

Ion Thruster Simulator

Classroom worksheet · Interactive simulation: <https://lkforge.com/tools/physics/ion/>

Name: _____ Date: _____

Learning objectives

- Explain how an ion thruster produces thrust.
- Contrast high specific impulse with low thrust.
- Identify suitable missions.

Variables to change

- Ion exhaust velocity
- Propellant flow rate
- Input power

Procedure

1. Run the thruster and note the very high exhaust velocity but small thrust.
2. Increase the propellant flow and observe thrust rise.
3. Let it run continuously and observe the slow but steady speed build-up.

Observations

Record thrust and exhaust velocity, and how a small steady thrust accumulates large delta-v over time.

Questions

1. How does an ion thruster work?
2. Why is its specific impulse so high?

3. Why is its thrust so small?
4. What missions suit ion propulsion?
5. Can an ion thruster launch from Earth's surface?

Answer key (instructors)

- **1.** It ionizes a propellant (e.g. xenon) and accelerates the ions electrostatically to very high speed.
- **2.** The exhaust velocity is very large, so each unit of propellant gives lots of delta- v .
- **3.** The mass flow rate is tiny, so the force ($\dot{m} \cdot v_e$) is small despite the high speed.
- **4.** Long-duration deep-space and station-keeping, where efficiency matters more than quick acceleration.
- **5.** No — its thrust is far too weak to overcome gravity; it works in space over long times.

An ion thruster electrostatically accelerates ionized propellant to very high exhaust velocity, giving excellent specific impulse but tiny thrust ($F = \dot{m} \cdot v_e$ with small $\dot{m}$). Run continuously in space, that gentle push builds large delta- v — ideal for deep-space missions.