1. Read each of the following descriptions. For each, indicate whether it is describing a *derivative* or an *integral*. Re-write the description as an equation using mathematical notation.

   (a) The probability that a standard Normal variable is between -1 and 1 is the *area* under the curve $\frac{1}{\sqrt{2\pi}}e^{\frac{-x^2}{2}}$ within that range, which is roughly 0.683.

   (b) An object's height position at time t is $y = t^3 + 5t - 7$. It's velocity is the function describing how that position is *changing*, in this case $3t^2 + 5$.

   (c) The total revenue for some company given the number of items they are producing (x) is known to be $-x^3 + 450x^2 + 52,500x$. Economists describe the *marginal revenue* as the *change* in total revenue, in this case $-3t^2 + 900t + 52,500$.

   (d) The force between two charged particles is proportional to the product of the charge values and inversely proportional to the square of their distances: $f(r) = \frac{kq_1q_2}{r^2}$, where r is the distance in meters, q_1 and q_2 are the charge of the first and second particle in coulombs, and k is a constant. We can compute the *work* done by the particles movements as a result of their charges by calculating the *area* under the force curve with respect to the distance.

2. Use Wolfram Alpha to compute the following.

   (a) `derivative x^2 - 2x + 3`
   (b) `integrate y^3 - 9`
   (c) `integrate 3w^2 + 2w - 9`
   (d) `derivative x sin(x^2)`

3. Evaluate the following by hand.

   (a) $\frac{d}{dx}\left(x^2 - 3x + 2\right)$
   (b) $\frac{d}{dx}\left(-9x^2 - x\right)$
   (c) $\frac{d}{dw}(w - 4)$
   (d) $\frac{d}{dx}(-3.41)$

4. Evaluate the following by hand.

   (a) $\int 2x\,dx$
   (b) $\int \left(-3y^2 + 2y - 1\right)\,dy$
   (c) $\int_0^1 -w^2\,dw$
   (d) $\int_{\frac{1}{2}}^3 4\,dx$

5. Evaluate the following by hand.

   (a) $\lim_{x\to 2}\left(x^2 - 4\right)$
   (b) $\lim_{y\to 1}\frac{y^2-2y+1}{y^3-y}$
   (c) $\lim_{w\to 2}\frac{w+1}{w-1}$
   (d) $\lim_{x\to\infty}\frac{x^2-1}{2x^2+1}$

6. What is the *order* of the following derivatives?
   (a) $f^4(x) = x^2 - 3x + 2$
   (b) $f'''(y) = \sin(y) + 3$
   (c) $\frac{d}{dx}\left(\frac{d}{dx}x^3\right)$
   (d) $\ddot{y} = -gt$

7. Evaluate the following by hand.
   (a) $\frac{d}{dz}\left(3z^3 + 2z^2 - 3z - 1\right)$
   (b) $\frac{d}{dx}x^4$
   (c) $\frac{d}{dw}\left(w^2 - 2w + 4\right)$
   (d) $\frac{d}{dy}\left(y^5 - 2y\right)$
   (e) $\frac{d}{dr}\left(2r^3 + 9\right)$
   (f) $\frac{d}{dy}\frac{1}{y}$

8. Evaluate the following by hand.
   (a) $\int z^2\, dz$
   (b) $\int_1^5 \left(2y^3 + y^2 + 1\right)\, dy$
   (c) $\int_1^5 \left(-x^4 - x^2 - 1\right)\, dx$
   (d) $\int \frac{1}{w}\, dw$
   (e) $\int_{-1}^{1} \left(x^4 - 2x\right)\, dx$
   (f) $\int \left(\frac{1}{3}w^2 + \frac{1}{2}w\right)\, dw$

9. Identify the type and order of the following differential equations.
   (a) $\dot{x} + x = t^2$
   (b) $y'' - 2y' + y = 0$
   (c) $\frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial x^2} = 0$
   (d) $\frac{du}{dx} = 2u + x^2$

10. The the initial value problem for the following ODEs:
    (a) $\frac{dy}{dx} = 10 - x, \quad y(0) = -1$
    (b) $y' = 6t^2, \quad y(1) = 5$
    (c) $\dot{w} = y^2 - 3y + 1, \quad w(0) = 10$

11. Sketch the directional field for the following ODE, including isoclines and at least one integral curve.

$$y' = x - y$$

12. Objects accelerate downwards due to gravity at -9.8 $meters/second^2$. Acceleration on an object is simply it's *change* in velocity, and velocity is simply it's *change* in position. Let v_0 be the initial velocity of the object and s_0 be the initial height of the object. Knowing gravity is acceleration allows us to write a very simple ODE for motion: $s''(t) = -9.8, \quad s'(0) = v_0, \quad s(0) = s_0$. Solve this to find the general equation for position given time. *Hint: You will need to do this in two stages, first to get velocity then to get position.*