Discovering Degrees Student Worksheet **TEACHER EDITION WITH SAMPLE RESPONSES**

Definition of Degree: The highest power of one term in a polynomial function (or the sum of all the exponents in any one term). The degree of a function determines the shape of the graph.

Definition of Constant: A term with a fixed value. It can be represented by a number or a letter that stands as a fixed number. If it is not a constant, it is called a *variable*.

Degree	Standard Form	# of Terms	Equation Name	Graph Description	Graph Name
0 Degree	y= a	1	Constant	Horizontal Line	Horizontal Line
1st Degree	Y= ax+b	2	Linear	Line	Line
2nd Degree	$Y= ax^2+bx+c$	3	Quadratic	U shape	Parabola
3rd Degree	$Y= ax^3+bx^2+cx+d$	4	Cubic	"Squiggly"	"S-Curve"/Cubic Parabola
4th Degree	$Y= ax^4+bx^3+cx^2+dx+e$	5	Quartic	Answers will vary (similar to U-shape when only 1st term) Maximum of 3 turning points	Answers will vary (similar to parabola when only 1st term)
5th Degree	$Y= ax^5+bx^4+cx^3+dx^2+ex+f$	6	Quintic	Answers will vary (similar to "squiggly" shape when only 1st term) Max of 4 turning points	Answers will vary (similar to s-curve/cubic parabola when only 1st term)
6th Degree	$Y=ax^6+bx^5+cx^4+dx^3+ex^2+fx+g$	7	6th Degree	Answers will vary (similar to U-shape	Answers will vary (similar to parabola

				when only 1st term) Max of 5 turning points	when only 1st term)
7th Degree	$Y=ax^7+bx^6+cx^5+dx^4+ex^3+fx^2+gx+h$	8	7th Degree	Answers will vary (similar to U-shape when only 1st term) Max of 6 turning points	Answers will vary (similar to parabola when only 1st term)
Generalization for nth degree	$Y=ax^n+bx^{n-1}+cx^{n-2}+dx^{n-3}+dx^{n-4}+$……..constant	n +1		More turning points with higher degrees and # of terms Maximum turning points = n-1	Works for one term: even= parabola-like and odd=cubic parabola-like More terms=turning points can't be more than n-1

Problem 2 Questions (0 degree):

1. What type of line do you have on the graph? Is it parallel/perpendicular to anything?
   Horizontal Line; parallel to x-axis and perpendicular to the y-axis
2. What do you notice about the graph when you change the values of the constant?
   The line shifts up and/or down.
3. What happens when your constant is a negative? Positive? Where is the line?
   Negative is below the x-axis and a positive value is above
4. Can you graph a vertical line? If so, how? It not, why?
   No you cannot because you would need to enter a function in the form of x=____

Problem 3 Question (1st degree):

1. What do you notice about the "a" value when you rotate the graph?
   The value changes as the slope of the graph changes.

2. When is the "a" value negative? Positive? Zero?

When the graph slants to the left the "a" value is negative. A positive "a" value slants the graph to the right. "a" cannot be zero on the graph but it would be a vertical line because that is when the graph "jumps" across to the other side.

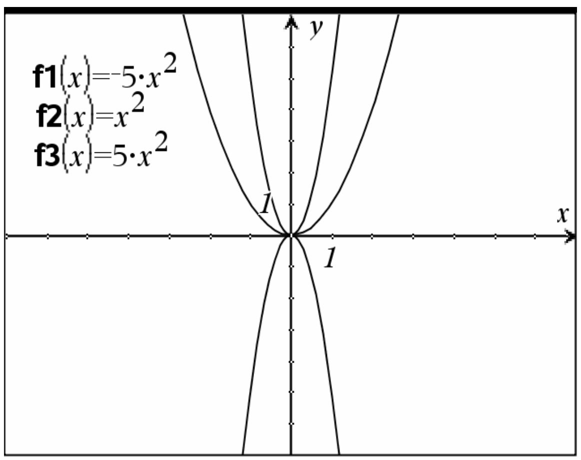
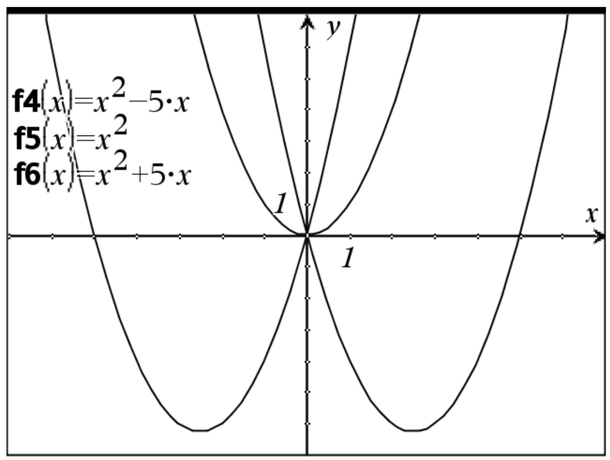
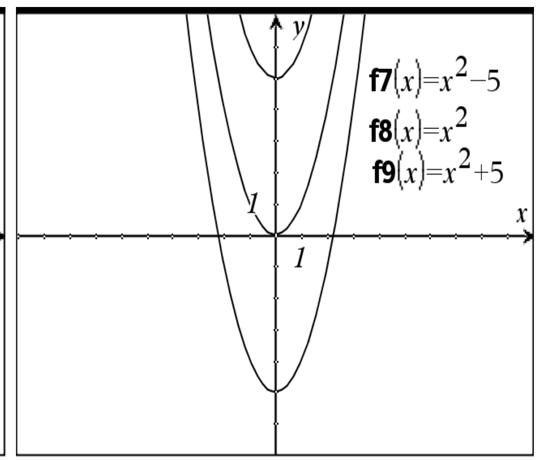
3. What do you notice about the "b" value when you drag and move the graph?

