Homework 1.

Resolution = 10MP
Camera Sensor = 14 mm wide
10 mm high.
f = 25mm

1) Compute the FOV.

$$HFOV = 2\phi = 2\tan^{-1}\left(\frac{d}{2f}\right)$$
$$= 2\tan^{-1}\left(\frac{14}{50}\right)$$
$$\boxed{HFOV = 31.2844^\circ}$$

$$VFOV = 2\phi = 2\tan^{-1}\left(\frac{d}{2f}\right)$$
$$= 2\tan^{-1}\left(\frac{10}{50}\right)$$
$$\boxed{VFOV = 22.62^\circ}$$

2) Case 1 : Minimum Distance (10m).

$$\frac{1}{D} + \frac{1}{D'} = \frac{1}{f}$$

ie $$\frac{1}{10} + \frac{1}{D'} = \frac{1}{0.025}.$$

$$\therefore D' = 0.02493 \approx 25mm$$
$$= 24.93mm.$$

$$D' = 0.02506$$
$$D' = 25.06mm$$

To find the height.

$$\frac{y_h'}{y_h} = \frac{D'}{D}$$

$$\frac{y_h'}{1.7} = \frac{0.02506}{10}$$

$$y_h' = 0.00426$$

$$y_h' = 4.26\,mm.$$

width. $$\frac{y_w'}{y_w} = \frac{D'}{D}$$

$$\frac{y_w'}{0.5} = \frac{0.02506}{10}$$

$$y_w' = 0.001253$$

$$y_w' = 01.253\,mm.$$

Area occupied $= y_h' \times y_w'$

$= 4.26 \times 1.253$

$$\boxed{A_{min} = 5.3377\,mm^2}$$

Case 2 : Maximum Distance (50m)

$$\frac{1}{50} + \frac{1}{D'} = \frac{1}{0.025}$$

$$D' = 0.02501$$

$$D' = 25.01\,mm$$

for height

$$\frac{y_h'}{y_h} = \frac{D'}{D} \Rightarrow \frac{y_h'}{1.7} = \frac{0.02501}{50}$$

$$y_h' = 0.00085$$

$$y_h' = 0.85\,mm$$

width $\frac{y_w'}{0.5} = \frac{0.02501}{50}$

$y_w' = 0.00025$

$y_w' = 0.25mm$

$A_{max} = 0.25 \times 0.85$

$\boxed{A_{max} = 0.2125}$.

Total no. of pixels = 10MP

$= 10 \times 10^6$ pixels.

Area of sensor $= 14 \times 10$

$= 140 mm^2$

Pixels occuppied = $\frac{\#Pixels}{total\ Area} \times A_{max\ or\ min.}$

for Minimum Distance = $\frac{10 \times 10^6}{140} \times 5.3377$

$\boxed{= 381264.285 \text{ pixels}}$
$\boxed{\text{or } 0.38MP}$

for Maximum Distance = $\frac{10 \times 10^6}{140} \times 0.2125$

$\boxed{= 15178.57 \text{ pixels.}}$
$\boxed{\text{or } 0.015MP}$

3) $d = 8.9\,mm$

$C = 0.019\,mm$.

Considering best performance to be everything sharp and infocus. Take Far Distance DOF

$$D_f = \frac{S(H-f)}{H-S}$$

For everything to be in focus D_f needs to be ∞. or $S = H$.

Now, $$H = \frac{f^2}{Nc} + f.$$

$$N = \frac{f}{d} = \frac{25}{8.9} = 2.80$$

$$\therefore H = \frac{25^2}{2.8 \times 0.019} + 25$$

$$\boxed{H = 11773.12}$$

or $$\boxed{H = 11.773\,m}$$

focal distance (S) should be $11.773\,m$