ST. MARY'S SCHOOL

Algebra II

VOLUME 1

Modeling and Function Algebra



STUDENT WORKBOOK

Mod 1 · Class meetings 1–25

Explain. Model. Make sense of the result.

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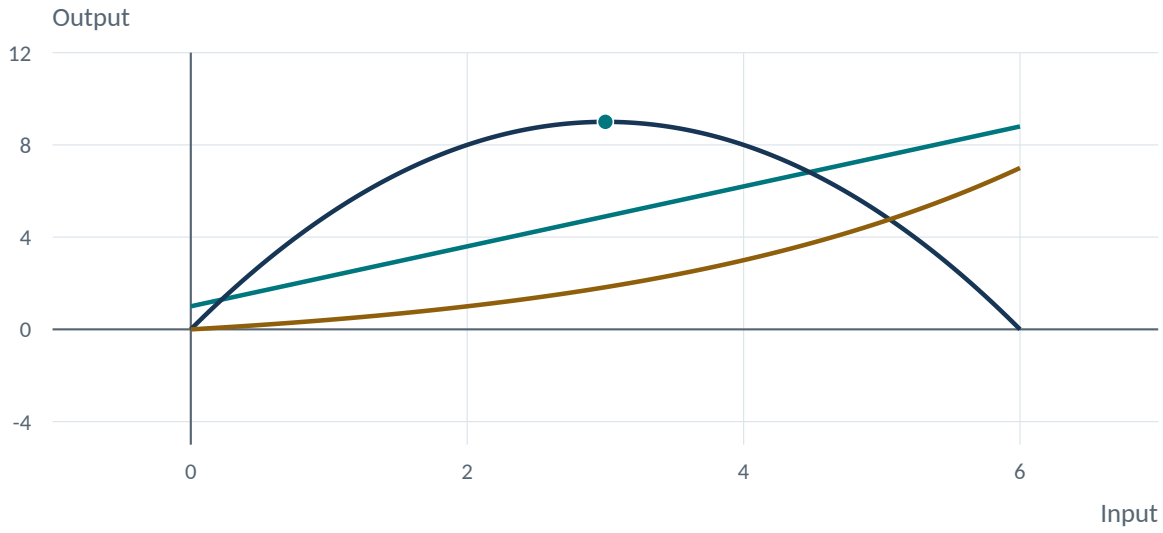
Algebra II

Volume 1

Modeling and function algebra

Student workbook

Classwork, independent practice and homework for Mod 1. Bring this book and your student reference to class.



Mod 1 | Class meetings 1 through 25

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GETTING STARTED

Your class and your work

Name _____ Class _____

During class

Attempt the retrieval questions on your own before discussing them. Record a reason for each model or representation you choose. The entry check helps your teacher decide which skills to revisit.

Homework

Regular assignments target 40 focused minutes, including about 25 minutes of current work, 10 minutes of cumulative practice and 5 minutes to explain or check your reasoning. Begin with the indicated cumulative item, then work through all required pages, record the time spent and mark your stopping point if you reach 40 minutes. Optional challenges are separate.

For sketches, supply scales, axis labels and units. Use separate graph paper when you need room. On investigation and assessment days, follow the shorter assignment printed for that meeting.

Local settings

This volume includes Southern Oregon places you may know. The source notes distinguish published place facts from the data created for classroom modeling.

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LESSON 1

Functions describe quantities

What do you already know? (1-4)

This entry check samples skills from earlier courses. Work independently without a calculator or the reference book. You have 20 minutes for both pages.

1.D1

Let $f(x) = 2x^2 - 3x + 1$. Find $f(-2)$ and show the substitution.

1.D2

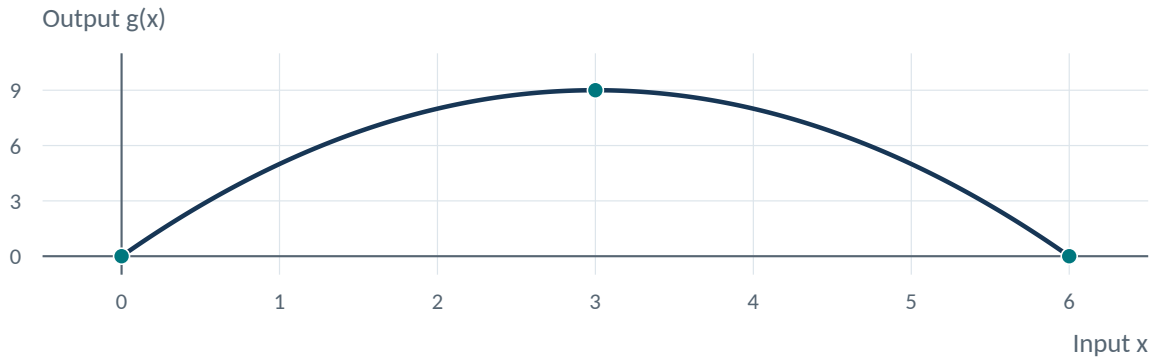
Solve $3(x - 2) = 15$. Show an equivalent equation before your answer.

1.D3

A line passes through $(1, 5)$ and $(4, 11)$. Find its slope and explain what the number compares.

1.D4

Use the graph to find $g(0)$ and the greatest output shown. At what input does that greatest output occur?



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1

LESSON 1 | ENTRY CHECK

What do you already know? (5-8)

1.D5

A model is $H(t) = -(t-4)^2 + 25$ for $0 \le t \le 8$. What is the greatest value of H, and when does it occur? Explain briefly.

1.D6

Find the next two outputs if this pattern continues: $5, 10, 20, 40, \ldots$. Is the change additive or multiplicative?

1.D7

A rectangle has area 36 square meters and length 9 meters. Find its width and include units.

1.D8

A taxi model is $C(d) = 5 + 2d$ for trips from 0 through 20 miles. What do d and $C(d)$ represent? Could a trip of 2.5 miles be an allowed input?

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LESSON 1 | WORK TOGETHER

Functions describe quantities

1.G1

For each table, suggest a linear, quadratic or exponential model. Record the pattern that supports your choice. For Table B, explain why a constant output difference is not the right test. Do the tables prove what happens at unlisted inputs?

Input	0	1	2	3	4
A	2	5	8	11	14
B	5	8	9	8	5
C	3	6	12	24	48

Compare your reasoning

Record one claim your group agrees on and the evidence that supports it.

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LESSON 1 | WORK TOGETHER

1

Use a model in context

1.G2

A club begins with 30 dollars and adds 6 dollars for each ticket it sells. It can sell at most 40 tickets. (a) Define the input and output. (b) Write a model. (c) Predict the total after 12 tickets. (d) State the allowed inputs. Explain why 12.5 and 50 are not allowed.

Compare your reasoning

Record one claim your group agrees on and the evidence that supports it.

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LESSON 1 | ON YOUR OWN

Show what you understand

Work independently. Use the remaining time to check the question, units and allowed inputs.

1.I1

A machine starts with 48 liters of water and uses 3 liters each minute. Its model is $W(t) = 48 - 3t$ while it runs from $t = 0$ to $t = 12$ minutes. Find and interpret $W(5)$. State the input, output and contextual domain. Is $t = 5.5$ allowed?

1.I2

At equal input steps, a data set has outputs $4, 12, 36, 108$. A student says the model must be linear because the outputs keep increasing. Explain the error and suggest a better family.

Exit check

1.E

A model gives the total cost of renting a bicycle from the number of hours rented. In one sentence each, identify the input, the output and one piece of information you need to specify its contextual domain.

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LESSON 1 | HOMEWORK 1 OF 2

1

Practice and return to earlier ideas

40-minute total. Start with 1.H1, then work through both pages. Include explanation and checking.

1.H1

Correct two items from the entry check that you missed or could not explain. For each, show the corrected reasoning and identify the mistake. If both are already secure, solve $p(-3)$ for $p(x) = x^2 + 2x$ and solve $4(x + 1) = 20$.

1.H2

A delivery costs $C(m) = 8 + 1.5m$ dollars for a distance of m miles, with $0 \leq m \leq 30$. Find $C(12)$ and interpret it. Explain why the formula being defined at $m = 40$ does not make 40 an allowed input.

1.H3

Equal input steps produce outputs $7, 11, 15, 19$. Suggest a function family and justify it. Explain why your answer does not determine a reliable prediction far beyond the observations.

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LESSON 1 | HOMEWORK 2 OF 2

1

Practice and return to earlier ideas

40-minute total. Start with 1.H1, then work through both pages. Include explanation and checking.

1.H4

Each row lists outputs at inputs $0, 1, 2, 3$. Suggest a function family for each row and show the differences or ratios that support it. Explain why increasing outputs alone cannot identify the family.

Input	0	1	2	3
A	3	7	11	15
B	2	3	6	11
C	2	6	18	54

1.H5

A machine has $V(t) = 80 - 5t$ liters of water for $0 \le t \le 12$ minutes. Make a table for inputs $0, 4, 8, 12$. Explain the meanings of the two numbers in $(8, 40)$. The expression gives $V(16) = 0$; explain why that does not make 16 an allowed input.

1.H6

(a) Evaluate $f(-3)$ for $f(x) = x^2 - 4x$. (b) Solve $5(x + 2) = 35$. (c) Find the slope through $(2, 3)$ and $(6, 15)$. Choose one part and explain a mistake that would change its answer.

Time spent on both pages: _____ minutes Question to revisit: _____

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2

LESSON
2

Average rate of change

2.R1

Find $f(3)$ for $f(x) = x^2 - 2x$. Explain what the answer represents if x is time and $f(x)$ is height.

2.R2

A table lists 0, 2 and 4 hours, with costs 10, 18 and 26 dollars. Find the increase in cost and the increase in time from the first observation to the second.

Work together

2.G1

The table shows water remaining. (a) Find the average rate on each of the three consecutive intervals and on the full interval. (b) Explain why dividing by the number of rows would be wrong. (c) Do these observations support a constant drainage rate?

Time (min)	2	4	6	8
Water (L)	42	36	30	24

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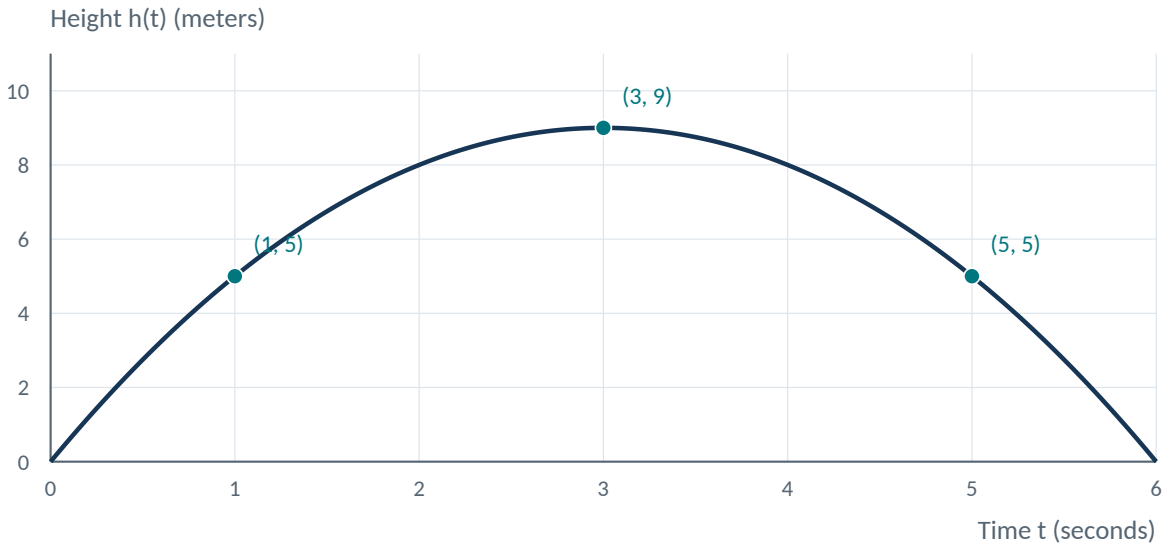
LESSON 2 | WORK TOGETHER

2

Compare representations and reasoning

2.G2

The graph shows height h in meters against time t in seconds. Find the average rate from 1 to 3 seconds, then from 1 to 5 seconds. Sketch the corresponding secant segments. Explain how the average rate can be zero even though the height changes.



