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|  In this activity you will discover the graphical connection between $y=f\left(x\right) $and the functions of the form:* $y=f\left(x\right)+c$, *c* is a constant
* $y=f(x-d)$, *d* is a constant
* $y=af\left(x\right), a$ is a constant and a > 0
* $y=f\left(kx\right), k$ is a constant and k > 0
* $y=-f\left(x\right)$
* $y=f\left(-x\right)$
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**Investigation: Type** $y=f\left(x\right)+c $

1. a. Sketch the graph of $f\left(x\right)=x^{2}$

 b. On the same set of axes sketch the graphs of

* $y=x^{2}+2$
* $y=x^{2}-3$

 c. If $y=f\left(x\right)$ is transformed to $y=f\left(x\right)+c$, where *c* is a constant, describe the transformation:

* if c > 0, then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* if c < 0, then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Any point (x, y) under this transformation becomes ( , )

2. Using the pattern you discovered in 1c, sketch $y=f\left(x\right), y=f\left(x\right)+2, and y=f\left(x\right)-2 $on the same set of axes for each of the following functions:

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| a. $f\left(x\right)=\left|x\right|$ | b. $f\left(x\right)=\sqrt{x}$ |
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**Investigation: Type** $y=f(x-d)$

1. a. Sketch the graph of $f\left(x\right)=x^{2}$

 b. On the same set of axes sketch the graphs of

* $y=(x-3)^{2}$
* $y=(x+3)^{2}$

 c. If $y=f\left(x\right)$ is transformed to $y=f\left(x-d\right)$, where *d* is a constant, describe the transformation:

* if d > 0, then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* if d < 0, then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Any point (x, y) under this transformation becomes ( , )

2. Using the pattern you discovered in 1c, sketch $y=f\left(x\right), y=f\left(x-2\right), and y=f\left(x+2\right) $on the same set of axes for each of the following functions:

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| a. $f\left(x\right)=\frac{1}{x}$ | b. $f\left(x\right)=x^{3}$ |
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**Try**. State the transformations for: $y=(x+3)^{2}-2$

**COMMUNICATION**

When a function is translated, we use key words such as translate (shift), units, up or down.

For example, $y=(x-2)^{2}+1$ the parent function has been shifted 2 units right and 1 unit up.

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**Horizontal & Vertical Translation Practice**

1. Each of the following graphs show a shift of the function *f*  that has formula $f\left(x\right)=x^{2}$.

Describe the shifts involved to obtain the function *g.*

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2. Consider the graph of *f* given in **Figures 2 to 7.** For the shifts given underneath the figures, **state** if they represent a horizontal or a vertical shift, and then sketch this shift on the axis provided.

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**SUMMARY**

In general, if *f* is a function and c is constant, then the graph of

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| $y=f\left(x\right)+c $is the graph of $y=f\left(x\right)$ shifted- **vertically** upwards if c > 0- **vertically** downwards if c < 0.*This is called an OUTSIDE CHANGE* | $y=f\left(x-h\right)$is the graph of $y=f\left(x\right)$ shifted*-* **horizontally** to the left if h > 0*-* **horizontally** to the right if h < 0*This is called an INSIDE CHANGE* |