

Preparation Notes

Please review and customize this deck to prepare it for use. Some notes:

- These professional learning (PL) materials (slide deck and accompanying handout) are being offered in editable forms so that you may make adjustments to better support the specific work happening in your school or district.
- These PL materials are designed to easily accommodate remote delivery:
 - A [Jamboard template](#) is provided to facilitate discussion of student work; the facilitator will need to make a copy of this and be ready to share the link with participants as noted in the deck.
 - Text that can be readily pasted (marked with “—”) into a video call chat feature is included when participants need to reference the handout.
 - There are placeholders for handout links to be shared with participants in the notes field of selected slides; the facilitator will need to add a link to the handout where indicated by “[insert link].”

M103 Overview

**XQ Badge Project PL Series Baseline
Session**

Month XX, XXXX

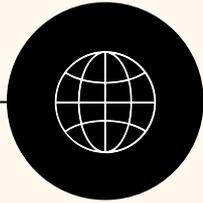


Community Building

What is your “six word math story?”

*Your story can be written as a continuous thought,
a string of words, or a combination of the two!*

Outcomes and Agenda



Participants will be able to:

- Explain the content and practice expectations for the M103 badge
- Analyze tasks through the lenses of (1) content and practice expectations and (2) learning principles
- Analyze student work for evidence of learning

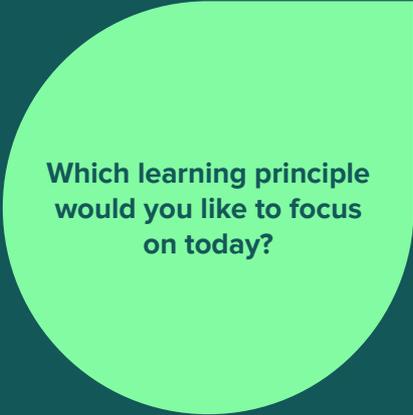


Agenda:

- Exploring the Content
- Task 1: Expectations and Learning Principles
- Task 1: Student Work
- Task 2: Expectations and Learning Principles
- Task 2: Student Work
- Closing

Learning Principles

1. Engage with cognitively demanding tasks in heterogeneous settings.
2. Engage in social activities.
3. Build conceptual understanding through reasoning.
4. Have agency in their learning.
5. View mathematics as a human endeavor across centuries.
6. See mathematics as relevant.
7. Employ technology as a tool for problem-solving and understanding.



**Which learning principle
would you like to focus
on today?**

01

Exploring the Content

M103: Modeling with Functions of Quadratic Type

What comes to mind?
What knowledge and skills
should students learn to
earn this badge?



**Come off mute
or put your
thoughts in the
chat!**

What's the Story of these Standards?

Selected Common Core Standards for Mathematics High School – Algebra

Write expressions in equivalent forms to solve problems

3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.★
 - a. Factor a quadratic expression to reveal the zeros of the function it defines.
 - b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Create equations that describe numbers or relationships ★

2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

Solve equations and inequalities in one variable

3. Solve quadratic equations in one variable.
 - a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.
 - b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b .

**How would you synthesize these?
What are the key takeaways
for students?**

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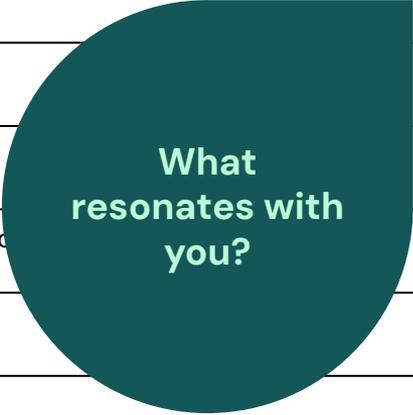
Share your thinking!

M103 Content and Practice Expectations (CPE)

103.a	Engage in the modeling cycle.
103.b	Interpret quadratic functions that arise in applications in terms of the context.
103.c	Analyze quadratic functions using different representations.
103.d	Build quadratic functions that model relationships between two quantities.
103.e	Construct and compare linear and quadratic models, solve problems, and draw conclusions.
103.f	Interpret expressions for quadratic functions in terms of the situation they model.
103.g	Summarize, represent, and interpret data on two quantitative variables for linear and quadratic model fits.
103.h	Understand the relevance of modeling with quadratic functions.
103.i	Use a quadratic function model to determine values of interest in a real-world problem.

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What
resonates with
you?

