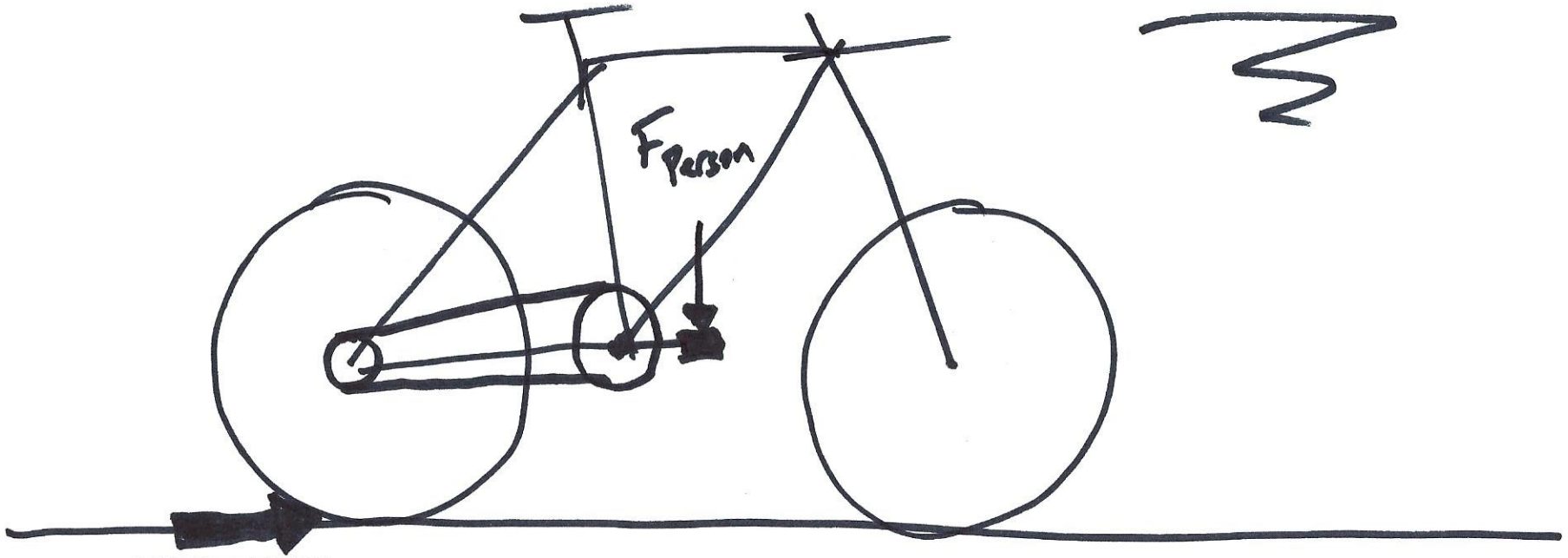
Propulsion Force

$\Sigma F_{ON} = m a_{com}$



$$F_{PROPULSION} + \left[\left(-F_{RR} \right) + \left(-F_{SLOPE} \right) + \left(-F_{DRAG} \right) \right] = m a_{com}$$

resistance

mass = bike + rider

PART 1

What torques are acting about bottom bracket?

CCW+

1. $-T_{Person} = F_{person}\, d_{\perp\, crank}$

$d_{\perp\, crank}$: 172.5 mm, 175 mm, 165 mm } ex.

