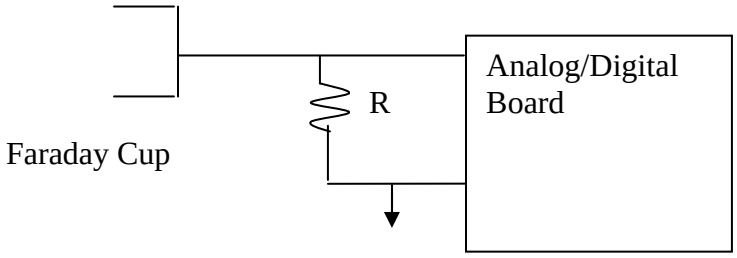
CHEMISTRY 133
Quiz 2 – SOLUTIONS

In the circuit shown below, a Faraday cup in a flame ionization detector (FID) is used to measure the current positive ions produced in the flame as they hit the cup. The A/D board shown in the circuit diagram is used to record the voltage drop across the resistor with resistance 135,000 Ω so that the Faraday cup current can be calculated. When the FID is used for detection of hydrocarbons, the current is proportional to moles carbon reaching the FID per second. The A/D board has 10 bits with a range of 0 to 1.000 V.
Answer the following questions below:



When 5.0 nmol/s reaches the FID, the average binary number recorded by the A/D board is: 1001001110.
For an A/D board with n bits, the following equation can be used:

$$decimal\ No. = \frac{(V - V_{min})2^n}{(V_{max} - V_{min})}$$

a) What is the decimal number corresponding to?
512 + 0·256 + 0·128 + 64 + 0·32 + 0·16 + 8 + 4 + 2 + 0·1 = ***590***

b) What voltage corresponds to A/D reading?
decimal # = 590 = (V – 0)·2^{10}/(1.000 V – 0 V) or V = (590)(1.000 V)/1024 = ***0.576 V***

c) What is the current coming from the Faraday cup? (assume zero current to A/D board)
I = V/R = 0.576 V/135,000 = ***4.27 x 10^{-6} A***

Bonus) Give the maximum detectable flux (in nmol/s).
Flux = F is proportional to current and current is proportional to measured voltage (since V = IR and R is constant). Thus F = kV or F_{max}/F = V_{max}/V
F_{max} = (V_{max}/V)F = (1.000 V/0.576 V)(5.0 nmol/s) = ***8.7 nmol/s***