M103 Content and Practice Expectations and Indicators

Content and Practice Expectations	Indicators Choose an artifact where you...
103.a: Engage in the modeling cycle.	i. engage with the full modeling cycle (problem, formulate, compute, interpret, validate, revise as necessary, report).
103.b: Interpret quadratic functions that arise in applications in terms of the context.	i. select two different data points that illustrate something interesting or important about the context you are modeling and describe what these points tell you about the topic.
	ii. use a model to compute output values and then interpret the values in the problem's context.
	iii. describe the domain of the quadratic function, including anything noticed about values that are not part of the domain or why the shape of the model might change for particular values of the domain.
	iv. describe the contextual meaning of the average rate of change between two points for a quadratic function.



What new
insights do you
have?

Let's Investigate

Choose at least one task to explore:

- Skeleton Tower
- Profit of a Company

Which content and practice expectations are evident in each one?

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Choose at least one task to explore:

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**Come off mute
or put your
thoughts in the
chat! What did
you find?**

What's the Same?

What's Different?

1. How do these content and practice expectations align to ways you've taught this topic before?
2. How are they different?

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Inequity Is our Reality

About

60%

of community college students and 40 percent of four-year students are placed into non-credit bearing developmental mathematics (Ganga et al., 2018)

Only

33%

of community college students complete the developmental math sequence. Only 20 percent complete a college-level math course over three years (Bailey, Jeong, & Cho, 2010).

We Must Lead the Movement

How can this approach give space for what math can be?

Is math...?

- About getting one right answer, the teacher's way
- Irrelevant
- About doing procedures
- Independent work
- Something my teacher made up
- Formulaic

Or could math be...?

- About using multiple strategies flexibly
- Connected to the real-world in ways that make sense
- About understanding and applying
- Collaborative work
- Lived across continents and centuries
- Novel, challenging problems

02

Task 1: Expectations and Learning Principles

Let's Do Some Math!

Part 1: Making sense of rocket launches

1. Watch this video of [Grasshopper 744m Test| Single Camera \(Hexacopter\)](#).
2. Reflect: What questions does this clip bring to mind?
3. Sketch a diagram that illustrates the rocket's flight.
Use the diagram you developed to sketch a graph.
4. Read the article "[Why SpaceX wants to land a rocket on a platform in the ocean](#)" by Joseph Stromberg.
5. What questions do the article and the video answer?
What new questions does this surface for you?

Do the task as a student would. Jot down any reflections that you have as you do the math!

Content and Practice Expectations

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Choose 1–2 Content
and Practice
Expectations that
student work could
give evidence of.

Content and Practice Expectations

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103.c: Analyze quadratic functions using different representations.

Learning Principles

In M103 Modeling with Functions of Quadratic Type, students will employ the following learning principles:

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Which of these principles does this task lend itself to? Which ones can the task be easily adapted to accommodate?

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**Share what
you came up
with!**

03

Task 1: Student Work

Round 1: What do you notice?

What do you notice?

- Jot down at least one thing you notice about this piece of student work.

Part 1: Making sense of rocket launches

Question 1:
What is the total height the rocket reach?

Question 2:
How much fuel did the rocket burn?

Question 3:
How did the rocket land?

2. Sketch a diagram that illustrates the rocket's flight. Use the diagram you developed to sketch a graph.



Part 2: Modeling with Quadratics

After some trials, SpaceX learned to control the flight of reusable rockets used to launch space ships into space.

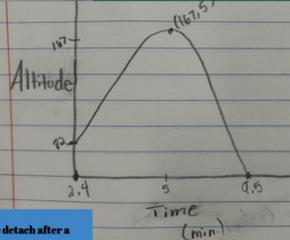
1. Watch and gather data from Stage 1 (watch from about 3:20 to 3:30) to create a model for the flight of the Phase 1 rocket used in that mission.

(Screenshot of your information that you gathered from the video. It can be handwritten, in a table format, on Desmos, etc.)

Speed	Altitude
69.74	82
decreased to 52.46	increased to a max of 167
increased to 71.73	decreased to 69
decreased to 39.79	
increased to 41.15	
decreased to 0	decreased to 0

Stage 2
maxed out at speed of 27000 and altitude 197

2. Prepare to share your findings. (Screenshot of your information along with the model (formula) you created based on the data and why it works for your data collected. This can be handwritten or technology based (Desmos).)



3. Read the article "Why SpaceX wants to land a rocket on a platform in the ocean" by Joseph Stromberg.

1. What questions do the article and the video answer? What new questions does this surface for you?

The article and the video answer question 3 by saying that it extended its legs to 70 feet wide, and reduced speed to 1.5 mph.

Questions here:
How reliable is the autonomy in the rocket?

