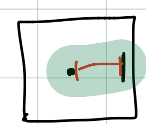
$x$ & $y$ are weird ?

$$\Delta f = \frac{\Delta f_1 + \Delta f_2}{2}$$
$$\Delta l = \frac{x}{2y}(\Delta f_1 - \Delta f_2) + \Delta l_1$$
$$\Delta \theta = -\frac{\Delta f_1 - \Delta f_2}{2y}$$

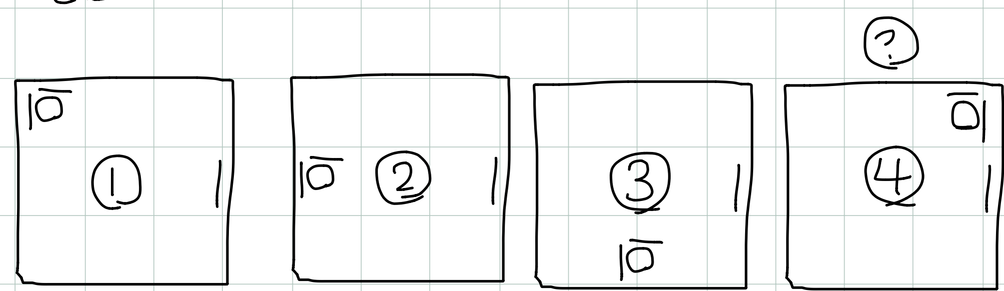
$$\Delta f_1 = \Delta f - y\Delta\theta$$
$$\Delta l_1 = \Delta l + x\Delta\theta$$
$$\Delta f_2 = \Delta f + \underbrace{c\,\Delta\theta}_{\text{Arc}}$$

$$\frac{\text{Arc}}{\text{Radius}} = \theta \quad \therefore \quad c =$$



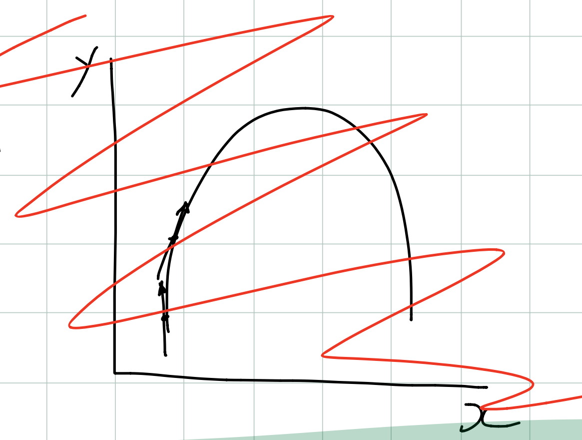
$$y = r\cos\phi$$
$$x = r\sin\phi$$

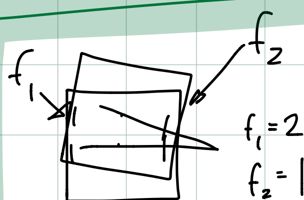
Test cases:



② 

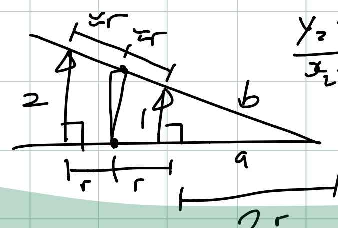
2-1




$f_1 = 2$

$f_2 = 1$




$$\frac{y_2 - y_1}{x_2 - x_1} = m$$

$$\frac{2-1}{2r-0} = \frac{1}{2r}$$

$$\frac{2r+a}{f_1} = \frac{a}{f_2}$$

$$\frac{2r}{f_1 a} + \frac{1}{f_1} = \frac{1}{f_2}$$

$$\frac{2r}{a f_1} = \frac{1}{f_2} - \frac{1}{f_1}$$

$$a = \frac{1}{\frac{f_1}{2r}\left(\frac{1}{f_2} - \frac{1}{f_1}\right)}$$

$$\theta = \tan^{-1}\left(\frac{f_2}{a}\right)$$

$$\frac{\text{Arc}}{\text{radius}} = \theta$$

$$\frac{2}{2r+a} = \frac{1}{a}$$

$$\frac{2r+a}{2} = a$$

$$r = \frac{a}{2}$$

$$\theta = \tan^{-1}\left(\frac{1}{2r}\right)$$

$$\cancel{\frac{b+2r}{b} = \frac{a+2r}{a}}$$

$$\cancel{1 + \frac{2r}{b} = 1 + \frac{2r}{a}}$$

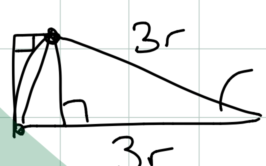
$$\cancel{b = a}$$

$$\Delta f = (r+a)\sin(\theta)$$

$$\Delta l = (r+a)(1 - \cos(\theta))$$

$$\Delta\theta = \tan^{-1}\left(\frac{\Delta y}{\Delta x}\right)$$

3r

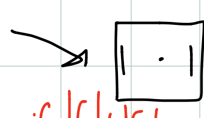



$\tan^{-1}\left(\frac{1}{2r}\right)$

$$\Delta y = 3r\sin\left(\tan^{-1}\left(\frac{1}{2r}\right)\right)$$

$$\Delta x = 3r - 3r\cos\left(\tan^{-1}\left(\frac{1}{2r}\right)\right)$$

$$\Delta\theta = \tan^{-1}\left(\frac{y}{x}\right)$$

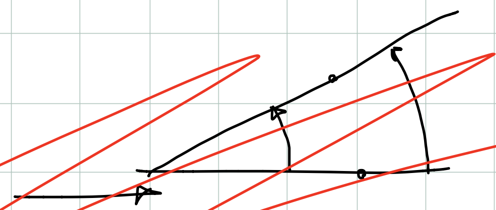


if $|f_1| \neq |f_2|$

$$\cancel{\frac{2r+a}{f_2} = \frac{a}{f_1}}$$

$$\cancel{\frac{2r}{f_2\,a} + \frac{1}{f_2} = \frac{1}{f_1}}$$

$$\cancel{\frac{1}{a} = \left(\frac{1}{f_1} - \frac{1}{f_2}\right)\frac{f_2}{2r}}$$



