Family edition

Phone Lab: Musts and Wants

Ages 11-14 · about 45 minutes, in one sitting

Your child designs a phone for a hiker and learns the difference between what a design must do and what it should do well.

What you need

- A computer or Chromebook with a current browser, and a mouse or trackpad.
- The lesson link: mytekdev.com/try/phonelab?lesson=musts-and-wants&ref=fam-phonelab-2. No account, no email and nothing to install.

Before you start: try it once yourself

Open mytekdev.com/try/phonelab?lesson=musts-and-wants&ref=fam-phonelab-2. A short guide opens over the app. The phone is the plain starting phone, and the box For: a hiker is on the right, under the card. It reads: "It has to live through a dunk in a creek and a drop on a rock, and still be light enough to carry all day."

1. **The brief.** Must: survives a dunk, not yet. Must: survives all three drops, not yet. Light to carry, 80. A long day, 36. The last line reads "Breaks a must, so it does not meet the brief yet."
2. **The first must.** Open Water, repair and power and pick Dunk under Water seal. The first must says yes. The drops still say not yet: the glass back cracks when the phone lands flat on its back.
3. **The second must.** Open Materials and pick a Plastic back. Both musts say yes and the last line reads "Meets the brief: 65 out of 100". The plastic back is thicker than glass, so the battery is a little smaller: 4,250 mAh.
4. **Raising the score.** A Plastic frame: 71. Thickness 9.0 with the aluminum frame: 67. Thickness 10.0: 68. The Small shape: 68. No cameras at all: 70.
5. **The trap.** Put the Glass back on at any point and the drops say not yet again. The score disappears, whatever the wants add up to.

> The moment that lands is the missing score. Children who have been chasing points lose all of them at once, and that is what a constraint is.

The ideas, in plain words

Engineers split what a customer asks for into two kinds. A constraint is a limit: a price that cannot be passed, a test that has to be survived. A criterion is a measure of how good the design is: lighter, longer lasting. A design is judged on its criteria only after it has met every constraint. The app calls them musts and wants, and shows no score while a must is broken.

The hiker's two wants pull against each other. A longer day needs a bigger battery, and a bigger battery is heavier. Light to carry counts for 60 of the 100 points and a long day for 40, so the best designs here are light ones. The

score reads the design itself, so it moves with every change and no test has to be run first.

The phone in the app is a model: a simple stack of layers. Real phones fit their parts together more cleverly, and a real thin phone holds more battery than this one does, because its makers spread the battery wider. How much a battery holds for its size and how heavy each material is come from published figures. How deep a camera is, how many hours a charge lasts and how a drop goes are estimates, set so that a normal phone comes out normal.

Do it together

1. Open mytekdev.com/try/phonelab?lesson=musts-and-wants&ref=fam-phonelab-2 together. A short guide opens over the app. Read the box `For: a hiker` on the right.

   > **You'll know it worked when:** Two lines start with Must, and both say not yet. Two more have a bar and a number.

2. Open `Water, repair and power` and pick `Dunk` under `Water seal`.

   > **If you get stuck:** Click the words Water, repair and power to open that part of the panel.
   >
   > **You'll know it worked when:** Must: survives a dunk now says yes.

3. Open `Materials` and try a different `Back` until both musts say yes.

   > **If you get stuck:** Plastic and Metal both work. Glass and Ceramic crack.
   >
   > **You'll know it worked when:** The box says Meets the brief, with a score out of 100. A plastic back gives 65.

4. Press `Keep this design`. Then change one thing at a time to raise the score.

   > **You'll know it worked when:** A plastic frame takes it to 71.

5. Ask: what happens to the score if a must breaks? Try it: put the Glass back on.

   > **You'll know it worked when:** The box says it breaks a must, and the score is gone.

Talk about it

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

- Which lines in the box are musts and which are wants? How can you tell?
- The dunk seal fixed one must. What fixed the other?
- Your last change made the score go down. Which want lost points, and why?

- What happens to the score when a must breaks?
- Say the hiker's brief in your own words: what must the phone do, and what should it be good at?

> The fourth question is the real test: a child who says the score does not count until the musts are met has the idea.

For younger and older kids

Younger: For a younger child, stop when both musts say yes and ask which change fixed which must.

Older: For a teenager, pick a second customer and ask which choices for the hiker now work against them.

Keep going

- Pick a second customer under Customers and meet their musts. Which of your changes for the hiker now work against you?
- Find two different phones that both meet the hiker's brief with the same score. What is different about them?
- Write a brief for a new customer: two musts and two wants. Swap briefs with someone and design for theirs using the card.

Bring it into other subjects

- Math: the score is 60 percent Light to carry and 40 percent A long day. Work out the score for bars of 90 and 27, then check it against the app.
- Science: why does a phone with a bigger battery weigh more? What else in the phone adds weight?
- English: write a brief for someone you know: two musts and two wants, each in one sentence.
- At home: pick something in your kitchen and name one constraint and one criterion its designer had.

For your records

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

LESSON	Phone Lab: Musts and Wants
SUBJECTS	Engineering design, Technology
TIME	45 minutes
WHAT WE DID	Designed a phone in a 3D model to meet a customer's two constraints, then improved it against two scored criteria and explained the difference between a constraint and a criterion.
SKILLS PRACTICED	Criteria and constraints; Defining a design problem; Improving a design

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/phonelab?lesson=musts-and-wants

Essential question: What is the difference between what a design must do and what it should do well?

Warm-up: A backpack for school. It must: _____ I would like it to: _____

1. **Vocabulary.** Criteria, constraint, brief, trade-off, customer: write each in your own words.

2. **The hiker's brief.** Musts: _____ and _____ Wants: _____ and _____

3. **The change table.** For each change write what you changed, whether both musts still say yes, and the score. Start with the first design that meets the brief.

1. What is the difference between a must and a want? Give one of each from the hiker.

2. Can the phone with the highest score fail the brief? Explain how.

Quick check

Name: _____

1. A constraint is (A) something a design should do well (B) a line a design cannot cross (C) the score a design gets

2. A phone scores well on Light to carry and A long day, and it does not survive a dunk. For the hiker it (A) meets the brief (B) fails the brief (C) meets half the brief

3. Write one want (criterion) a designer could score for a phone.

Answers

QUESTION	ANSWER	WHY
1	B	A constraint is yes or no. Criteria are what gets scored.
2	B	Surviving a dunk is a must. A design that breaks a must fails, whatever it scores.
3	Anything that can be more or less	Lighter, a longer day, cheaper, a bigger screen. "Survives a dunk" is yes or no, so it is a constraint.

If your state or umbrella school asks, this lesson covers NGSS MS-ETS1-1.

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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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