

Ball changing direction

KJF problem 10.11

A 20 g plastic ball is moving to the left at 30 m/s. How much work must be done on the ball to cause it to move to the right at 30 m/s?

Solution: Consider the energy of the ball, which is all kinetic.

Initial velocity: $v_i = -30 \text{ ms}^{-1}$

Final velocity: $v_f = +30 \text{ ms}^{-1}$

$$\begin{aligned}\Delta K &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ &= \frac{1}{2}m(v_f^2 - v_i^2) \\ &= \frac{1}{2}m(30^2 - 30^2) = 0\end{aligned}$$

so *no work* is done on the ball.

Alternatively: consider the work done bringing the ball to a stop

$$\begin{aligned}W_1 &= \frac{1}{2}m(0 - 30^2) = 0.5 \times 0.02 \times -900 \\ &= -9 \text{ J}\end{aligned}$$

Work done to accelerate the ball from rest to $+30 \text{ ms}^{-1}$

$$\begin{aligned}W_2 &= \frac{1}{2}m(30^2 - 0) = 0.5 \times 0.02 \times 900 \\ &= +9 \text{ J}\end{aligned}$$

so the total work done is

$$\begin{aligned}W &= W_1 + W_2 \\ &= -9 + 9 = 0 \text{ J}\end{aligned}$$