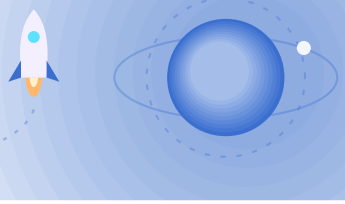
LESSON T4-03 · TIER 4 · FALLING AROUND THE WORLD

# Equal-Area Courier

GRADES 6–12



Name _____ Date _____ Class / Period _____

## Equal times, equal areas

Johannes Kepler found a rule for orbits: draw a line from the planet to the craft, and in equal times that line sweeps out equal areas. It means a craft must speed up when it is close to the planet and slow down when it is far away.

**Mission goal: watch a whole trip around an oval orbit and see how the speed changes.**

**Standards practiced:** HS-ESS1-4 · Words to know: equal-areas, orbital-speed, ellipse, prediction

## 1 LOOK

OBSERVE BEFORE YOU TOUCH A CONTROL

### Step 1 · Fast and slow

- Our craft flies an oval orbit _____ km by _____ km above Terra. Its lowest point is _____ km from the centre of Terra and its highest point is _____ km from the centre.
- One full trip takes _____ minutes. We will use time warp to watch it.

### Step 2 · Where is it fastest?

- In step 1 you watched the Speed number change as the craft went around.
- Gravity pulls the craft toward Terra all the time. Falling toward Terra speeds the craft up; climbing away slows it down.

### Step 3 · Equal times, equal areas

- Draw a line from Terra to the craft. As the craft moves, the line brushes over an area, like a clock hand.
- Cut the orbit into 8 time slices of _____ minutes each, one eighth of the trip.

**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 many times faster is the craft at the lowest point of its oval orbit than at the highest point? Mark the range you expect.

*Hint: A ratio of 2 would mean twice as fast. Aim for a band about 0.3 wide.*

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

**Because...**

**Prediction 2.** Where on its oval orbit does the craft move fastest?

*Hint: Think of a ball rolling down into a valley and back up the other side.*

□ At its highest point (farthest from Terra)

□ The same speed everywhere

□ At its lowest point (closest to Terra)

**Because...**

**Prediction 3.** Draw a line from Terra to the craft. In equal amounts of time, what does the line sweep out?

*Hint: The area is the patch of the picture the line brushes over, like the blade of a clock hand.*

□ More area near the low point

□ The same area everywhere

□ More area near the high point

**Because...**

## 3 EXPERIMENT

CHANGE ONE VARIABLE AT A TIME

**Step 1.** Press **[.]** to speed up time and watch the Speed number for one whole trip around the orbit. Press **[,]** to slow time down. Do not fire the engine.

**Step 2.** Read the numbers, then press Got it.

**Step 3.** Read the numbers, then press Got it.

| 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*