Ghost Key: guided opening

This worksheet follows the opening of your actual mission. The lab continues from the same flight; nothing resets when you take command.

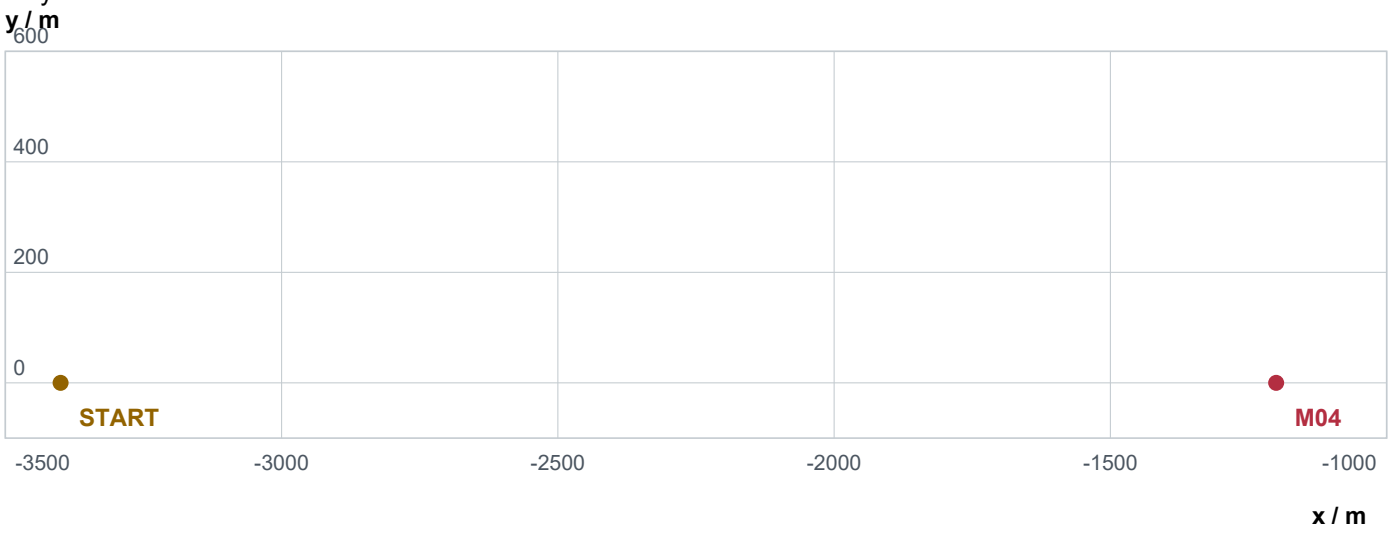
CADET / GROUP _____ CLASS _____ DATE _____

ATTEMPT ID _____ PARTNER _____

Deliver the infiltration team with the station intact. First learn to plot a course, clear one mine and stop. Then choose your own remaining route, targets and docking approach. Use the matching Mission Lab for the full map and rules.

Quantity	Starting value	Meaning
Position x, y / m	(-3400, 0)	Location on the map
Velocity v_x, v_y / m/s	(60, 0)	Change of position per second
Mission time / s	0	Clock before this flight

Plot: label the first waypoint (-2800, 100) m. Later add your coast endpoint and stopping point, with times. Connect your predicted points before execution; use a different line for observations. This equal-scale window shows the opening only.



Which value tells you the ship is already moving? Explain its units.

A worked course segment

Enter the commands in the highlighted game boxes. Record your first prediction before executing, even if it differs from the worked example.

Commands: total duration 10 s; burn 10 s; $a_x = 0$, $a_y = +2$ m/s². Both axes share the same 10 s interval.

$v_x,f = 60 + 0 \times 10 = 60$ m/s; **$v_y,f = 0 + 2 \times 10 = 20$ m/s**

$\Delta x = 60 \times 10 = 600$ m; **$\Delta y = ½ \times 2 \times 10^2 = 100$ m**

x_f = -3400 + 600 = -2800 m; **y_f = 0 + 100 = 100 m**

The boxes ask for final coordinates, not displacements. Velocity predictions do not command the engine.

First prediction before execution

Quantity	x component	y component
Final position	x = _____ m	y = _____ m
Final velocity	v_x = _____ m/s	v_y = _____ m/s

Commit, execute, observe. The game pauses at t = 10 s. Compare at that same instant.

Observed after execution

Quantity	x component	y component
Final position	x = _____ m	y = _____ m
Final velocity	v_x = _____ m/s	v_y = _____ m/s

Why does x change when a_x is zero? Use the initial velocity in your explanation.

Graph connection: area under velocity-time gives displacement. The x rectangle is 60 × 10 = 600 m. The y triangle is ½ × 10 × 20 = 100 m. These are changes of position, not coordinates.

