23. Let m_m be the mass of the meteor and m_e be the mass of Earth. Let v_m be the velocity of the meteor just before the collision and let v be the velocity of Earth (with the meteor) just after the collision. The momentum of the Earth-meteor system is conserved during the collision. Thus, in the reference frame of Earth before the collision, $m_m v_m = (m_m + m_e)v$, so

$$v = \frac{v_m m_m}{m_m + m_e} = \frac{(7200\,\mathrm{m/s})(5 \times 10^{10}\,\mathrm{kg})}{5.98 \times 10^{24}\,\mathrm{kg} + 5 \times 10^{10}\,\mathrm{kg}} = 6 \times 10^{-11}\,\mathrm{m/s}\ .$$

We convert this as follows:

$$\left(6 \times 10^{-11}\,\frac{\mathrm{m}}{\mathrm{s}}\right)\left(\frac{1000\,\mathrm{mm}}{\mathrm{m}}\right)\left(\frac{3.2 \times 10^{7}\,\mathrm{s}}{\mathrm{y}}\right) = 2\ \mathrm{mm/y}\ .$$