CH 660 Spring 2007

Problem set 1 (due on Friday April 27)

Problem 1 (2 pt).
To investigate the reproducibility of a method for the determination of selenium in foods, nine measurements were made on a single batch of brown rice with the following results (microgram/g): 0.07, 0.07, 0.08, 0.07, 0.07, 0.08, 0.08, 0.09, 0.08.
Assuming that there is no systematic errors calculate: (1) mean (2) standard deviation (3) 95% and (4) 90% confidence interval for the concentration.

Mean = 0.077 microgram/kg. Standard deviation = 0.007 microgram/kg.
Degrees of freedom = 8
t (95%, 8) = 2.306, t (95%, 8) = 1.860.
confidence interval (95%) = 0.005
confidence interval (90%) = 0.004

Problem 2 (2 pts).
The results give the concentration of tin recovered from the same product after boiling for different times in an open vessel:

Boiling time (min)	Tin found (mg/kg)
30	57, 57, 55, 56, 56, 55, 56, 55
75	51, 60, 48, 32, 46, 58, 56, 51

Test whether:
(1) the variability of the results is greater for the longer boiling time
(2) the means differ significantly

The means are 55.875 and 50.25 mg/kg and the standard deviations are 0.8345 and 8.828 mg/kg.
(1) $F_{7,7}$ (calculated) = 112. Critical value is 3.79. variability is significantly greater for longer boiling time.
(2) A pooled estimate of variance is not appropriate.

$$t_{calculated} = \frac{\left|\bar{x}_1 - \bar{x}_2\right|}{\sqrt{s_1^2/n_1 + s_2^2/n_2}} = 1.8$$

$$\text{degrees of freedom} = \left\{ \frac{\left(s_1^2/n_1 + s_2^2/n_2\right)^2}{\frac{\left(s_1^2/n_1\right)^2}{n_1+1} + \frac{\left(s_2^2/n_2\right)^2}{n_2+1}} \right\} - 2 = 7$$

Critical value (95%, 7) = 2.365. The means do not differ significantly.

Problem 3 (2 pts)
Problem 2-11 from the textbook

2-11. (a) Electrical power $P = I \times V = 0.25\ A \times 3.0\ V = 0.75\ W$

Radiant power $\Phi = 0.01 \times P = 0.0075\ W$ or 7.5 mW

Photon flux $\Phi_p = 7.5 \times 10^{-3}\ J\ s^{-1}/(hc/\lambda)\ J\ photon^{-1}$

$$= \frac{7.5 \times 10^{-3} \times 550 \times 10^{-9}}{6.634 \times 10^{-34} \times 3.00 \times 10^{8}}\ \frac{photons}{s}$$

$$\Phi_p = 2.07 \times 10^{16}\ photons\ s^{-1}$$

(b) Since the photons are traveling at $3.00 \times 10^{8}\ m\ s^{-1}$ and are emitted into an area of $10\ cm^2$ ($10^{-3}\ m^2$), the volume covered each second is $3 \times 10^{8}\ m\ s^{-1} \times 10^{-3}\ m^2 = 3 \times 10^{5}\ m^3\ s^{-1}$

The flux density is thus $\dfrac{2.07 \times 10^{16}\ photons\ s^{-1}}{3 \times 10^{5}\ m^3\ s^{-1}}$

$= 6.9 \times 10^{10}\ photons\ m^{-3}$

Hence, there are 6.9×10^{10} photons in a cubic meter.

(c) Photon emittance $M_p = \dfrac{7.5 \times 10^{-3}\ W}{10\ cm^2} = 7.5 \times 10^{-4}\ W\ cm^{-2}$

Problem 4 (2 pts)
Problem 3-6 from the textbook

3-6. $W' = b\lambda/W$

$= (1.0\ m \times 488 \times 10^{-9}\ m)/100 \times 10^{-6}\ m = 4.88 \times 10^{-3}\ m$

$= 4.88\ mm$