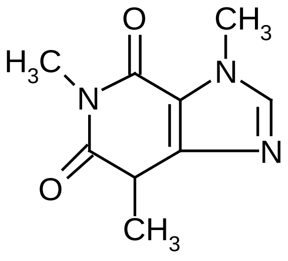
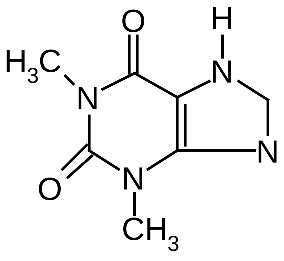
CHEMISTRY 447 WINTER, 2001

1. (10) An energetic Chemistry 448 student decided to undertake a rather difficult special project so that he (or she) could improve his/her overall grade in the course. The project involved the direct determination of caffeine in an ice tea mix by high performance reverse phase liquid chromatography. The detector used was a flow-through UV-VIS absorbance type set at 254 nm. Since the student observed that the HPLC system was not maintaining a perfectly constant flow rate over the course of a single day's experiments, he/she decided to use an internal standard method. The internal standard chosen was theophylline whose structure is shown below along with caffeine. In preliminary experiments it was determined that theophylline eluted with a retention time approximately 2 minutes less than caffeine using a given mobile phase. Initial injection of a standard solution containing 20 μg/ml of both caffeine and theophylline yielded peak absorbances of 0.15 and 0.10, respectively, with retention times of 8 and 6 minutes each. Subsequent injection of a tea sample prepared by dissolving 100 g of ice tea mix in 100 ml of H_2O, and by spiking this sample to contain 25 μg/ml theophylline, yielded peak absorbances of 0.21 for caffeine and 0.11 for theophylline. Based on this information, a) calculate the concentration of caffeine in mg/ml in the 100 ml sample and b) calculate the concentration, in ppm (parts per million), of caffeine in the solid ice tea mix.



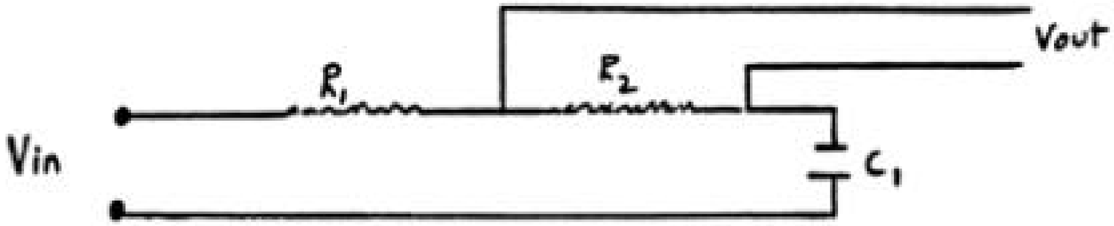
Caffeine



Theophylline

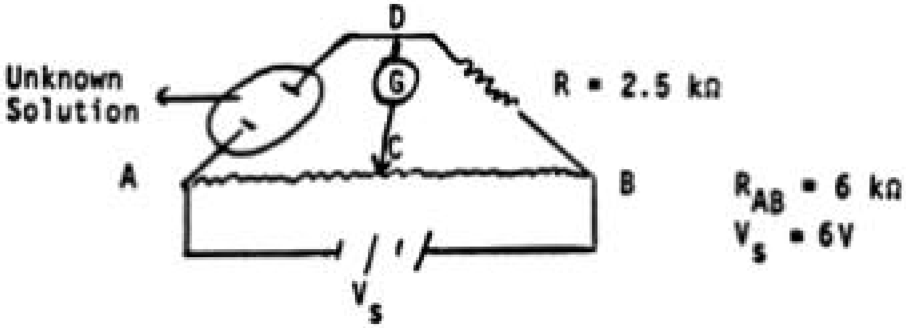
2. (10) Explicitly explain the difference between performing an analytical recovery study and using a standard addition analytical technique.

3. (10) For the following circuit, sketch the ratio of output voltage to input voltage as a function of the frequency of the input voltage, where Vin = 1.0 volts.



Make sure you label your axes carefully and quantitatively (R_1 = 10kΩ , R_2 = 10kΩ , C_1 = 10 μf). What type of filter is this?

4. The following circuit was used to determine the conductance of an unknown solution:



a. (5) If AB is a linear slidewire type resistor and zero current flows through the galvanometer when C is moved to a position 1/4 of the way between A and B, then what is the conductance of the unknown solution?

b. (5) Assuming that the galvanometer was removed after achieving the null point position, what would be the potential measured across resistor DB if the meter used to measure this potential had an input impedance of 10 kΩ and the same solution remained as resistor AD?

5. (5) Plot the output intensity vs. wavelength for a H_2 - Lamp source.

6. (5) If you could use a high intensity continuous laser source in UV-Vis absorption spectrophotometry, would it improve the detection limits of the method? Explain.

7. (7) What is Folgett's advantage?