Explain one decision

Write one sentence that connects your calculation or representation to the question being asked.

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LESSON 2 | ON YOUR OWN

2

Show what you understand

Work independently. Use the remaining time to check the question, units and allowed inputs.

2.I1

For $P(t) = t^2 + 2t$, find the average rate on $[1, 4]$. Show both output values. If P is measured in centimeters and t in seconds, interpret the rate.

2.I2

A temperature rises from $-8°\text{C}$ at 6 a.m. to $-2°\text{C}$ at 9 a.m. Find its average rate. A student says the rate must be negative because both temperatures are negative. Explain.

Exit check

2.E

A plant is 18 cm tall on day 2 and 30 cm tall on day 6. Calculate its average growth rate over this interval. Does your answer say that it grew the same amount on every day?

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LESSON 2 | HOMEWORK 1 OF 2

2

Practice and return to earlier ideas

40-minute total. Start with 2.H4, then work through both pages. Include explanation and checking.

2.H1

For $f(x) = x^2 - 1$, find the average rate from $x = 2$ to $x = 5$. Show the endpoint outputs.

2.H2

A battery reading falls from 82% at 1 p.m. to 58% at 4 p.m. Find and interpret the average rate in percentage points per hour.

2.H3

A graph contains the marked points $(2, 7)$ and $(6, 15)$. What is the slope of the secant segment between them? Explain why the graph between those points need not be a line.

2.H4

A shuttle carries at most 14 passengers. Its fare total is $F(n) = 6n$ dollars. Find $F(9)$ and state the contextual domain.

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2

LESSON 2 | HOMEWORK 2 OF 2

Practice and return to earlier ideas

40-minute total. Start with 2.H4, then work through both pages. Include explanation and checking.

2.H5

The table gives water remaining. Calculate the average rate on each consecutive interval and on the entire interval. During which listed interval does the water decrease fastest on average? Explain why equal output changes would not necessarily mean equal rates here.

Time (min)	0	2	5	9
Water (L)	96	88	70	54

2.H6

An object has height $h(t) = -t^2 + 6t$ meters on $0 \le t \le 6$ seconds. Find $h(2)$, $h(3)$ and $h(4)$. Calculate the average rate on $[2, 4]$. Explain why that rate does not mean the height stayed constant. Then find the average rate on $[0, 2]$.

2.H7

A club has $M(n) = 16 + 3n$ dollars after selling n whole tickets, with capacity 24 tickets. Find and interpret $M(7)$. How many tickets give a total of 61 dollars? State the domain and explain why a count of 31 is excluded.

Time spent on both pages: _____ minutes Question to revisit: _____

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LESSON 3

Predict from a rate and a point

3.R1

Find the average rate from $(2, 10)$ to $(6, 22)$. State the change in input separately.

3.R2

Find $q(2)$ and $q(4)$ for $q(x) = x^2$. Are the outputs themselves the changes in output?

Work together

3.G1

A tank contains 46 liters at minute 3 and fills at a constant rate of 4 liters per minute. (a) Predict the volume at minute 8. (b) Work backward to minute 1. (c) Write a rule using minute 3 as the anchor. Explain why multiplying 4 by 8 and adding 46 would be wrong.

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3

LESSON 3 | WORK TOGETHER

Compare representations and reasoning

3.G2

Use $f(x) = x^2$ on $[1, 5]$. (a) Calculate its average rate. (b) Starting from $(1, 1)$, use that rate to predict $f(5)$ and $f(3)$. (c) Compare with the actual outputs. Explain which prediction must be exact and why.

Explain one decision

Write one sentence that connects your calculation or representation to the question being asked.

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LESSON 3 | ON YOUR OWN

3

Show what you understand

Work independently. Use the remaining time to check the question, units and allowed inputs.

3.I1

A model has $F(2) = 7$ and an actual average rate of 5 output units per input unit on $[2, 6]$. Find $F(6)$. Then estimate $F(4)$ by using the same rate. Label each answer as exact or estimated and explain.

3.I2

At 10 a.m., a water level is 80 cm. Over the previous hour it fell at an average rate of 6 cm per hour. Estimate the level at 10:20 a.m. State the assumption, and explain why using 20 as the input change would be wrong.

Exit check

3.E

A function has $g(1) = 4$ and actual average rate 3 on $[1, 5]$. What is $g(5)$? Must $g(3) = 10$? Explain both answers.

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3

LESSON 3 | HOMEWORK 1 OF 2

Practice and return to earlier ideas

40-minute total. Start with 3.H7, then work through both pages. Include explanation and checking.

3.H1

A linear model has output 18 at input 4 and rate -2. Find its output at input 9 and write an anchor-form rule.

3.H2

For $f(x) = x^2 + 1$, compute the average rate on $[0, 4]$. Use the anchor $(0, 1)$ to recover $f(4)$ and estimate $f(2)$. Compare the estimate with the actual value.

3.H3

A runner has traveled 3.2 km after 20 minutes. Assuming a constant pace of 0.16 km per minute, estimate the distance traveled at 25 minutes. State what makes the answer exact within this model.

3.H4

Equal input steps give outputs $2, 6, 18, 54$. Identify a suitable model family and give evidence.

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LESSON 3 | HOMEWORK 2 OF 2

Practice and return to earlier ideas

40-minute total. Start with 3.H7, then work through both pages. Include explanation and checking.

3.H5

A linear function has $R(4) = 30$ and rate -3. Write its rule using the known point, then simplify. Find $R(0)$ and $R(9)$. At what input is the output 18? Check that input in your rule.

3.H6

Consider $f(x) = 4x - 3$ and $g(x) = 4x - 3 + (x - 2)(x - 8)$. Evaluate both functions at inputs 2 and 8, and calculate each average rate on $[2, 8]$. Starting from input 2, use that rate to predict the output at 5. Compare with both actual outputs at 5. What does the comparison establish?

3.H7

(a) Solve $2(3x - 4) = 22$. (b) Find the average rate between $(1, -7)$ and $(5, 5)$. (c) Express 5 minutes in hours. Explain how mixing minutes and hours could produce a wrong rate prediction.

Time spent on both pages: _____ minutes Question to revisit: _____

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4

LESSON
4

Build and interpret linear models

4.R1

Find $q(3)$ for $q(x) = (x - 1)^2 + 2$.

4.R2

Solve $5x + 7 = 32$ and check your result.

Work together

4.G1

A rental shop charges 34 dollars for 2 hours and 58 dollars for 5 hours. Assume a fixed fee plus a constant hourly charge. (a) Build a model in point-slope form and slope-intercept form. (b) Interpret each coefficient. (c) Predict a 7-hour charge. (d) State one reason the model might fail for a week-long rental.

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LESSON 4 | WORK TOGETHER

Compare representations and reasoning

4.G2

A tank holds 60 liters at minute 4 and then drains at a constant rate of 3 liters per minute until empty. Let t be minutes measured from the original clock start; the stated model is used only from minute 4 onward. Build the rule, predict the volume at minute 10, and find the contextual domain. What does its intercept mean, and is that intercept an observed starting volume?

Explain one decision

Write one sentence that connects your calculation or representation to the question being asked.

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LESSON 4 | ON YOUR OWN

4

Show what you understand

Work independently. Use the remaining time to check the question, units and allowed inputs.

4.I1

A fundraiser pays a fixed setup cost. Its net proceeds are 70 dollars after selling 10 tickets and 190 dollars after selling 25 tickets. Assume a linear model and a capacity of 60 tickets. Construct the model in point-slope and slope-intercept forms, interpret its coefficients, predict the net proceeds from 40 tickets, and state the domain.

4.I2

A student models a height with a line because it passes through two recorded points. Is that enough to conclude the height changes at a constant rate? State what additional assumption or evidence is needed.

Exit check

4.E

A linear cost model passes through $(3, 29)$ and has slope 5 dollars per item. Write the rule in two forms and interpret the intercept.

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LESSON 4 | HOMEWORK 1 OF 2

4

Practice and return to earlier ideas

40-minute total. Start with 4.H4, then work through both pages. Include explanation and checking.

4.H1

A line passes through $(2, 9)$ and $(6, 21)$. Write it in point-slope form and slope-intercept form.

4.H2

A bicycle rental costs 22 dollars for 1 hour and 46 dollars for 4 hours. Assume a fixed fee plus a constant hourly charge. Build the model and predict the cost for 6 hours.

4.H3

An order contains at most 80 whole notebooks. Include a zero-notebook order in this model. Its cost is $C(n) = 25 + 3n$. Explain the two coefficients and state the contextual domain. Is $C(2.5)$ an allowed order cost?

4.H4

For $f(x) = x^2$, calculate the average rate on $[1, 3]$.

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LESSON 4 | HOMEWORK 2 OF 2

4

Practice and return to earlier ideas

40-minute total. Start with 4.H4, then work through both pages. Include explanation and checking.

4.H5

Two parking plans charge $A(t) = 6 + 4t$ and $B(t) = 12 + 3t$ dollars for $0 \le t \le 10$ hours; fractional hours are allowed. Interpret both rates and fixed fees. Compare the charges for 2 hours and for 8 hours. Find the time when the costs agree and explain which plan is cheaper on either side of that time.

4.H6

A tank holds 200 liters at hour 2 and 140 liters at hour 5. Assume constant drainage from hour 2 until empty. Construct point-slope and slope-intercept models. Find the volume at hour 8 and the contextual domain. Explain whether the intercept is an observed starting volume.

4.H7

Each row lists outputs at inputs $0, 1, 2$. Suggest a family for each row using differences or ratios. Find the average rate for row B over the full interval. Does having an average rate make row B linear? Explain.

Input	0	1	2
A	8	11	14
B	1	4	9
C	3	6	12

Time spent on both pages: _____ minutes Question to revisit: _____

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LESSON
5

Read quadratic forms

5.R1

A line has rule $C(x) = 4x + 9$. Interpret its slope and intercept in a possible cost context.

5.R2

Evaluate $2(x - 3)^2 - 8$ at $x = 0$ and $x = 3$.

Work together

5.G1

The three expressions below represent the same function. Verify that claim by expanding. Then match each form to the information it shows most directly: initial output, zeros, minimum. Use that information to sketch a graph and label the key points.

