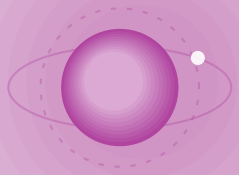
TEACHER ANSWER KEY

Tier 3 · Atmosphere & Ascent





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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.

T3-01 · Falling Speed Lab (Grades 6–12)

P1. The rocket will fall back under its parachute. How fast will it be dropping just before it lands? 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).

P2. Now picture the same rocket loaded until it is twice as heavy, falling under the same parachute. Will its steady fall speed be faster, slower or the same?

Answer: Faster

P3. Back to the normal rocket, but the parachute is twice as wide. Will its steady fall speed be faster, slower or the same?

Answer: Slower

Standards: MS-PS2-2 (practice) – Predict how terminal speed changes with mass and with area.; HS-PS2-1 (practice) – Drag approximately balances weight within 5% in the constant-density calibration.
Force balance is judged only over the quasi-steady part of the fall: the samples where the speed changes by under 3% of surface gravity per second while the engine is off (found from the flight, not marked by hand). Teacher note: the Science Sounding Rocket falls under its parachute; the band is graded on its centre, within 25% of v = sqrt(2 m g / (rho CdA)) for the empty rocket near the ground. Transfer: a different air density.

T3-02 · Max Q Conductor (High School (9–12))

P1. Two climbs: one holds half power while the rocket is in thick air, the other uses full power from the start. Which one has the lower peak air push (q)?

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

P2. When did the air push peak (Max Q)? Mark that moment on the flight clock.

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

HS data-interpretation application; no standard code is claimed. Teacher note: the q limit and the q-times-angle limit are the weakest joint of the Science Sounding Rocket (qLimits.ts); the gate is where the gentle climb has left Max Q behind. The learner marks the flight-clock time of their own peak (within 2 s), read from the live measurement. Transfer: a different air-density profile. Touching a cosmetic shake band is not a failure.

T3-03 · Gravity Turn Ghost (High School (9–12))

P1. Why does the flight path bend during a gravity turn?

Answer: Gravity keeps pulling the velocity direction downward while thrust follows it

No fixed "turn at 10 km" law; alternative efficient safe paths pass. Teacher note: the corridor is the climb angle against height along a vacuum point-mass reference path (tip-over of 11.5 degrees at 1 km), plus or minus 25 degrees; it is not the ideal path through air. The coast height and speed bands at the end of the first stage are 50% to 120% and 70% to 120% of that reference. Transfer: new thrust and payload. No standard code is claimed.

T3-04 · Loss Budget Duel (High School (9–12))

P1. Two ghost flights both reach the end of the first stage. Which one wastes less speed on fighting gravity (the lower total loss)?

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

P2. What is gravity loss?

Answer: Speed not gained because thrust also has to fight gravity

Gravity loss is a defined trajectory diagnostic, not dissipated gravitational energy. The efficiency badge is withheld when the goal fails. Teacher note: the goal is a 100 km orbit (both ends within 15%) using no more than 1.1 times the propellant of an ideal staged ascent of (circular speed + the better ghost's gravity loss); air drag and steering cost the rest. Transfer: a different scale height. No standard code is claimed.

T3-05 · Weathercocking and Active Control (High School (9–12))

P1. A stable rocket is flying nose-first. Something turns its nose a few degrees to one side, so the air meets it at an angle, like a gust from the side. Which way will the air turn the nose?

Answer: Back toward the way the rocket is moving

P2. With the steering assist (SAS) turned off, does a stable rocket still straighten itself out?

Answer: Yes, the air pushes the nose back by itself

The simulator has no wind field (wind-gusts is not modelled), so the disturbance is a nose kick the learner gives with the yaw key: what the air reacts to is the angle between the nose and the airflow, and that is the same for a gust and for a kick. Teacher note: the rocket is the Orbital Starter with its bottom tank a quarter full (a stable balance); a kick counts from 3 degrees and is over when the angle has halved; two are needed, one with the steering assist on and one with it off. Transfer: a new kick direction. No standard code is claimed.