Coast to the next waypoint

The next example supplies fewer answers. Keep the measured endpoint of the first segment as the starting state of this segment.

G / U (givens / unknowns): at t = 10 s, p = (-2800, 100) m and v = (60, 20) m/s.

Commands: 5 s total; 0 s burn; $a_x = a_y = 0$. End mission time = _____ s.

$\Delta x = v_x \Delta t$; $\Delta y = v_y \Delta t$; $x_f = x_i + \Delta x$; $y_f = y_i + \Delta y$

S / S Substitute and solve both axes. Use 5 s, not the final clock reading.

First prediction before execution

Quantity	x component	y component
Final position	x = _____ m	y = _____ m
Final velocity	v_x = _____ m/s	v_y = _____ m/s

Do not execute yet. Schedule the shot on page 4, then commit this coast and run it. Ship motion and projectile motion share the mission clock.

Observed after execution

Quantity	x component	y component
Final position	x = _____ m	y = _____ m
Final velocity	v_x = _____ m/s	v_y = _____ m/s

Why does switching the engine off fail to stop either velocity component?

Hit M04 from a moving ship

This is a real mission shot. Clearing one mine opens an option; it does not make the rest of the field safe.

Given at launch	x / m	y / m
Ship at mission time 10 s	-2800	100
Mine M04 center	-1200	0
Target minus ship	1600	-100

Choose flight interval $\tau = 5$ s. The round reaches the target center at mission time 10 + 5 = 15 s. Its map velocity must be displacement divided by τ:

v_round = (1600/5, -100/5) = (320, -20) m/s

The ship contributes (60, 20) m/s at release. Subtract that contribution to find the relative launch components you enter:

u = v_round - v_ship = (260, -40) m/s

Enter: Main; firing time 10 s; $u_x = 260$, $u_y = -40$ m/s. Relative speed $\sqrt{(260^2 + 40^2)} \approx 263$ m/s, below 600. Commit the shot, then the coast from page 3.

Before execution	Your prediction
Round map velocity / m/s	(_____, _____)
Center-arrival mission time / s	_____

After execution: impact time _____ s; object hit _____; rounds remaining _____.

The mine has radius 26 m. The round hits its near surface before the calculated center-arrival time.

Why is u_y negative even though the ship is moving upward? Explain the addition of velocities.

Plan and observe a two-axis stop

You now calculate more of the maneuver. Stopping changes velocity over time and uses distance.

Start: t = 15 s; p = (-2500, 200) m; v = (60, 20) m/s.

Goal: v_f = (0, 0) m/s after a 20 s burn. Total duration is also 20 s.

a_x = (0 - 60)/20 = _____ m/s²

a_y = (0 - 20)/20 = _____ m/s²

Check $\sqrt{(a_x^2 + a_y^2)} \le 4$ m/s². Use $\Delta x = v_{x,i}\,\Delta t + \frac{1}{2}a_x(\Delta t)^2$, then x_f = x_i + Δx. Repeat for y.

S / S Calculate the displacements and endpoint. End mission time: _____ s.

First prediction before execution

Quantity	x component	y component
Final position	x = _____ m	y = _____ m
Final velocity	v_x = _____ m/s	v_y = _____ m/s

Commit your prediction and execute the brake. Read the final state at the same time.

Observed after execution

Quantity	x component	y component
Final position	x = _____ m	y = _____ m
Final velocity	v_x = _____ m/s	v_y = _____ m/s

Why did the ship continue moving while the acceleration opposed its velocity?

Review, then take command

Watch the recorded opening and pause or scrub it. Preserve your first predictions alongside observations. Then begin the lab without resetting the mission.

Choose one prediction. Did it match the observation? Explain using the starting values, signs, units and equation.

How did clearing M04 help the route? Why does it not guarantee a safe crossing?

Copy the handoff into your Mission Lab

Read from the game	Your handoff record
Mission time / s	_____
Position x, y / m	(_____, _____)
Velocity v_x, v_y / m/s	(_____, _____)
Hull / main rounds remaining	_____ / _____
Cleared target / turret status	_____ / _____

The guided opening ends at t = 35 s, p = (-1900, 400) m, v = (0, 0) m/s. Hull is 100; five rounds remain; M04 is cleared and both turrets are active. The laboratory begins from those actual conditions. If you chose to leave guidance early, record your actual state instead.

Choose your next objective. What starting data and clearance checks will your next calculation need?

Save flight record exports the opening and lab as one attempt, including predictions and guidance progress. Import it from Review to move devices; return to the flight to resume guidance. Select **Take command · begin lab** when ready. Completion records participation, not a grade.