Form	Expression
Standard	$2x^2 - 12x + 10$
Factored	$2(x - 1)(x - 5)$
Vertex	$2(x - 3)^2 - 8$

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5

LESSON 5 | WORK TOGETHER

Compare representations and reasoning

5.G2

The outputs below come from a quadratic model at equal input steps. Find the first and second differences. Identify the axis and maximum, and explain how the table supports your conclusions. Can a finite table alone prove the same rule for every input?

Input	0	1	2	3	4
Output	4	10	12	10	4

Explain one decision

Write one sentence that connects your calculation or representation to the question being asked.

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LESSON 5 | ON YOUR OWN

5

Show what you understand

Work independently. Use the remaining time to check the question, units and allowed inputs.

5.I1

For $g(x) = x^2 - 10x + 16$, write equivalent factored and vertex forms. Identify the zeros, the value at input 0 and the minimum. Explain why your chosen form is useful for each question.

5.I2

Equal input steps give outputs $2, 5, 10, 17, 26$. Suggest a linear or quadratic model and justify your choice using rates or differences.

Exit check

5.E

Which form of $f(x) = x^2 - 8x + 7$ would most directly show its least possible output? Write that form and identify the least output and its input.

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5

LESSON 5 | HOMEWORK 1 OF 2

Practice and return to earlier ideas

40-minute total. Start with 5.H4, then work through both pages. Include explanation and checking.

5.H1

Write $x^2 - 12x + 20$ in factored and vertex forms. State the zeros and minimum.

5.H2

A height model is $h(t) = -2(t - 3)^2 + 18$, with height in meters and time in seconds. Use $0 \le t \le 6$. Identify its greatest height and when it occurs. Then find its initial height.

5.H3

A student claims $(x - 4)^2 = x^2 + 16$. Correct the statement and explain what term was missed.

5.H4

A linear model has output 11 at input 2 and slope 3. Find the output at input 5.

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LESSON 5 | HOMEWORK 2 OF 2

5

Practice and return to earlier ideas

40-minute total. Start with 5.H4, then work through both pages. Include explanation and checking.

5.H5

For $p(x) = -2x^2 + 16x - 24$, find equivalent factored and vertex forms. Use the three forms to identify the zeros, the output at input 0 and the greatest output. State where the greatest output occurs and explain why it is a maximum.

5.H6

The table comes from a quadratic function. Find its first and second differences, axis of symmetry and maximum output. Calculate its average rate from input -1 to input 3. Explain why that rate and the maximum answer different questions.

Input	-1	0	1	2	3
Output	-1	8	11	8	-1

5.H7

A linear rental model costs 11 dollars at 2 hours and adds 1.5 dollars per hour. Write an anchor rule and a slope-intercept rule. Find the 6-hour cost. A student uses $11 + 1.5(6) = 20$. Explain the error and check your corrected model at 2 hours.

Time spent on both pages: _____ minutes Question to revisit: _____

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6

LESSON
6 Find the greatest or least value

6.R1

Find the average rate of $f(x) = x^2$ on $[1, 5]$. Does that rate tell you the least output of the function?

6.R2

A model is used only for $0 \le t \le 4$. Is $t = 6$ an allowed input even if its formula can be evaluated there? Explain.

Work together

6.G1

A rectangular garden uses 40 meters of fencing for three sides, with an existing wall as the fourth side. Let x be either side perpendicular to the wall. (a) Express the remaining fenced side in terms of x. (b) Write the area and its contextual domain. (c) Find the largest area and the corresponding dimensions. (d) Explain why maximizing the perimeter is not the question.

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LESSON 6 | WORK TOGETHER

6

Compare representations and reasoning

6.G2

A process has cost $C(x) = (x - 7)^2 + 20$ dollars, but only settings $0 \le x \le 5$ are allowed. A student reports a minimum cost of 20 dollars. Check that answer and find the best allowed setting.

Explain one decision

Write one sentence that connects your calculation or representation to the question being asked.

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6

LESSON 6 | ON YOUR OWN

Show what you understand

Work independently. Use the remaining time to check the question, units and allowed inputs.

6.I1

A ball's height in meters is modeled by $h(t) = -5t^2 + 20t + 1$ on $0 \le t \le 4$, with t in seconds. Find its greatest height during the modeled interval and the time when it occurs. Explain your choice of method and check the allowed inputs.

6.I2

For the same ball model, a student answers “2 meters” when asked for the greatest height. Explain what the number 2 actually means and give the requested quantity.

Exit check

6.E

A machine's loss is $L(x) = (x - 6)^2 + 9$ dollars for settings $0 \le x \le 4$. Find the least allowed loss and the setting that gives it. Explain why the unrestricted minimum is not the answer.

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LESSON 6 | HOMEWORK 1 OF 2

6

Practice and return to earlier ideas

40-minute total. Start with 6.H6, then work through both pages. Include explanation and checking.

6.H1

A height model in meters is $h(t) = -2t^2 + 12t + 3$ for $0 \le t \le 6$ seconds. Find its greatest height and when it occurs. Give a reason that your answer is a maximum.

6.H2

A cost model is $C(x) = (x - 8)^2 + 12$ dollars on $0 \le x \le 5$. Find the smallest allowed cost and the setting that produces it.

6.H3

Write $x^2 - 4x + 1$ in vertex form. Then explain the difference between the minimum output and the input where it occurs.

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LESSON 6 | HOMEWORK 2 OF 2

6

Practice and return to earlier ideas

40-minute total. Start with 6.H6, then work through both pages. Include explanation and checking.

6.H4

A rectangular garden uses 60 meters of fencing on all four sides. Let x be its width. Write the length, area function and contextual domain. Find the greatest area and corresponding dimensions. Compare that area with the area when the width is 10 meters, and explain why area is the quantity to optimize.

6.H5

(a) Revenue is $R(p) = -3(p-8)^2 + 300$ dollars for prices $10 \le p \le 14$ dollars. Find the greatest allowed revenue and its price. (b) Cost is $C(x) = (x-3)^2 + 10$ dollars on $0 \le x \le 8$. Find both its least and greatest allowed costs and their inputs. Explain why the vertex is not automatically the answer to every extreme-value question.

6.H6

For $f(x) = -x^2 + 8x + 1$ on $[0, 6]$, find the average rate over the interval, the greatest output and the input where that output occurs. Explain which calculation answers each question. Then find $f(3)$ and state why it is not the maximum.

Time spent on both pages: _____ minutes Question to revisit: _____

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LESSON 7

Build a quadratic model

7.R1

A line passes through $(1, 5)$ and $(4, 17)$. Write its rule.

7.R2

For $Q(x) = 8 - (x - 3)^2$, give the largest output and where it occurs.

Work together

7.G1

Two partners model a parabolic arch with base points $(0, 0)$ and $(12, 0)$ and highest point $(6, 9)$. Each chooses a different form. Write both rules, verify they agree and predict the height at 2 meters.

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7

LESSON 7 | PARTNER INVESTIGATION

Compare methods and defend a decision

7.G2

A class knows a quadratic has zeros at 1 and 7. Sketch two possible graphs. Tell a partner which single additional measurement would distinguish them and which measurement would be useless.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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LESSON 7 | INDEPENDENT WORK

Apply the idea on your own

7.I1

A quadratic model for a garden bed gives zero area at widths 0 and 16 meters. At 4 meters the area is 96 square meters. Find a model, its largest area and the width that gives it.

7.I2

An artist says a parabola with vertex $(4, 10)$ must pass through $(5, 11)$. Evaluate the claim.

Exit check

7.E

A quadratic function has a maximum of 7 at input 2 and passes through $(0, 3)$. Write its rule.

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LESSON 7 | HOMEWORK 1 OF 2

7

Practice the current lesson

40-minute total across all 2 pages. Start with 7.H4 on the final page, then return here. Show reasoning and check your work.

7.H1

A parabolic spray arc passes through $(0, 1)$ and peaks at $(3, 10)$ in meters. Construct its equation, give its height at 5 and find the interval where it rises from its starting height and returns to that height. Sketch and label the arc.

7.H2

A quadratic profit model for a hypothetical Medford orchard sale breaks even at 10 and 30 boxes. Profit is 80 dollars at 20 boxes. Model profit, find it at 15 and interpret a negative model output at 5. Choose a practical domain if only 35 boxes are available.

7.H3

A sensor reads 2, 5 and 12 at inputs 0, 1 and 2. Construct a quadratic by equations, verify all three pairs and predict at 3.

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LESSON 7 | HOMEWORK 2 OF 2

7

Recall, explain and check

7.H4

A line passes through $(2, 14)$ and $(6, 26)$. Write point-slope and intercept forms. A second model agrees at both points but takes value 17 at 4. Decide which model has constant rate and explain what the shared endpoints establish.

7.H5

A classmate writes $y = (x - 2)(x - 8)$ for every quadratic with those zeros. Use two test inputs and a sketch to explain the missing information.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

7.X

Can two parabolas have the same vertex and a second point and still differ? Include an exceptional case.

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8

LESSON
8

Exponential patterns and models

8.R1

Calculate the first differences of 3, 7, 13, 21 over unit inputs. What increases regularly?

8.R2

A model starts at 80 and retains 75 percent after one day. Find the first two new readings at the same daily percentage.

Work together

8.G1

Compare sequences A (12, 18, 27, 40.5) and B (12, 18, 24, 30) at inputs 0 through 3. Find both rules, predict both outputs at 5 and describe the evidence that would make your choice change.

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LESSON 8 | PARTNER INVESTIGATION

8

Compare methods and defend a decision

8.G2

A lab measures 160 units at minute 3 and 20 units at minute 9. Compare two models, constant amount lost per minute and constant percentage lost per minute. Predict at minute 5 with each and design a measurement to distinguish them.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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LESSON 8 | INDEPENDENT WORK

8

Apply the idea on your own

8.I1

At hour 1 a sample has 30 units. At hour 4 it has 101.25 units. Assume exponential growth with a constant percent change per hour. Build a model using hours as the input and predict at hour 5.

8.I2

An observer records 4, 8, 16 at hours 0, 1, 3. Evaluate the claim of a constant hourly doubling.

Exit check

8.E

Write two equivalent forms for 50 units doubling every 3 days. Identify which factor acts per day.

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LESSON 8 | HOMEWORK 1 OF 2

Practice the current lesson

40-minute total across all 2 pages. Start with 8.H4 on the final page, then return here. Show reasoning and check your work.

8.H1

A culture rises from 24 at hour 2 to 81 at hour 5. Construct an exponential rule in anchored and initial-value form. Use both at hour 6, sketch the curve and identify the percent increase per hour.

8.H2

Compare two classroom batteries, A with 96 units losing 4 units per hour and B with 96 units losing 4 percent per hour. Build a table for hours 0, 1, 2 and 4. Which first pair of readings distinguishes the models? Discuss a limit of each rule.

8.H3

An amount halves every four days. Express its daily multiplier as a radical and decimal, then calculate the percent decrease over eight days. Explain why dividing 50 percent by four gives the wrong daily rate.

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8

LESSON 8 | HOMEWORK 2 OF 2

Recall, explain and check

8.H4

A quadratic bridge model has zeros 0 and 10 and height 6 at 5. Build its rule, find its height at 2 and decide whether the average rate from 2 to 8 determines its highest point by itself.

