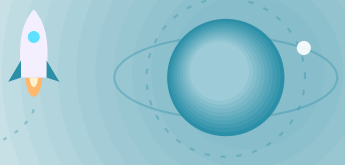
LESSON T5-01 · TIER 5 · TRANSFERS & RENDEZVOUS

Two-Burn Mail

HIGH SCHOOL (9–12)



Name _____ Date _____ Class / Period _____

Two burns to a higher circle

To climb to a higher circular orbit you cannot just fire the engine once. One burn makes an oval that comes back to where you fired. A second burn at the top of the oval makes it round. Together they are called a Hohmann transfer.

Mission goal: go from a circle {lowKm} km up to a circle {highKm} km up with two forward burns, using as little speed change as you can.

Standards practiced: HS-ESS1-4 · Words to know: hohmann-transfer, transfer-time, delta-v, tangential-burns

1 LOOK

OBSERVE BEFORE YOU TOUCH A CONTROL

Step 1 · Raise the far side

- Our craft circles Terra _____ km up at _____ m/s. We want a circle _____ km up.
- A burn changes the orbit on the OPPOSITE side from where you fire. Speeding up raises the far side of the orbit; slowing down lowers it.

Step 2 · Make the circle

- You now coast up the oval. The trip to the top takes _____ minutes, half of the oval's _____-minute lap.
- A circle _____ km up needs _____ m/s. At the top of your oval you will be moving slower than that, so the second burn is a push forward too.

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. Going from a low circle to a higher circle takes two burns: one now and one later. Which pair of pushes describes them (first burn, then second burn)?

Hint: Prograde means pushing the way you are already moving (speeding up); retrograde means pushing against it (slowing down).

□ Retrograde, then prograde

□ Prograde, then retrograde

□ Retrograde, then retrograde

□ Prograde, then prograde

Because...

Prediction 2. After the first burn you coast up an oval orbit. How many MORE burns does the trip need to end as a circle at the top?

Hint: An orbit always comes back to the place where the engine was fired.

□ None: the oval is already the orbit we want

□ One more, at the top of the oval

Because...

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3 EXPERIMENT

CHANGE ONE VARIABLE AT A TIME

Step 1. Click PROGRADE in the Flight Computer so the nose points the way you are moving. Press **[Space]** to light the engine and **[C]** for half throttle. Watch the Orbit high point climb. When it reads _____ km (at least _____) press **[X]** to cut the engine.

Step 2. Press **[.]** to speed up time until the Height stops rising: that is the top. Slow time down with **[,]**. Then press **[C]** for half throttle and watch the Orbit low point rise. When it reads _____ km press **[X]** to cut the engine.

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*