Challenge 9-6 Polynomials by Interpolation

Constant differences of the dependent variables can also be used to determine cubic, quartic, and higher degree polynomial functions.

Constant third differences indicate a cubic polynomial. Constant fourth differences indicate a quartic polynomial, and so on.

Once the degree of the polynomial is determined, polynomial interpolation can be used. For a cubic model an equation of the form $f(x) = ax^3 + bx^2 + cx + d$ will be appropriate. Substitute any four points from the data set to identify the constants a, b, c, and d by solving the appropriate system of linear equations.

For each data, determine the degree of the polynomial that is the best fit and then find the polynomial by interpolation.

"	X	-4	-3	-2	-1	0	1	2	3	4	
	У	21	5	-5	-9	-7	1	15	35	61	
-											
2.	x	-4	-3	-2	-1	0	1	2	3	4	
	У	-795	-284	-61	12	25	20	-9	-116	-403	
-											•
3. [x	-4	-3	-2	-1	0	1	2	3	4	
	у	-348	-154	-52	-12	-4	2	36	128	308	
- / [1
∣	X	-4	-3	-2	-1	0	1	2	3	4	
	У	-1003	-222	-11	20	21	22	53	264	1045	
-											
5. [x	-4	-3	-2	-1	0	1	2	3	4	1
ľ	У	1268	442	152	98	100	98	152	442	1268	

Itesson Reteach 9-6 Modeling Real-World Data (continued)		Illenge	terpolation		
After determining a parent function to model a data set, use the regression	Constant differe			he used to	
teature on a graphing calculator to find a function that models the data.	determine cubic	, quartic, and higher	degree polynomial fu	unctions.	
Make sure the x-values are evenly spaced.	Constant third d	lifferences indicate a cate a quartic polyno	cubic polynomial. Co mial, and so on.	onstant fourth	
y 71 93 121 157 204	Once the degree	e of the polynomial i	s determined, polyno	mial interpolation	
Step 1 Find first differences.	can be used. For $f(x) = ax^3 + bx$	or a cubic model and $x^2 + cx + d$ will be a	equation of the form appropriate. Substitute	e any four points	
First differences: 22 28 36 47 204 - 157 = 47	from the data se appropriate syst	et to identify the cons tem of linear equatio	stants <i>a</i> , <i>b</i> , <i>c</i> , and <i>d</i> b ns.	by solving the	
Step 2 Since first differences are not constant, find second differences. Second differences: 6 8 11	For each data.	determine the dear	ee of the polynomia	al that is the best	
Step 3 Since second differences are not constant, analyze ratios.	fit and then fin	d the polynomial b	y interpolation.		
$\frac{93}{71} = 1.310, \frac{121}{93} = 1.301, \frac{157}{121} = 1.298, \frac{204}{157} = 1.299$	1. <u>x</u>	-4 -3 -2		1 2	3 4
Step 4 An exponential model best fits the data since the ratios are		21 5 -0	-9 -7	1 15	35 01
regression. Select ExpReg from the STAT CALC menu.		Qua	idratic; $y = 3x^2$ ·	+ 5 <i>x</i> - 7	
ExpReg	2. <u>x</u>	-4 -3 -2		1 2	3 4
$y = a^*b^x$ An exponential model		-795 -284 -6	1 12 25	20 -9	-116 -403
$a = 24.8379125$ that fits the data is $f(x) = 24.8(1.3^{x})$.		Quartic; y	$= -2x^4 + 3x^3 -$	$-7x^2 + x + 2$	5
b = 1.301415677 $r^2 = .999953961$	3. x	-4 -3 -2	1 0	1 2	3 4
r = .9999769803	<u>y</u> –	-348 -154 -5	2 -12 -4	2 36	128 308
Complete to units a function that models the circan data		Cubi	$c; y = 5x^3 - x^2$	+2x - 4	
	4. <u>x</u>	-4 -3 -2	1 0	1 2	3 4
x 3 4 5 6 7 y 33 56 86 123 167	y –	1003 -222 -1	1 20 21	22 53	264 1045
3. Are the x-values evenly spaced? Yes			Quintic; $y = x^5$	+ 21	
4. Are the first differences constant? No	5. x	-4 -3 -2	2 -1 0	1 2	3 4
5. Are the second differences constant? Yes	y 1	268 442 152	2 98 100	98 152	442 1268
6. What is an appropriate model for the data? Ulladiratic model $f(\mathbf{x}) = 3.5\mathbf{x}^2 - 1.5\mathbf{x} + 6$		Qua	rtic; $y = 5x^4 - 7$	$x^{2} + 100$	
7. Find a function that models the data. $7(x) = 3.3x = 1.3x + 0$					
Copyright O by Hot, Rinehast and Winston. 47 Holl Algebra 2	Copyright © by Holt, Rinehat	rt and Winston.	48		Holt Algebra 2
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		ding Strate	gies		
Image: Stress big str	LESSON Rea 9-6 <i>Draw</i> Sometimes there	ding Strate v Conclusions	gies	es the relationship.	
