# Math 110, Spring 2015

MML homework due SUN 15 March 11:59PM
Written exercises due MON 16 March in class

Read Section 9.1 of the textbook and Unit 8 of the coursepack. The reading is very important this week because there is a lot of conceptual explanation there and relatively little MML homework. After doing the reading and the MML, please read the steps below and then try the two self-check problems. These will be checked for completion as part of your MML grade for this week.

MML homework: Section 9.1 # 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
MML homework: Section 5.4 # 45, 50, 47, 39, 41

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## Steps to writing a differential equaiton

You can often translate a sentence, bit by bit, directly from English to math. "And" often means "+"; "difference" usually means "−", and so on. As an examle, consider the sentence "the velocity of a falling object is proportional to the time it has been falling." Suppose $s(t)$ is the position after time $t$. Applying these rules,

- the velocity of a falling object $\longrightarrow$ $ds/dt$;
- is proportional to $\longrightarrow$ $= k\cdot$ ;
- the time it has been falling $\longrightarrow$ $t$;

giving us $ds/dt = k \cdot t$, which is the equation for the situation. We still have to specify that $t$ is in units of time, $s$ is position, and $k$ is a constant of proportionality measured in units of distance per squared time. For example, if $s$ is in feet and $t$ is in seconds, then the gravitational constant $k$ will be in meters per second squared (in fact it is roughly 32 in these units).

Notice that in the above example we named $s(t)$ (height) **before** we named $s'(t)$, our derivative. This trick often helps when translating real-world situations into symbols. On the problems below, perform the following steps for each situation.

(a) Identify the independent variable (in the examples below, it will always be "$t =$ time"; but you should figure out/decide/make up what units we use to measure $t$.)

(b) Identify the quantity we could measure directly and give it a variable name (like $s =$ height in feet), including units of measurement you might use.

(c) Make sure the rate that the problem describes is really measured by dividing those two quantities. Is velocity really measured in feet/second? *Sure!* So we're on the right track using $s'(t)$ or $ds/dt$ as our rate.

(d) Write a differential equation.

Those three steps seem trivial, but they're really the steps that trip up most students when they encounter these problems on an exam or later in another course or in

real life. So slow down and make sure you get them right. Use the steps above to translate each of the following sentences into differential equations. Define your variables, including units. Also explain whether the constant of proportionality, is positive or negative.

## Self-check problems

1. The rate at which the temperature of my coffee changes is proportional to the difference between the current temperature of my coffee and room temperature (70° F).

   (a) $t$ = time measured how? _____

   (b) Variable/Name/Units for a quantity we could measure directly:
   $T$ = measured in _____

   (c) derivative mentioned in the problem: $d$_____

   (d) differential equation:

2. The deceleration due to air resistance of an object traveling horizontally is proportional to the square of its velocity. For the dependent variable, you could choose any of a number of things: position, velocity, acceleration. One of these choices makes it possible to write a first order differential equation. See if you can choose that one and write the equation.

   (a) $t$ = time measured how? _____

   (b) Variable/Name/Units for a quantity we could measure directly:

   (c) derivative mentioned in the problem:

   (d) differential equation: