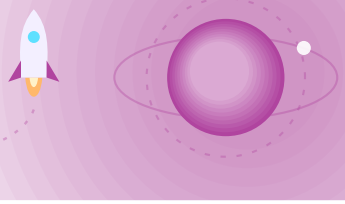
LESSON T3-04 · TIER 3 · ATMOSPHERE & ASCENT

Loss Budget Duel

HIGH SCHOOL (9–12)



Name _____ Date _____ Class / Period _____

Where does the speed go?

The engine of a rocket pays for every metre per second it gains, and some of that payment is wasted. Part of it just holds the rocket up against gravity, part goes to steering, part to the air. Fly smart and you waste less fuel.

Mission goal: reach a {orbitKm} km orbit with no more than {limitKg} kg of fuel.

1 LOOK

OBSERVE BEFORE YOU TOUCH A CONTROL

Step 1 · Fly the first stage

- Two ghost flights tip over at 1 km: ghost A tips over a lot, early; ghost B tips over only a little and climbs nearly straight up for longer.
- Gravity loss is the speed the engine spends just holding the rocket up against gravity instead of gaining useful speed.

Step 2 · Reach the orbit

- An orbit _____ km up needs a sideways speed of _____ m/s.
- An ideal ascent also pays the gravity loss, so it needs about _____ m/s of speed change and burns about _____ kg of fuel. You may use up to _____ kg of the _____ kg on board.

Write the numbers shown in the sim in the blanks above, then record what you notice:

2 PREDICT

COMMIT TO A HYPOTHESIS FIRST

Prediction 1. Two ghost flights both reach the end of the first stage. Which one wastes less speed on fighting gravity (the lower total loss)?

Hint: A ghost is a computer flight with no air. Loss means speed the engine paid for but did not turn into useful speed.

□ Ghost B: climbs straight up for longer

□ Ghost A: tips over early

Because...

Prediction 2. What is gravity loss?

Hint: Think about a rocket that hovers: its engine burns fuel, but its speed does not grow.

□ Energy dissipated by gravity

□ Speed not gained because thrust also has to fight gravity

Because...

3 EXPERIMENT

CHANGE ONE VARIABLE AT A TIME

Step 1. Press **[Space]** to light the engine and **[Z]** for full throttle. Climb straight up to about 1 kilometre, hold **[W]** for about one second to tip the nose over, then click PROGRADE in the Flight Computer. Keep burning until the first tank runs dry.

Step 2. Press **[Space]** to drop the empty stage and light the second engine. Keep the nose on PROGRADE and keep burning until the low point of your orbit is above _____ kilometres, then press **[X]** to cut the engine so your orbit stays between _____ and _____ kilometres.

Trial	What I changed	What I measured / saw	Matched my prediction?
1			Yes · No · Partly
2			Yes · No · Partly
3			Yes · No · Partly

4 EXPLAIN

CLAIM · EVIDENCE · REASONING

Claim — What did you find out? (answer the mission goal in one sentence)

Evidence — Which numbers or observations from the sim support your claim?

Reasoning — Which science idea connects your evidence to your claim?

Self-check: □ I made a prediction before experimenting □ I used numbers from the sim □ I explained *why*, not just *what*