LESSON C-02 · CAPSTONE MISSIONS

Interplanetary Mail

HIGH SCHOOL (9–12)



Name _____ Date _____ Class / Period _____

Mail to another world

Planets keep moving while you travel, so you aim at where Ares WILL be, not where it is. You wait in orbit for the right moment, leave Terra with one big burn, and coast round the Sun to Ares.

Mission goal: leave Terra at the right moment and arrive inside the sphere of influence of Ares, the region where its gravity rules.

1 LOOK

OBSERVE BEFORE YOU TOUCH A CONTROL

Step 1 · Wait for the window

- Terra goes round the Sun in _____ days and Ares in _____. Terra is faster, so the angle between them keeps changing. The same angle comes back every _____ days.
- The trip along the transfer orbit takes _____ days, and Ares keeps moving the whole time.

Step 2 · Leave Terra

- The craft must leave Terra with a speed of _____ m/s more than Terra has round the Sun. From the _____ km circle that needs a burn of about _____ m/s.
- After the burn the craft climbs away from Terra. When it leaves Terra's sphere of influence the Sun's gravity takes over.

Step 3 · Coast to Ares

- You are on an oval round the Sun that reaches out to the orbit of Ares. The trip is half a lap of that oval.
- Ares is moving toward the point where your orbit reaches it.

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. How far must Ares be AHEAD of Terra, seen from the Sun, when you leave? Mark the range you expect.

Hint: The angle is measured in radians: 1 radian is about 57°. The marks show 30°, 60° and 90°. Aim for a band about 0.2 wide.

My prediction (circle or fill in): _____ to _____

Because...

Prediction 2. To reach a planet that is farther from the Sun, which way should the escape burn push, compared with the way Terra moves round the Sun?

Hint: Speeding up in your orbit around the Sun lifts the far side of that orbit.

□ Against the way Terra moves

□ The way Terra moves

□ Straight toward the Sun

Because...

Prediction 3. How many days will the trip to Ares take? Mark the range you expect.

Hint: The transfer orbit is an oval round the Sun. The trip is half a lap of that oval.

My prediction (circle or fill in): _____ to _____

Because...

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3 EXPERIMENT

CHANGE ONE VARIABLE AT A TIME

Step 1. Press **[M]** for the map. Press **[.]** to speed up time and watch the Target is ahead by number. Slow time down with **[,]** as it nears _____° to _____°. The bar is full when you are inside that window.

Step 2. Click PROGRADE in the Flight Computer. Press **[Space]** to light the engine and **[Z]** for full throttle (press **[Space]** again for the next stage if the engine runs out). Burn about _____ m/s, then press **[X]** and speed time up with **[.]** until the Do bar fills: you are then orbiting the Sun.

Step 3. Press **[.]** to speed up time. Watch the Flight clock. The bar fills when you enter the sphere of influence of Ares.

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*