3. What new questions surface for you? (What are some out-standing questions that you may still have?)

Question 1: does the first stage detach at a certain altitude or speed

Question 2: does the weather play a role in the detachment

Criteria for Success

Conference and Provide Revision Support	Accept with Revision	Accept
<p>The student's artifact shows an emerging understanding of the expectations of the indicator(s). After conferencing and additional instruction/learning, the student may provide a revised or different artifact as evidence of the indicator(s).</p>	<p>The student's artifact is approaching a full understanding of the expectations of the indicator(s). The artifact may contain execution errors that should be corrected in revision. The student may revise the selected artifact or submit a different artifact.</p>	<p>The student's artifact demonstrates evidence that they have met the expectations of the indicator(s).</p>

What resonates with you? What questions surface for you?

Humanizing Assessment

A strong performance-based assessment system shifts our lens from breadth—or content coverage—to depth.

(Safir and Dugan, 2021, p. 144)

Source: Safir, Shane, and Jamila Dugan. *Street Data: A Next-Generation Model for Equity, Pedagogy, and School Transformation*. Corwin, 2021.

Round 2: What evidence of learning is there?

103.c: Analyze quadratic functions using different representations.

Let's examine some work together:

Conference and Provide Revision Support

The student's artifact shows evidence of an emerging understanding of the expectations of the indicator(s). After conferencing and additional instruction/learning, the student may provide a revised or different artifact as evidence of the indicator(s).

Accept with Revision

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Accept

The student's artifact demonstrates evidence that they have met the expectations of the indicator(s).

Examining Student Work

The image shows a digital workspace for examining student work. On the left is a vertical toolbar with icons for editing, erasing, pointing, adding a page, inserting an image, creating a circle, adding a text box, and using a lasso. The main workspace is divided into three sections: "Conference and Provide Revision Support", "Accept with Revision", and "Accept". A dark teal callout bubble with rounded corners contains the text "Put your thoughts on the Jamboard!". A teal arrow points from this bubble to the "Add Page" icon in the toolbar. In the bottom right corner, there is a circular label "Work Sample 1".

Example #1

Part 1: Making sense of rocket launches

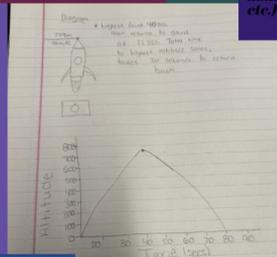
1. Watch this video of *Grasshopper 71m Test Single Camera (Hexacopter)*.
2. Reflect: What questions does this clip bring to mind? (Pose 3 questions about the video clip here.)

Question 1:
Why did it only reach an altitude of 74m?

Question 2:
How did it safely return to the ground?

Question 3:
How fast did it go upwards and return back downwards?

2. Sketch a diagram that illustrates the rocket's flight. Use the diagram you developed to sketch a graph.



Questions here:

The article tells us how it has a safe return as it fires its engines as well as has steerable fins that slow the rocket in order to get a stabilized landing. It tells us it has to slow until it reaches 1.3 miles per hour before landing.

New Questions:

1. What questions do the article and the video answer? What new questions does this surface for you?

1. How do they intend on landing the rocket with accuracy?
2. How can they increase their chance of success?

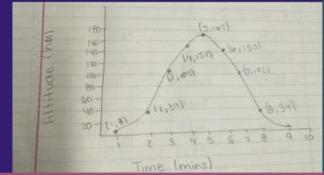
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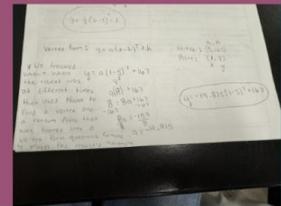
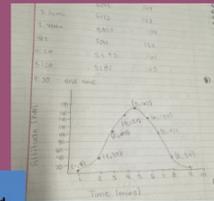
1. Watch and gather data from *SpaceX April 2022 launch of Ax-1* [watch from about 3:26 to 3:36] to create a model for the flight of the Phase I rocket used in that mission.

(Screenshot of your information that you gathered from the video. It can be handwritten, in a table format, on Desmos, etc.)



2. Prepare to share your findings. (Screenshot of your information along with the model(formula) you created based on the data and why it works for your data collected. This can be handwritten or technology based (Desmos).)

Screenshot your findings here.



Question 1:

Why did it speed up as the aircraft lifted higher instead of staying a constant speed?

Question 2:

How did they know the time it would take to lift and land the aircraft?

