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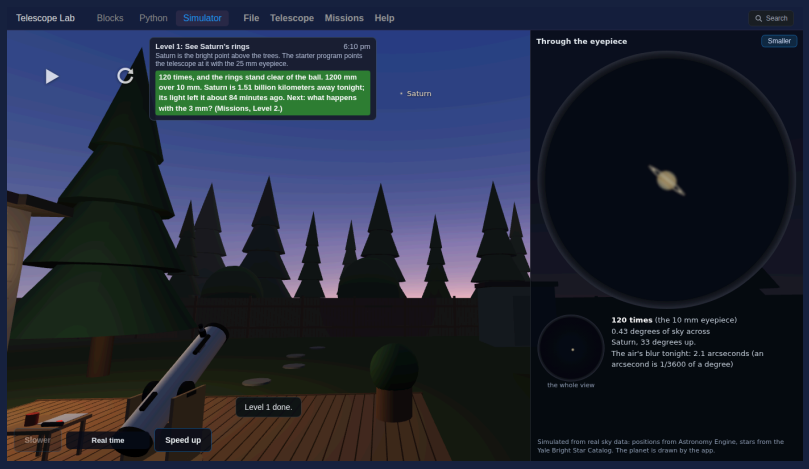
Telescope Lab: Too Much Power, Magnification and the Air

Grades 6-8 · 45 minutes

Physical science · Math



Slides, rubric and answer key · **Print and go** · **No student accounts** · **Chromebook friendly**

What's included

- A one-page overview: objectives, essential question, vocabulary, standards and assessment
- A 45-minute lesson sequence: warm-up, direct instruction, guided practice, independent practice, closure
- Slides for the board: a PowerPoint file that also opens in Google Slides
- A student worksheet with a QR code and a magnification and apparent size table
- A 3-question exit ticket, two to a page, with an answer key
- A rubric: 3 criteria, 4 levels, scored out of 12
- Differentiation for English learners, students with IEPs or 504 plans, and students who need more support or more challenge
- Cross-curricular extensions, and notes for teaching it in grades 4 and 5 and in high school
- Standards: NGSS and Common Core math

Telescope Lab: Too Much Power, Magnification and the Air

Grades 6-8 · 45 minutes · Physical science, Math

A backyard telescope's magnification is a ratio: its focal length, 1200 mm, over the eyepiece's. Students work out 48, 120 and 400 times before they run each eyepiece in Level 1 of Telescope Lab, and see Saturn grow from a small dot to rings that stand clear of the ball. Then Level 2 asks which eyepiece shows Saturn best. The 3 mm makes it biggest, and blurriest: the air above the backyard blurs everything by 2 to 4 arcseconds, and magnifying multiplies the blur along with the planet. Students make a table of apparent sizes, find that both grow in proportion to the magnification, and learn the rule of thumb that about 50 times per inch of mirror is the most a telescope can usefully show.

At a glance

ESSENTIAL QUESTION

Is more magnification always a better view?

OBJECTIVES

Students will be able to:

- calculate a telescope's magnification as a ratio of two focal lengths
- predict the magnification of each eyepiece before testing it
- show with a table that the planet's apparent size and the air's blur are both proportional to the magnification
- explain why more power past the air's blur makes the view bigger but not sharper
- describe how the mirror, the eyepiece and the air each change the light on its way to the eye

VOCABULARY

Focal length, Magnification, Eyepiece, Arcsecond, Seeing, Proportional

STANDARDS

7.RP.A.2a, 7.RP.A.2c, MS-PS4-2

TIME AND MATERIALS

45 minutes, grades 6-8.

- One computer or Chromebook per student
- A projector
- The worksheet and exit ticket, one copy each per student
- The rubric, one copy per student if you grade the work
- A calculator

PREP

Make copies of the worksheet and exit ticket. Before class, open mytekdev.com/try/telescopelab?lesson=too-much-power-magnification-and-the-air&ref=tpt-telescopelab-1 once on a student computer, which checks that your school's filter allows the app, and follow the short guide yourself: about ten minutes.

