The figure below right shows the potential energy $U(x)$ of a solid ball that can roll along an $x$ axis. The scale on the $U$ axis is set by $U_S = 500$ J. The ball is uniform, rolls smoothly, and has a mass of 2.00 kg. It is released at $x = 6.00$ m headed in the negative direction of the $x$ axis with a mechanical energy of 360 J.

a) If the ball can reach $x = 0$ m, what is its speed there, and if it cannot, what is its turning point?

Since the potential energy of the ball cannot be larger than the mechanical energy, the ball does not reach $x = 0$ m. It turns around at a point where the potential energy is equal to the mechanical energy.

For $1 < x < 5$, the potential energy is expressed as $U(x) = -125(x - 1) + 500$

Equating this with the mechanical energy, we get $360 = -125(x - 1) + 500 \Rightarrow x = 2.12$ m

b) Suppose, instead, it is headed in the positive direction of the $x$ axis when it is released at $x = 6.0$ m with 360 J. If the ball can reach $x = 14$ m, what is its speed there, and if it cannot, what is its turning point?

For $6 < x < 14$, the potential energy is always smaller than 360 J. Thus the ball reaches $x = 14$ m. At $x = 14$ m, the kinetic energy of the ball is $K(x = 14 m) = E - U(x = 14 m) = 60$ J

Kinetic energy of a rolling object consists of translational kinetic energy and rotational kinetic energy. The speed of the ball is $K = (1/2)mv^2 + (1/2)I\omega^2 = (1/2)mv^2 + (1/2)(mr^2)(v/r)^2 = (7/10)mv^2 \Rightarrow v = \sqrt{(10K/7m)} = 6.55$ m/s