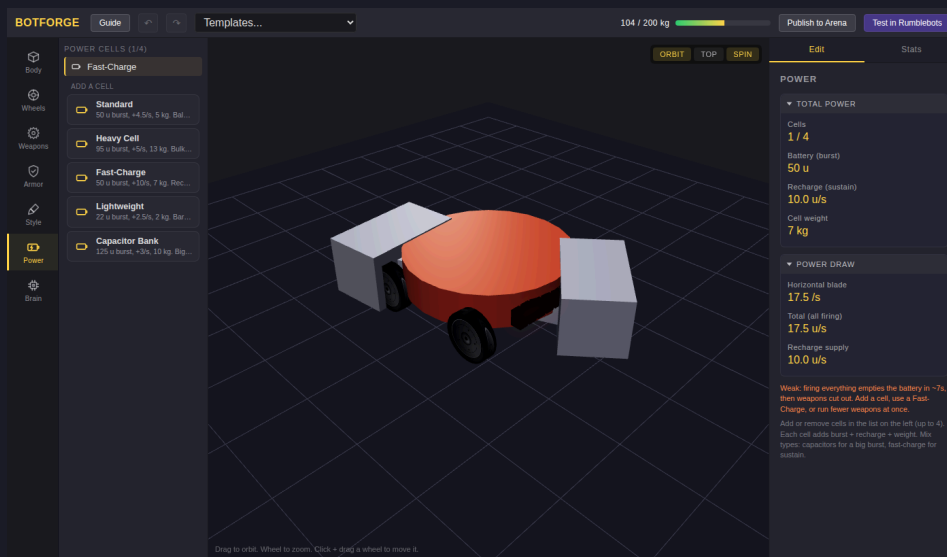


mytekDev

BotForge: Keep the Spinner Spinning

Grades 5-8 · 45 minutes

Math · Engineering



Slides, rubric and answer key

Print and go

No student accounts

Real rate math

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
- 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 3-4 and 9-12
- Standards: Common Core math and NGSS engineering design

BotForge: Keep the Spinner Spinning

Grades 5-8 · 45 minutes · Math, Engineering

BotForge opens on a spinner bot whose blade empties its battery in under 7 seconds, and then cuts out mid-fight. Students read three numbers the app shows, the battery, its recharge and the blade's power draw, and work out the run time themselves: the battery divided by what is lost each second. Then they spend as little of the 200 kg weight limit as they can on battery cells that keep the blade spinning for at least 15 seconds.

At a glance

ESSENTIAL QUESTION

How long will a battery last, and how can a designer make it last longer?

OBJECTIVES

Students will be able to:

- find how much power a bot loses each second by subtracting its recharge from its weapons' draw
- work out how long a battery lasts by dividing what it holds by what it loses each second
- predict a bot's sustained run before checking it in the app
- choose battery cells that meet a run time while using as little of the weight limit as possible

VOCABULARY

battery, recharge, power draw, rate, brown out, sustained run, trade-off

STANDARDS

5.NBT.B.7, 6.RP.A.3b, MS-ETS1-2, 6.NS.B.3, 3-5-ETS1-2

TIME AND MATERIALS

45 minutes, grades 5-8.

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

PREP

Make copies of the worksheet and exit ticket. Before class, open mytekdev.com/try/botforge?lesson=keep-the-spinner-spinning&ref=tpt-botforge-1 once on a student computer and press Power on the left, to see the numbers this lesson uses and to check that your school's filter allows it. No account is needed.

ASSESSMENT

- Formative: the questions under What to look for, asked while students work, and the exit ticket (answer key included).
- Summative: the worksheet's predictions and the student's battery choice, scored with the rubric out of 12.

TECHNOLOGY AND PRIVACY

Runs in any browser, Chromebooks included, with nothing to install. The 3D bot is drawn by the computer's graphics, so older computers turn it more slowly. Students need no account and no email: the link works signed out, and nothing they make is stored on our server unless they choose to save it to an account. If your school blocks new sites, ask IT to allow mytekdev.com.