ASSESSMENT

- Formative: the questions under What to look for, asked while students work, and the exit ticket (answer key included).
- Summative: the worksheet, scored with the rubric.

TECHNOLOGY AND PRIVACY

Runs in any browser, Chromebooks included, with nothing to install. Students need no account and no email: the link works signed out, and nothing they do is stored on our server unless they choose to save.

Lesson sequence

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
0 to 5	**Warm-up** Hook	Show the title, essential question and Today I can slides (about 1 minute). Then the warm-up: zooming a photo of the Moon.	Answer the warm-up on the worksheet.
5 to 13	**Direct instruction (I do)** Model it	Project Level 1. The night is 16 February 2027 in a sample backyard on the edge of Denver, not where anyone in the class is. The backyard is in the middle: the deck, the trees, the telescope and Saturn above them. The eyepiece view is on the right: the big circle is what your eye would see, the small one the whole view to scale, with the magnification, the sky across and the air's blur under them. The box at the top left says the level's goal and, after each run, what happened, with the run's own numbers. Explain focal length with the vocabulary slide, then show the ratio slide: magnification is 1200 mm over the eyepiece's focal length. Students write their three predictions on the worksheet before anything runs. **It's working when:** 1200 / 25 = 48. 1200 / 10 = 120. 1200 / 3 = 400. A shorter eyepiece gives more magnification: the eyepiece is in the bottom of the fraction.	Fill in the vocabulary and predict the three magnifications.
13 to 22	**Guided practice (We do)** Predict, then run	Students open the link or scan the QR code. A short guide has them press play with the 25 mm, change the eyepiece block to the 10 mm and then the 3 mm, checking each prediction against the panel under the eyepiece view, and then opens Level 2. **Watch for:** Students who expect the 25 mm to magnify most because 25 is the biggest number. Point at the fraction: the eyepiece divides.	Follow the guide. Check each prediction, and copy the air's blur from the panel.
22 to 37	**Independent practice (You do)** Level 2 and the size table	Students change Level 2's program to show all three eyepieces, at least 3 seconds each, finishing on the one that shows Saturn best: the for each eyepiece block with use this eyepiece and wait 3 inside it. Then they fill in the size table: apparent size = magnification x true size, for the rings (37 arcseconds) and for the blur. The round play button runs the program from the start of the night; Speed up and Slower, at the bottom, change how fast the night goes (up to 10 times in the backyard). A program's seconds are the night's seconds at any speed. Walk the room with the What to look for questions. **If they ask:** "The for each eyepiece block starts with the list 25, 10, 3. Why does that list not pass the level, and which order does?" The order **Watch for:** Students who finish on the 3 mm because it is biggest. The level wants the best view, and the box says why the 3 mm is not it.	Pass Level 2, fill in the table, and answer the questions.

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
37 to 45	**Closure** More power, more blur. And exit ticket	Show the closure slide and take answers. Then the rule of thumb: about 50 times per inch of mirror (2 per millimeter), here about 400, is the most a telescope can usefully show, and the air usually stops you sooner. Hand out the exit ticket.	Discuss, then answer the exit ticket.

Before you teach: a ten-minute walkthrough

Open mytekdev.com/try/telescopelab?lesson=too-much-power-magnification-and-the-air&ref=tpt-telescopelab-1. A short guide opens over Level 1, See Saturn's rings. The night is 16 February 2027 in a sample backyard on the edge of Denver, not where anyone in the class is. The backyard is in the middle: the deck, the trees, the telescope and Saturn above them. The eyepiece view is on the right: the big circle is what your eye would see, the small one the whole view to scale, with the magnification, the sky across and the air's blur under them. The box at the top left says the level's goal and, after each run, what happened, with the run's own numbers.

