3.3

$p = 0.75 \quad n = 15$

$\bar{x} = pn = 0.75 \times 15 = 11.3$

$\sigma^2 = pn(1-p) = 11.3 \times 0.25 = 2.81$

$\sigma = \sqrt{\sigma^2} = 1.68$

3.5 $p = 1/60$

(a) $n = 250 \quad \bar{x} = pn = \frac{250}{60} = 4.2 \qquad \sigma = \sqrt{pn(1-p)} = \left(4.2 \times \frac{59}{60}\right)^{1/2}$

$\sigma = 2.0$

(b) no errors in $n=100$ $\quad P(0) = \cancel{\left(\frac{100!}{100!\ 0!}\right)} \cancel{p^{0}} (1-p)^{100}$ for $n=100$

$P(0) = \left(\frac{59}{60}\right)^{100} = 0.186$

3.8 $S+B = 846$ cts / 10 min

$B = 73$ cts / 10 min

---

equal times ...

Rate $S = 77.3/\text{min} \qquad \sigma_S^2 = \sigma_{S+B}^2 + \sigma_B^2 = 846 + 73$

$\sigma_S = \sqrt{919} = 30.3$

$\sigma_{\text{Rate } S} = 30.3 / 10\ \text{min} = 3.0$

3.9 unequal times $\frac{T_{B+S}}{T_B} = \sqrt{\frac{S+B}{B}} = \sqrt{\frac{846}{73}} = 3.4$

$T_{S+B} + T_B = 20$ & $T_{B+S} = 3.4\,T_B$

$T_B = 4.5$ min

use eq 3.53 for unequal times and Estimate cts from Rates

Est $\sigma_S = \left(\frac{S+B}{T_{B+S}} + \frac{B}{T_B}\right)^{1/2} = \left(\frac{84.6}{15.6} + \frac{7.3}{4.5}\right)^{1/2}$

Est $\sigma_S = 2.7$

better by $2.7/3.0 = 0.9$

3.16 use Excel to evaluate statistics ..

$\bar{x}_e$ = mean $= \Sigma x_i/25 = 366.1$

sample variance $= \frac{1}{24}\Sigma(x-\bar{x}_e)^2 = 3187.1$

chi^2 $= \Sigma(x-\bar{x}_e)^2/\bar{x}_e = 21.22$

$\chi^2_\nu = \chi^2/24 = 0.884$ (a little low ...)

→ from fig 3.11 approx 60% of data sets would have a larger χ^2_ν for $N=25$

→ this set is OK for ~ 4 times out of 10

		"A"	"B"
3.17	Rate $\bar{X}_R$	= 2162.4	2081.5
	N	= 5×2×2162.4	5×2×2081.5
		21624	20815
	$\sqrt{N}$	147.1	144.
	σ_{Rate}	= 14.7	14.4

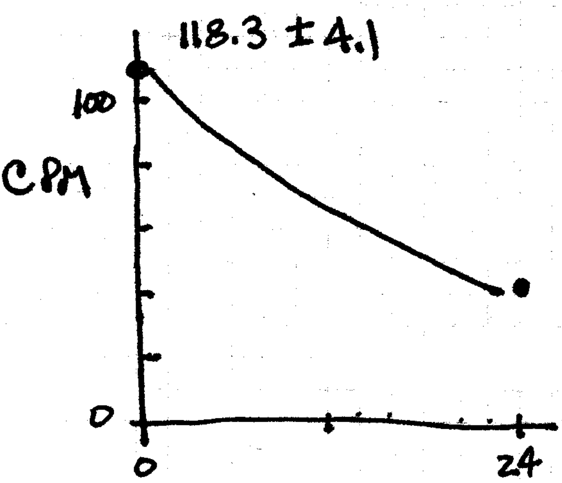
difference in means is 2162.4 − 2081.5 = 80.9

$$\text{diference}/\sigma = 80.9/14.7 = 5.5$$

- very small chance that these values are the "same"

