Station Card: Conservation Laws (Orbits)

Energy + angular momentum shape orbits

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Name: _____ **Section:** _____

Date: _____

Station: _____ **Group members:** _____

Goal: Use the demo to make a claim supported by (1) at least one number/readout and (2) at least one sanity check.

Demo: `/demos/conservation-laws/`

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Setup: Use $M = 1\,M_\odot$ and $r_0 = 1\,\text{AU}$ (defaults).

Your station artifact (fill in): 1) **Escape test:** Find the speed factor where the orbit becomes "escape/parabolic" (about $\sqrt{2}$).
2) **Direction check:** Change direction to 60°. Does the escape speed factor change?
3) **What does change:** At a fixed speed factor, compare h and periapsis r_p at 0° vs 60°.
4) **Explanation (1–2 sentences):** Use "energy sets bound vs unbound" and "angular momentum sets closest approach."

> 💡 Word bank + sanity checks
>
> **Word bank:** - **Speed factor** (v/v_{circ}): speed compared to circular speed at the same r_0.
> - **Specific energy** ε: determines bound ($\varepsilon < 0$) vs escape ($\varepsilon = 0$) vs hyperbolic ($\varepsilon > 0$). -
> **Angular momentum** h: depends on the tangential part of the velocity; it controls how close the orbit swings in (r_p).
> **Key relationship (specific orbital energy):**
>
> $$\varepsilon = \frac{v^2}{2} - \frac{\mu}{r}$$
>
> **Sanity checks:** - Escape happens at:
>
> $$v_{\text{esc}} = \sqrt{2}\, v_{\text{circ}}$$

(so speed factor ≈ 1.414), regardless of direction. - Changing direction changes h (and therefore r_p), even if the speed magnitude stays the same. - "Bound vs unbound" tracks the sign of ε.