Image: Stresson Problem Solving 9-5 Modeling Real-World Data The table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population minds draw in the future if the	LESSON Rea 9-6 Draw Sometimes there Often we can us	Iding Strate v Conclusions e is a pattern in real-water to draw	gies vorld data that describi conclusions about the	es the relationship.	
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Esson Problem Solving 9-6 Modeling Real-World Data The table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population might grow in the future if the current trend continues. Lincoln Valley Population 2000–2006 Year 1 2 3 4 5 6 7	LESSON Rea 9-6 Draw Sometimes there Often we can us Function Constant Differences/ Batios	between working strate	gies vorld data that describi conclusions about the Quadratic Constant second differences between walkes	es the relationship. function. Exponential Constant ratios between wyalues	Square Root Constant second differences
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Lincoln Valley Population grow in the future if the considering flow the population might grow in the future if the current trend continues. Lincoln Valley Population 2000-2006 Year 1 2 3 4 5 6 7 Population 1049 1137 1229 1326 1434 1542 1662	Sometimes there Often we can us Function Constant Differences/ Ratios	y Conclusions be is a pattern in real-we the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced).	gies vorld data that describ conclusions about the <u>Quadratic</u> Constant second differences between y-values (x-values evenly spaced).	es the relationship. e function. Exponential Constant ratios between y-values (x-values evenly spaced).	Square Root Constant second differences between x-values (y-values evenly spaced).
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Problem Solving 9:60 Modeling Real-World Data The table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population might grow in the future if the current trend continues. Lincoln Valley Population 2000-2006 Lincoln Valley Population 2000-2006 Year 1 2 3 4 5 6 7 Population 1049 1137 1229 1326 1434 1542 1662 The independent variable? What is the dependent variable? Assign x or y to each variable. The independent variable? (x) is the year. The dependent variable (y) is the population.	LESSON Rea 950 Draw Sometimes there Often we can us Function Constant Differences/ Ratios	ding Strate y Conclusions b is a pattern in real-we the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced).	gies vorld data that describ conclusions about the Quadratic Constant second differences between y-values (x-values evenly spaced).	es the relationship. function. Exponential Constant ratios between y-values (x-values evenly spaced).	Square Root Constant second differences between x-values (y-values evenly spaced).
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Problem Solving 9:60 Modeling Real-World Data The table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population might grow in the future if the current trend continues. Lincoln Valley Population 2000-2006 Year 1 2 3 4 5 6 7 Population 1049 1137 1229 1326 1434 1542 1662 A the independent variable? What is the dependent variable? Assign x or y to each variable. The independent variable? What is the gendent variable? Assign x or y to each variable. (y) is the population. Aske a scatter plot of the data. Do the data form a linear pattern? For this to be true, explain what must be true about finite differences. Possible answer: The first few points appear to be linear, but the later points start a curve upward. For the data to be linear, the first differences must be constant. Image y	Use the graphs	ding Strate y Conclusions b is a pattern in real-w the pattern to draw Constant first differences between y-values (x-values evenly spaced).	gies conclusions about the <u>Quadratic</u> Constant second differences between y-values (x-values evenly spaced).	es the relationship. function. Exponential Constant ratios between p-values (x-values evenly spaced). y Graph E	Square Root Constant second differences between x-values (y-values evenly spaced).