The "b" value changes when I move the graph up and down.

4. When is the "b" value negative? Positive? Zero?

"b" is negative when the graph hits the y-axis above the origin. The "b" value is negative when it hits below the origin. It is zero when the graph crosses the origin.

Problem 4 (2nd degree): Graph 1: BLUE Graph 2: RED Graph 3: GREEN

Page 4.1 (change "a" value)	Page 4.2 (change "b" value)	Page 4.3 (change "c" value)
		

Problem 4 Questions:

1. What do you notice on Page 4.1 when you change the value of "a"? How does a positive value differ from a negative value? Can "a" be zero? TRY THIS ON YOUR HANDHELD.

The graph gets wider or narrower. A bigger value makes the graph skinnier and as the value approaches zero (smaller fractions) the graph gets closer to being flat and on the x-axis. The graph opens *up with a positive value and down with a negative value. "A" cannot be zero as the equation will no longer be quadratic as the "x^2" term would be gone.*

2. What do you notice on Page 4.2 when you change the value of "b"? How does a positive value differ from a negative value? What happens with "b" is zero?

The graph moves right/left depending on the value of "b." A positive value moves the graph to the LEFT and a negative value moves the graph to the RIGHT. A zero value makes the bottom point (minimum) hit the origin (if c is zero) or the y-axis (if c is a value other than 0).

3. What do you notice on Page 4.3 when you change the value of "c"? How does a positive value differ from a negative value? What happens with "c" is zero?

"c" represents where the parabola will cross the y-axis. The graph moves up/down depending on the value of "c." A positive value moves the graph UP and a negative value moves the graph to the DOWN. A zero value for "c" makes the bottom of the graph (minimum) sit on the origin (if b is zero also). If "c" is zero and "b" is an integer than the graph will move right/left but the graph will cross the y-axis on the value of "c."

Problem 5 Questions (3rd degree):

1. What shape is the graph of a 3rd degree equation? Give it a name of your own choice.

Answers will vary.

2. The value for "d" is zero in the equation on Page 5.1 (d is the constant at the end). Predict what will happen if you add a value for "d". Did your prediction hold up? What happens when "d" is positive? Negative?

Predictions will vary. When "d" is added, the s-curve moves up or down on the y-axis. A negative value moves the graph down and a positive value moves it up.

Problem 6 Questions (exploring higher degrees):

1. What shape is the graph of a 4th degree equation (enter only first term x^4)? 5th degree (x^5)? 6th degree (x^6)? 7th degree (x^7)?

   If students ONLY enter first terms (x^4, x^5, x^6, x^7, etc.) then these generalizations hold true: *4th is a parabola, 5th is an s-curve, 6th is a parabola, 7th is an s-curve, etc. Students can enter more terms and try to find other generalizations such as there can only be a maximum of n-1 turning points.*

2. What pattern do you see? Explain how to describe the graph of a 100th degree equation.

   Even degrees are parabolas while odd degrees are s-curves. A 100th degree equation is even so the graph would be a parabola.

Problem 8-Extensions/Homework:

1. Find creative names for each graph so that it will be easier to remember the type by degree. Explain your naming method.
2. What would the graph of a 10,576,201th degree equation look like? Explain your reasoning.
3. Share 3 things you learned today.