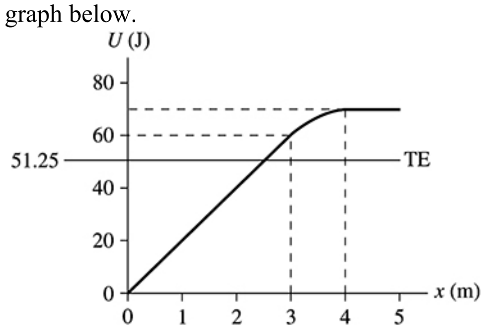
11.37. Model: The force is conservative, so it has a potential energy.

Visualize: Please refer to Figure P11.37 for the graph of the force.

Solve: The definition of potential energy is $\Delta U = -W(\mathrm{i} \to \mathrm{f})$. In addition, work is the area under the force-versus-displacement graph. Thus $\Delta U = U_\mathrm{f} - U_\mathrm{i} = -$ (area under the force curve). Since $U_\mathrm{i} = 0$ at $x = 0$ m, the potential energy at position x is $U(x) = -$ (area under the force curve from 0 to x). From 0 m to 3 m, the area increases linearly from 0 N m to -60 N m, so U increases from 0 J to 60 J. At $x = 4$ m, the area is -70 J. Thus $U = 70$ J at $x = 4$ m, and U doesn't change after that since the force is then zero. Between 3 m and 4 m, where F changes linearly, U must have a quadratic dependence on x (i.e., the potential energy curve is a parabola). This information is shown on the potential energy graph below.



(b) Mechanical energy is $E = K + U$. From the graph, $U = 20$ J at $x = 1.0$ m.

The kinetic energy is $K = \frac{1}{2}mv^2 = \frac{1}{2}(0.100 \text{ kg})(25 \text{ m/s})^2 = 31.25$ J. Thus $E = 51.25$ J.

(c) The total energy line at 51.25 J is shown on the graph above.

(d) The turning point occurs where the total energy line crosses the potential energy curve. We can see from the graph that this is at approximately 2.5 m. For a more accurate value, the potential energy function is $U = 20x$ J. The TE line crosses at the point where $20x = 51.25$, which is $x = 2.56$ m.