12. We use Eq. 8-17, representing the conservation of mechanical energy (which neglects friction and other dissipative effects).

(a) In the solution to exercise 4, we found $U_A = mgh$ (with the reference position at C). Referring again to Fig. 8-26, we see that this is the same as U_0 which implies that $K_A = K_0$ and thus that $v_A = v_0$.

(b) In the solution to exercise 4, we also found $U_B = mgh/2$. In this case, we have

$$\begin{aligned} K_0 + U_0 &= K_B + U_B \\ \frac{1}{2}mv_0^2 + mgh &= \frac{1}{2}mv_B^2 + mg\left(\frac{h}{2}\right) \end{aligned}$$

which leads to $v_B = \sqrt{v_0^2 + gh}$.

(c) Similarly, $v_C = \sqrt{v_0^2 + 2gh}$.

(d) To find the "final" height, we set $K_f = 0$. In this case, we have

$$\begin{aligned} K_0 + U_0 &= K_f + U_f \\ \frac{1}{2}mv_0^2 + mgh &= 0 + mgh_f \end{aligned}$$

which leads to $h_f = h + v_0^2/2g$.

(e) It is evident that the above results do not depend on mass. Thus, a different mass for the coaster must lead to the same results.