3.19 B = 50 cpm $S+B = 1683/10\,\text{min}$ T_0

$S+B = 914/10\,\text{min}$ − $T_0 + 24\,\text{hr}$



41.4 ± 3.0

$$A = A_0 e^{-\lambda t}, \quad \lambda = \frac{\ln 2}{T_{1/2}}$$

$$\ln(A/A_0) = -\lambda t$$

$$\ln(A_0/A) = \frac{\ln 2}{T_{1/2}} t$$

$$T_{1/2} = \frac{\ln 2 \ t}{\ln(A_0/A)}$$

$$T_{1/2} = \frac{\ln 2 * 24\,\text{hr}}{\ln(118.3/41.4)}$$

$$T_{1/2} = 15.8\,\text{hr}$$

3.19 (continue)

$$T_{1/2} = \ln 2\, t \Big/ \ln(A_0/A) \quad , \qquad \text{call } A_0/A = \text{Ratio "R"}$$

$$T_{1/2} = \ln 2\, t \ln^{-1}(R)$$

$$\sigma^2_{T_{1/2}} = \left(\frac{\partial T_{1/2}}{\partial t}\right)^2 \sigma_t^2 + \left(\frac{\partial}{\partial R} T_{1/2}\right)^2 \sigma_R^2$$

- assume $\sigma_t^2 = 0$ [no error in clock ... 10 min << 24 hr]
- $\sigma_R^2 / R^2 = \sigma_{A_0}^2 / A_0^2 + \sigma_A^2 / A^2$ error in ratio of activities

$$\sigma_R^2 = \left[\left(4.1/118.3\right)^2 + \left(3.0/41.4\right)^2\right]\left(\frac{118.3}{41.4}\right)^2 = 5.268 \times 10^{-2}$$

- $\frac{\partial}{\partial R} T_{1/2} = \ln 2\, t \ln^{-2}(R) \left(\frac{1}{R}\right)$ chain rule ...
- $\sigma^2_{T_{1/2}} = 0 + \left(\frac{\ln 2\, t}{(\ln R)^2} \frac{1}{R}\right)^2 \sigma_R^2$

$$= \left(\frac{\ln 2 * 24}{\left(\ln\left(\frac{118.3}{41.4}\right)\right)^2 \left(\frac{118.3}{41.4}\right)}\right)^2 (5.268 \times 10^{-2})$$

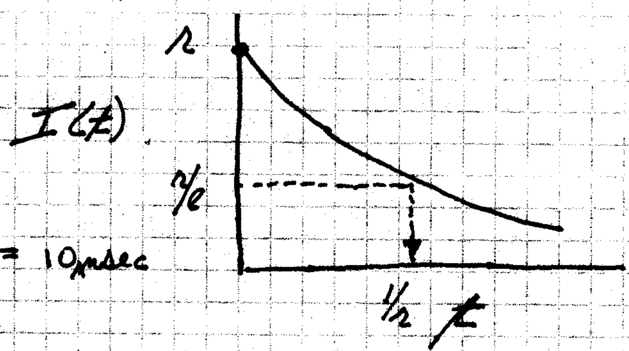
$$= (5.281\ \text{hr})^2 (5.268 \times 10^{-2})$$

$$\sigma^2_{T_{1/2}} = 1.469\ \text{hr}^2$$

$$\sigma_{T_{1/2}} = 1.2\ \text{hr}$$

$$T_{1/2} = 15.8 \pm 1.2\ \text{hr}$$

3.23 $r = 100\ \text{Hz}$.



for scale $\frac{1}{r} = 10^{-2}\ \text{sec} = 10\ \text{msec}$

faction of intervals less than some time τ is

$$frac_< = \int_0^\tau I(t)\,dt = \int_0^\tau r e^{-rt}\,dt = \left[\frac{1}{r} - \frac{1}{r} e^{-r\tau}\right] r$$

$$= 1 - e^{-r\tau}$$

for $\tau = 10$ msec $r = 100$ Hz

$$frac_< = 1 - e^{-100(0.01)} = 1 - e^{-1} = 0.632$$