

Powering Down

FOCUS

Mathematics Objectives

- Use mathematical modeling to represent a problem situation and to propose a solution.
- Test and verify the appropriateness of math models.
- Explain why the results from mathematical models may not align exactly to the problem situation.

Language Objective Explain, orally and in writing, how to apply a mathematical model to solve a real-world problem involving a multistep equation.

Essential Understanding Many real-world problem situations can be represented with a mathematical model, but that model may not represent a real-world situation exactly.

COHERENCE

Earlier in this topic, students:

- solved different types of multistep equations.

In this lesson, students:

- develop a mathematical model to represent and propose a solution to a problem situation involving a multistep equation.

Later in this course, students will:

- refine their mathematical modeling skills.

Cross-Cluster Connection Using equations to model situations connects to graphing relationships using functions in Topic 3.

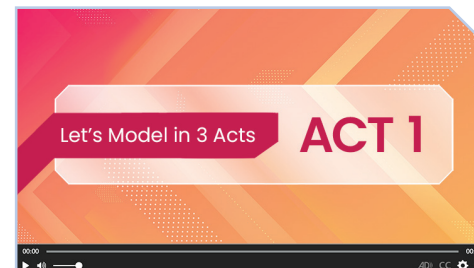
RIGOR

Conceptual Understanding Students draw on their understanding of equality concepts to develop a representative model.

Application Students apply their mathematical model to test and validate its applicability to similar problem situations.

Materials

Provide manipulatives and other tools that students request.

**Student Resources**

 Family Engagement

Teacher Resources

 enVision on the Go



Act 1 The Hook



10–15 min

Act 1

Powering Down

I can ... use mathematical modeling to solve problems.

Let's Model in 3 Acts

Lesson 2-6

ACT 1

ACT 1

- After watching the video, what is the first question that comes to mind?
- Write the Main Question you will answer.
- Construct Arguments** Predict an answer to this Main Question. Explain your prediction.
- On the number line below, write a time that is too early to be the answer. Write a time that is too late.

Too early

Too late
- Plot your prediction on the same number line.

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Lesson 2-6 113

Students are tasked with determining how much longer a smartphone's battery will last.

Play the Video

Take advantage of your students' reactions to watching the video. Ask: *What did you notice? What do you wonder?*

Brainstorm Questions WHOLE CLASS

Have students complete **Question 1**. Encourage them to ask any question that comes to mind. Listen for both mathematical and non-mathematical questions. Ask students what makes each question interesting.

- *What questions do you have?* [Sample questions: How much can he use his device before it loses power? How much power is left in the battery? How long has he been using the device so far?]

MTP Pose the Main Question WHOLE CLASS

After the question brainstorming, pose the Main Question students will be tasked with answering. Have students complete **Question 2**.

Main Question

- **What time will it be when the phone runs out of power?**

Ask About Predictions WHOLE CLASS

Have students complete **Questions 3–5**. Survey the class about their predictions.

- Why do you think your prediction is the solution to the Main Question?
- Who had predictions that are close?
- How many of you agree with that prediction?
- Who has a different prediction?

Act 2 The Model

20–30 min

Act 2

ACT 2

6. What information in this situation would be helpful to know? How would you use that information?

7. **Use Appropriate Tools** What tools can you use to solve the problem? Explain how you would use them strategically.

8. **Model with Math** Represent the situation using mathematics. Use your representation to answer the Main Question.

9. What is your answer to the Main Question? Is it earlier or later than your prediction? Explain why.

Build G.R.I.T. Self-Efficacy
When your estimate is not close to your exact answer, reflect on your original assumptions. Believe in your ability to improve your estimate next time.

114 Lesson 2-6

Sample Student Work

Time	Percent
3:42	20
3:57	16
4:16	11

$\frac{15 \text{ minutes}}{4 \text{ percent}} = \frac{3.75 \text{ minutes}}{1 \text{ percent}}$

$\frac{19 \text{ minutes}}{5 \text{ percent}} = \frac{3.8 \text{ minutes}}{1 \text{ percent}}$

The unit rate is about 3.8 minutes per percent.
 $3.8 \times 11 \approx 42$ minutes.
The battery will last until 4:58.

