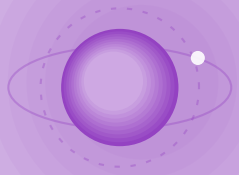
TEACHER ANSWER KEY

Tier 2 · Propellant & Staging





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Predictions below have fixed answers. Questions marked **Measured live** are graded against what the simulation actually produces, so the exact value depends on the student's run; use the tolerance shown in-game.

T2-01 · Exhaust Exchange (Grades 6–12)

P1. The engine throws its exhaust backward and the rocket moves forward. How do the push on the rocket and the push on the exhaust compare?

Answer: They are equal and point opposite ways

P2. While the engine fires in empty space, which group of things keeps the same total momentum?

Answer: The rocket and its exhaust together

Standards: HS-PS2-2 (practice) – Momentum of a defined two-module system is conserved. Rocket exhaust is a transfer application, not a substitute for the standard's two-object collision task.; MS-PS2-1 (practice) – Assessed through the two-module collision (separation/docking) variant, not the exhaust view.
Do not require conservation of rocket momentum alone; the system is rocket plus exhaust. Teacher note: the craft starts in a 120 km orbit (no air, no ground); the capsule separates from its engine stage and the 0.1% momentum residual is measured on that separation. Transfer: a different mass ratio.

T2-02 · The Fuel Trap (Grades 6–12)

P1. Does adding more and more fuel always make a rocket go higher?

Answer: No, the extra weight can stop it lifting off at all

P2. Picture a version of this rocket with a lot more fuel that never leaves the pad. What went wrong?

Answer: Measured live in the sim: compare the student's answer with the result shown after the flight (tolerance applies).

Standards: MS-PS2-2 (practice) – The mass-force trial supports MS-PS2-2: more mass at the same force accelerates less.
The rocket equation is HS enrichment. Teacher note: the Orbital Starter is flown once (builder locked) past the 10 km gate; the added-fuel design (a thrust-to-weight of 0.9) is read from the same calculator the answer is graded against. Transfer: a new engine and payload.

T2-03 · Shed the Dead Mass (High School (9–12))

P1. The first tank is empty and the second engine is about to fire. What happens to how fast the rocket speeds up if we drop the empty first stage first?

Answer: Measured live in the sim: compare the student's answer with the result shown after the flight (tolerance applies).

Engineering application; no standard code is claimed. Teacher note: the Orbital Starter is flown with its first stage dropped when empty; the launch-mass budget is its stock mass rounded up to the next 500 kg and the gate is 20 km. Transfer: a side-booster layout with different crossfeed.

T2-04 · Nozzle Altitude Match (High School (9–12))

P1. The same engine at the same throttle. Where does it push hardest?
Answer: High up, where the air is thin

P2. How hard will the engine push in air at half the ground pressure (about 50 kPa)? Mark the range you expect.
Answer: Measured live in the sim: compare the student's answer with the result shown after the flight (tolerance applies).

Standards: HS-PS2-1 (enrichment) – Force-data application: read thrust and flow at two pressures and interpolate.
No claim that visual bell length alone determines Isp. Teacher note: the sounding rocket is flown through thick and thin air; thrust and fuel flow must stay within 10% of the engine model at both, and the slider band is graded on its centre, within 4% of the model at 50 kPa.

T2-05 · Payload Frontier / SSTO (High School (9–12))

P1. The Science Sounding Rocket has one stage. Could it reach orbit all by itself?
Answer: Measured live in the sim: compare the student's answer with the result shown after the flight (tolerance applies).

P2. What is the biggest thing holding that one-stage rocket back?
Answer: Measured live in the sim: compare the student's answer with the result shown after the flight (tolerance applies).

Real Earth versus a clearly labelled compact world; no universal "SSTO impossible" conclusion. No standard code is claimed.
Teacher note: the questions are about the one-stage Science Sounding Rocket (ideal speed gain below what an orbit needs); the learner flies the two-stage Orbital Starter to an orbit between 56 and 104 km, with its capsule and last stage (at least 90% of what it really delivers) intact.
