Family edition

Air Traffic Control Lab: Which Runway, Headwind and Crosswind

Ages 14-18 · about 45 minutes, in one sitting

In Air Traffic Control Lab your child decides which end of the runway the airliners land on, with the trigonometry pilots use for wind.

What you need

- A computer or Chromebook with a current browser.
- The link: mytekdev.com/try/airtrafficlab?lesson=which-runway-headwind-and-crosswind&ref=fam-airtrafficlab-3. No account, no email and nothing to install.
- A calculator set to degrees.

Before you start: try it once yourself

Open mytekdev.com/try/airtrafficlab?lesson=which-runway-headwind-and-crosswind&ref=fam-airtrafficlab-3. A short guide opens over Level 7, Which runway, with a Python program. The tower view is on the left: the airport from the control tower, the airliners with their landing lights on and a tag with each call sign. The radar is on the right: the runway at the top, the dashed final approach line, and a green dot for each airplane with its data block (call sign, altitude in hundreds of feet, speed in tens of knots). Under the radar the radio log keeps every word said, marked "you" or "program". Click an airplane on the radar to give it an instruction.

1. **The program.** The first line prints the headwind and crosswind on each runway, rounded to a tenth of a knot; the line under the stage shows it after "print:". Then use_runway("36") chooses the runway before the shift starts, and a rule clears each arrival at 5 miles.
2. **The signs.** A negative headwind is a tailwind. The crosswind's sign says which side it blows from; its size is the same on both ends of one runway.
3. **The if.** if tower.headwind("18") > tower.headwind("36"): then use_runway("18") on the next line, indented; else: and use_runway("36"). Python needs the colons and the indents.
4. **Other winds.** Level 7 always has the wind from 190 at 16. Missions, Build your traffic sets any wind in 10 degree steps, and the program and its print line run there too; the print line shows as the shift starts, and that is all the check needs, so stop the shift once it shows.
5. **Numbers to expect.** Level 7: 36, headwind -15.8, crosswind -2.8; 18, 15.8 and 2.8. On 36 Fernway 44 goes around at 1:04; on 18 all three land by 10:15. In Build your traffic: 240 at 20 gives 36: -10, -17.3 and 18: 10, 17.3, so the if picks 18; 300 at 12 gives 36: 6, -10.4 and 18: -6, 10.4, so it picks 36.

> The app's crosswind is the wind speed times the sine of the angle between where the wind comes from and the way the runway points, so it is positive from the right and negative from the left. Children who compute it as a size only are right; the sign is a bonus.

The ideas, in plain words

Runways are numbered by the way they point, in tens of degrees: 36 points north (360), and the same strip seen from the other end is 18, pointing south. Winds are reported by where they blow from. An airplane lands into the wind because the headwind slows it over the ground, so it touches down slower and stops sooner.

The wind makes the hypotenuse of a right triangle with the runway. The side along the runway is the headwind, W cos θ, and the side across is the crosswind, W sin θ, where θ is the angle between the wind's direction and the runway's. Most airliners are not allowed to land with more than 10 knots of tailwind, and every airplane has a crosswind it has been shown to handle.

Choosing the runway is the tower's job. When the wind changes enough, the airport "turns around" and every arrival and departure moves to the other end. Air traffic controllers in the United States are hired by the FAA, which says it hired a record 2,235 trainees in its 2026 fiscal year. Applicants must apply before turning 31, and the median pay was $148,080 a year in 2025 (Bureau of Labor Statistics).

Do it together

1. Before opening the app: the wind is from 190 degrees at 16 knots. Runway 18 points to 180. Work out 16 × cos 10° and 16 × sin 10°.

   > **You'll know it worked when:** A headwind of 15.8 knots, and a crosswind of 2.8.

2. Open mytekdev.com/try/airtrafficlab?lesson=which-runway-headwind-and-crosswind&ref=fam-airtrafficlab-3 and press play. Read the line under the stage that starts "print:".

   > **You'll know it worked when:** 36: -15.8 -2.8, 18: 15.8 2.8. The program lands on 36, and the first arrival goes around: too much tailwind.