Lesson sequence

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
0 to 7	Warm-up Hook	Show the title, essential question and Today I can slides (about 1 minute). Then have students open the link or scan the QR code on the worksheet: BotForge opens on a spinner bot. A short guide runs along the bottom; tell students to do its first step only: press Power on the left. The panel on the right warns: firing everything empties the battery in about 7 seconds, then weapons cut out. Ask: "What does that mean in a fight?"	Open Power, read the warning, and answer the question.
7 to 15	Direct instruction (I do) Model it	Show the vocabulary slide. Then point to the three numbers in the Power panel: Battery (burst) 50 u, Recharge (sustain) 10.0 u/s, and under Power draw, Total (all firing) 17.5 u/s. Say: every second the blade uses 17.5 and the battery gets 10 back, so it loses $17.5 - 10 = 7.5$ every second. The battery holds 50, so it lasts $50 / 7.5$, about 6.7 seconds. Open Stats at the top right and find Sustained run: 6.7s. Say: if the recharge were 17.5 or more, nothing would be lost, and the Stats would say unlimited. Show the cells slide: each cell in Add a cell lists its burst, its recharge and its weight, and the meter at the top shows the whole bot, 104 of 200 kg.	Copy the three numbers and the two steps into the worksheet.
15 to 23	Guided practice (We do) Predict, then check	Together: press Power, add a Standard cell from Add a cell, then delete the Fast-Charge with the delete control on its row (a bot always keeps at least one cell). Before anyone opens Stats, students work out the new run: $50 / (17.5 - 4.5) = 50 / 13$, about 3.8 seconds, and write it down. Then open Stats: Sustained run 3.8s. Then add a second Standard cell and predict again: $100 / (17.5 - 9) = 100 / 8.5$, about 11.8 seconds. Before moving on, check that every worksheet has both predictions and both checks.	Change the cells, work out each run on paper, then check it in Stats.
23 to 37	Independent practice (You do) The lightest 15 seconds	Walk the room and ask the questions under What to look for. Students find cells that give a sustained run of 15 seconds or more while weighing as little as possible (Cell weight is in the Power panel), working each try out on paper before checking it in Stats. Up to four cells fit. The lightest answers weigh 11 kg: Fast-Charge plus two Lightweight cells (37.6 seconds), or three Lightweight plus one Standard (21.1 seconds). Students who finish find the lightest cells that never brown out (Sustained run says unlimited): Fast-Charge plus three Lightweight cells, 13 kg, recharge 17.5, exactly the draw.	Work out, check and record each set of cells, and circle the lightest one that reaches 15 seconds.
37 to 45	Closure Compare, and exit ticket	Collect the lightest answers on the board and ask: "Why not just add four Heavy Cells?" (They weigh 52 kg, more than a quarter of the 200 kg limit, and every kilogram spent on cells cannot go to armor or a bigger weapon.) Ask the essential question again, then hand out the exit ticket.	Compare answers, explain the trade-off, then answer the exit ticket on their own.

What to look for

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

- How much power does the bot lose each second right now? Where did those numbers come from?
- Why do you subtract before you divide?

- Your cells say unlimited. What does that tell you about recharge and draw?
- This set of cells reaches 15 seconds. Can you find a lighter one?
- Without the app: a battery of 80, recharge 12.5, draw 17.5. How long does it last?

The last one is the real test. A student who works it out ($80 / 5 = 16$ seconds) without the app understands the rate, not just where to read it.

Cross-curricular extensions

- Science: a phone battery works the same way. Why does a phone die faster while playing a game than while it sits in a pocket? (The game draws more power each second.)
- Math: graph the battery level over 10 seconds for the starter bot: start at 50 and take away 7.5 each second. When does the line reach zero? (Between 6 and 7 seconds.)
- Engineering: real combat robot builders choose batteries by weight too. Write a sentence on what you would do with the weight your lightest cells saved.
- Lesson 2 programs the bot's brain to save battery without losing the spinner's wind-up.

Vocabulary

battery	How much power the bot holds, counted in units (u). A full battery is the most it can spend at once.
recharge	How much power the battery gets back every second (u/s).
power draw	How much power the weapons use every second while they fire (u/s).
rate	How much of something happens each second, like 7.5 units lost per second.
brown out	When the battery runs empty and the weapons cut out until it fills again.
sustained run	How long the weapons can fire nonstop before the battery runs empty.
trade-off	Giving up some of one thing to get more of another, like weight for power.