Lost 9% in 34 minutes

$\frac{34 \text{ minutes}}{9\%} = \frac{x \text{ minutes}}{11\%}$

$34 \cdot 11 = 9x$
 $42 \approx x$

Phone will be at 0% after 42 minutes

4:16 $\xrightarrow{42 \text{ minutes}}$ 4:58

Tandy's Work

Tandy finds each unit rate using a table and then adds the remaining time.

Li's Work

Li uses the first and last data points to find a unit rate, then writes and solves an equation to find the remaining time.

Identify Important Information WHOLE CLASS

Have students complete **Question 6**.

- What information do you need to know to solve the problem? [The current battery percent, how long the phone has already been used, the unit rate of minutes per percent used]
- How could you get that information?
- Why do you need that information?

Reveal the Information WHOLE CLASS

As students identify needed information, you can use the online interactivity to estimate, reveal, and share the information.

Current time: 3:42
Current battery: 20%
Data point 2: 16% at 3:57
Data point 3: 11% at 4:16

MTP Develop a Model SMALL GROUPS

For **Question 7**, students might select pencil and paper, concrete models, a ruler, a calculator, a spreadsheet, digital software, or other grade-appropriate tools to solve the problem.

As students answer **Questions 8 and 9**, look for inefficient methods that they are using and prompt them to think about organizing the information before making a model.

- What is the unit rate? [About 3.75 minutes per percent of battery]

MTP Share Solution Strategies WHOLE CLASS

After students answer **Questions 8 and 9**, use the Sample Student Work as you facilitate a discussion about solution methods.

Act 3 The Solution



15-30 min

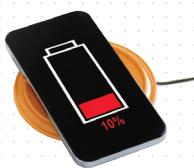
Act 3

ACT 3

10. Write the answer you saw in the video.

11. **Reasoning** Does your answer match the answer in the video? If not, what are some reasons that would explain the difference?

12. **Make Sense and Persevere** Would you change your model now that you know the answer? Explain.



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Lesson 2-6 115

Reflect

13. **Model with Math** Explain how you used a mathematical model to represent the situation. How did the model help you answer the Main Question?

14. **Look for Relationships** What pattern did you notice in the situation? How did you use that pattern?

Create a Problem

15. Write your own problem related to the video in Act 1. Include any information needed to solve your problem. Explain how you would use a mathematical model to represent the situation. Then solve your problem.

116 Lesson 2-6

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Use the Video to Reveal the Answer

WHOLE CLASS

The final part of the video shows the remaining time before the device powers down. Have students complete **Question 10**.

Main Question Answer

The phone lasts until 4:51.

MTP Validate Conclusions SMALL GROUPS

After **Questions 11 and 12**, discuss possible sources of error inherent in using math to model real-world situations. Point out that the models are still useful even though they are not perfect.

- **Why does your answer not match the answer in the video?**
[The rate the battery drains also depends on what you use the phone for.]
- **How useful was your model at predicting the answer?**
- **How could your model better represent the situation?**

Reflect on Thinking SMALL GROUPS

Have students complete **Questions 13 and 14** as an extension. Discuss how students applied mathematical processes.

Create a Problem INDIVIDUAL

Use **Question 15** as an opportunity for students to revisit other questions they had during **Question 1** brainstorming.

Possible Student Solution

He is able to start charging his phone when the battery is at 20%. 21 minutes later, the battery is at 43%. When will the phone be charged to 100%?

Needed information:

- The phone was at 20% at 3:42.
- The phone charged 23% in 21 minutes.

$$\frac{21 \text{ minutes}}{23 \text{ percent}} = 0.9 \text{ minutes per percent}$$

$$0.9 \times 80 = 72 \text{ minutes}$$

The phone will be fully charged at 4:54.