8.H5

At hours 0, 1 and 3, amounts are 10, 20 and 80. Compare the two interval ratios, convert both to hourly factors and evaluate whether the data support one exponential rule.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

8.X

Find two different models through (0, 8) and (2, 18). Predict at 1.

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DAY
9

Modeling checkpoint

Lessons 1–8

Today's class

Start with the retrieval prompt. Your teacher will issue a 25-minute individual checkpoint, then return to the application tasks.

9.R

A model takes outputs 6 and 18 at times 2 and 5. Find its average rate and predict at 4 under a constant-rate assumption.

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9

DAY 9 | PRACTICE AND REPAIR

Use your assigned route

9.G1

After the checkpoint, sort these series at inputs 0, 1, 2, 3 and propose equations. A: 4, 8, 12, 16. B: 4, 8, 16, 32. C: 4, 7, 8, 7. Name a numerical reason and a limit of each prediction.

9.G2

In pairs, model a rectangle beside a wall with 28 m of fence on three sides. Draw it, express area using the width, then decide which dimensions a gardener should choose. Explain why the zero-area cases matter.

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DAY 9 | INDIVIDUAL WORK AND REFLECTION

9

Record independent evidence

9.I1

Independently, a school hall earns $P(n) = -2(n - 6)^2 + 40$ dollars at whole batch counts 2 to 5. Recommend a count and justify it without assuming every algebraic input is feasible.

9.E

Record one cue you used to choose a family and one way your answer could be tested.

Targeted homework • up to 20 minutes

9.H

Spend up to 20 minutes on the checkpoint skill your teacher marked. Rework that checkpoint item, then compare outputs 8, 12, 18, 27 with 8, 12, 16, 20 at inputs 0, 1, 2, 3. Write one rule and one reason for each.

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10

LESSON
10

Fit models with technology

10.R1

At times 1 and 4, a count rises from 8 to 20. Estimate at 3 using a constant rate.

10.R2

At equal steps, outputs are 5, 10, 20. Give a one-step and a two-step multiplier.

Work together

10.G1

For each of these three data sets at inputs 0, 1, 2, 3, choose a suitable model family. A gives 4, 6, 9, 11. B gives 2, 5, 6, 5. C gives 8, 12, 18, 27. Sketch each scatterplot, use technology to fit your chosen family and predict at 2.5.

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LESSON 10 | PARTNER INVESTIGATION

10

Compare methods and defend a decision

10.G2

At weeks 0, 1, 2, 3 a hypothetical Medford club sells 12, 15, 19, 20 tickets. Fit a line. Predict week 4 and week 40. Discuss which assumptions matter if the room holds 45 people.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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LESSON 10 | INDEPENDENT WORK

Apply the idea on your own

10.I1

At inputs 0, 1, 2, 3, a measurement gives 6, 8, 13, 15. Fit a line and report its prediction at 1.5. Compare the prediction with the observed output at 2.

10.I2

Four quarterly amounts of donated fabric are 20, 30, 45 and 67.5 meters. Fit a model with technology, state its quarterly multiplier and predict quarter 5 if the first observation is quarter 0. Give one reason to question a projection to quarter 20.

Exit check

10.E

A model fits four years of enrollment almost perfectly. Give one additional check before predicting enrollment 15 years later.

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LESSON 10 | HOMEWORK 1 OF 2

10

Practice the current lesson

40-minute total across all 2 pages. Start with 10.H4 on the final page, then return here. Show reasoning and check your work.

10.H1

For weeks 0 through 4 the outputs are 7, 10, 12, 16, 20. Sketch the data, fit a line, interpret both coefficients and predict at 3.5. Compare the observed and fitted values at week 2.

10.H2

In a simulated bounce experiment the heights at times 0 to 4 are 2, 8, 10, 8, 2. Fit a quadratic and compare its predictions at times 3 and 6. State an interval on which you would use it and explain your decision.

10.H3

Masses at hours 0, 1, 2, 3 are 100, 80, 64, 51.2 grams. Fit an exponential equation. Predict at hour 5, calculate the average rate over hours 0 to 2 and compare it with the first hour's change.

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10

LESSON 10 | HOMEWORK 2 OF 2

Recall, explain and check

10.H4

Depths at minutes 1 and 5 are 14 and 26 cm. Construct the straight line through the observations. Find the estimate at minute 3 and build a different quadratic agreeing at both endpoints.

10.H5

A quadratic and a line both fit a narrow range well. Write a short recommendation describing the graph, context and one extra observation that would help distinguish the families.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

10.X

How could changing the fitting criterion alter an exponential estimate?

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LESSON
11

Construct and interpret residuals

11.R1

Calculate $L(2.5)$ if $L(x) = 8 + 4x$. Interpret a residual if the observation is 21.

11.R2

A line predicts volume at time 17 using readings from times 1 to 6. Classify that prediction.

Work together

11.G1

At times 0, 2, 4, 7 the observed lengths are 13, 17, 18, 26 cm. Compare them with $L(t) = 12 + 2t$. Make a table, draw a residual plot and mark the observed-to-predicted vertical distance on a sketch at time 4.

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LESSON 11 | PARTNER INVESTIGATION

11

Compare methods and defend a decision

11.G2

For the same data compare $M(t) = 13 + 1.5t$. Pick a model by squared error. Does beating this one competitor prove that the winner has the least possible squared error among all lines? Does it prove the model will work tomorrow?

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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LESSON 11 | INDEPENDENT WORK

Apply the idea on your own

11.I1

For inputs 1, 3, 6 the measured values are 9, 14, 21. Compare with $F(x) = 2x + 8$. Plot the residuals and explain the largest vertical miss.

11.I2

Candidate A has residuals 3, -3, 0. Candidate B has residuals 1, 1, 1 on the same inputs. Choose by squared error, and explain why adding signed residuals gives a different impression.

Exit check

11.E

A model predicts 27 liters. Its residual is 2 liters. Find the measured amount and describe the direction of error.

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LESSON 11 | HOMEWORK 1 OF 2

11

Practice the current lesson

40-minute total across all 2 pages. Start with 11.H4 on the final page, then return here. Show reasoning and check your work.

11.H1

At times 0, 2, 3, 5, 8 the observed counts are 7, 10, 14, 16, 24. Use $L(t) = 2t + 7$. Build a complete prediction and residual table, graph the residuals at their actual times and identify the largest misses.

11.H2

Compare the preceding line with $M(t) = 2t + 6$ using both sums of squares. Decide which is preferable on these observations. Explain how the result would change numerically if every output and prediction were expressed in dozens.

11.H3

Three predictions are 12, 16, 20 and the corresponding residuals are $2, -1, 0$. Recover the observations. Increase every prediction by one, recalculate and compare the two fits.

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LESSON 11 | HOMEWORK 2 OF 2

11

Recall, explain and check

11.H4

A sample drops from 81 to 36 units in two hours. Derive its exponential multiplier per hour, predict after three hours and compare with a constant-rate prediction from those same endpoints.

11.H5

A student plots observed output against residual in place of input against residual. Give two inputs with the same observed output but different predictions, and explain what gets lost in that plot.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

11.X

Show how raising a line by one unit changes each residual. When does that reduce the total of the squares?

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12

LESSON
12

Use residual patterns to question a model

12.R1

At input 4, observed output is 13 and predicted output is 16. Locate the residual point.

12.R2

A model gives residuals 2, 0 and −3. Compute the squared-error sum.

Work together

12.G1

At inputs 0 through 6, model A has residuals 3, 1, −1, −2, −1, 1, 3. Plot them. Use the signs to describe where A misses and sketch a revised curve relative to A.

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LESSON 12 | PARTNER INVESTIGATION

12

Compare methods and defend a decision

12.G2

Model B has residuals $1, -1, 1, 0, -1, 1, -1$ on the same inputs. Compute both sums of squares and compare the patterns. Write one prediction you would trust and one you would investigate separately.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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12

LESSON 12 | INDEPENDENT WORK

Apply the idea on your own

12.I1

Models P and Q have residuals $2, 1, -1, -2$ and $1, -2, 2, -1$ at equally spaced inputs. Compare sizes and patterns. Does squared error distinguish them?

12.I2

A fitted line predicts weekly sales of $S(w) = 8w + 20$ over weeks 1 through 5. The store can supply 85 units per week. Discuss the algebraic, practical and observed input ranges and predictions at weeks 4 and 10.

Exit check

12.E

A residual plot has a smooth arch even though every miss is less than two units. Explain why both facts matter.

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LESSON 12 | HOMEWORK 1 OF 2

Practice the current lesson

40-minute total across all 2 pages. Start with 12.H4 on the final page, then return here. Show reasoning and check your work.

12.H1

For inputs 0 through 6 draw residual plots for A $(3, 1, -2, -4, -2, 1, 3)$ and B $(1, -1, 1, 0, -2, 1, 0)$. Calculate both squared sums. Write a recommendation naming a visible feature and a numerical comparison.

12.H2

A simulated sensor runs only between 0 and 12 minutes. Measurements were made at 2, 4, 6, 8 and 10 minutes. Classify predictions at 5, 11 and 15. Describe a specific additional measurement that would reduce uncertainty.

12.H3

Create two series of five residuals with equal squared sums, one showing a trend and one with the order scrambled. Draw them and predict how the fitted line might need to change for the trending series.

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LESSON 12 | HOMEWORK 2 OF 2

Recall, explain and check

12.H4

A quadratic has zeros 1 and 9 and reaches 16 at 5. Build its rule, calculate the average rate from 1 to 9 and explain how a zero rate can coexist with positive outputs inside.

12.H5

Explain how a high fit statistic and a clearly curved residual plot can occur together. State what you would compare before changing families.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

12.X

Design an experiment to detect systematic error hidden by averaging across two sites.

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DAY
13

Table Rocks modeling investigation

Lessons 8 and 10–12

Today's class

Work as a team during the investigation. Everyone records the evidence. Your teacher will distribute a fresh 20-minute individual follow-up.

13.R

A line through $(0, 14)$ and $(4, 6)$ predicts a depth at day 2. If the observation is 9, find the residual and describe its sign.

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13

DAY 13 | TEAM INVESTIGATION

Choose a model for simulated pool depth

Day	0	1	2	3	4
Depth (cm)	16.2	12.0	8.9	6.8	5.1

13.G1

Table Rocks investigation, team record. Simulated depth in cm at days 0, 1, 2, 3 and 4 is 16.2, 12.0, 8.9, 6.8 and 5.1. Label and draw the scatterplot. Before fitting, compare differences and ratios. Fit a line and a positive exponential with graphing technology. Record both equations, the software used and the regression command or model option selected.

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DAY 13 | TEAM EVIDENCE

13

Plot residuals and make a prediction

13.G2

Using your team's equations, construct both residual plots, compare the sums of squared errors on the original depth scale and predict depth on day 6. Record one condition that could invalidate that prediction. Each partner must be able to defend the choice.

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13

DAY 13 | INDIVIDUAL WORK AND REFLECTION

Record independent evidence

13.I1

Your teacher will issue the individual follow-up. Put away the team sheet and base your answer on the new measurements.

13.E

Name one model assumption and one observation that could challenge it.

Targeted homework • up to 20 minutes

13.H

If assigned, spend up to 20 minutes revising one team claim. Use your equation to predict day 5, compare with a new simulated reading of 4.1 cm and explain the residual.

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LESSON
14

Read and evaluate piecewise rules

14.R1

Write the domain of a continuous measurement from minute 0 through minute 5.