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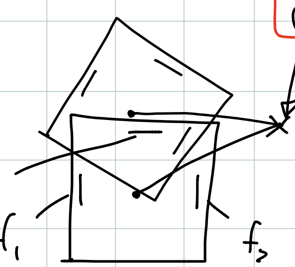
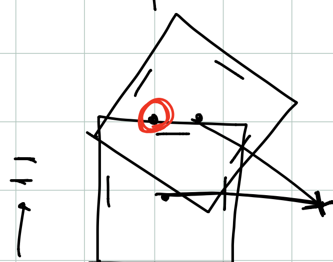



(Once this point is located, the rest is easy / geometry)

=



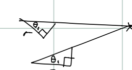
except for some orthogonal movement

prediction: only applies ~~if $f_1 \neq f_2$~~

$$\Delta f = (r+a)\sin(\theta)$$

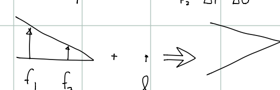
$$\Delta l = (r+a)(1-\cos(\theta)) + l_1$$

$$\Delta\theta = \tan^{-1}\left(\frac{\Delta f}{\Delta l}\right)$$




$f_1 = \Delta f + \Delta\theta$

$f_2 = \Delta f - \Delta\theta$

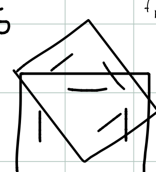



$r = 10$

$l_1 = 1.5$

$f_1 = 2$

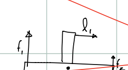
$f_2 = -1$



~~$f_1 = 4$~~

~~$f_2 = 1$~~

~~$l_1 = 0.5$~~




| | $x$ | $y$ |
|---|---|---|
| $f_1$ | 0 | 4 |
| $f_2$ | 0 | 1 |
| $l_1$ | 0.5 | 0 |
| | 0.5 | 5 |

$\sqrt{0.25 + 25} = 5.024$

$84.3°$

$\theta = 1.47$

$\tan^{-1}\left(\frac{5}{0.5}\right)$

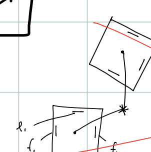
$$\frac{1}{a} = \frac{f_1}{2r}\left(\frac{1}{f_2} - \frac{1}{f_1}\right)$$

$$\theta = \tan^{-1}\left(f_2 \times \frac{1}{a}\right)$$

$$\frac{2}{2\times 10}\left(\frac{1}{-1} - \frac{1}{2}\right)$$

$$-\frac{1}{10}\left(\frac{3}{2}\right)$$

$$-\frac{3}{20} = \frac{1}{a}$$




| | $x$ | $y$ |
|---|---|---|
| $f_1$ | 0 | 10 |
| $f_2$ | 0 | 5 |
| $l_1$ | 4 | 0 |
| | 4 | 15 |

$\rightarrow 15.52$

$\tan^{-1}\left(\frac{15}{4}\right) = 1.31$

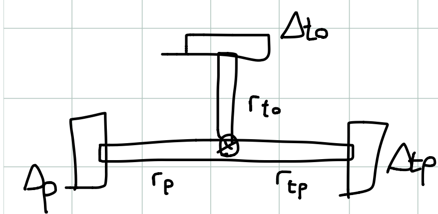
$$30 \times \sin\left(\tan^{-1}\left(\frac{3}{-20}\right)\right) \qquad \tan^{-1}\left(\frac{-3}{20}\right)$$

$$\Delta f = -4.45$$

$$\Delta l = -1.168$$

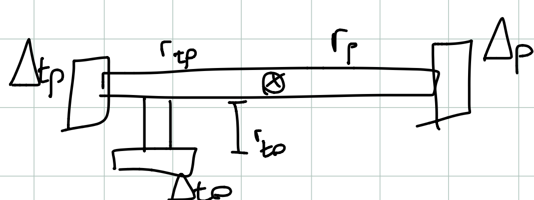
$$\Delta\theta = 1.314 = 75.29°$$

## Config 2




$$\Delta_p = \Delta P - r_p \Delta\theta$$
$$\Delta_{tp} = \Delta P + r_{tp} \Delta\theta$$
$$\Delta_{to} = \Delta O + r_{to} \Delta\theta$$

## Config 3




$$\Delta_p = \Delta P - r_p \Delta\theta$$
$$\Delta_{tp} = \Delta P + r_{tp} \Delta\theta$$
$$\Delta_{to} = \Delta O + r_{to} \Delta\theta$$

Δa=((−(ep-etp))/(rp+rtp))
Δo=((ep*rto+eto*(rp+rtp)-etp*rto)/(rp+rtp))
Δp=((ep*rtp+etp*rp)/(rp+rtp))