1. **The telescope.** An 8 inch (203 mm) mirror with a 1200 mm focal length, and three eyepieces: 25, 10 and 3 mm. The starter blocks are point at Saturn, then use the 25 mm eyepiece.
2. **Level 1.** It passes when Saturn is in view at 100 times or more for 3 seconds. The 25 mm gives 48 times and does not pass; the box says to try a shorter eyepiece. The 10 mm passes at 120 times, about 8 seconds after play. The 3 mm passes too, at 400 times, and the box says the rings are there but blurred.
3. **Level 2.** It wants all three eyepieces for 3 seconds each, finishing on the best. The starter shows only the 3 mm. The for each eyepiece block runs its list in order with use this eyepiece inside it; its own list, 25, 10, 3, ends on the 3 mm and does not pass. 25, 3, 10 with wait 3 passes in 14 seconds. A wait of 2 is too short.
4. **Speed.** The round play button runs the program from the start of the night; Speed up and Slower, at the bottom, change how fast the night goes (up to 10 times in the backyard). A program's seconds are the night's seconds at any speed. Each press of play is a new night's air, so the blur the panel reports changes between 2 and 4 arcseconds from run to run. The magnifications and the times do not change.
5. **Numbers to expect.** Magnification 48, 120 and 400; sky across 1.08, 0.43 and 0.13 degrees. Saturn is 16.5 arcseconds across, its rings 37, and it is 1.51 billion kilometers away. The highest useful power for this mirror is about 400 (2 per millimeter). The air's blur, shown under the view, is 2.1 arcseconds on the first run of a new project and 2 to 4 after that.

> The telescope will not point at the Sun or within 15 degrees of it, and says why: sunlight through a telescope burns the eye in an instant and the damage is permanent. Every view and picture in the app is simulated from real sky data and says so, with its source; none is a real observation.

Background for the teacher

A telescope's mirror gathers light and brings it to a focus; the eyepiece is a magnifying glass for that small image. Magnification is the telescope's focal length over the eyepiece's, so a shorter eyepiece magnifies more and shows a smaller piece of sky. On the way, the light is reflected by the mirror, transmitted through the eyepiece's lenses and,

before any of that, transmitted through the air, whose moving pockets of warm and cool bend it a little differently each instant. That shimmer is called seeing, and from a backyard it blurs everything by 2 to 4 arcseconds.

Magnifying multiplies every angle in the view by the same number: Saturn's 37 arcsecond rings and the air's blur alike, so both apparent sizes are proportional to the magnification. Past the point where the blur is big enough for the eye to see, more power shows no new detail; the image only gets bigger, dimmer and softer. The rule of thumb of 50 times per inch of mirror (2 per millimeter) is the most any telescope can usefully show; most nights the air stops you sooner. The real big telescopes go to mountaintops, and to space, to get above as much of that air as they can.

Astronomers, telescope operators (the job this app is closest to), engineers who build cameras and adaptive optics, and data scientists who sort survey pictures all work with telescopes like these. Anyone can help with real data through citizen science projects such as Zooniverse and the AAVSO.

What to look for

Ask these while students work. A student who has understood the lesson can answer them without help:

- Why does the 3 mm eyepiece magnify more than the 25 mm?
- How big do Saturn's rings look at 120 times, in arcseconds?
- Tonight the air blurs by about 2 arcseconds. How big does that blur look at 400 times?
- Why did the 3 mm not show more detail than the 10 mm?
- Which order of eyepieces passes Level 2, and why?

> The fourth question is the one that matters. A student who says "the blur grew 400 times too, so the rings are no sharper compared with it" understands that magnification multiplies everything. A student who says "it was blurry" has the result but not the idea.