Differentiation

ENGLISH LEARNERS

- Post the vocabulary with a picture for each word: a battery being filled, a tap running out, a scale for weight.
- Model each calculation on the board with the numbers from the app beside it.
- Give the sentence frame: "It loses ... every second, so it lasts ... seconds."

STUDENTS WITH IEPs OR 504 PLANS

- Where the IEP allows a modified assignment, give the subtraction already done and ask only for the division and the check.
- Allow a calculator for every step.
- Pair students: one changes the cells, the other works out the run and checks Stats.
- Read the exit ticket aloud.

STUDENTS WHO NEED MORE SUPPORT

- Write the two steps on the board: lost each second = draw - recharge; run = battery / lost each second.
- Start the student from Fast-Charge plus one more cell, so only one cell changes at a time.
- Check in at minute 28: does the student work the run out before opening Stats?

STUDENTS READY FOR MORE

- Find the lightest cells that never brown out. (Fast-Charge plus three Lightweight cells, 13 kg.)
- Open Weapons and pick the blade. Its note says where damage tops out for its size: above that speed, the extra spin only drains the battery. Lower the speed toward that number and watch Sustained run. (At 1000 RPM with one Fast-Charge cell it reads about 20 seconds.) What, if anything, does the bot give up?
- Why does the app call Sustained run the worst case? (It assumes every weapon fires nonstop; in a fight they fire in bursts and the battery refills in between.)

Adapting for other grades

Younger students: For grades 3 and 4, give the amount lost each second and work only the division, or use whole-number versions of the numbers. Score the second and third rubric rows only (out of 8; 6 or more meets the objectives).

Older students: For grades 9 to 12, write the run time as a function of recharge, $t(r) = 50 / (17.5 - r)$, graph it, and explain what happens as r approaches 17.5.

Student worksheet

Name: _____ Date: _____



Open the app: scan the QR code, or go to mytekdev.com/try/botforge?lesson=keep-the-spinner-spinning

Essential question: How long will a battery last, and how can a designer make it last longer?

Lost each second = draw - recharge. Sustained run = battery / lost each second. The starter blade draws 17.5 u/s.

CELLS	BATTERY (U)	RECHARGE (U/S)	LOST EACH SECOND	I WORK OUT	STATS SAYS	CELL WEIGHT
Fast-Charge	50	10				7 kg
Standard						
2 Standard						
My try:						
My try:						
My lightest:						

1. **Change cells.** Press **Power** on the left. Add cells from **Add a cell**; delete one with the control on its row.
2. **Check.** Open **Stats** at the top right and read **Sustained run**.

1. Why not just add four Heavy Cells?

Exit ticket

Name: _____

1. A battery holds 100 u, recharges 10 u/s, and the weapons draw 15 u/s. How long do the weapons last? (A) 20 seconds, (B) 10 seconds, (C) 6.7 seconds.
2. The recharge is 20 u/s and the weapons draw 17.5 u/s. The sustained run is: (A) 2.5 seconds, (B) 37.5 seconds, (C) unlimited.
3. Name two ways to make a spinner's battery last longer, and what each one costs.

Exit ticket

Name: _____

1. A battery holds 100 u, recharges 10 u/s, and the weapons draw 15 u/s. How long do the weapons last? (A) 20 seconds, (B) 10 seconds, (C) 6.7 seconds.
2. The recharge is 20 u/s and the weapons draw 17.5 u/s. The sustained run is: (A) 2.5 seconds, (B) 37.5 seconds, (C) unlimited.
3. Name two ways to make a spinner's battery last longer, and what each one costs.