3. Open `Python`, change "36" in use_runway to "18", go back to `Simulator` and press play.

   > **You'll know it worked when:** All three land into the wind.

4. Ask: what if the wind blew straight across the runway, from 090?

   > **You'll know it worked when:** Cosine of 90 degrees is 0: no headwind on either end, 15 knots across both.

Talk about it

Ask these while you work together. A child who has understood it can answer them without help:

- What angle do you use, and how do you find it?
- What does a negative headwind mean for the pilot?
- Why is the crosswind the same size on both ends?
- Without a calculator, how can you tell which end has the headwind?
- What does your if do for a wind straight across?

> The fourth question is the one that matters. A child who says "the end that points toward where the wind comes from" has the idea behind the cosine. A child who can only push calculator buttons has the numbers without the picture.

For younger and older kids

Younger: For a younger child, draw the wind arrow on graph paper and measure the two parts with a ruler instead of using a calculator.

Older: For an older child, write the if that picks the runway with the bigger headwind, and test it with other winds in `Missions`, `Build your traffic`.

Keep going

- Show that the headwind on 18 is always the negative of the headwind on 36. Why?
- Find the wind from the south that gives exactly 10 knots of tailwind on 36 at 16 knots of wind.
- Change the if so the program refuses to land on a runway with more than 20 knots of crosswind, and prints why.

Bring it into other subjects

- Physics: a 150 knot airliner with a 15.8 knot headwind: what is its groundspeed, and how much shorter is the landing roll, if it goes as the square of the speed?
- Geography: find the runway numbers at your nearest airport, and the wind that usually blows there.
- Careers: look up what a meteorologist at an airport does, and how wind reports reach the tower.
- Computer science: change the if into a function that takes the wind and returns the runway, and test it with five winds.

For your records

Ready to copy into an hour log, a portfolio or a transcript.

LESSON	Air Traffic Control Lab: Which Runway, Headwind and Crosswind

SUBJECTS	Math
TIME	45 minutes
WHAT WE DID	Split a wind into headwind and crosswind with cosine and sine, chose the landing runway at a simulated airport, and wrote a Python condition that chooses it for any wind.
SKILLS PRACTICED	Right triangle trigonometry; Vector components; Conditions in Python

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/airtrafficlab?lesson=which-runway-headwind-and-crosswind

Essential question: How do you split a wind into the part that helps and the part that pushes sideways?

Warm-up: A runway points north, and the wind is from the north-east at 20 knots. How much blows straight down the runway? _____

1. **Vocabulary.** Runway number, wind direction, headwind, tailwind, crosswind, component: write each in your own words.

2. **Level 7.** Wind from 190 at 16. Runway 18: angle ____, headwind ____, crosswind ____. Runway 36: angle ____, headwind ____, crosswind ____. Land on: ____ .

3. **My table.** Wind / headwind on 36 / headwind on 18 / crosswind / runway. 240 at 20: ____. 300 at 12: ____. 150 at 18: ____. 360 at 8: ____. 090 at 15: ____.

4. **My if.** Write it: _____

1. Why do airplanes land into the wind?

2. What should a program do when neither runway has a headwind?

Quick check

Name: _____

1. A wind from 200 at 10 knots on runway 18. The headwind is: (A) 10 × cos 20° (B) 10 × sin 20° (C) 10 × cos 200°

2. A headwind of -12 knots means: (A) 12 knots from the front (B) 12 knots from behind (C) 12 knots across

3. A friend lands on runway 36 in a wind from 170 at 15 knots. Use what you learned today to say what will happen, and what to change.

Answers

QUESTION	ANSWER	WHY
1	A	The angle between 200 and 180 is 20 degrees; the part along the runway uses cosine.
2	B	A negative headwind is a tailwind.
3	Open answer	On 36 the headwind is 15 cos 170°, about -14.8: a tailwind over 10 knots, so the pilot will go around. Use 18, where it is a headwind.

If your state or umbrella school asks, this lesson covers Common Core Math HSG-SRT.C.8, Common Core Math MP4.

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The app this lesson uses is free and runs in the browser, with nothing to install and no account needed. It is at mytekdev.com.

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