Cross-curricular extensions

- Math: graph apparent ring size against magnification for the three eyepieces. Is the graph a straight line through the origin? What is its slope?
- Science: hold a pencil over a hot road or a candle and look past it. That shimmer is the same thing as seeing.
- History: Galileo's first telescopes magnified about 20 times, and he could not make out Saturn's rings; he drew it as three bodies.
- Careers: look up what a telescope operator does at a big observatory.

Vocabulary

Focal length	How far a mirror or lens brings light to a focus. This telescope's is 1200 mm; each eyepiece has its own.
Magnification	How many times bigger something looks: the telescope's focal length over the eyepiece's.

Eyepiece	The small lens you look through. A shorter one magnifies more and shows less sky.
Arcsecond	A tiny angle: 1/3600 of a degree. Saturn's rings are about 37 arcseconds across.
Seeing	How much the moving air blurs the view: 2 to 4 arcseconds from this backyard.
Proportional	Two amounts that grow by the same factor: double one and the other doubles.

Differentiation

ENGLISH LEARNERS

- Keep the vocabulary slide up, and point at the telescope, the eyepiece view or the box at the top as you say each word: the picture carries the meaning.
- Give a sentence frame on a card: The ____ mm eyepiece magnifies ____ times, because 1200 divided by ____ is ____.
- Show a magnifying glass over printed text at two distances: the letters grow, and so does any smudge on them.

STUDENTS WITH IEPS OR 504 PLANS

- Pair students, one at the keyboard and one recording results.
- Give the three divisions on a card with the answers left blank, and allow a calculator.
- Where the IEP allows a modified assignment, score the first two rubric rows only.

STUDENTS WHO NEED MORE SUPPORT

- Do the three predictions together on the board before anyone runs a program.
- Fill in the first row of the size table together, for 48 times.
- The box at the top says after each run what the magnification was and what to try next.

STUDENTS READY FOR MORE

- Work out the exit pupil, the beam of light that leaves the eyepiece: 203 mm divided by the magnification. Compare it with a dark-adapted pupil, about 7 mm, and explain why 400 times looks dimmer.
- Each eyepiece shows about 52 degrees to the eye. Work out how much sky each shows: 52 divided by the magnification. Check against the panel.
- Open Telescope, Configurator. Change the mirror and the focal length, and predict the magnification and the highest useful power before reading them.

Adapting for other grades

Younger students: In grades 4 and 5, do the three divisions together and let pairs run the eyepieces and say which view is best. Stop before the size table. Score the first two rubric rows, total 8, and 6 meets the objectives.

Older students: In high school, add diffraction: the mirror alone could show 0.68 arcseconds (1.22 times the wavelength over the mirror's width). Compare it with the air's 2 to 4, and explain why big telescopes go to mountaintops (Level 7 of the app).

Student worksheet

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/telescopelab?lesson=too-much-power-magnification-and-the-air

Essential question: Is more magnification always a better view?

Warm-up: Can you zoom a photo of the Moon until it shows more than the photo had in it?

_____

1. **Vocabulary.** Focal length, magnification, eyepiece, arcsecond, seeing, proportional: write each in your own words.

2. **My predictions.** 1200 / 25 = _____ 1200 / 10 = _____ 1200 / 3 = _____
3. **What the app showed.** 25 mm: _____ times. 10 mm: _____ times. 3 mm: _____ times. The air's blur tonight: _____ arcseconds.
4. **Size table.** Apparent size = magnification x true size. Rings (37 arcseconds) at 48: _____ at 120: _____ at 400: _____. My blur at 48: _____ at 120: _____ at 400: _____. Rings divided by blur at each power: _____ _____ _____
5. **Level 2.** The order of eyepieces that passed: _____. The best eyepiece: _____.