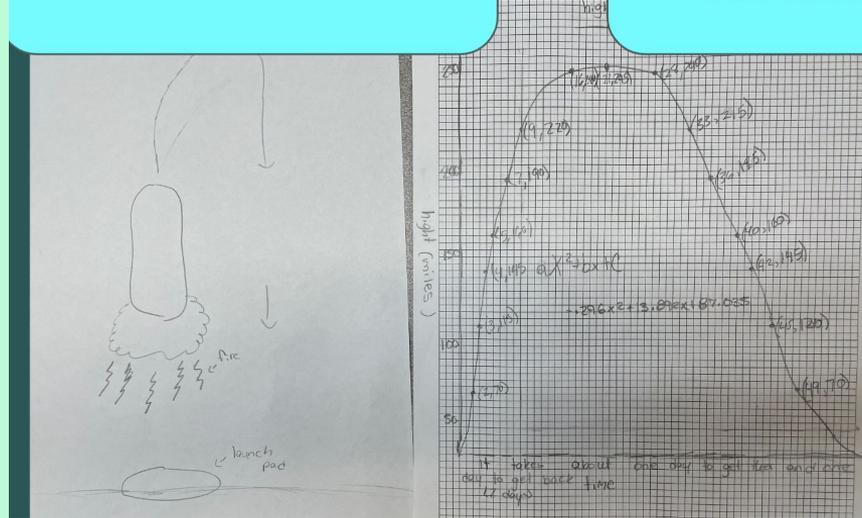
Question 3:

How did they estimate the highest point and the time it would take to reach it?

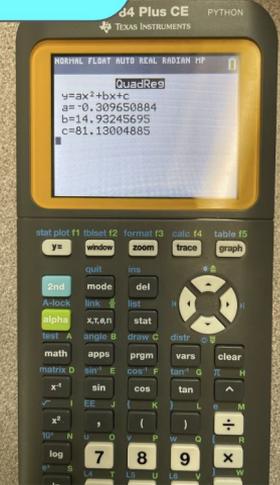
Let's compare notes.

Example #2

Student Drawing and Graph (Equation Included)



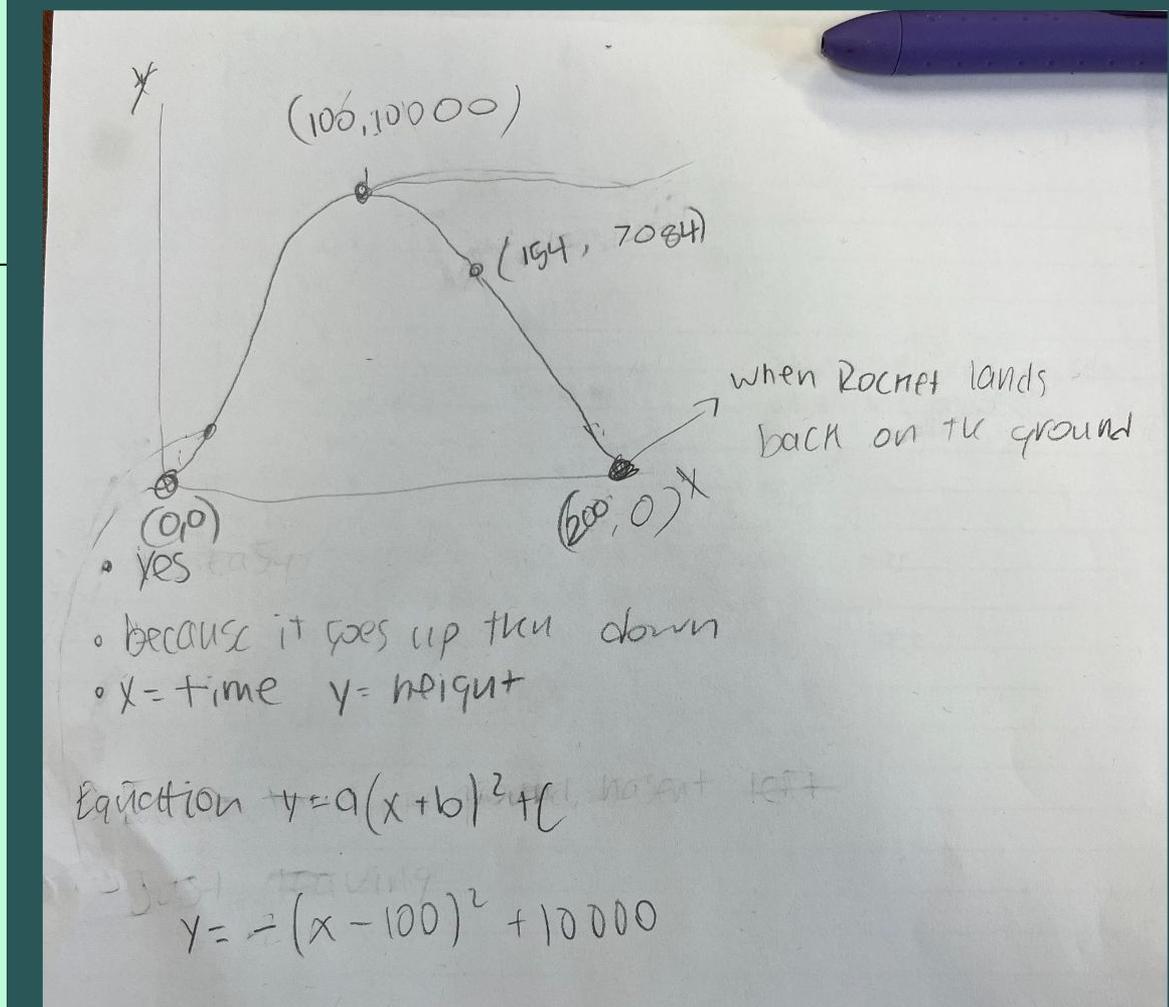
Student Calculator after using Stat/Edit and Stat/Calc/QuadReg



