4. We denote the mass of the father as m and his initial speed v_i. The initial kinetic energy of the father is

$$K_i = \frac{1}{2} K_{\text{son}}$$

and his final kinetic energy (when his speed is $v_f = v_i + 1.0$ m/s) is

$$K_f = K_{\text{son}} \ .$$

We use these relations along with Eq. 7-1 in our solution.

(a) We see from the above that $K_i = \frac{1}{2} K_f$ which (with SI units understood) leads to

$$\frac{1}{2} m v_i^2 = \frac{1}{2} \left(\frac{1}{2} m (v_i + 1.0)^2 \right) \ .$$

The mass cancels and we find a second-degree equation for v_i:

$$\frac{1}{2} v_i^2 - v_i - \frac{1}{2} = 0 \ .$$

The positive root (from the quadratic formula) yields $v_i = 2.4$ m/s.

(b) From the first relation above ($K_i = \frac{1}{2} K_{\text{son}}$), we have

$$\frac{1}{2} m v_i^2 = \frac{1}{2} \left(\frac{1}{2} \left(\frac{m}{2} \right) v_{\text{son}}^2 \right)$$

and (after canceling m and one factor of 1/2) are led to $v_{\text{son}} = 2 v_i = 4.8$ m/s.