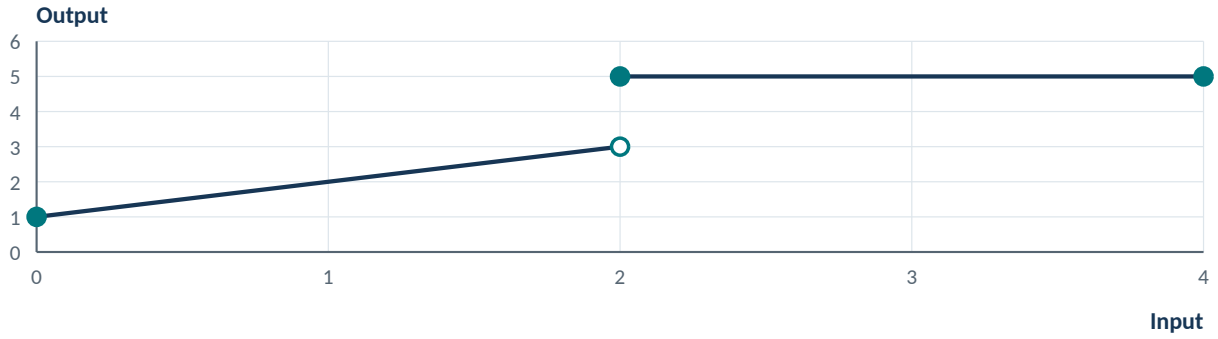
14.R2

A model has output 3 at input 1 and 11 at input 5. Find the average rate.

Work together

14.G1

Read the supplied graph with your partner. List its domain and the values at inputs 1, 2, 3 and 4. Estimate at 1.5 and explain what changes at 2.



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14

LESSON 14 | PARTNER INVESTIGATION

Compare methods and defend a decision

14.G2

For $-2 \le x < 1$ a model uses $2x + 1$, and for $1 \le x \le 4$ it uses $5 - x$. Evaluate at $-2, 0.5, 1, 4$. Draw both segments, marking every endpoint.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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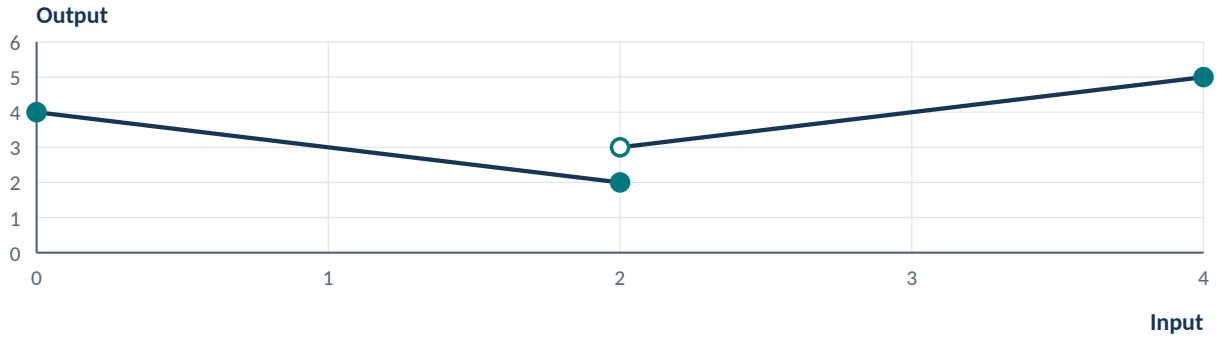
LESSON 14 | INDEPENDENT WORK

14

Apply the idea on your own

14.I1

Use the second graph supplied with this problem. Give the output at 0, 2 and 3, estimate the output at 3.5 and explain the two different heights plotted over 2.



14.I2

A rule gives $2t$ for $0 \leq t < 3$ and 9 for $3 \leq t \leq 5$. Find the average rate on $[2, 4]$. Explain why using either formula for both endpoints fails.

Exit check

14.E

Two branches are defined on $[0, 2)$ and $(2, 6]$. Which input needs a decision before this can model every real time from 0 to 6?

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LESSON 14 | HOMEWORK 1 OF 2

14

Practice the current lesson

40-minute total across all 2 pages. Start with 14.H4 on the final page, then return here. Show reasoning and check your work.

14.H1

A walker's distance from a start is $2t$ km for $0 \le t \le 2$, 4 for $2 < t \le 3$ and $4 - (t - 3)$ for $3 < t \le 7$, with t in hours. Make a table at each boundary and midpoint, sketch and interpret all three intervals.

14.H2

A graph joins filled $(0, 2)$ to open $(3, 8)$. A second segment joins filled $(3, 4)$ to filled $(5, 0)$. Draw it, determine the value at 3, then construct equations and interval restrictions for both segments.

14.H3

Use the preceding graph to find each input giving output 4 or 8. Describe why solving an unrestricted branch equation can give an extra answer.

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LESSON 14 | HOMEWORK 2 OF 2

14

Recall, explain and check

14.H4

Use readings 7, 12 and 14 at times 0, 2 and 5. Find interval and overall average rates, fit the line through the endpoints and compute its residual at 2.

14.H5

A student filled both dots at a jump because the time itself is allowed. Use a vertical-line argument and revise the graph so it represents a function.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

14.X

Build two different functions that differ only at one point. Explain what their graph markers must show.

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15

LESSON
15

Construct piecewise models

15.R1

Translate $[1, 4)$ into inequalities. Which endpoint is included?

15.R2

A tank holds 18 liters when a pump starts at minute 3. Find the amount at minute 7 at 2 L/min.

Work together

15.G1

A hypothetical Greenway outing starts with 20 minutes of riding at 0.2 mile per minute, pauses 10 minutes, then returns along the same route at 0.25 mile per minute. Build and graph distance from the starting point for the whole outing.

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LESSON 15 | PARTNER INVESTIGATION

15

Compare methods and defend a decision

15.G2

A vendor's marginal rates are 3 dollars per pound for the first 4 pounds and 2 dollars per additional pound up to 10. A partner proposes $2w$ for every order over 4. Compare at 4, 4.1 and 8 pounds. Repair and sketch the rule.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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15

LESSON 15 | INDEPENDENT WORK

Apply the idea on your own

15.I1

A pump fills an empty container at 5 L/min for 3 minutes, stops for 2 minutes, then drains at 3 L/min until empty. Give a complete rule in interval notation and a labeled graph.

15.I2

For positive masses up to 5 kg a shipment costs 8 dollars through 2 kg, then a flat 13 dollars above 2 kg. Write the rule, mark the two endpoints above 2 on a graph and explain the jump.

Exit check

15.E

A student gives each time after 4 the rule $3(t-4)$ for a tank already containing 20 liters at minute 4. Correct the rule and explain the added term.

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LESSON 15 | HOMEWORK 1 OF 3

15

Practice the current lesson

40-minute total across all 3 pages. Start with 15.H4 on the final page, then return here. Show reasoning and check your work.

15.H1

A runner goes out from a trail marker for 12 minutes at 0.15 mile/min, rests 4 minutes, then takes 18 minutes to return. Write the three rules, sketch and find every time at which the runner is 0.9 mile from the marker.

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LESSON 15 | HOMEWORK 2 OF 3

15

Compare rules and boundary behavior

15.H2

At an invented orchard stand the first 5 pounds cost 4 dollars per pound and each additional pound costs 3 dollars. Model orders from zero to 12 pounds, graph and find the weight of a 32-dollar order. Contrast this with a flat discount on the entire purchase above 5 pounds.

15.H3

A rule uses x on $[0, 3)$, 5 on $[3, 6]$, and $5 + 2(x - 6)$ on $(6, 9]$. Calculate its values at 2.9, 3, 5.9, 6 and 6.1. Use the values and branch slopes to explain which boundary has a jump and which has a continuous change of slope.

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LESSON 15 | HOMEWORK 3 OF 3

15

Recall, explain and check

15.H4

A club's expected weekly attendance is modeled by 10, 15, 22.5 and 33.75 people at weeks 0, 1, 2 and 3. Fit a family, predict week 4 and compute the residual if 45 attend. Describe what a sequence of negative future residuals would suggest.

15.H5

A piecewise parking model gives a 10-dollar flat fee for the first two hours. Two students disagree about the cost at exactly zero. Write two plausible domain choices and the assumption behind each.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

15.X

Can two adjacent full branch formulas agree at a boundary while their model excludes it? Draw an example.

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16

LESSON
16

Absolute value as distance and a piecewise rule

16.R1

Plot -4 and 3 on a number line. Find the distance between them.

16.R2

For $2x$ on $[0, 2)$ and 5 on $[2, 4]$, find outputs at 1.5 and 2.

Work together

16.G1

On a straight practice section marked in miles, a volunteer stands at coordinate 3. Compare the signed displacement and the distance from the volunteer at 0, 2, 3 and 5. Graph both rules on $[0, 6]$.

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LESSON 16 | PARTNER INVESTIGATION

16

Compare methods and defend a decision

16.G2

Build a model that charges a base of 6 dollars plus 2 dollars per unit missed from 4. Write the branches, mark their endpoints and find all inputs costing 12 dollars on $[0, 10]$.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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16

LESSON 16 | INDEPENDENT WORK

Apply the idea on your own

16.I1

A sensor's score is $18 - 2|t - 6|$ on $[3, 10]$. Graph the rule, write both branch equations and find its highest and lowest scores on the domain.

16.I2

Construct a distance-based charge with minimum 5 at input 8 and charge 11 at input 10. Predict the charge at 6 and explain your reasoning with a number line.

Exit check

16.E

Does $|x + 2|$ measure distance from 2 or from -2? Justify by locating the input where the distance is zero.

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LESSON 16 | HOMEWORK 1 OF 3

16

Practice the current lesson

40-minute total across all 3 pages. Start with 16.H4 on the final page, then return here. Show reasoning and check your work.

16.H1

Use a target temperature of 18 degrees Celsius and a cost score of 4 plus 1.5 per degree of deviation. Build absolute-value and piecewise rules, sketch on $[10, 26]$, and find all temperatures costing at most 10.

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16

LESSON 16 | HOMEWORK 2 OF 3

Compare rules and boundary behavior

16.H2

Compare $A(x) = |x - 4|$ with $B(x) = 2|x - 4| - 3$. Make a table at 1, 3, 4, 5 and 7, then find all inputs where the two outputs agree.

16.H3

A two-piece graph has left rule $12 - 2x$ and right rule $2x - 4$, meeting where they are equal. Recover the turning point, write one absolute-value rule and verify at one input on each side.

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LESSON 16 | HOMEWORK 3 OF 3

Recall, explain and check

16.H4

A line passes through $(1, 12)$ and $(5, 4)$. Compute its rate and zero. Compare it with the supplied curve $Q(x) = 14 - 2x + (x - 1)(x - 5)$. Check both endpoints and evaluate $Q(7)$. Explain which conclusion about the line transfers to the curve and which does not.

16.H5

A student models every V-shaped graph by $a|x - h| + k$. Draw a continuous example with unequal arm slopes, write both rules and explain why the proposed single multiplier fails.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

16.X

Find all x with $|x - 1| = |x - 7|$ by distance reasoning and by algebra.

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17

DAY
17

Modeling with Functions review

Lessons 1–16

Today's class

Start with the mixed diagnostic. Your teacher will assign a repair route before the individual transfer problem.

