**Activity 4.1.2 – Evaluating and Graphing** $f\left(x\right)=kx^{-n}$**for *n* a**

**Natural Number**

**Indirect Variation**: If the product of two variables equals a constant the variables are *indirectly related*. Variables *x* and *y* are indirectly related if they satisfy the equation $xy=k$ for some constant *k*. When we solve for *y*, we get $y=\frac{k}{x}$ or $y=kx^{-1}$.

To investigate the effect *k* has on the graph of $y=kx^{-1}$ we will use the graphing calculator and the *Transform* application.

Follow the steps below:

* Press APPS and choose Transfrm.
* In Y1 enter $AX^{-1}$.
* Set the window to the ZStandard by pressing ZOOM 6
* Press WINDOW and key cursor over to SETTINGS: Set A = 3 and Step = 1.
* Press Graph
* Use the left and right arrow keys to investigate how the change in A affects the graph.
1. When A is positive what quadrants will the graph appear?
2. When A is negative what quadrants will the graph appear?
3. As $\left|x\right|$ increases what happens to *y*?
4. As$ \left|x\right|$ decreases what happens to *y*?
5. What happens when *k* = 0?
6. Does this graph model an inverse (indirect) variation graph? Why or why not?
7. Fill in the tables using the table feature.

 A = 3 A = -20 A = 30

|  |  |
| --- | --- |
| *x* | *y* |
| -1 |  |
|  -.5 |  |
| 0 |  |
| .5 |  |
| 1 |  |

|  |  |
| --- | --- |
| *x* | *y* |
| -1 |  |
| -.5 |  |
| 0 |  |
| .5 |  |
| 1 |  |

|  |  |
| --- | --- |
| *x* | *y* |
| -1 |  |
| -.5 |  |
| 0 |  |
| .5 |  |
| 1 |  |

Let’s continue to investigate how increasing the absolute value of A – increasing $\left|A\right|$ – affects the graph of $Y=AX^{-1}$.

1. Sketch the graph of $Y=AX^{-1}$.
2. When A is positive: b) When A is negative:

Next, we will investigate how the value of *n* affects the graph of $y=kx^{-n}$.

* In Y1 enter $AX^{-B}$
* Set the window to the ZStandard by pressing ZOOM 6
* Press WINDOW and cursor over to SETTINGS: Set A = 3, B = 1 Step = 1.
* Press Graph
* Use the right arrow key to investigate how the change in B affects the graph (B is even and odd.)
1. What do you notice?
2. Next Set B to 4 and use the left and right arrow keys to see what happens when A is positive and when A is negative. What do you notice?
3. Set B to 5 and use the left and right arrow keys to see what happens when A is positive and when A is negative. What do you notice?
4. Let’s summarize using the equation of the form$ y=kx^{-n}$. In the graphing calculator we substituted A for *k* and B for *n*.
5. If *n* is even and *k* is positive what quadrants will the graph appear?
6. If *n* is odd and *k* is positive what quadrants will the graph appear?
7. If *n* is even and *k* is negative what quadrants will the graph appear?
8. If *n* is odd and *k* is negative what quadrants will the graph appear?
9. As $\left|x\right|$ increases what happens to *y*?
10. As$ \left|x\right|$ decreases what happens to *y*?
11. What happens if *n* = 0?
12. What type of graph do you have?
13. Sketch the graph of $y=kx^{-n}$ when:
14. *k* is positive and *n* is odd: b) *k* is negative and *n* is odd:

 

1. *k* is positive and *n* is even: b) *k* is negative and *n* is even

 

1. Use your calculator to sketch the following graphs. Make sure you uninstall the Transfrm app prior to graphing the functions.

|  |  |  |
| --- | --- | --- |
| a) $y=4x$Domain: Range: End behavior: | b) $y=4x^{2}$Domain: Range: End behavior:  | c) $y=\frac{4}{x}$Domain: Range: End behavior: |

|  |  |  |
| --- | --- | --- |
| d) $y=4x^{-2}$Domain: Range: End behavior: | e) $y=\frac{1}{4}x^{2}$Domain: Range: End behavior:  | f) $y=x^{3}+5x$Domain: Range: End behavior: |

**Review Problems**

Simplify the following expressions containing negative exponents. Express the final result using only positive exponents.

1. $x^{2 }∙ x^{-7}$ 2. $\frac{5x^{6}y^{-4}}{30x^{-4}y^{5}}$ 3. $(5x^{-2}y^{3})(2x^{5}y^{8})$

4. $\frac{x^{-5}}{x^{-7}}$ 5. $x^{-3} ∙ x^{5} ∙x$ 6. $\frac{-4x^{4}y^{-2}}{5x^{-1}y^{4}}$

7.$ (3a^{-5}b^{-8})(2a^{2}b^{-3})$ 8. $(5x^{-2}y^{-3})(3x^{-4}y)$ 9. $\frac{-6x^{-3}y^{5}z^{8}}{24x^{-5}y^{6}z^{-3}}$