1. Why did 400 times not show more detail than 120 times?

2. Write an equation for the rings' apparent size, a, at a magnification m.

Exit ticket

Name: _____

1. A telescope has a 900 mm focal length. A 9 mm eyepiece magnifies: (A) 9 times (B) 100 times (C) 8100 times

2. You switch from 100 times to 200 times. The air's blur looks: (A) the same size (B) twice as big (C) half as big

3. A friend wants the strongest eyepiece for the sharpest view of Saturn. Use what you learned today to answer.

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Exit ticket

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Answer key: exit ticket

QUESTION	ANSWER	WHY
1	B	900 / 9 = 100: the telescope's focal length over the eyepiece's.
2	B	Magnification multiplies every angle in the view, the blur included: it is proportional.
3	Open answer	Past the air's blur, more power makes the blur bigger along with the planet, so the view gets bigger and softer, not sharper. A middle eyepiece (here 120 times) showed Saturn best.

Worksheet: what students should find

BLANK	WHAT THE APP SHOWS
My predictions	48, 120, 400.
What the app showed	48, 120, 400 times. The blur: 2.1 arcseconds on a new project's first run, 2 to 4 after that.
Size table	Rings: 1,776, 4,440 and 14,800 arcseconds (about 30 arcminutes, 1.2 degrees and 4.1 degrees). With a blur of 2.1: 101, 252 and 840 arcseconds. Rings divided by blur: about 18 at every power.
Level 2	Any order that ends on the 10 mm and includes the 3 mm, such as 25, 3, 10. The best: the 10 mm, 120 times.
Question 2	a = 37 x m: the apparent size is proportional to the magnification, with 37 (the true size) as the constant.

> Each run is a new night's air, so a student's blur may be 2.1, 3.6 or any value from 2 to 4; the ratio of rings to blur is then 37 divided by their blur, the same at every power. The magnifications do not change.

Rubric

Score each row from 1 to 4.

Name: _____

CRITERIA	4 EXCEEDS	3 MEETS	2 APPROACHING	1 BEGINNING
Calculating magnification	Predicts all three before running, explains why a shorter eyepiece magnifies more, and checks each against the app.	Calculates all three correctly.	Calculates one or two.	No calculation.
Showing proportion	Completes the size table, shows the ratio to magnification is constant for both rows, and writes the equation.	Completes the size table.	Completes part of the table.	No table.
Explaining the best view	Passes Level 2 and explains with numbers why more power past the air's blur adds no detail.	Passes Level 2 and says the air blurs the high power view.	Passes Level 2 without a reason.	Does not pass Level 2.

Total: ____ / 12. A score of 9 or more meets the objectives.

Standards

The lesson is built for 7.RP.A.2a: students test a table of apparent sizes at three magnifications and find the ratio to magnification constant, for the planet and for the air's blur. Writing apparent size = magnification x true size is 7.RP.A.2c. The telescope as a model of light reflected by a mirror and transmitted through lenses and through moving air is MS-PS4-2.

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
Common Core Math	**7.RP.A.2a**	7	Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.	Students fill in a table of apparent sizes at 48, 120 and 400 times, for Saturn's rings and for the air's blur, and test for equivalent ratios.
Common Core Math	**7.RP.A.2c**	7	Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as t = pn.	Students write apparent size = magnification x true size (a = 37m for the rings).
NGSS	**MS-PS4-2**	6-8	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.	Students use the telescope as a model: the mirror reflects light to a focus, the eyepiece's lenses transmit it, and the moving air transmits it unevenly, blurring it by 2 to 4 arcseconds.

Checked November 2026 against: Common Core State Standards for Mathematics, grade 7, Ratios and Proportional Relationships, NGSS MS-PS4-2, Waves and their Applications in Technologies for Information Transfer.

Optional: save student work in a free class

The whole lesson runs at the link on the worksheet, with no accounts and no sign-up.

To keep students' work, and see it all in one place, make a free class. It takes about ten minutes, once, and covers every lesson in this series: mytekdev.com/tools/class-setup

Students in a class open mytekdev.com/tools/telescope-lab/lessons/too-much-power-magnification-and-the-air/start instead of the worksheet link. Each one gets their own copy of the starter, and the same link reopens it next time.

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