.00 \times 10^5$ -kg subway train is brought to a stop from a speed of 0.500 m/s in 0.400 m by a large spring bumper at the end of its track. What is the force constant  $k$  of the spring?

In a downhill ski race, surprisingly, little advantage is gained by getting a running start. (This is because the initial kinetic energy is small compared with the gain in gravitational potential energy on even small hills.) To demonstrate this, find the final speed and the time taken for a skier who travels 70.0 m along a  $30^\circ$  slope, neglecting friction:

(a) Starting from rest.

(b) Starting with an initial speed of 2.50 m/s.

(c) Does the answer surprise you? Discuss why it is still advantageous to get a running start in very competitive events.

The 70.0-kg swimmer in Figure 7.41 starts a race with an initial velocity of 1.25 m/s and exerts an average force of 80.0 N backward with his arms during each 1.80 m-long stroke. [Video on how to solve](#)

(a) What is his initial acceleration if water resistance is 45.0 N?

(b) What is the subsequent average resistance force from the water during the 5.00 s it takes him to reach his top velocity of 2.50 m/s?

(c) Discuss whether water resistance seems to increase linearly with velocity.

A 75.0-kg cross-country skier is climbing a  $3.0^\circ$  slope at a constant speed of 2.00 m/s and encounters air resistance of 25.0 N. [Video on how to solve](#)

(a) Find his power output for work done against the gravitational force and air resistance.

(b) What average force does he exert backward on the snow to accomplish this?

(c) If he continues to exert this force and to experience the same air resistance when he reaches a level area, how long will it take him to reach a velocity of 10.0 m/s?