Problem 1:

(a): $C = (S + N_A + N_p) A$

$\therefore VAR(C) = VAR((S + N_A + N_p) A)$

$= VAR(SA + N_A A + N_p A)$

Assuming that the sources are independant

then $= A^2 VAR(S) + A^2 VAR(N_A) + A^2 VAR(N_p)$

so, S is constant, and $VAR(N_A) = 2$, $VAR(N_p) = S$

$\Downarrow$

$VAR(C) = 0 + 2 \cdot A^2 + S \cdot A^2$

$= A^2 (2 + S)$

$\therefore \boxed{VAR(C) = A^2 (2+S)}$

(b): So signal-to-noise(C): $\dfrac{E(C)}{\text{standard deviation}(C)}$

Expected value of C:

$E(C) = E((S + N_A + N_p) A)$

$= E(SA + N_A A + N_p A)$

$= A E(S) + A E(N_A) + A E(N_p)$

assuming S is constant, $E(N_A) = 0$, $E(N_p) = 0$

$E(C) = AS$

Standard Deviation of C:

standard deviation of (C): $\sqrt{VAR(C)} = \sqrt{A^2(2+S)}$

$$\text{signal to noise (c)} = \frac{AS}{\sqrt{A^2(2+S)}}$$

$$\therefore \boxed{\text{signal to noise (c)} = \frac{S}{\sqrt{(2+S)}}}$$

(c):

$$\text{signal to noise (c)} = \frac{S}{\sqrt{2+S}}$$

if signal to noise (c) = 50:

$$50 = \frac{S}{\sqrt{2+S}}$$

$$S = 2502$$

$\therefore$ the minimum value that S can be for the signal-to-noise to not exceed 50 is being $\boxed{2502 \text{ or less}}$.

Problem 2:

$f = 4cm$

$z' = 6cm$

$d = 1cm$

(a): $\frac{1}{z'} + \frac{1}{-z} = \frac{1}{f}$

$$\frac{1}{6cm} + \frac{1}{-z} = \frac{1}{4cm}$$

$$z = -12\,cm$$

we have to place the image $\boxed{\text{12cm away}}$ from the lens to get the image in focus.

(b): the image blur Equation:

$$b = d\,\frac{(\bar{z}' - z')}{\bar{z}'}$$

since $\frac{2cm}{1000} = \frac{1}{500}\,cm$

$$\therefore \quad \frac{1}{500}\,cm = 1cm\,\frac{(\bar{z}' - 6cm)}{\bar{z}'}$$

$$\bar{z}' = 6.012\,cm$$

$$\frac{1}{6.012cm} + \frac{1}{-\bar{z}} = \frac{1}{4cm}$$

$$\bar{z} = 11.95\,cm$$

$\boxed{\text{the max distance} = 12cm - 11.95\,cm = 0.05\,cm}$

Problem 3:

(a): $D = (S + N_A + N_p)A + N_Q$

the expected value of D:

$$E(D) = E((S + N_A + N_P)A + N_Q)$$
$$= E(SA + N_A A + N_P A + N_Q)$$
$$= E(SA) + E(N_A A) + E(N_P A) + E(N_Q)$$

$$E(N_A) = E(N_P) = E(N_Q) = 0$$
$$\therefore \; E(D) = \boxed{H = SA}$$

variance of D :

$$VAR(D) = VAR(SA + N_A A + N_P A + N_Q)$$
$$= VAR(SA) + VAR(N_A A) + VAR(N_P A) + VAR(N_Q)$$

since $S =$ constant, $VAR(N_A) = \sigma_A^2$, $VAR(N_P) = S$,

$$VAR(N_Q) = \sigma_Q^2$$

$$\therefore \; VAR(D) = 0 + A^2\sigma_A^2 + A^2 S + \sigma_Q^2$$
$$= \boxed{\sigma_D^2 = Ar + \sigma_c^2}$$

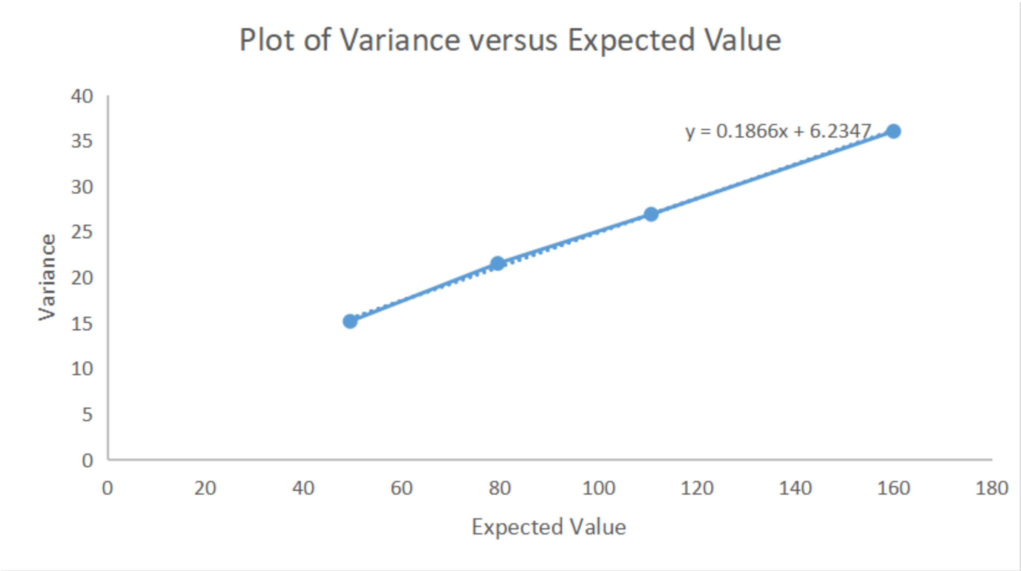
(b)

already run my program and show ~~the~~ data

to TA.

c):

image	μ	var of D
image1	49.422600	15.144367
image2	79.483444	21.494219
image3	110.72905	26.888958
image4	160.090271	35.988853



Since $\sigma_D^2 = A\mu + \sigma_c^2$

$$\sigma_D^2 = 0.1866\mu + 6.2347$$

$$\therefore \boxed{\begin{array}{l} A = 0.1866 \\ \sigma_c^2 = 6.2347 \end{array}}$$