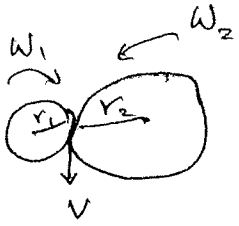
Assignment

circumference
$= 2\pi r$

arc $= r\Delta\theta$

angular velocity $= \frac{\Delta\theta}{\Delta t} = \omega$



V = translational velocity
tangential velocity

$= r_1\omega_1 = r_2\omega_2$

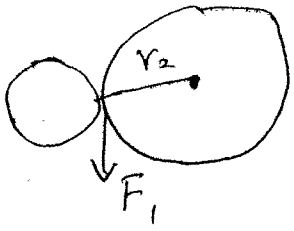
since $r_1 < r_2$

$\omega_1 > \omega_2$

torque $= r \times F$

torque applied on circle 1

$\tau_1 = r_1 \times F_1$



$\tau_2 = r_2 \times F_1$

Don't know F_1 ?

So use cons. of energy

$$\boxed{\tau_1 \cdot \omega_1 = \tau_2 \cdot \omega_2}$$

($F_1 \cdot V_1 = F_2 V_2$)
or
$F_1 d_1 = F \cdot d_2$)

$$\frac{\tau_1}{\tau_2} = \frac{\omega_2}{\omega_1}$$

$$\boxed{\frac{\tau_1}{\tau_2} = \frac{r_1}{r_2}}$$

$F_1 d_1 = F_2 d$

$d_1 = r_1 \theta_1$

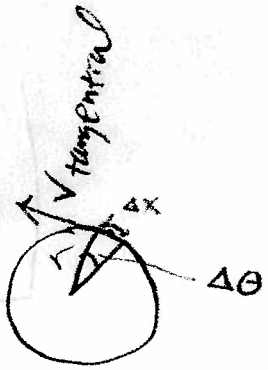
$d_2 = r_2 \theta_2$

$\tau_1 \frac{\Delta\theta_1}{\Delta t} = \tau_2 \frac{\Delta\theta_2}{\Delta t}$

$\tau_1 = r_1 F_1$

$\tau_1 \theta_1 = \tau_2 \theta_2$

Find ω_1, ω_2 compare with the theoretical calc.



$r\Delta\theta \cong \Delta x$

$V_{tangential} = \frac{\Delta x}{\Delta t} = r\frac{\Delta\theta}{\Delta t} = r\omega$

Question 1: Find ω

$\frac{\Delta\theta}{\Delta t} = \omega$

formula:

- $\omega = \frac{\Delta\theta}{\Delta t}$ (Since angular velocity)

$= \frac{?\ \text{revs}}{60\ \text{sec}} \times \frac{2\pi\ \text{rad}}{1\ \text{rev}}$

$= ?\ \frac{\text{rad}}{\text{sec}}$

Instruction:

- attach gear ~~#~~ ____ on motor, ~~mark~~ a point on the gear ~~with~~ sharpie
- set power @ 1
- Count how many revolutions the gear goes thru in 60 sec

(2)

Knowing the point of contact is same

Velocity on the

(or else the gears will be slipping)

$V_{tangential\ on\ 1} = V_{tangential\ on\ 2}$

$r_1 \omega_1 = r_2 \omega_2$ $\quad \boxed{\frac{r_1}{r_2} = \frac{\omega_2}{\omega_1}}$

(eq. 1)

Question 2:

couple motor gear to a ~~diff~~ diff gear

size gear

(a) — Calc. ω_2 based on the value you got from ω_1 (use same condition as in Question 1

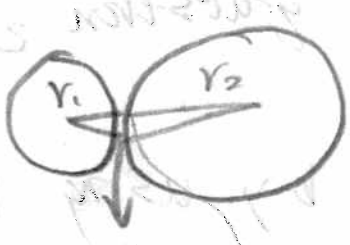
(b) — now using the same procedure as in question 1 & find ω_2

(c) — Compare the results ~~in 2a & 2b~~ 2a

(3) Work = $F \cdot \Delta x$ ← dot product

Force is going same direction as Δx (tangential displacement)

Therefore work = $F\Delta x$



F is same between wheel 1 & 2 (Newton's 3rd Law)

conservation of energy ⇒ $\text{Work}_1 = \text{Work}_2$

$$F_1 \Delta x_1 = F_2 \Delta x_2$$

$$F_1 r_1 \Delta\theta_1 = F_2 r_2 \Delta\theta_2$$

$$\text{power}_1 = F_1 r_1 \frac{\Delta\theta_1}{\Delta t} = F_2 r_2 \frac{\Delta\theta_2}{\Delta t} = \text{power}_1$$

$$F_1 r_1 \omega_1 = F_2 r_2 \omega_2$$

$$(F_1 r_1)\omega_1 = (F_2 r_2)\omega_2$$

$$\tau_1 \omega_1 = \tau_2 \omega_2$$

Question 3:

$$\boxed{\frac{\tau_2}{\tau_1} = \frac{\omega_1}{\omega_2} = \frac{r_2}{r_1}} \quad \text{(eq. 2)}$$

(a) Calle. the ratio of <u>output torque</u> / <u>Input torque</u> ($\frac{\tau_2}{\tau_1}$) (use same given condition in Question 1)

(a) Based on the ratio of $\frac{\omega_2}{\omega_1}$ value you got etc. from question 2

(b) Do the same by using ratio $\frac{r_2}{r_1}$ obtained from question 2

(c) compare your results in a & b
What conclusion can you make from this ?

- Larger torque is created by having a Larger output gear coupled to a smaller input gear

- angular velocity is smaller when larger torque is produced.