TEACHER ANSWER KEY

# Tier 1 · Anatomy, Force & Stability

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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.

## T1-01 · Force Cart in Vacuum (Grades 6–12)

**P1.** If we double the engine's thrust from 50% to 100%, what happens to our acceleration?
**Answer:** It doubles

**P2.** If our rocket is twice as heavy, what happens to our acceleration under the same thrust?
**Answer:** It accelerates slower

**P3.** At full thrust, how fast will our speed grow every second? 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:** MS-PS2-2 (practice) – Predict how acceleration changes when the force doubles and when the mass doubles.; HS-PS2-1 (practice) – Acceleration versus F/m agrees within 5% on calibrated intervals; the band question asks for a = F/m.
Teacher note: the craft is fixed (22,670 kg, 250 kN) and starts on the surface of the Moon (no air) so the push is the only force that changes; it does not fall while the briefing is read. The band is graded on its centre, within the approved 10% of F/m.

## T1-02 · Rocket Anatomy Relay (Middle School (6–8))

**P1.** Our rocket has a fuel tank, an engine, a parachute and fins. Which tank can feed the engine?
**Answer:** Only a tank that is joined to the engine

**P2.** A flight has three jobs: light the engine, climb past the marker height, and open the parachute. In which order do they happen?
**Answer:** Light the engine, climb past the marker, open the parachute

**Standards:** MS-PS2-2 (enrichment) – Engineering application of MS-PS2-2: follow the fuel path and the order of a real flight.
Teacher note: the Science Sounding Rocket is ready on the pad (the builder is locked). Resource and attachment paths are real, and the learner flies the whole job: engine on, up past the 5 km marker, then a parachute landing; this is not a word-matching anatomy quiz.

## T1-03 · Balancing Act (Grades 6–12)

**P1.** The balance point (CoM) is ahead of the pressure point (CoP), and a gust gives the nose a small upward nudge. What happens to the wobble?
**Answer:** It dies away

Stability is enrichment of force and motion; no standard code is claimed. Teacher note: the rocket is the Orbital Starter with its bottom tank a quarter full, so its balance point is ahead of its pressure point; the builder is locked. Transfer: a new payload location.

## T1-04 · Fuel Moves the Balance (Grades 6–12)

**P1.** Imagine the engine burns the bottom tank first. As the fuel drains, does the rocket's balance flip between steady and wobbly?

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

**P2.** Now imagine the engine burns the top tank first instead. Does the balance flip this time?

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

Controlled-variable investigation; no standard code is claimed. Teacher note: the Orbital Starter is flown with its steering assist; its bottom tank drains first. The other drain order is calculated from the same balance model (no second craft is flown). Dry mass never teleports in flight.

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## T1-05 · The Hanging Rocket Myth (Grades 6–12)

**P1.** The engine sits above the balance point, and its push goes straight through that point. A kick makes the rocket start to spin. What does the engine's push do to the spin?

**Answer:** Nothing: the push goes through the balance point

**P2.** Now the engine sits below the balance point, and its push still goes straight through that point. What does the engine's push do to a spin?

**Answer:** Nothing: the push goes through the balance point

**P3.** Which of these can pull a spinning rocket back to straight?

**Answer:** A parachute pulling from above, outside the rocket

**P4.** The engine's push now misses the balance point, off to the right when you look at the rocket from the side with its nose pointing up. Which way does the push turn the rocket?

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

Force-vector reasoning only; this lesson does not claim full NGSS coverage. Teacher note: the learner flies the Orbital Starter, whose push goes through its balance point, and the nose must stay steady (within 10 degrees) for 10 s; the other cases are questions about the force picture. Transfer: offset one thrust line and predict the torque sign.

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