Names: _____

With your partner(s), read through the instructions and do the activities described. Write your results and/or answers on this worksheet. Discuss your questions, ideas, and findings with each other. Only one report should be submitted from each group. This report is due Monday.

1. **Functions in *Mathematica***: Evaluate the *Mathematica* commands below. You do not need to record the outputs by hand on this worksheet; instead, print off a copy of your *Mathematica* notebook when you are done and attach it to your lab report.

   (a) To define the function $f(x) = x^2 - 5x + 3$, evaluate

   ```
   f[x_] := x^2 - 5*x + 3
   ```

   (b) To see the mathematical expression for $f(x)$, evaluate

   ```
   f[x]
   ```

   (c) To see the mathematical expression for $f(x)$ in traditional form, evaluate

   ```
   TraditionalForm[f[x]]
   ```

   (d) To find the value of $f(-3)$, evaluate

   ```
   f[-3]
   ```

   (e) To see the mathematical expression for $|f(x)|$ in traditional form, evaluate

   ```
   TraditionalForm[Abs[f[x]]]
   ```

   (f) To see the mathematical expression for $f(x-2)$, evaluate

   ```
   f[x-2]
   ```

   (g) To see the mathematical expression for $f(x-2)$ in traditional form, evaluate

   ```
   TraditionalForm[f[x-2]]
   ```

   (h) To expand the expression for of $f(x-2)$, evaluate

   ```
   Expand[f[x-2]]
   ```

   (i) To graph $f(x)$ on the domain $[-2, 8]$, evaluate

   ```
   Plot[f[x], {x, -2, 8}]
   ```

   (j) To define a second function $g(x) = \frac{1}{x+2}$, evaluate

   ```
   g[x_] := 1/(x+2)
   ```

   (k) To define the composition $h = f \circ g$, evaluate

   ```
   h[x_] := f[g[x]]
   ```

   (l) To see the expression for $h(x)$ in traditional form, evaluate

   ```
   TraditionalForm[h[x]]
   ```

   (m) To find the value of $h(1)$, evaluate

   ```
   h[1]
   ```

   (n) To graph $h(x)$ on the domain $[-4, 4]$, evaluate

   ```
   Plot[h[x], {x, -4, 4}]
   ```

   (o) To restrict the y-range to $[-2, 3]$ and add axes labels, evaluate

   ```
   Plot[h[x], {x, -4, 4}, PlotRange -> {2, 3}, AxesLabel -> {x,y}]
   ```

   (p) To graph the parametric equations $x = t^2 - 4t$ and $y = 4\sqrt{t+1}$ for $t \in [-1, 5]$, evaluate

   ```
   ParametricPlot[{t^2 - 4t, 4*Sqrt[t+1]}, {t, -1, 5}]
   ```

2. **Operations on functions** Define and plot the following functions in *Mathematica*. (You do not need to sketch their graphs by hand.) What is the domain and range of each?

$$f(x) = \frac{1}{x-5} \qquad g(x) = \sqrt{x+4}$$

For each of the following functions, (i) state the domain, (ii) state the range, and (iii) sketch a complete graph.

(a) $p(x) = f(x) + g(x)$

(b) $q(x) = \dfrac{f(x)}{g(x)}$

(c) $r(x) = f(g(x))$

3. **Parametric Equations** For each pair of parametric equations, (i) determine the values of t for which the equations are defined, (ii) sketch a complete graph of the relationship between x and y, (iii) state with an explanation whether y is a function of x, and (iv) state with explanation whether x is a function of y.

   Note: It is up to you to determine what range of t-values to have *Mathematica* plot. Try experimenting with different ranges to see how that effects the graph. Also, you may want to use the `PlotRange` option to change your viewing rectangle.

   (a) $x = t^3 - t^2 + 3$ and $y = t$

   (b) $x = |t + 3|$ and $y = 1/t$

   (c) $x = \sqrt{2 - t}$ and $y = \sqrt{t + 4}$

4. **Quadratic functions using transformations**

   (a) Use *Mathematica* to find the graph of $y = -2(x-1)^2 + 3$. Describe carefully (in words and with sketches) how this graph is related to the graph of x^2.

   (b) Use *Mathematica* to find the graph of $y = x^2 - 6x + 7$. Describe carefully (in words and with sketches) how this graph is related to the graph of x^2.

   (c) Think carefully about what you observed above in parts (a) and (b). Can you use your graph and answer to part (b) to express $y = x^2 - 6x + 7$ in the form $a(x-h)^2 + k$? (Try to answer this first *without* completing the square, but then you may complete the square to verify your answer.)

Remember to include a print-off of your *Mathematica* work for Problem 1. Staple it!