2. $+T_{CHAIN} = F_{CHAIN}\, d_{\perp\, CHAIN}$

$\Sigma T = I\alpha$ Remember... $\alpha : 0\ rad/s^2$

$\Sigma T = 0\ Nm$

$T_{CHAIN} + (-T_{PERSON}) = 0\ Nm$

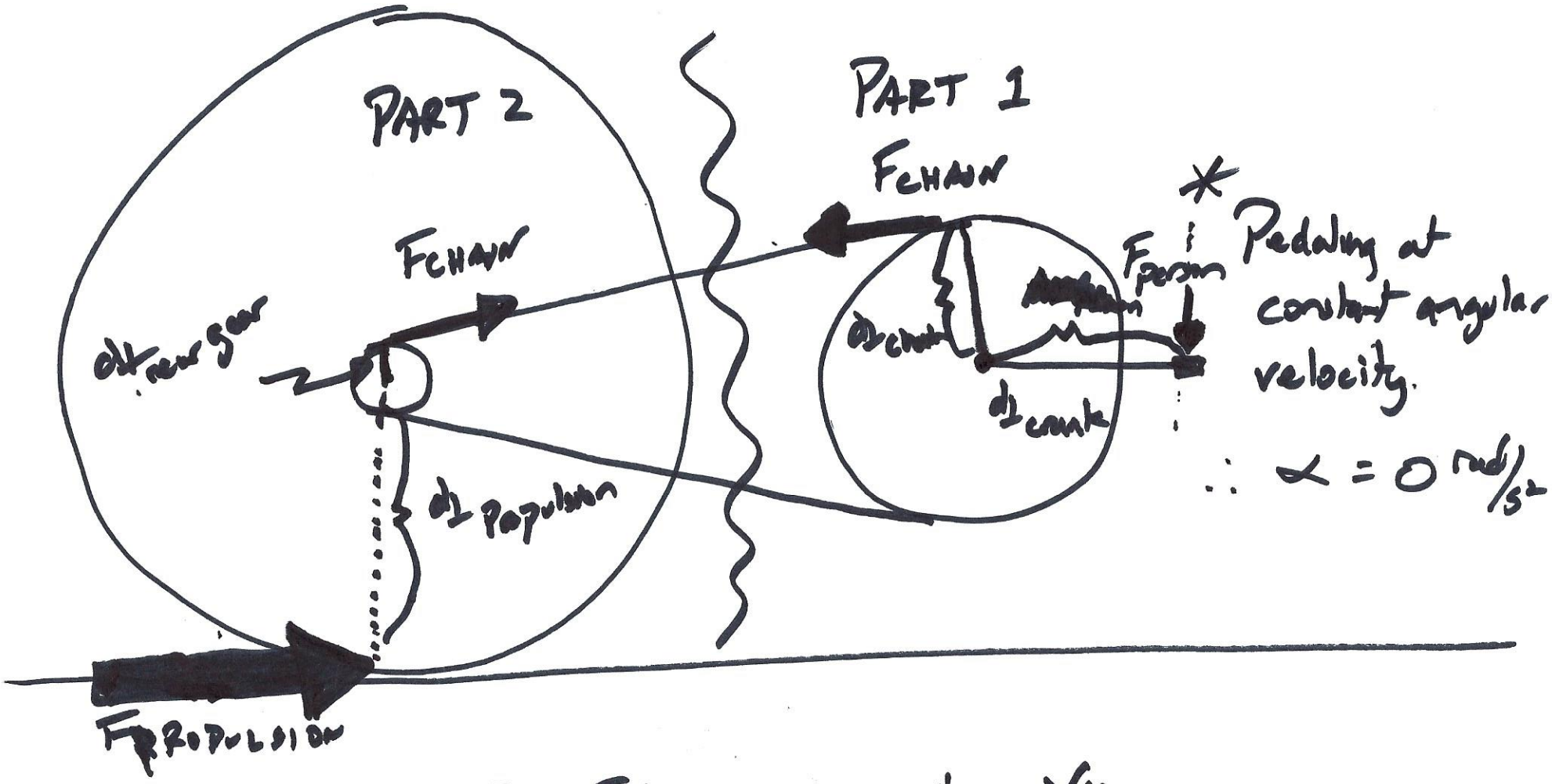
$T_{CHAIN} = T_{PERSON}$

$F_{CHAIN}\, d_{\perp CHAIN} = F_{PERSON}\, d_{\perp CRANK}$

PART 1 VICTORY

$$F_{CHAIN} = \frac{F_{PERSON}\, d_{\perp CRANK}}{d_{\perp CHAIN}}$$

Drive Train



1. $T = Fd_1$ units: Nm, CCW +

2. $\Sigma T = I\alpha$ units: Nm

PART 2

CCW+

$$-T_{CHAIN} = F_{CHAIN}\, d_{\perp\, REAR\ GEAR}$$

$$+T_{PROPULSION} = F_{PROPULSION}\, d_{\perp\, PROPULSION}$$

$d_{\perp\, PROPULSION}$ ↕ wheel radius

$\Sigma T = I\alpha \qquad \alpha = 0\ rad/s^2$

$\Sigma T = 0\ Nm$

$$T_{PROPULSION} + (-T_{CHAIN}) = 0\ Nm$$

$$T_{PROPULSION} = T_{CHAIN}$$

$$F_{PROPULSION}\, d_{\perp\, PROPULSION} = F_{CHAIN}\, d_{\perp\, REAR\ GEAR}$$

$$F_{PROPULSION} = \frac{F_{CHAIN}\, d_{\perp\, REAR\ GEAR}}{d_{\perp\, PROPULSION}}$$

$$F_{PROPULSION} = \frac{\left(\frac{F_{PEDAL}\, d_{\perp\, CRANK}}{d_{\perp\, CHAIN}}\right) d_{\perp\, REAR\ GEAR}}{d_{\perp\, PROPULSION}}$$

$$F_{PROPULSION} = \frac{\frac{F_{PERSON}\, d_{\perp CRANK}\, d_{\perp REAR\ GEAR}}{d_{\perp CHAIN}}}{\frac{d_{\perp PROPULSION}}{1}}$$

$$F_{PROPULSION} = \frac{F_{PERSON}\left(d_{\perp CRANK}\right) d_{\perp REAR\ GEAR}}{d_{\perp CHAIN}\ \left(d_{\perp PROPULSION}\right)}$$

F_{PERSON} : What the cyclist is doing

$d_{\perp CRANK}$: Crank arm length

$d_{\perp REARGEAR}$: Size of the rear cog eg 11 teeth

$d_{\perp CHAIN}$: Size of the front ring eg 53 teeth

$d_{\perp PROPULSION}$: Whee radius

$$F_{PROPULSION} = \frac{F_{PERSON}\left(d_{CRANK}\right) d_{REAR\ GEAR}}{\left(d_{PROPULSION}\right) d_{CHAIN}}$$

Fixed

OR

$$F_{PROPULSION} = \frac{F_{PERSON}\left(\text{crank arm length}\right)\left(\text{rear gear size}\right)}{\left(\text{wheel size}\right)\left(\text{front gear size}\right)}$$

You select these while riding.

- Choose $\frac{\text{big rear gear}}{\text{small front gear}}$ to generate lots of $F_{PROPULSION}$ for F_{person} eg going uphill

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- Choose $\frac{\text{small rear gear}}{\text{big front gear}}$ so that you get multiple revolutions of rear wheel for each pedal revolution. eg going fast

$$\frac{\frac{A}{B}}{\frac{C}{D}} = \frac{A}{B} \cdot \frac{D}{C} = \frac{AD}{BC}$$