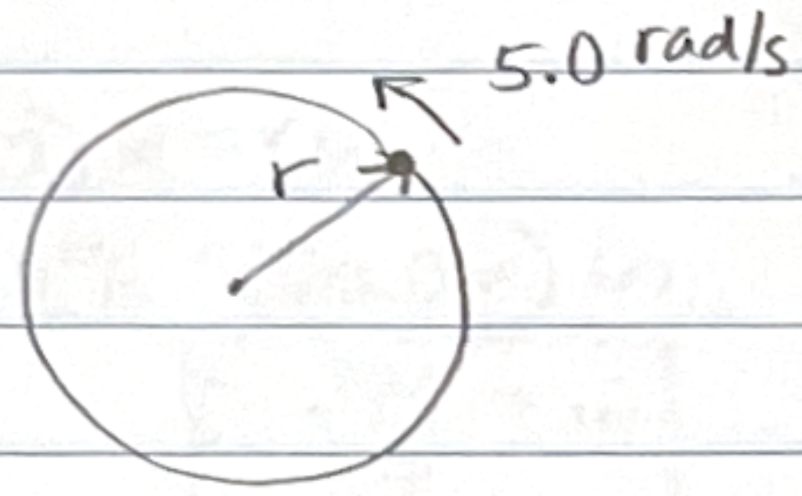
Relating Translational and Rotational Quantities

1) $r = 4.00\,m$

$\omega = 5.0\,rad/s$



a) $a_t = r\alpha$

$a_t = r(0)$ since ω is constant

$\boxed{a_t = 0}$

$a_r = \frac{v^2}{r}$

$a_r = r\omega^2$

$a_r = (4.00\,m)(5.0\,rad/s)^2$

$\boxed{a_r = 100\,m/s^2, \text{ toward center}}$

b) $\boxed{a_t = 0}$ because ω is constant

$a_r = r\omega^2$

$a_r = (1.0\,m)(5.0\,rad/s^2)$

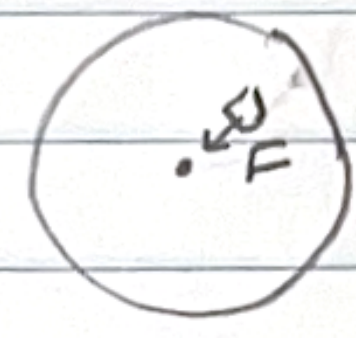
$\boxed{a_r = 5\,m/s^2, \text{ toward center}}$

c) $V_t = r\omega$

$V_t = (1.00\,m)(5.0\,rad/s)$

$\boxed{V_t = 5.0\,m/s}$

d)



$\Sigma F_r = ma_r$

$f_s = (1\,kg)\frac{v^2}{r}$

$f_s = (1\,kg)\frac{(5.0\,m/s)^2}{1\,m}$

$f_s = 25\,\frac{kg \cdot m}{s^2}$

$\boxed{f_s = 25\,N, \text{ toward center}}$

2) $d = 1.20\,m$, so $r = 0.60\,m$

$\omega = 200.0\,\frac{rev}{min}$

a) $\omega = 200.0\,\frac{rev}{min}\left(\frac{2\pi\,rad}{1\,rev}\right)\left(\frac{1\,min}{60\,s}\right) = \boxed{20.9\,\frac{rad}{s}}$