Problem Solving 9:93 Modeling Real-World Data The table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population might grow in the future if the current trend continues. Lincoln Valley Population 2000-2006	Use the graphs 1. a. What typ b. What as	Ading Strate y Conclusions is a pattern in real- te the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced). y Graph A s above for Exercisis per of function is repr	gies rorld data that describi- conclusions about the Quadratic Constant second differences between y-values (x-values evenly spaced). o *	es the relationship. function. Exponential Constant ratios between <i>y</i> -values (<i>x</i> -values evenly spaced).	Square Root Constant second differences between x-values (y-values evenly spaced).
Problem Solving9:0Modeling Real-World DataThe table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population might grow in the future if the current trend continues.Lincoln Valley Population 2000-2006 Year 1 2 3 4 5 6 7 Population 1049 1137 1229 1326 1434 1542 16621. What is the independent variable? What is the dependent variable? Assign x or y to each variable.The independent variable? What is the dependent variable? Assign x or y to each variable.The independent variable? What is the gendent variable? Assign x or y to each variable.Output to the data. Do the data form a linear pattern? For this to be true, explain what must be true about finite differences. Possible answer: The first few points appear to be linear, but the later points start a curve upward. For the data to be linear, the first differences must be constant.Use the table of data.a. Find the first differences. 88, 92, 97, 108, 108, 120 b. Find the second differences.a. Find the third differences. 8, 5, 11, 0, 12 to the third differences.a. Find the third differences. 4, 5, 11, 0, 12b. Find the third differences.a. Find the third differences.b. Find the third differences.a. Find the third differences.b. Find the third differences.b. Find the thir	Use the graphs 1. a. What typ b. What co Graph A	ding Strate y Conclusions is a pattern in real- we the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced).	gies vorld data that describ conclusions about the Quadratic Constant second differences between y-values (x-values evenly spaced). • • • • • • • • • • • • •	es the relationship. function. Exponential Constant ratios between y-values (x-values evenly spaced). y Graph E Quadrat	Square Root Constant second differences between x-values (y-values evenly spaced).
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Problem Solving Modeling Real-World Data Modeling Real-World Data The table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population might grow in the future if the considering how the population might grow in the future if the current trend continues. <u>Lincoln Valley Population 2000-2006</u> <u>Year 1 2 3 4 5 5 6 7</u> Population 1049 1137 1229 1326 14341 1542 1662 1. What is the independent variable? What is the dependent variable? Assign x or y to each variable. The independent variable (x) is the year. The dependent variable (y) is the population. 2. Make a scatter plot of the data. Do the data form a linear pattern? For this to be true, explain what must be true about finite differences. Bossible answer: The first few points appear to be linear, but the later points start a curve upward. For the data to be linear, the first differences must be constant. 3. Use the table of data. a. Find the first differences. <u>A, 5, 11, 0, 12</u> b. Find the second differences. <u>A, 5, 11, 0, 12</u> c. Find the third differences. <u>A, 5, 11, 0, 12</u> d. Find the tratics between y-values. <u>All ratios round to 1.08</u> . 4. What kind of function will best describe the data? Justify your conclusion. Exponential function, because the ratios between y-values are	Use the graphs 1. a. What typ b. What cor Graph A The Lasson Lass	ding Strate y Conclusions is a pattern in real- be the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced).	gies rorld data that describi- conclusions about the Quadratic Constant second differences between y-values (x-values evenly spaced). o * es 1–2. esented by Graph A? raw about the data set stant second differences esented by Graph B? w about the data set first differences spaced x-vali	es the relationship. function. Exponential Constant ratios between <i>y</i> -values (x-values (x-values evenly spaced).	Square Root Constant second differences between x-values (y-values evenly spaced).