17.R

Diagnostic, on your own. (a) The outputs 8, 12, 18 occur at equal input steps. Predict a fourth value. (b) Give the least output of $(x-3)^2+2$ on $[0,2]$. (c) Predict at minute 4 from 18 liters at minute 2 and a rate of -3 L/min. (d) An observed 7 compares with a predicted 9. Give its residual.

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DAY 17 | PRACTICE AND REPAIR

17

Use your assigned route

17.G1

Route A, models and extrema. Construct the quadratic through zeros 0 and 10 with output 24 at 4. Determine its greatest output first on $[0, 10]$, then on $[0, 3]$. Sketch the two domains.

17.G2

Route B, functions in pieces and data. A meter reads $2t$ for $0 \le t \le 3$ and $6 + (t - 3)$ for $3 < t \le 8$. Draw it. At time 5 a measurement is 9. Find the residual and the average modeled rate across $[2, 5]$.

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17

DAY 17 | INDIVIDUAL WORK AND REFLECTION

Record independent evidence

17.I1

A group fundraiser has net dollars $N(n) = -(n - 8)(n - 2)$ for whole batches from 3 to 7. Recommend a batch count. Then compare its prediction at 4 with an observed 10 dollars.

17.E

From your route, write a short prompt with no method named and solve it. Exchange it with another student.

Targeted homework • up to 20 minutes

17.H

Choose one repair, up to 20 minutes. For Route A, find the maximum of $20 - (t - 6)^2$ on $[1, 4]$. For Route B, model paying 5 dollars through 2 hours and 3 per additional hour through 5 hours. Draw the graph and check its boundary.

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DAY
18

Modeling with Functions exam

Lessons 1–16 • Review on Day 17

Today's class

After the exam on Lessons 1–16, use the reflection and parallel practice below to revisit your reasoning.

18.G1

After the assessment, a fountain arc has height $H(t) = 1 + 6t - t^2$ on $[0, 5]$. A photograph can show only the portion from seconds 0 to 2. Determine the greatest visible height and compare it with the whole arc.

18.I1

Individually, write which input or domain check changed your decision, then create another viewing window giving the same visible maximum.

Homework • No new work tonight.

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19

LESSON
19

Composition as an input-output chain

19.R1

Evaluate $3u^2 - u$ at $u = -2$.

19.R2

A sensor gives 8 liters and a dispenser fills 2-liter bottles. What quantity does dividing by 2 produce?

Work together

19.G1

A hypothetical Medford print shop uses $s(n) = 4n + 2$ sheets for n photo sets. Its cost in dollars for s sheets is $C(s) = 0.25s + 3$. Build the chain, price seven sets, find a set count costing 10.50 and discuss the reverse order.

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LESSON 19 | PARTNER INVESTIGATION

19

Compare methods and defend a decision

19.G2

With $f(x) = 2x + 1$ and $g(x) = x^2 - 2x$, predict whether order matters, construct both expressions and test at 0 and 2.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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19

LESSON 19 | INDEPENDENT WORK

Apply the idea on your own

19.I1

A delivery uses $d(n) = 3n + 2$ miles for whole counts 0 through 12. A cost rule $C(d) = 4 + 0.5d$ applies through 20 miles. Build the composite, price four stops and determine all admissible counts.

19.I2

For $f(x) = x - 2$ and $g(x) = x^2 + x$, find both compositions, verify at 3 and explain why matching at one input would not establish equality.

Exit check

19.E

If $f(3) = 8$ and $g(8) = 5$, what can you conclude about $g(f(3))$ and $f(g(3))$?

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LESSON 19 | HOMEWORK 1 OF 2

Practice the current lesson

40-minute total across all 2 pages. Start with 19.H4 on the final page, then return here. Show reasoning and check your work.

19.H1

A club prints $p(n) = 6n + 4$ pages for n packets. An invented printing charge is $C(p) = 0.08p + 2$ for up to 100 pages. Write the cost rule by packet count, price 10 packets, and find the largest allowable integer count. Give units at each stage.

19.H2

For $f(x) = 3x - 1$ and $g(u) = u^2 + 2u$, build and simplify both compositions. Compare at 0 and 1, then find one input where the outputs agree if possible.

19.H3

A dispenser gives $v(t) = 5t$ ounces for $0 \le t \le 8$ seconds. A second rule $P(v) = 2 + 0.2v$ applies only to volumes from 10 to 30 ounces. Build the rule in time, state the joint domain and sketch its segment.

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LESSON 19 | HOMEWORK 2 OF 2

19

Recall, explain and check

19.H4

A charge is 6 dollars for the first 2 miles and 1.50 dollars per additional mile through 8 miles. Construct both branches, compute charges at 2 and 6 miles and find the average dollar change per mile across that interval.

19.H5

Give two different linear functions whose compositions agree in both orders and another pair whose compositions differ. Show the algebra and explain what your examples establish.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

19.X

Find every real x for which $f(g(x)) = g(f(x))$ with $f(x) = 2x$ and $g(x) = x^2$.

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LESSON
20

Compose tables and graphs

20.R1

Given $f(2) = 5$ and $g(5) = 9$, trace the inputs in $g(f(2))$.

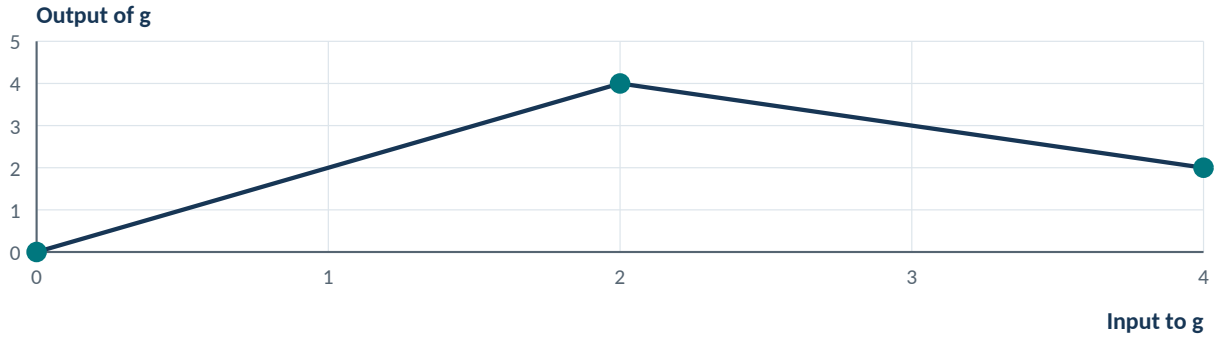
20.R2

For $g(u) = \sqrt{u - 1}$ decide whether inputs 0, 1 and 4 are allowed.

Work together

20.G1

A complete inner table maps inputs 0, 1, 2, 3 to 1, 3, 2, 5. Read outer outputs from the supplied graph of g. Make and graph a composite table, then apply $h(y) = 10 - y$ to every valid output.



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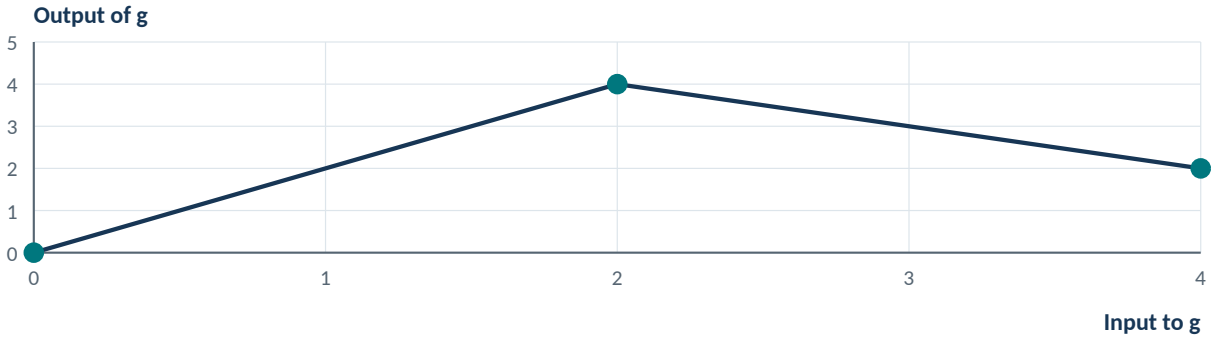
20

LESSON 20 | PARTNER INVESTIGATION

Compare methods and defend a decision

20.G2

For $f(x) = x + 1$ on $[-1, 3]$, use the same g-graph. Sample x every half unit, sketch the continuous $g(f(x))$ and identify the input giving the greatest output.



Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

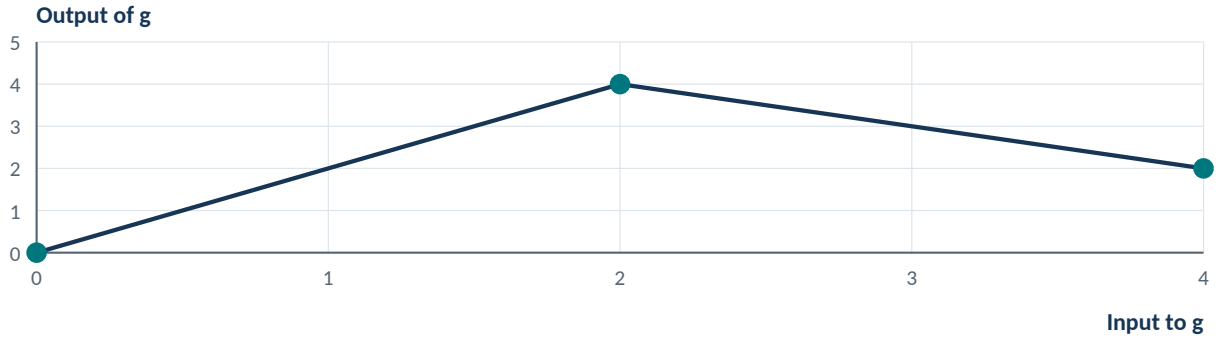
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LESSON 20 | INDEPENDENT WORK

Apply the idea on your own

20.I1

Use the supplied g-graph. A complete table for f maps inputs 2, 4, 6 and 8 to 0, 1.5, 4 and 5. Build $g \circ f$, graph all valid pairs, then evaluate $k(g(f(4)))$ for $k(v) = v^2 - 1$.



20.I2

A second table lists $q(1) = 3$ and $q(2) = 4$ as sample readings from a continuous function on $[0, 5]$. Explain the status of $q(3)$ and $q(7)$.

Exit check

20.E

A composite table has columns x, f and final output. Which columns are the coordinates on the composite graph? Explain where the middle column is used.

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LESSON 20 | HOMEWORK 1 OF 2

20

Practice the current lesson

40-minute total across all 2 pages. Start with 20.H4 on the final page, then return here. Show reasoning and check your work.

20.H1

On $[0, 4]$ a graph of g joins $(0, 1), (2, 5), (4, 1)$ with straight segments. Use $f(x) = x/2$ on $[0, 10]$. Make a composite table at even inputs, find the valid domain, and sketch the complete graph.

20.H2

A discrete table maps codes 1, 2, 3, 4 to quantities 4, 2, 0, 6. A graph through $(0, 2), (2, 6), (4, 4)$ is linear between points and defined only on $[0, 4]$. A final rule halves its input. Construct all three columns and graph the valid final outputs by code.