b) $V_t = r\omega$

$V_t = (.60\,m)(20.9\,rad/s)$

$\boxed{V_t = 12.5\,m/s}$

c) $\omega_f = 1000.0\,rev/min$

$\Delta t = 60\,s = 1\,min.$

$\alpha = ?$

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

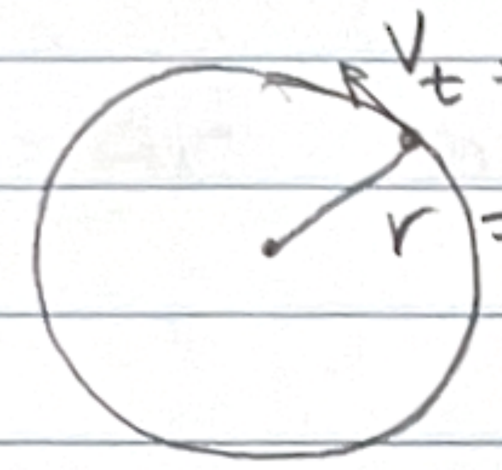
$\alpha = \frac{1000.0\,rev/min - 200.0\,rev/min}{1\,min}$

$\boxed{\alpha = 800\,rev/min^2}$

d) $\Delta\theta = \omega_i \Delta t + \frac{1}{2}\alpha\Delta t^2$

$\Delta\theta = (200\,\frac{rev}{min})(1\,min) + \frac{1}{2}(800\,\frac{rev}{min^2})(1\,min)^2$

$\boxed{\Delta\theta = 600\,rev}$

3) 

$v_t = 30.0\,m/s$

$r = 50.0m$

a) $v = r\omega$

$30.0\,m/s = (50.0m)\,\omega$

$\boxed{0.6\,\frac{rad}{s} = \omega}$

b) $a_r = r\omega^2$

$a_r = (50.0m)(.6\,\frac{rad}{s})^2$

$\boxed{a_r = 18\,m/s^2\text{, toward center}}$

c) $\boxed{a_t = 0}$ because ω is constant

d) $s = 15.0m$

$s = v \cdot \Delta t$

$15m = (30\,m/s)\Delta t$

$\boxed{0.5s = \Delta t}$

e) $s = r\theta$ OR $\omega = \frac{\Delta\theta}{\Delta t}$

$15.0m = (50.0m)\,\theta$

$\boxed{0.3\,rad = \theta}$

$(0.6\,\frac{rad}{s}) = \frac{\Delta\theta}{0.5s}$

$\boxed{0.3\,rad = \Delta\theta}$

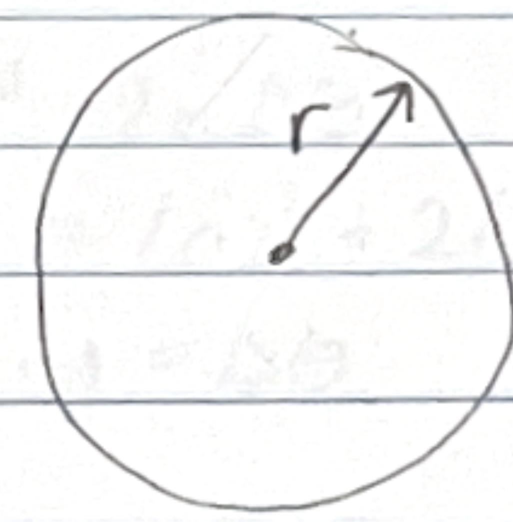
f) $\Sigma F_r = ma_r$

$f_s = ma_r$

$\mu_s(mg) = ma_r$

$\mu_s = \frac{a_r}{g}$

$\mu_s = \frac{(18\,m/s^2)}{9.8\,m/s^2} = \boxed{1.8}$

4) 

$r = 2.00\,cm$

$\omega_i = 0$

$\omega_f = 1.5 \times 10^3\,\frac{rev}{min}$

$\alpha = 10\,rad/s^2$

a) $\omega_f = 1.5 \times 10^3\,\frac{rev}{min}\left(\frac{1\,min}{60s}\right)\left(\frac{2\pi\,rad}{1rev}\right)$