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Problem Solving Modeling Real-World Data The table shows the population of Lincoln Valley over the last 7 years. The town council is developing iong range plans and is considering how the population might grow in the future if the considering how the population might grow in the future if the considering how the population might grow in the future if the considering how the population 1049 1137 1229 1326 1434 1542 1662 1. What is the independent variable? What is the dependent variable? Assign x or y to each variable. 1. What is the independent variable? What is the dependent variable? Assign x or y to each variable. 1. What is the independent variable? What is the dependent variable? Assign x or y to each variable. 2. Make a scatter plot of the data. Do the data form a linear pattern? For this to be true, explain what must be true about finite differences. 3. Make a scatter plot of the data. Do the data form a linear pattern? For this to be true, explain what must be true about finite differences. 8. 89, 97, 108, 108, 120 b. Find the first differences. 4. 5, 11, 0, 12 6. Find the third differences. 1. 6, -11, 12 6. Find the third differences. All ratios round to 1.08. 7. What kind of function will best describe the data? Justify your conclusion. Exponential function, because the ratios between <i>y</i> -values are almost constant. 6. Priorit the population of Lincoln beamset. 7. Which function best models the quine. 6. Priorit the population for the beat answer.	Use the graphe 1. a. What typ b. What co Graph A The 2. a. What co 3. On the cool of a function Constant Differences/ Ratios Use the graphe 1. a. What typ b. What co Graph A The 3. On the cool of a function with evenly	ding Strate y Conclusions is a pattern in real- we the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced).	gies vorld data that describ- conclusions about the Quadratic Constant second differences (x-values evenly spaced).	es the relationship. function. Exponential Constant ratios between y-values (x-val	Square Root Constant second differences (y-values evenly spaced).
Problem Solving9.60Modeling Real-World DataThe table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population might grow in the future if the considering how the population might grow in the future if the considering how the population 1049 1137 1229 1326 1434 1542 16621. Uncoln Valley Population 2000-2006 Team in the independent variable? What is the dependent variable? Assign x or y to each variable.The independent variable? What is the dependent variable? Assign x or y to each variable.The independent variable (x) is the year. The dependent variable (y) is the population.Adake a scatter plot of the data. Do the data form a linear pattern? For this to be true, explain what must be true about finite differences. B8, 92, 97, 108, 108, 120 b. Find the first differences. B8, 92, 97, 108, 108, 120 b. Find the first differences. B8, 92, 97, 108, 108, 120 b. Find the ratios between y-values. All ratios round to 1.08.Image: 1 the product of the data? To be the data? Justify your conclusion.Exponential function, because the ratios between y-values are almost constantChoose the letter for the best answer: Choise the letter for the best answer:6. Predict the population of Lincoln Valley in 2012.	Use the graphs 1. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A C. a. What typ b. What coo Graph	ding Strate y Conclusions is a pattern in real- we the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced). yaced). Graph A s above for Exercis- be of function is repri- nclusions can you dra at a set has constant regionate plane at right thas constant first conditioned first of the set of the set of the spaced x-values.	gies cord data that describ conclusions about the Quadratic Constant second differences between y-values (x-values evenly spaced). * * * * * * * * * * * * * * * * * *	es the relationship. function. Exponential Constant ratios between p-values (x-values evenly spaced). Graph E Quadral at for the function repre- es between y-v ues. a a a a a a a a a a a a a	Square Root Constant second differences between x-values (y-values evenly spaced).
Problem Solving9:00Modeling Real-World DataThe table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population might grow in the future if the current trend continues.Lincoln Valley Population 2000–2006 Tyear 1 104 2 3 3 4 5 5 6 7 Population 1049 1137 1229 1326 1434 1542 16621. What is the independent variable? What is the dependent variable? Assign x or y to each variable.The independent variable? What is the dependent variable? Assign x or y to each variable.The independent variable? (x) is the year. The dependent variable (y) is the population.2. Make a scatter plot of the data. Do the data form a linear pattern? For this to be true, explain what must be true about finite differences. B 9, 29, 97, 108, 108, 120 b. Find the second differences.3. Use the table of data.a. Find the first differences. (1.6, -11, 1.2) A 1, 6, -11, 12a. Find the trid differences. (1.6, -11, 1.2)a. Find the ratios between y-values. A 11 ratios round to 1.08.A twat kind of function will best describe the data? Justify your conclusion.Exponential function, because the ratios between y-values are almost constantChores the letter for the best answer. S. Which function best models the given data?5. Which function best models the given data?6. Predic the population of Lincoln Valley in 2012.a. Find the train function, hegas the fails almost constant6. Predic the population of Lincoln Valley in 2012.Chores the letter for	Use the graphs 1. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A C. The C. a. What typ b. What coo Graph A C. The C. a. What typ b. What coo Graph A C. The C. a. What typ b. What coo Graph A C. The C. a. What typ b. What coo Graph A C. The C. a. What typ b. What coo Graph A C. The C. a. What typ b. What coo Graph A C. The C. a. What typ b. What coo Graph A C. The C. A. What typ C. B. What typ C. B. What typ C. B. What typ C. B. What typ C. C. B. C.	ding Strate y Conclusions is a pattern in real- be the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced).	gies corld data that describi- conclusions about the Quadratic Constant second differences between y-values (x-values evenly spaced). 5 * es 1–2. esented by Graph A? raw about the data set evenly spaced x- esented by Graph B? w about the data set fant first difference spaced x-vali- , sketch the graph atios between y-value	es the relationship. function. Exponential Constant ratios between j-values (x-values evenly spaced). Graph E Quadrat et for the function represes between y-v ues. a a a a a a a a between y-values (x-values) (x-values (x-values) (x-	Square Root Constant second differences between x-values (y-values evenly spaced).
