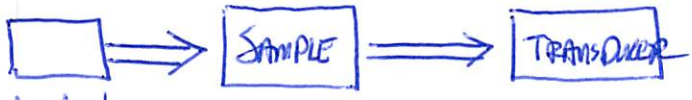
Name Answer Key

Quiz 1 (10 pts)
CEM 434
Fall 2016

1 (2 pts). Show the basic design of an instrument used for a chemical measurement.



Perturbation Source (heat, λ, etc.)

Source → Sample holder/Sample → Transducer

2 (4 pts). What is the definition of the *sensitivity* and *linear dynamic range* of a measurement? How is the sensitivity related to the minimum concentration detectable, C_{min}?

Sensitivity is the slope of the response curve. $m = \Delta \text{Signal}/\Delta \text{Conc.}$

LDR = range of concentration over which a predictable, linear response is observed.

$y_{min} = y_{blank} + 3s$ $\quad s$ = std dev of background/noise

$C_{min} = \frac{y_{min} - y_{blank}}{m} = \frac{3s}{m}$

3 (4 pts). A 25.0 mL sample containing vitamin C gave an instrument signal of 23.6 units (corrected for the blank). When exactly 0.500 mL of 0.0287 M vitamin C was added to the solution, the signal increased to 37.9 units. Calculate the molar concentration of vitamin C assuming the signal was directly proportional to the analyte concentration.

Standard addition problem

25.0 mL of Vit. C ⇒ 23.6 units (solution)

0.500 mL of 0.0287 M Vit C + solution ⇒ 37.9 units

$I_x = 23.6$ units $\quad I_{x+s} = 37.9$ units

$[x]_f = [x]_i \left(\frac{V_0}{V}\right) \quad [S]_f = [S]_i \left(\frac{V_s}{V}\right)$

V = Total Volume

$\frac{I_x}{I_{s+x}} = \frac{[x]_i}{[x]_f + [S]_f}$

$[S]_f = (0.0287\,M)\left(\frac{0.500\,mL}{25.5\,mL}\right) = 5.63\times10^{-4}\,M$

$[x]_f = [x]_i \left(\frac{25.0\,mL}{25.5\,mL}\right) = [x]_i \cdot 0.981$

$\frac{23.6}{37.9} = \frac{[x]_i}{0.981[x]_i + 5.63\times10^{-4}}$

$37.9[x]_i = 23.2[x]_i + 1.32\times10^{-2}\,M$

$[x]_i = 9.04\times10^{-4}\,M$