2014 F=ma Exam: Problem 24

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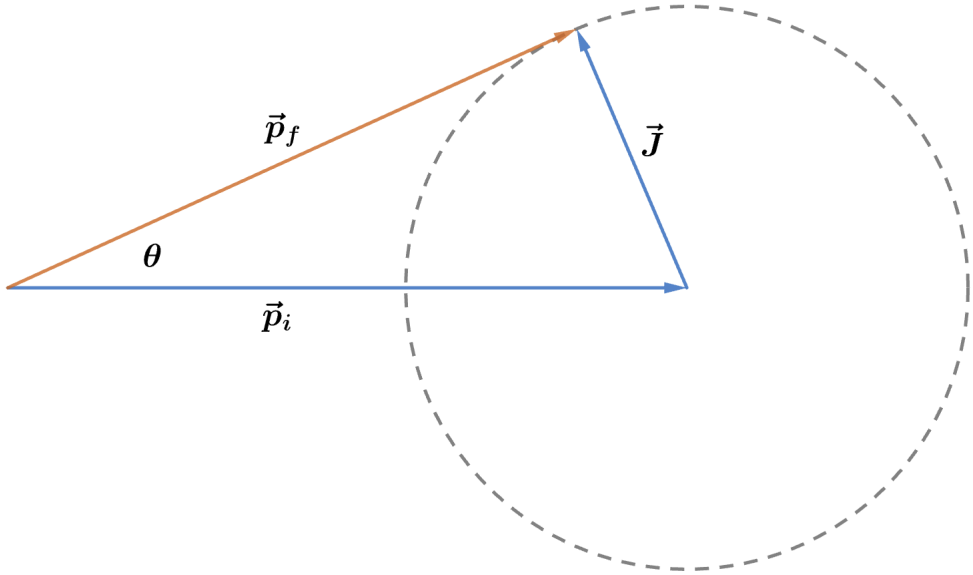

The astronaut has some initial momentum $\vec{p}_i = m_{\text{ast}}\vec{v}$ and can fire her launcher in any direction to deliver impulse $J = 455\,\text{N s}$ (found in the previous problem) on herself. Since the final momentum

$$\vec{p}_f = \vec{p}_i + \vec{J}$$

the tip of the final momentum vector can be anywhere on the sphere reachable by $\vec{J}$. To maximize the angle θ between $\vec{p}_i$ and $\vec{p}_f$, we take $\vec{p}_f$ to be tangent to the sphere. Then

$$\sin\theta = \frac{J}{p_i}$$

$$\theta = \arcsin\left(\frac{J}{m_{\text{ast}}v}\right) = \arcsin\left(\frac{455}{100\cdot 10}\right) = 27^\circ$$

so the answer is $\boxed{\text{C}}$.