Let's compare notes.

Example #3

Let's compare notes.



Three Key Components of the Math Badging System

- Content and Practice Expectations
- Learning Principles
- Criteria for Success

Which one excites you the most?

What one will have the greatest impact on students?

What questions surface for you?



**Come off
mute or share in
the chat!**

04

Task 2: Expectations and Learning Principles

Let's Do Some Math!

Task 2: Height of a Ball

Students are given a problem like this to work on in groups:

Work with your group to develop a model that describes the height of a ball thrown at a given time during the throw. Have one person in the group throw a ball while another records a video of the event. Make sure that the video includes the entire path of the ball from the throw to when it hits the ground. Prepare your findings to share with the class.

Sample Learning Experience

Students could be given the largely unstructured task above, along with the tools needed to carry it out: a ball, recording technology, and tools to make mathematical models, like spreadsheets and access to graphing software. Consider bringing the class together at strategic points to facilitate progress toward the goal of developing a mathematical model.

In these instances, monitor, select, and sequence groups to report on their efforts.

The following questions can be used to facilitate discussion early in the process:

1. Watch a selected group's video. Ask students to describe what they notice while watching the video. Listen for descriptions of key elements, such as the height of the ball upon release, the highest point the ball reached, and when and where the ball landed.
2. Ask students, "How might we represent this mathematically?" As students share, make note of ideas that surface. When they use hand signals or share descriptions that allude to the graph of a quadratic function, encourage students to sketch what that might look like.

Take a moment
to read Task 2:
Height of a Ball

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Do the task as a student would.
Share reflections in the chart in your handout as you do the math!

Content and Practice Expectations

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Content and Practice Expectations

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**Share what
you came up
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05

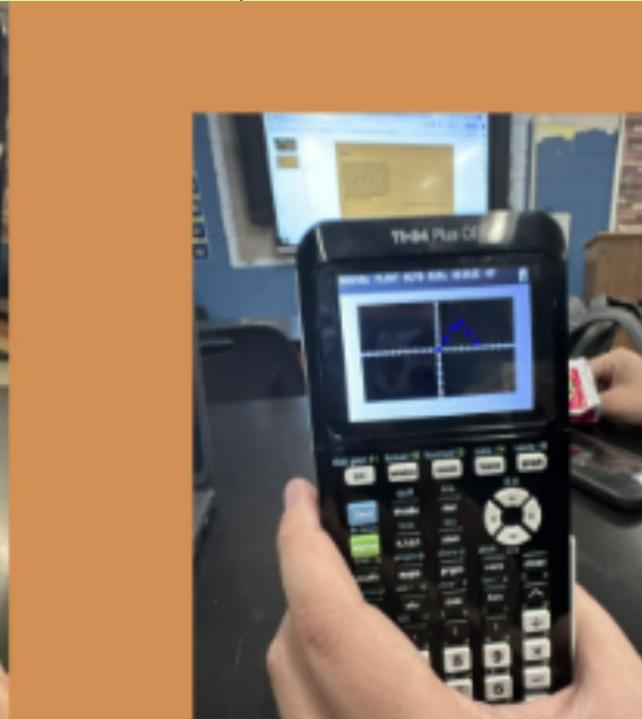
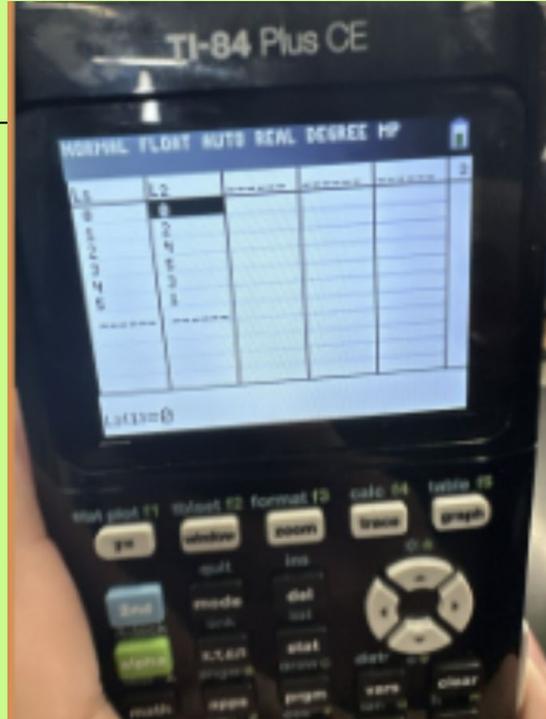
Task 2: Student Work

