## PART I

Suppose we make some choice of zeropoint for our ephemeris & fit the data. We can write the results of fitting as a multivariate normal $x \sim N(\mu, \Sigma)$, where

$$\mu = \begin{pmatrix} T_0 \\ P \end{pmatrix}, \quad \Sigma_1 = \begin{pmatrix} \sigma_{T_0}^2 & \sigma_{T_0}\sigma_P \\ \sigma_P\sigma_{T_0} & \sigma_P^2 \end{pmatrix}.$$

Now consider we predict the eclipse time at cycle number $E$. The eclipse time is given by: $T = T_0 + EP$, and the uncertainty in this time is given by

$$\sigma_T^2 = \sigma_{T_0}^2 + 2\sigma_{T_0}\sigma_P E + \sigma_P^2 E^2,$$

using the standard error propagation formula.

## PART 2

Now suppose we switch our zeropoint, so that the eclipse we are predicting now has a cycle number of $E' = E - N$. Obviously $E = E' + N$. Under the change of variable we can write:

$$\sigma_T^2 = \sigma_{T_0}^2 + 2\sigma_{T_0}\sigma_P\left(E' + N\right) + \sigma_P^2\left(E' + N\right)^2$$
$$= \left(\sigma_{T_0}^2 + \sigma_P^2 N^2 + 2\sigma_{T_0}\sigma_P N\right) + 2\left(\sigma_{T_0}\sigma_P + \sigma_P^2 N\right)E' + \sigma_P^2 E'^2$$

If we choose $N = \mathrm{nint}\left(-\sigma_{T_0}\sigma_P / \sigma_P^2\right)$, this will minimise the second term in the equation above, and we can write:

$$\sigma_T^2 \sim \sigma_P^2 E'^2.$$

$P = 0.176 - 0.114806 = 0.006 \pm 0.001$

$\Delta P = \sqrt{\overset{(1)}{0.001}^2 + 0.00000\overset{(4)}{4}^2} \approx 0.001$

$P_K = 0.0612858(3)$

$T_0 = 58407.1955$

$T_1 = 58408.114806$

$\Delta T = 0.0807$

$\Delta T / P = 13.16$