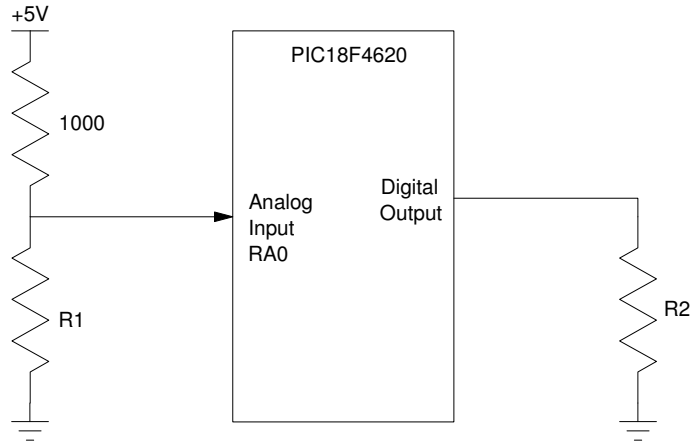
ECE 376 - Homework #1

PIC Background. Due Wednesday, January 22nd

	Answer
1) A PIC processor can drive up to 25mA on its I/O pins. Assuming the output is 5V, what is the smallest R2 can be?	5V / 25mA = 200 **200 Ohms**
2) The PIC processor we're using can measure time to 100ns. Assume you're generating the note C3 (220Hz). What's the smallest change in frequency a PIC can generate at 220Hz? (i.e. if you add 100ns to the period)?	**0.009679Hz**
3) The PIC can measure time to 100ns (one clock). How many clocks go by from the time a pitcher throws a 100mph fast ball to the time it crosses the plate 90 feet away?	**6,136,364 clocks**
4) The A/D on a PIC is a 10-bit A/D (meaning you can read 0..5V with a resolution of one part in 1023 (4.88mV). Suppose you use your PIC to measure resistance using a voltage divider shown below. If R1 is 750 Ohms, what is the resolution of the ohm-meter in Ohms? (hint: the resolution is 4.88mV. Convert this to Ohms)	**2.599 Ohms**
5) If R1 is a temperature sensor (in your kit) with $R \approx 1000 \cdot \exp\left(\frac{3903}{T} - \frac{3903}{298}\right)$ What temperature corresponds to 750 Ohms? What is the resolution of this temperature sensor in degrees C?	**T = 304.69K** **dT = 0.0947K**



1) A PIC processor can drive up to 25mA on its I/O pins. Assuming the output is 5V, what is the smallest R2 can be?

$$R = \left(\frac{5V}{25mA}\right) = 200\Omega$$

If you want to drive an 8 Ohm speaker with a PIC processor, add a 200 Ohm resistor in series.

2) The PIC processor we're using can measure time to 100ns. Assume you're generating the note C3 (220Hz). What's the smallest change in frequency a PIC can generate at 220Hz? (i.e. if you add 100ns to the period)?

The width of 1/2 cycle (toggle twice every cycle) is

$$t_1 = \left(\frac{1}{2 \cdot 220Hz}\right) = 2.272727ms$$

The smallest amount of time you can add is 1 clock (100ns).

$$t_2 = t_1 + 100ns = 2.272827ms$$

This corresponds to a frequency of

$$Hz = \frac{1}{2 \cdot t_2} = 219.9903Hz$$

for a change in frequency of

$$\delta Hz = 0.009679Hz$$

3) The PIC can measure time to 100ns (one clock). How many clocks go by from the time a pitcher throws a 100mph fast ball to the time it crosses the plate 90 feet away?

90ft = 27.432 m

100mph = 44.704 m/s

$$t = \left(\frac{27.432m}{44.604m/s}\right) = 0.613636s$$

$$clocks = (0.613636s)\left(\frac{10{,}000{,}000clocks}{s}\right) = 6,136,364$$

A PIC can execute 6,136,364 clocks by the time a baseball crosses the plate.

4) The A/D on a PIC is a 10-bit A/D (meaning you can read 0..5V with a resolution of one part in 2014 (4.88mV).

Suppose you use your PIC to measure resistance using a voltage divider shown below. If R1 is 750 Ohms, what is the resolution of the ohm-meter in Ohms? (hint: the resolution is 4.88mV. Convert this to Ohms)

$$V_1 = \left(\frac{750}{750+1000}\right)5V = 2.1429V$$

The smallest change in voltage you can measure is 4.88mV

$$V_2 = V_1 + 0.00488$$

This corresponds to a resistance of

$$R_2 = \left(\frac{V_2}{5-V_2}\right)1000 = 752.9941\Omega$$

The smallest change in resistance you can measure is 2.599 Ohms

5) 750 Ohms corresponds to

$$R \approx 1000 \cdot \exp\left(\frac{3903}{T} - \frac{3903}{298}\right)$$

$$T = 304.6926K$$

752.599 Ohms corresponds to

$$T = 305.5978K$$

The difference is 0.0947K

With this circuit, a PIC can measure a temperature difference of 0.0947K