Round 1: What do you notice?

What do you notice?

- Jot down at least one thing you notice about this piece of student work.

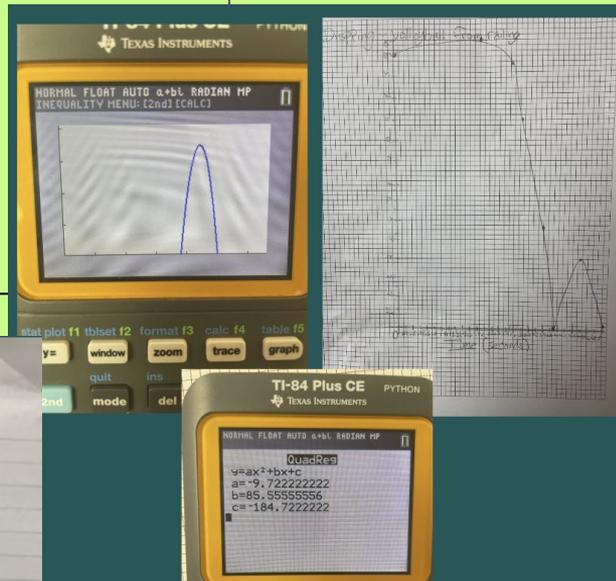
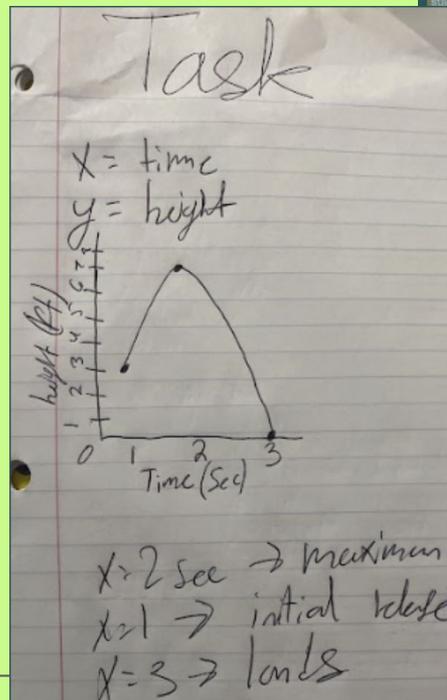
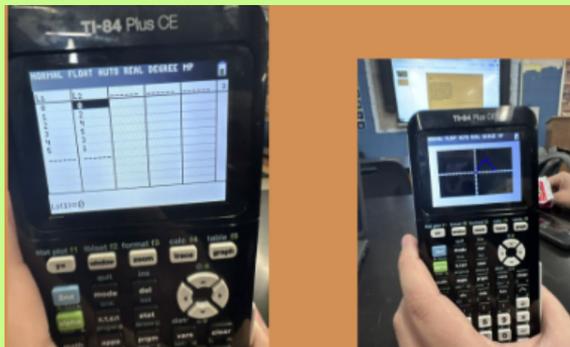
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mute or
share in the
chat.



Round 1: What do you notice?

Now take a look through all of the slides.

- Jot down what you notice.
- Are there any trends? What stands out to you?



Reflect on
your own and
then get
ready to
share!

Round 2: What evidence of learning is there?

103.c: Analyze quadratic functions using different representations.

Let's examine some work together:

Conference and Provide Revision Support

The student's artifact shows evidence of an emerging understanding of the expectations of the indicator(s). After conferencing and additional instruction/learning, the student may provide a revised or different artifact as evidence of the indicator(s).

Accept with Revision

The student's artifact shows evidence of approaching a full understanding of the expectations of the indicator(s). The artifact may contain execution errors that should be corrected in revision. The student may revise the selected artifact or submit a different artifact.

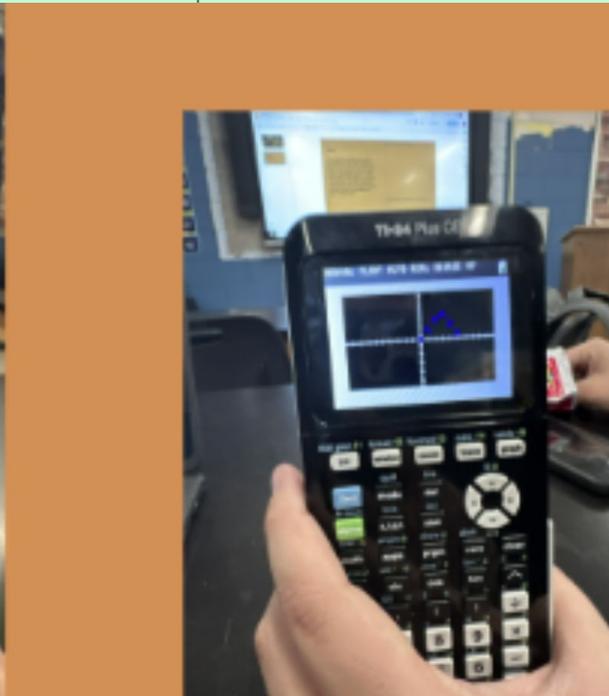
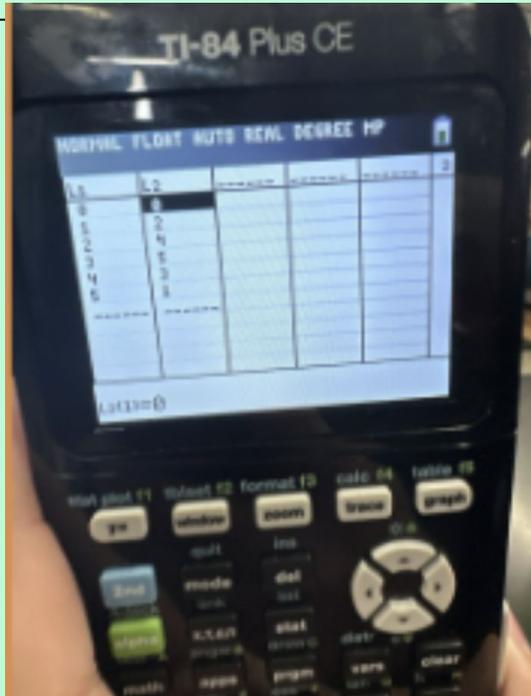
Accept

The student's artifact demonstrates evidence that they have met the expectations of the indicator(s).

Examining Student Work

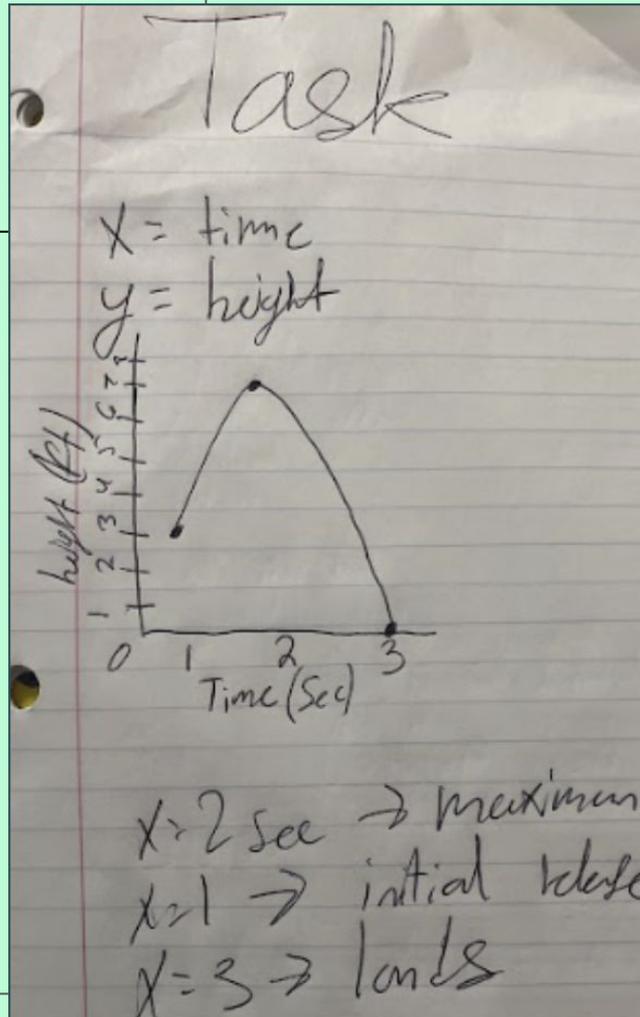
The image shows a digital workspace for reviewing student work. At the top, there are three options: "Conference and Provide Revision Support", "Accept with Revision", and "Accept". On the left is a vertical toolbar with icons for editing, erasing, pointing, Jamboard, image insertion, lassoing, and zooming. The "Jamboard" icon, which depicts a document with a pencil, is circled in green, and a large green arrow points from a callout box to it. The callout box is a dark green rounded rectangle containing the text "Put your thoughts on the Jamboard!". In the bottom right corner, there is a circular label that says "Work Sample 1".

