Rotation, torque, rotational inertia Ch.8

1. A record player is going at 78 rpm. (a) What is its angular velocity? (b) If the diameter of the record is 25 cm, what is the linear velocity of the edge of the record? When the record player is turned off, it takes 5 seconds to come to rest. (c) Find its angular acceleration. (d) What is the centripetal acceleration of the edge of the record in part a?

$\omega = 2\pi f$

$= 2\pi \frac{rad}{rev}\left(\frac{78\,rev}{60\,s}\right)$

a) $\boxed{\omega = 8.17 \frac{rad}{s}}$

$v = r\omega$

$= 0.125\,m\,(8.17 \frac{rad}{s})$

b) $\boxed{v = 1.02 \frac{m}{s}}$

$\omega_f = \omega_i + \alpha t$

$\alpha = \frac{\omega_f - \omega_i}{t}$

$\alpha = \frac{0 \frac{rad}{s} - 8.17 \frac{rad}{s}}{5\,s}$

c) $\boxed{\alpha = -1.63 \frac{rad}{s^2}}$

$a_c = r\omega^2$

$= 0.125\,m\,(8.17 \frac{rad}{s})^2$

d) $\boxed{a_c = 8.34 \frac{m}{s^2}}$

2. (a) How much torque is exerted by a torque wrench if 450 N of force are exerted 75 cm from its end? (b) If this same torque were applied to a flat disk-shaped flywheel with a weight of 450 N and a radius of 30 cm, what would be its angular acceleration?

$\tau = rF$

$= 0.75\,m\,(450\,N)$

a) $\boxed{\tau = 338\,Nm}$

$\tau = I\alpha$

$= \frac{1}{2} MR^2 \alpha$

$\alpha = \frac{\tau}{0.5MR^2}$

$= \frac{rF_g}{0.5 F_g R^2}$

$= \frac{0.75\,m\,(450\,N)\,9.8 \frac{m}{s^2}}{0.5\,(450\,N)\,(0.3\,m)^2}$

$F_g = mg \quad m = \frac{F_g}{g}$

b) $\boxed{\alpha = 163 \frac{rad}{s^2}}$

3. A baseball with radius 5 cm attains a rotational frequency of 500 rpm in 0.1 seconds. It has a ~~mass~~ weight of 1.2 N. What torque was applied to it?

$\tau = I\alpha$

$= \frac{I\omega_f}{t}$

$= \frac{I 2\pi f}{t}$

$= \frac{2}{5} MR^2 (2\pi) f$

t

$\alpha = \frac{\omega_f - \omega_i}{t}$

$\tau = \frac{0.4\left(\frac{1.2\,N}{9.8 \frac{m}{s^2}}\right)(0.05\,m)^2\left(\frac{500\,rev}{60\,s}\right)2\pi}{0.1\,s}$

$\boxed{\tau = 0.0641\,Nm}$