Answer key: worksheet and exit ticket

Measured in the app on the starter bot (draw 17.5 u/s, the bot 97 kg without cells):

CELLS	BATTERY	RECHARGE	LOST EACH SECOND	SUSTAINED RUN	CELL WEIGHT
Fast-Charge	50	10	7.5	6.7 s	7 kg
Standard	50	4.5	13	3.8 s	5 kg
2 Standard	100	9	8.5	11.8 s	10 kg
Fast-Charge + Lightweight	72	12.5	5	14.4 s (not quite)	9 kg
Fast-Charge + 2 Lightweight	94	15	2.5	37.6 s	11 kg
3 Lightweight + Standard	116	12	5.5	21.1 s	11 kg
Fast-Charge + Standard	100	14.5	3	33.3 s	12 kg
Fast-Charge + 3 Lightweight	116	17.5	0	unlimited	13 kg

No set of cells under 11 kg reaches 15 seconds.

EXIT TICKET	ANSWER	WHY
1	A	It loses $15 - 10 = 5$ each second, and $100 / 5 = 20$ seconds.
2	C	The recharge is more than the draw, so the battery never loses power.
3	Any two of: add cells (costs weight); use cells with more recharge, like Fast-Charge (costs weight); lower the blade's RPM (no damage lost down to where the Weapons note says damage tops out; weaker hits below that); fire less often (fewer hits)	Full credit for two ways, each with what it costs.

Rubric

Score each row from 1 to 4.

Name: _____

CRITERIA	4 EXCEEDS	3 MEETS	2 APPROACHING	1 BEGINNING
Works out the run	Every run is worked out right in two steps, with units, and the student explains what each step means.	Every run is worked out right in two steps.	Some runs are right; others skip the subtraction or divide the wrong way.	No run is worked out.
Predicts, then checks	Every prediction was written before checking Stats, and any difference is explained.	Every prediction was written before checking Stats.	Some predictions are missing or written after checking.	Stats was read without predicting.
Meets the brief	Reaches 15 seconds with 11 kg of cells, or explains why no lighter set works.	Reaches 15 seconds and records the cell weight, with no more than a cell or two more than needed.	Reaches 15 seconds but does not record the weight, or uses far more weight than needed without noticing.	Does not reach 15 seconds.

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

Standards

The math standards are the center of this lesson: students work with rates and decimals to find how long a battery lasts. The NGSS standard covers choosing a design that meets a requirement within a weight limit.

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
Common Core Math	5.NBT.B.7	5	Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.	Students subtract and divide the app's decimal rates to find the power lost each second and the run time.
Common Core Math	6.RP.A.3b	6	Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?	Students find the rate the battery empties, in units per second, and use it to find how many seconds a full battery lasts.
NGSS	MS-ETS1-2	6-8	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	Students compare sets of cells against a requirement (15 seconds) and a constraint (weight), and choose the lightest that works.
Common Core Math	6.NS.B.3	6	Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.	Students divide multi-digit decimals with the standard algorithm, such as $50 / 7.5$ and $100 / 8.5$, to find each run time.
NGSS	3-5-ETS1-2	3-5	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	Students work out several sets of cells on paper, compare how well each meets the 15-second run and how much it weighs, and circle the lightest that works.

Checked October 2026 against: Common Core State Standards, Grade 5 Number and Operations in Base Ten, Common Core State Standards, Grade 6 Ratios and Proportional Relationships, NGSS middle school engineering design, Common Core State Standards, Grade 6 The Number System, NGSS 3-5 engineering design.

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. Work stays in the browser tab until it is closed.

To keep students' work, and see every student's bot 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/botforge/lessons/keep-the-spinner-spinning/start instead of the worksheet link. Each one gets their own copy of the starter, and the same link reopens it next time. A student who

started at the worksheet link and then signs up keeps what they made.

Terms of use

Thank you for downloading this lesson. The plan, the handouts and the art were made by mytekDev.

You may:

- print and copy it for your students
- change it for your own classes
- post it on your class website or learning management system
- share this file with other teachers, whole and unchanged, with this page included

You may not:

- sell it, or put it in a product you sell
- share a changed copy
- claim it as your own

The app this lesson uses is free and runs in the browser. Students need no account. It is at mytekdev.com.

Questions, or found a mistake? Ask on the Teachers Pay Teachers Q&A for this resource, or write to us at mytekdev.com/contact.

© 2026 mytekDev. All rights reserved.