Interpreting a Potential Energy Graph

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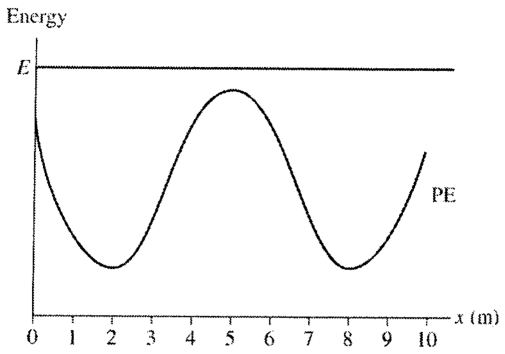
This material is borrowed/adapted from Chapter 10 of the *Student Workbook* for *Physics for Scientists and Engineers.*

XX-1: Interpreting a Potential Energy Graph

A particle with the potential energy shown in the graph is moving to the right at $x = 0$ m with total energy E.



(a) At what value or values of x is the particle's speed a maximum?

At 2 m and 8 m, where the potential energy is smallest.

(b) At what value or values of x is the particle's speed a minimum?

At 5 m, where the potential energy is largest.

(c) At what value or values of x is the potential energy a maximum?

At 5 m.

(d) Does this particle have a turning point in the range of x covered by the graph? If so, where?

There are no turning points, as the potential energy never crosses the total energy line.

(e) In which intervals of x is the force on the particle to the right?

Since $F_x = -\frac{dU}{dx}$ (negative of slope), we know that the force is to the right (F_x is positive) from 0 m to 2 m and from 5 m to 8 m.

(f) In which intervals of x is the force on the particle to the left?

The force is to the left (F_x is negative) from 2 m to 5 m and from 8 m to 10 m.

(g) At what value or values of x is the magnitude of the force a maximum?

When the slope of U versus x is steepest: $x = 0$ m, 3.5 m, 6.5 m, and 10 m.

(h) At what value or values of x are positions of stable equilibrium?

Equilibrium occurs when $F_x = 0$ N. Stable equilibrium occurs when the force felt on either side of the point pushes the particle back toward the point. This happens at the minima of potential energy: $x = 2$ m and 8 m.

(i) At what value or values of x are positions of unstable equilibrium?

Unstable equilibrium occurs when the force felt on either side of the equilibrium point pushes the particle away from the point. This happens at the maximum of potential energy: $x = 5$ m.

(j) If the particle is released from rest at $x = 0$ m, will it reach $x = 10m$? Explain.

No. If released from rest, the particle's total energy is the initial potential energy and can never exceed this value. The particle will turn around at about $x = 3.5$ m.