69. We use the impulse-momentum theorem $\vec{J} = \Delta\vec{p}$ where $\vec{J} = \int \vec{F}\,dt$. Integrating the given expression for force from the moment it starts from rest up to a variable upper limit t, we have $\vec{J} = \left(16t - \frac{1}{3}t^3\right)\hat{\imath}$ with SI units understood.

(a) Since $\left(16t - \frac{1}{3}t^3\right)\hat{\imath} = m\vec{v}$ with $m = 1.6$, we obtain $\vec{v} = 24\,\hat{\imath}$ in meters-per-second, for $t = 3.0$ s.

(b) Setting $\left(16t - \frac{1}{3}t^3\right)\hat{\imath} = m\vec{v}$ equal to zero leads to $t = 6.9$ s as the positive root.

(c) We can work through the $\frac{d\vec{v}}{dt} = 0$ condition using our $\left(16t - \frac{1}{3}t^3\right)\hat{\imath} = m\vec{v}$ relation, or more simply observe, from the outset, that this is equivalent to finding when the acceleration, hence the force, is zero. We obtain $t = 4.0$ s as the positive root, which we plug into the $\left(16t - \frac{1}{3}t^3\right)\hat{\imath} = m\vec{v}$ relation and find $\vec{v}_{\text{max}} = 27\,\hat{\imath}$ m/s.