18. (a) Regardless of the direction of the thrust, the change in linear momentum of the space probe is given by the impulse-momentum theorem (also using Eq. 10-8):

$$\Delta p = (3000\,\mathrm{N})(65.0\,\mathrm{s}) = 1.95 \times 10^5\ \mathrm{kg{\cdot}m/s}\ .$$

(b) The change in speed for the probe of mass m is

$$\Delta v = \frac{\Delta p}{m} = \frac{1.95 \times 10^5\ \mathrm{kg{\cdot}m/s}}{2500\,\mathrm{kg}} = 78.0\,\mathrm{m/s}\ .$$

Let the initial and final speeds of the probe be v_i and v_f, respectively. Then, the change in its kinetic energy is $\Delta K = \frac{1}{2}m(v_f^2 - v_i^2)$. If the thrust is backward then $v_f = v_i - \Delta v$, and

$$\begin{aligned}
\Delta K &= \frac{1}{2}m\left((v_i - \Delta v)^2 - v_i^2\right) \\
&= \frac{1}{2}(2500\,\mathrm{kg})\left((300\,\mathrm{m/s} - 78.0\,\mathrm{m/s})^2 - (300\,\mathrm{m/s})^2\right) \\
&= -5.09 \times 10^7\ \mathrm{J}
\end{aligned}$$

If the thrust is forward then $v_f = v_i + \Delta v$, and

$$\begin{aligned}
\Delta K &= \frac{1}{2}m\left((v_i + \Delta v)^2 - v_i^2\right) \\
&= \frac{1}{2}(2500\,\mathrm{kg})\left((300\,\mathrm{m/s} + 78.0\,\mathrm{m/s})^2 - (300\,\mathrm{m/s})^2\right) \\
&= 6.61 \times 10^7\ \mathrm{J}\ .
\end{aligned}$$

If the thrust is sideways then $v_f = \sqrt{(\Delta v)^2 + v_i^2}$, and

$$\Delta K = \frac{1}{2}m\left((\Delta v)^2 + v_i^2 - v_i^2\right) = \frac{1}{2}(2500\,\mathrm{kg})(78.0\,\mathrm{m/s})^2 = 7.61 \times 10^6\ \mathrm{J}\ .$$