Problem Solving Modeling Real-World Data The table shows the population of Lincoln Valley over the last 7 years. The town council is developing long range plans and is considering how the population might grow in the future if the current trend continues. $ \frac{1}{1000} \frac{1}{1$	Use the graphs 1. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A The C. a. What typ b. What coo Graph A C. A Gr	ding Strate y Conclusions is a pattern in real- be the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced).	gies corld data that describi- conclusions about the Constant second differences between y-values (x-values evenly spaced). o * es 1–2. esented by Graph A? raw about the data set stant second differences esented by Graph B? w about the data set stant second differences stant second differences spaced x-values second y Graph B? w about the data set second y Graph B? w about the data	es the relationship. function. Exponential Constant ratios between <i>y</i> -values (x-values evenly spaced).	Square Root Constant second differences between x-values (y-values evenly spaced).
Problem Solving Modeling Real-World Data The table shows the population of Lincoln Valley over the last ty gens. The town council is developing long range plans and is considering how the population might grow in the future if the considering how the population might grow in the future if the considering how the population might grow in the future if the considering how the population might grow in the future if the considering how the population 2000–2006 $\overline{\frac{1}{20041100110491137122913261434415421662}}$ 1. What is the independent variable? What is the dependent variable? Assign x or y to each variable. The independent variable (x) is the year. The dependent variable (y) is the population. 1. Make a scatter plot of the data. Do the data form a linear pattern? For this to be true, explain what must be true about finite differences. 1. Make a scatter plot of the data. Do the data form a linear pattern? For this to be true, explain what must be true about finite differences. 88, 92, 97, 108, 108, 120 b. Find the first differences. <u>1. 611, 12</u> d. Find the third of function will best describe the data? Justify your conclusion. Exponential function, because the ratios between y-values are <u>almost constant</u> Choose the letter for the best answer . A y = 101.9x + 932.1 A 2270 B y = 31.x ² + 77.0x + 969.6 G 2450 C y = 996.6x ⁰²²³³ (f) 2650 (j) y = 974.9(1.08) ^x (j) 2860	LESSON General Constant Differences/ Ratios Use the graphs 1. a. What typ b. What con Graph A The 2. a. What typ b. What con Graph A The 3. On the cool of a function with evenly 4. On the cool of a function the points (ding Strate y Conclusions is a pattern in real- be the pattern to draw Linear Constant first differences between y-values (x-values evenly spaced). Graph A s above for Exercis be of function is repri- nclusions can you dra at a set has const data set has const refinate plane at right in that has constant first con- conditional set of the set of the set of the refinate plane at right in that sconstant first co- conditional set of the set of the set of the refinate plane at right in that sconstant first co- conditional set of the set of the set of the set of the refinate plane at right in that sconstant first co- co-d, 6) and (0, 0).	gies rorld data that describ conclusions about the Quadratic Constant second differences (x-values evenly spaced). es 1–2. esented by Graph A? raw about the data set stant second difference sented by Graph B? w about the data set fa ant first difference spaced x-value , sketch the graph atios between y-values , sketch the graph of lifferences and includ	es the relationship. function. Exponential Constant ratios between y-values (x-values evenly spaced).	Square Root Constant second differences between x-values (y-values eventy spaced).