20.H3

Construct a continuous f on $[0, 3]$ and an outer function g defined only on $[0, 4]$ so the composite is defined on exactly $[1, 3]$. Demonstrate both domain tests and supply three composite points.

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LESSON 20 | HOMEWORK 2 OF 2

Recall, explain and check

20.H4

At times 1 and 4 a tank has measured volumes 16 and 25 liters. Build a constant-rate rule, then use it to predict at 3 and 6. If the observed volume at 3 is 20, compute and interpret its residual.

20.H5

A graphing tool connected four composite points even though the domain was four product codes. Explain what false claim a segment between codes 2 and 3 suggests. Describe when connecting plotted points would be reasonable.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

20.X

Can a composite have a connected domain while its inner range skips some values? Give an example.

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21

LESSON
21 Decompose a function

21.R1

Expand $(x-2)(x+4)$.

21.R2

With $g(x)=x+3$ and $h(u)=u^2$, find $h(g(-1))$.

Work together

21.G1

For $F(x)=2(x-3)^2+7$, give two different nontrivial inner/outer pairs and a three-function chain. Recompose every answer and test it at 1.

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LESSON 21 | PARTNER INVESTIGATION

21

Compare methods and defend a decision

21.G2

A partner tries $g(x) = x + 2$ and $h(u) = u(u - 3)$ for $(x + 2)(x - 1)$. Decide whether it works. Generalize to $(x + a)(x + b)$.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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21

LESSON 21 | INDEPENDENT WORK

Apply the idea on your own

21.I1

Decompose $(x-2)(x+4)$ using an identity pair, a nontrivial pair and a nontrivial three-stage chain. Verify each by composition.

21.I2

A proposed chain for $\sqrt{2x-6}+1$ is subtract 3, take a square root, then double and add 1. Find a test input showing the error and repair the chain.

Exit check

21.E

Explain why testing one number can disprove a decomposition but a single matching example rarely verifies it.

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LESSON 21 | HOMEWORK 1 OF 2

Practice the current lesson

40-minute total across all 2 pages. Start with 21.H4 on the final page, then return here. Show reasoning and check your work.

21.H1

For $F(x) = 3(x + 2)^2 - 4$, write an identity pair, two substantive two-stage decompositions and one three-stage chain. Verify algebraically and compute the output at $x = -5$.

21.H2

Use a factor-based substitution to decompose $(x + 1)(x - 5)$. Then find a decomposition using a completed square. Show that both expand to the same polynomial and identify its least value.

21.H3

Design a three-function chain with exactly the domain $[4, \infty)$ and final output 7 at input 4. Give its single expression, evaluate at 8 and justify the domain restriction.

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21

LESSON 21 | HOMEWORK 2 OF 2

Recall, explain and check

21.H4

A population in a simulation grows from 9 to 72 in three hours. Find its one-hour multiplier, write a model, predict at hour 4 and compare with the constant-rate extrapolation across the same initial interval.

21.H5

A student claims every decomposition of $x^2 - 4$ must start by squaring x. Use the factored form to construct a counterexample and explain the role of recomposition.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

21.X

Give infinitely many decompositions of $F(x) = x^2$.

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LESSON
22

Translations and reference points

22.R1

For $q(x) = 4 - (x + 1)^2$, locate the greatest output.

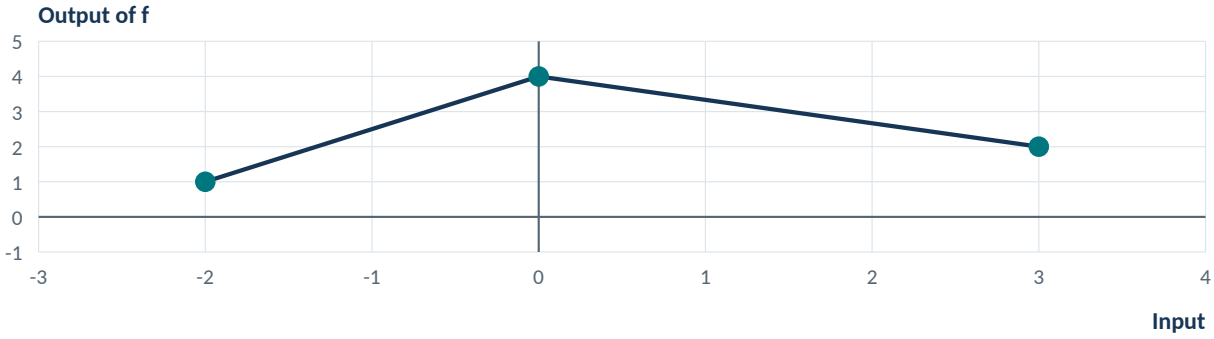
22.R2

Solve $x - 5 = -2$. How far apart are the new and old input?

Work together

22.G1

Use the asymmetric reference graph supplied. Sketch $f(x - 2)$ and $f(x) + 2$ on separate axes. Label every corner and endpoint and determine both domains and ranges.



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22

LESSON 22 | PARTNER INVESTIGATION

Compare methods and defend a decision

22.G2

A graph with the same shape has corners $(-3, 4), (-1, 7), (2, 5)$. Find its rule in terms of f and use addition functions to explain the order of operations.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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LESSON 22 | INDEPENDENT WORK

22

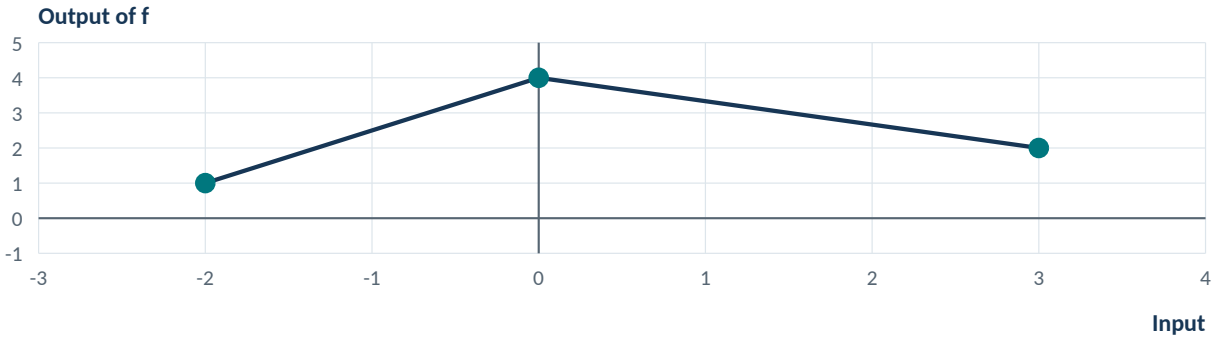
Apply the idea on your own

22.I1

A function on $[1, 6]$ has a least value of -2 at 4. For $g(x) = f(x + 3) - 5$, find the transformed domain, least value and where it occurs. Show how the old and new inputs are related.

22.I2

Use the supplied reference graph. Write and sketch a rule that sends its peak to $(4, 1)$ using translations. Verify the other endpoints and give a composition with addition functions.



Exit check

22.E

A student moves the old point $(3, 8)$ to $(5, 8)$ on $f(x + 2)$. Test the claim by solving for the input that gives old input 3.

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LESSON 22 | HOMEWORK 1 OF 2

22

Practice the current lesson

40-minute total across all 2 pages. Start with 22.H4 on the final page, then return here. Show reasoning and check your work.

22.H1

For the graph joining $(-3, 2), (1, 6), (4, 0)$ sketch $f(x + 2) - 4$. Make a point table, report domain and range and write the composite using addition functions.

22.H2

A model on $[0, 8]$ reaches its maximum of 12 at time 3 hours. A second run follows the same curve, 2 hours later and 5 units lower. Construct the second rule and graph the peak and endpoints symbolically. When is the peak on the original clock?

22.H3

Find translations that turn $f(x) = x^2$ into a curve with zeros 1 and 7 and the same shape. Verify the zeros, identify the minimum and explain how the two shifts appear in the formula.

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LESSON 22 | HOMEWORK 2 OF 2

Recall, explain and check

22.H4

Compose $f(x) = x + 1$ with $g(x) = x^2 - 1$ in both orders. Find where the orders agree and connect one of the formulas to an input translation.

22.H5

Two students argue that the graph of $f(x - h)$ shifts right for every real h. Correct the statement for positive, negative and zero h with one point formula.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

22.X

When can an input translation of a function leave every output the same?

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23

LESSON
23 Scaling and reflections

23.R1

An old point $(1, 6)$ belongs to f. Locate it on $f(x + 4) - 2$.

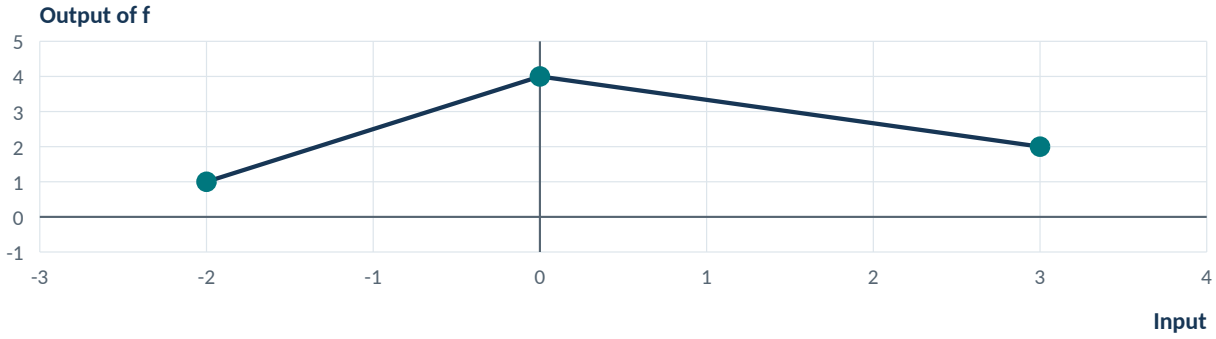
23.R2

Evaluate $-2f(3)$ if $f(3) = -4$.

Work together

23.G1

From the asymmetric reference graph, sketch $2f(x)$ and $f(2x)$. Label the three corners and use each graph to explain whether the widths and heights change.



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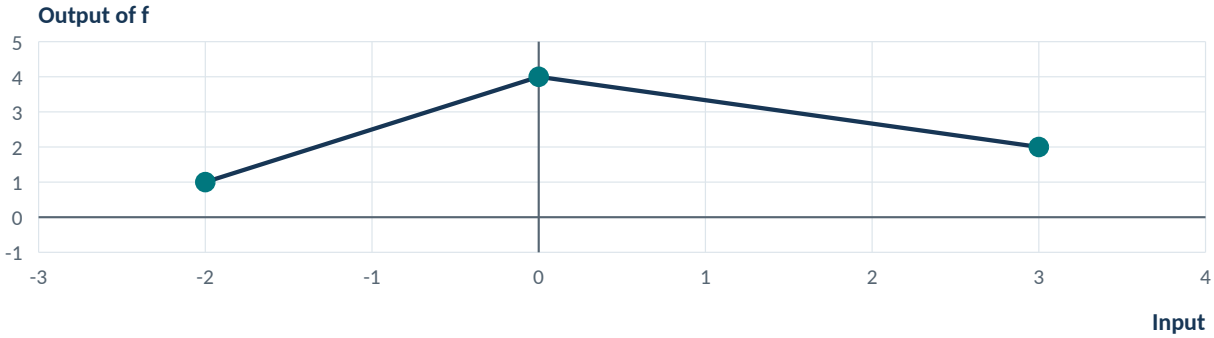
LESSON 23 | PARTNER INVESTIGATION

23

Compare methods and defend a decision

23.G2

Using the same reference graph, make a table of the corresponding corners for $-f(x)$ and $f(-x)$ and describe the effect on the peak. Then sketch $-f(-x)$, label its corners and describe its peak or minimum.



Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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LESSON 23 | INDEPENDENT WORK

23

Apply the idea on your own

23.I1

A piecewise-linear graph has corners $(-3, 2), (1, -4), (5, 3)$. Sketch $g(x) = -2f(-x/2)$, report its domain and range and name the magnitude and axis of each dilation/reflection.

23.I2

A student claims $f(3x)$ triples all distances from the vertical axis. Use a general point, one numerical check and a composition with M_3 to evaluate the claim.

Exit check

23.E

A graph contains $(2, 5)$. Distinguish the corresponding points of $-f(2x)$ and $f(-2x)$.

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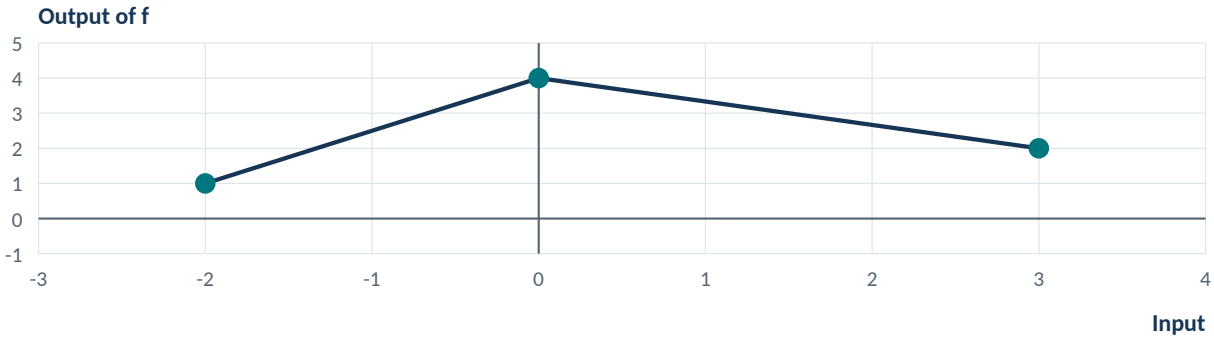
LESSON 23 | HOMEWORK 1 OF 2

Practice the current lesson

40-minute total across all 2 pages. Start with 23.H4 on the final page, then return here. Show reasoning and check your work.

23.H1

Use the reference graph from class. Sketch $3f(-x)$ and $f(x/3)$, list the transformed corners, and compare their domains and ranges. Verify one point from each graph by substitution.



23.H2

A curve has marked points $(2, 3)$ and $(6, 1)$. Under $g(x) = af(bx)$ their corresponding points are $(-1, 9)$ and $(-3, 3)$. Recover a and b. Describe the two changes and verify both points.

23.H3

Use $f(x) = x^2$ to show why a single parabola may make input and output scaling look identical. Then choose an asymmetric function and show that the same equivalence fails.

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23

LESSON 23 | HOMEWORK 2 OF 2

Recall, explain and check

23.H4

Construct a two-stage and a three-stage decomposition of $3(x-2)^2+4$. Recompose each, find the minimum and decide which inputs give 16.

23.H5

A student says a vertical scale factor of -3 makes a graph "negative three times as tall." Replace this with a point-based statement that distinguishes scale magnitude, distance and sign.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

23.X

Find the horizontal factor and reflection for $f(-x/4)$. Verify with a point of your choice.

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LESSON
24

Build transformations in context

24.R1

How many minutes have elapsed 0.6 hour after a start? How many hours is 9 minutes?

24.R2

The point $(4, 6)$ belongs to f. Locate it under $3f(x/2)$.

Work together

24.G1

A hypothetical Table Rock hiking log gives cumulative gain in feet after 0, 20 and 50 minutes as 0, 180 and 480. Convert the table to hours and meters. Write the transformed function, plot the points and calculate the average gain in meters per hour on the full interval.

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LESSON 24 | PARTNER INVESTIGATION

24

Compare methods and defend a decision

24.G2

Let $E(t)$ be an elevation in feet t minutes after 8:00. A class dashboard starts at 8:15 and displays meters above the 8:15 elevation, using seconds s. Construct its formula and prove the displayed value at its start is zero.

Partner record

Show a second representation or test case. Record one point of agreement and the evidence that settled it.

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LESSON 24 | INDEPENDENT WORK

Apply the idea on your own

24.I1

A Crater Lake exhibit model $d(t)$ gives depth in feet t minutes after a virtual descent begins at 10:05. A display uses signed meters relative to the surface, h hours after 10:00. Build the rule and convert a point $d(10) = 240$.

24.I2

A temperature sensor works for the first 30 minutes after 9:10 and reports Celsius. Give Fahrenheit temperature and its domain in hours after 9:00. Test both time endpoints.

Exit check

24.E

A student's unit conversion multiplies by 60 on the outside solely because the new input is hours instead of minutes. Explain the correction using a one-hour input.

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LESSON 24 | HOMEWORK 1 OF 2

24

Practice the current lesson

40-minute total across all 2 pages. Start with 24.H4 on the final page, then return here. Show reasoning and check your work.

24.H1

A Greenway field exercise models cumulative distance $d(t)$ miles t minutes after 8:30. A second clock reads seconds after 8:40. Build a rule for kilometers traveled since 8:40. If $d(10) = 1.2$ and $d(25) = 3.1$, use the rule and give both new coordinates for the latter point.

24.H2

A simulated sensor measures $T(t) = 8 + 0.4t$ Celsius at t minutes after noon for $0 \le t \le 30$. Give Fahrenheit temperature as a function of seconds since 12:10, using the readings from that time forward. State its domain, evaluate at 300 seconds and check with the original rule.

24.H3

A lake cross-section drawing has a point 0.5 mile from its origin and 300 feet below the surface. On a new diagram the origin is 0.2 mile farther along and heights are signed meters relative to the surface. Give the new coordinates in km and meters, explaining the sign of each coordinate.

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LESSON 24 | HOMEWORK 2 OF 2

Recall, explain and check

24.H4

A charge is $C(x) = 3|x - 5| + 2$ for $0 \le x \le 7$. Write both branches, find its minimum and maximum, and explain how the answer changes if the domain becomes $[6, 7]$.

24.H5

At SMS, $v(t)$ is the volume in liters collected t minutes after class begins. A display uses $V(h) = 1000v(60h)$. Identify the units of h and V, explain the inside and outside factors, and convert the observation $v(30) = 2$ to the new coordinates.

Time on all pages _____ minutes Question to revisit _____

Optional challenge • up to 10 additional minutes

24.X

Write a formula to reverse a feet-to-meters conversion and a time-origin shift in one step.

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25

DAY
25

Mod 1 cumulative check

Lessons 1–24

Today's class

Your teacher will issue the 45-minute cumulative check. After collection, work through the parallel problems and complete your re-entry plan.

25.G1

After the check, model a new clock. A function $H(m)$ gives height in feet m minutes after 10 a.m. Write height in inches s seconds after 10:05. A group proposes $12H((s+5)/60)$. Test the new start and correct it.

25.G2

Choose a second repair. Sketch the piecewise-linear function on $[0, 4]$ formed by joining $(0, 1), (2, 5), (4, 3)$ with straight segments. Mark its corresponding points on $-f(2x)$. Compare the original maximum with the maximum and minimum of the transformed function.

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25

DAY 25 | INDIVIDUAL WORK AND REFLECTION

Record independent evidence

25.I1

Independently construct a two- and three-function decomposition of $2(x+1)^2-3$. Verify at $x=2$ and explain what that single numerical check can establish.

25.E

Write your re-entry plan with one task ID from this volume, the idea you will retrieve and a fresh numerical example.

Targeted homework • up to 20 minutes

25.H

If assigned, spend up to 20 minutes on one gap from the check. Solve either $g(x)=f(-2x)$ with marked point $(4,3)$, or maximize $9-(x-3)^2$ on $[0,2]$. Explain the choice you made.

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OPTIONAL CHALLENGES

Extensions for meetings 1 through 6

1.O

Create two different real-world contexts using the same rule $F(x) = 20 + 4x$. Give one an integer-only domain and the other a continuous domain.

2.O

Construct a nonconstant function whose average rate on $[0, 4]$ is zero. Explain why it works.

3.O

Find two different functions with $f(0) = 0$ and $f(4) = 8$ but different values at input 2. What does this show about prediction from an average rate?

4.O

Two delivery plans are $A(d) = 12 + 2d$ and $B(d) = 6 + 3d$, with distance $d \geq 0$ in miles. Find when the costs agree and explain which is cheaper for shorter trips.

5.O

A quadratic has zeros 1 and 7 and passes through $(0, 14)$. Construct its factored form and find its minimum.

6.O

The revenue model is $R(p) = -10(p - 12.5)^2 + 2000$ dollars, but the price p must be a whole number of dollars from 8 through 18. Find the best allowed price or prices and explain.

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SOURCE NOTES

Texts and Southern Oregon settings

St. Mary's School Algebra II follows the 25-meeting Mod 1 sequence. The College Board Pre-AP Algebra 2 Course Guide (2024) supplies the framework. The lessons, problems and assessments are an SMS adaptation.

OpenStax reading

Based in part on OpenStax, Algebra and Trigonometry 2e, © 2026 Rice University. Read selected portions of sections 3.1–3.6, 4.1, 4.3, 5.1, 6.1, 6.7 and 6.8. The teacher guide identifies lesson-specific readings; section 6.7 is used here for exponential models, not its logarithmic example. Access for free at openstax.org. The SMS adaptation is distributed under CC BY-NC-SA 4.0.

Desmos Graphing Calculator • regression instructions

OpenStax Algebra and Trigonometry 2e

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Southern Oregon

The Bear Creek Greenway links communities including Ashland and Medford. Table Rocks has seasonal vernal pools. The BLM lists the Upper Table Rock trail to the top at 2.5 miles round trip. The National Park Service reports a greatest depth of 1,943 feet for Crater Lake. Those place facts are used in meetings 13, 15 and 24. All field readings, fees, business figures, schedules and model profiles in the exercises are invented classroom data.

Oregon State Parks • Scenic and Regional Trails

Bureau of Land Management • Table Rocks Natural History

Bureau of Land Management • Plan Your Visit to Table Rocks

National Park Service • Crater Lake



See the relationships.

A function connects two quantities. This volume develops the habit of moving between a story, a table, a graph, and an equation, then using those connections to decide what a result means.

Investigations, classwork, and homework give you space to test ideas and explain your decisions. Use the companion reference for worked examples and explanations.

STUDENT WORKBOOK · VOLUME 1

Table Rock illustrations created for this SMS edition. Artistic interpretations of the Rogue Valley landscape.

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