Example #1



Let's Compare
Notes

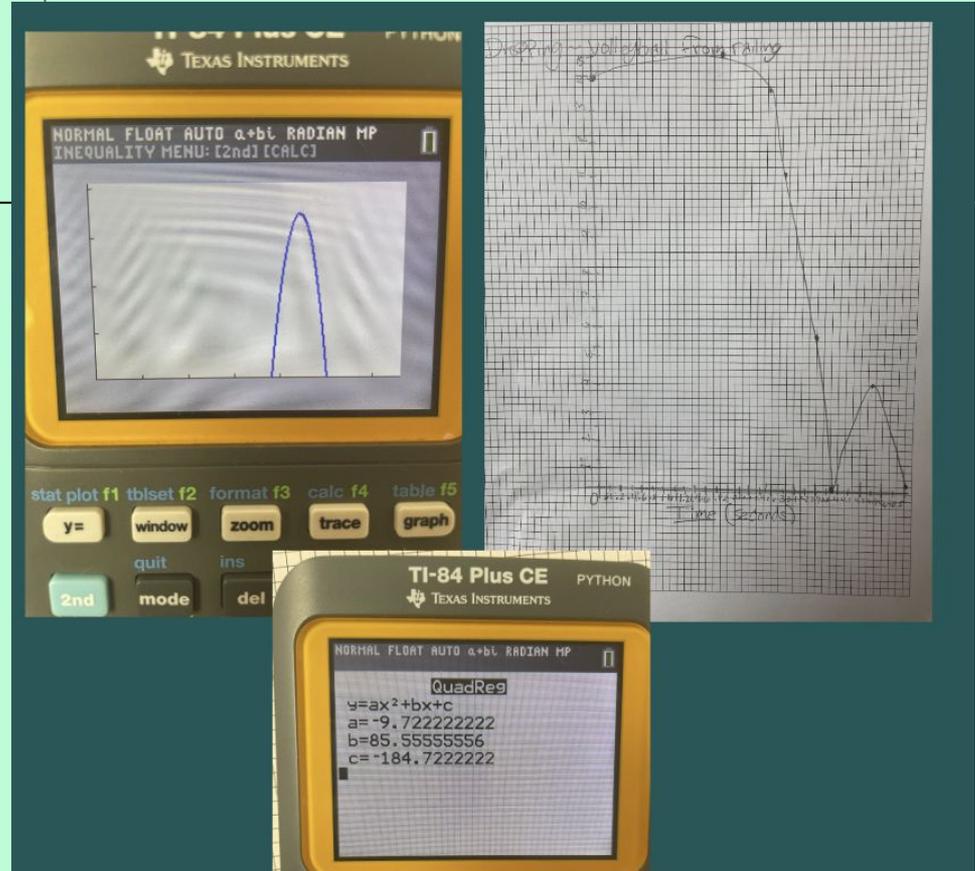
Example #2



Let's
Compare
Notes

Example #3

Let's
Compare
Notes



Let's Hear Some Reflections

What kinds of support will students need to demonstrate evidence of learning?

Has your thinking changed at all on how to implement this task? If so, how?

**Come off
mute or share in
the chat!**

06

Closing

What Are Your Takeaways?

Choose one question to respond to:

1. Which content and practice expectation are you most excited about? Why?
2. Which learning principle are you most excited about connecting to M103 content? Why?
3. What impact do you think using a portfolio system will have on your students? Why?