$\omega_f = \boxed{157\,rad/s}$

b) $a_t = r\alpha$

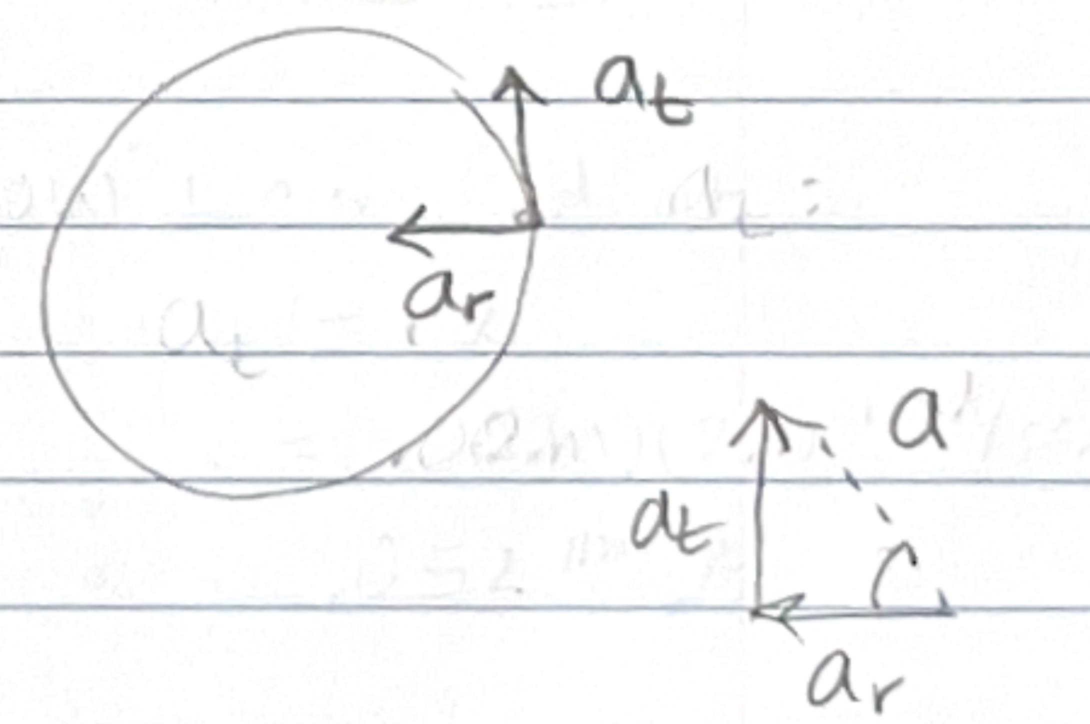
$a_t = (.02m)(10\,rad/s^2)$

$\boxed{a_t = 0.2\,m/s^2}$

c) $a_r = \omega^2 r$

$a_r = (157\,rad/s)^2(.02m)$

$a_r = \boxed{493\,m/s^2\text{, toward center}}$

d) 

$a = \sqrt{a_r^2 + a_t^2}$

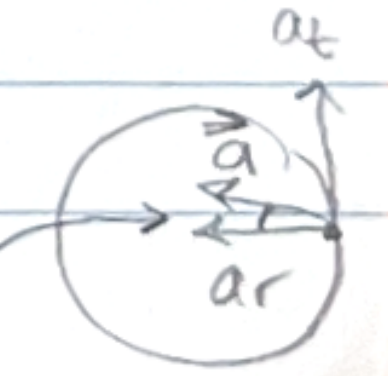
$a = \sqrt{(493\,m/s^2)^2 + (0.2\,m/s^2)^2}$

$a = 493\,m/s^2$

$\tan\theta = \frac{a_t}{a_r}$

$\tan\theta = \frac{0.2}{493}$

$\theta = 0.02°$

$\vec{a} = 493\,m/s^2$ at $0.02°$ 

e) $s = \theta r$, so I need θ: $\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$

$(157 \text{ rad/s})^2 = (0)^2 + 2(10 \text{ rad/s}^2)\Delta\theta$

$1232.45 \text{ rad} = \Delta\theta$

$s = (1232.45 \text{ rad})(.02\text{m})$

$\boxed{s = 25\text{m}}$