Name ____ Date ________ Period _____

1. Electrical wire with a diameter of 0.50 cm is wound on a spool with a radius of 30 cm and a height of 24 cm.
(a) Through how many radians must the spool be turned to wrap one even layer of wire?

The number of turns of wire that can be wound on the spool (across the height) is

$\frac{24\text{ cm}}{0.50\text{ cm}} = 48$ turns. So $\theta = (2\pi\text{ rad/turn})(48\text{ turns}) = 301\text{ rad} = \boxed{3.0\times10^2\text{ rad}}$.

(b) What is the length of this wound wire?

The radius at the center of the wire is $R = 0.30\text{ m} + 0.0050\text{ m}/2 = 0.3025\text{ m}$.

$s = R\theta = (0.3025\text{ m})(301\text{ rad}) = \boxed{91\text{ m}}$.

2. A yo-yo with an axle diameter of 1.00 cm has a 90.0-cm length of string wrapped around it many times, but in such a way that the string completely covers the surface of its axle, but there are no double layers of string. The outermost portion of the yo-yo is 5.00 cm from the center of the axle.
(a) If the yo-yo is dropped with the string fully wound, through what angle does it rotate by the time it reaches the bottom of its fall?

The length of one wrap is equal to the circumference of the axle, $c = \pi d = \pi(1.00\text{ cm}) = 3.14\text{ cm}$.

90.0 cm of wire can then wrap $\theta = \frac{90.0\text{ cm}}{3.14\text{ cm}} = 28.66\text{ rev} = (28.66\text{ rev})\times\frac{2\pi\text{ rad}}{1\text{ rev}} = \boxed{180\text{ rad}}$.

(b) How much arc length distance has a piece of the yo-yo on its outer edge traveled by the time it bottoms out?

$s = r\theta = (5.00\text{ cm})(180\text{ rad}) = 900\text{ cm} = \boxed{9.00\text{ m}}$.

3. In a noninjury noncontact skid on icy pavement on an empty road, a car spins 1.75 revolutions while it skids to a halt. It was initially moving at 15.0 m/s, and because of the ice it was able to decelerate at a rate of only 1.50 m/s^2. Viewed from above, the car spun clockwise. Determine its average angular velocity as it spun and slid to a halt.

First find the time from kinematics.

$v = v_o + at$, ☞ $t = \frac{v - v_o}{a} = \frac{0 - 15.0\text{ m/s}}{-1.50\text{ m/s}^2} = 10.0\text{ s}$.

$\bar{\omega} = \frac{\Delta\theta}{\Delta t} = \frac{(1.75\text{ rev})\times(2\pi\text{ rad})/(1\text{ rev})}{10.0\text{ s}} = \boxed{1.10\text{ rad/s, down}}$.

4. In the spin-dry cycle of a modern washing machine, a wet towel with a mass of 1.50 kg is "stuck to" the inside surface of the perforated (to allow the water out) washing cylinder. To have decent removal of water, damp/wet clothes need to experience a centripetal acceleration of at least 10g. Assuming this value, and that the cylinder has a radius of 35.0 cm, determine the constant angular acceleration of the towel required if the washing machine takes 2.50 s to achieve its final angular speed.

$a_c = 10g = r\omega^2$, ☞ $\omega = \sqrt{\frac{10g}{r}} = \sqrt{\frac{10(9.80\text{ m/s}^2)}{0.350\text{ m}}} = 16.73\text{ rad/s}$.

$\omega = \omega_o + \alpha t$, ☞ $\alpha = \frac{\omega - \omega_o}{t} = \frac{16.73\text{ rad/s} - 0}{2.50\text{ s}} = \boxed{6.69\text{ rad/s}^2}$.