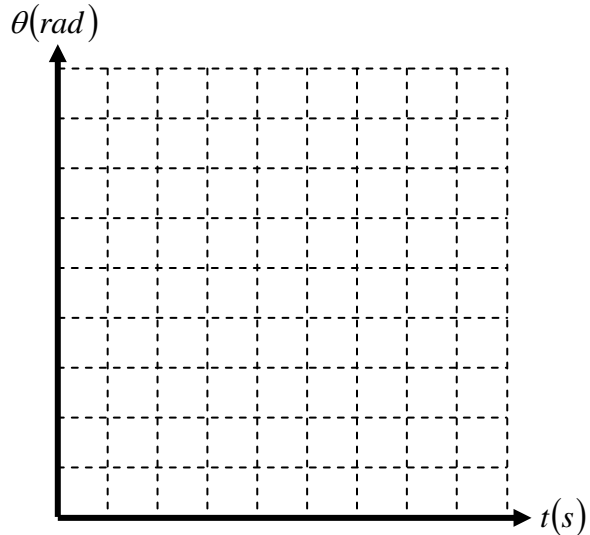# Rotation: Worksheet 5
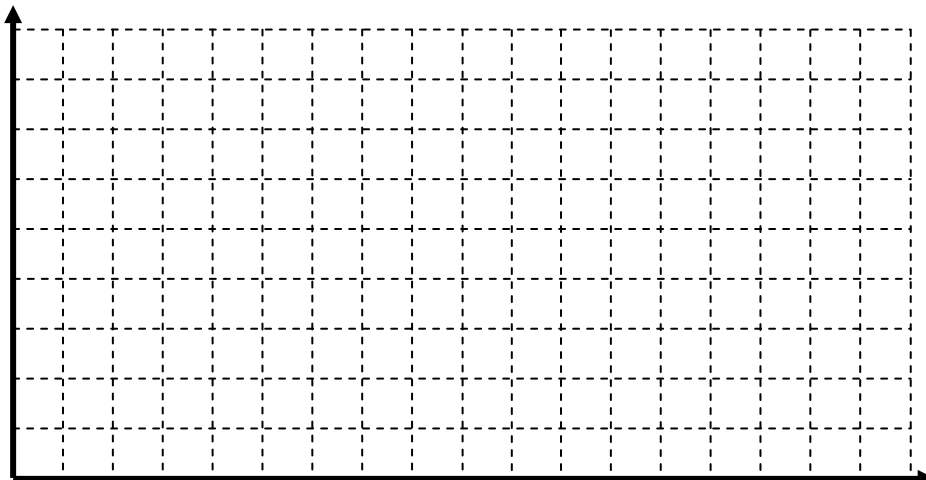# Uniform Angular Acceleration

1. The following data comes from a line drawn on a wheel from the center of the wheel out to the rim.

   a. Plot the data quantitatively.

   $\theta(rad)$

	$t(s)$	$\theta(rad)$
	0	0
	1.0	0.25
	2.0	1.00
	3.0	2.25
	4.0	4.00
	5.0	6.25
	6.0	9.00
	7.0	12.25
	8.0	16.00

   $t(s)$

   b. Draw a smooth curve through the data points. Which quantities should be graphed in order to yield a straight line?

   c. Calculate values for any of the quantities identified in (b) that are not given in the data, and record these values in the table above. Label the top of the column, including units.

   d. On the axis below, plot the quantities you indicated in (b). Label the axis with the variables, units and appropriate numbers to indicate the scale.

e. Draw a best-fit straight line through the data.

f. Write an equation for the line.

g. Since the angular position is proportional to the time squared $\left(\theta \propto t^2\right)$ the motion of the wheel must be uniformly accelerated. Hence you can compare the equation of the line to the 3rd Kinematic Equation (Rotational) and then determine the angular acceleration of the wheel.

2. A automobile tire of radius 14 *inch* $(0.356\ m)$ on a car traveling at $60\ mph$ has an angular velocity of $75.4\ rad/s$. The car slows uniformly to an angular velocity of $18.7\ rad/s$ $(15\ mph)$ in $10.0\ s$.

a. What is the angular acceleration of this tire?

b. What is the angular displacement of a line drawn on the tire from center point to rim during this acceleration? Give your answer in radians and in revolutions.

c. What is the linear displacement of the automobile during the $10.0\ sec$ of acceleration assuming that the tires do not slip?

3. A centrifuge starts from rest and reaches an angular velocity of $30\,000.\ rpm$ in $5.0\ s$. What is the angular acceleration in rad/s^2 of this device?

4. An automobile engine slows from $3000.\ rpm$ to $500.\ rpm$ in $4.0\ s$. What is the angular displacement of the engine during this time period?

5. A flywheel rotating at $20.\ rpm$ undergoes an angular acceleration of $+2.0\ rad/s^2$ for precisely $5.0\ rev$.
   a. What is the angular velocity of the flywheel at the end of this acceleration?

   Suppose the flywheel has a radius of $1.5\ m$. An ant is riding on the outside of the flywheel. After precisely $5.0\ rev$, what is the ant's
   b. linear velocity?
   c. Radial acceleration?
   d. While it is rotating, what is the ant's tangential acceleration?

6. A small rubber wheel is used to drive a large pottery wheel, and they are mounted so that their circular edges touch. The small wheel has a radius of $3.0\ cm$ and accelerates at the rate of $7.5\ rad/s^2$, and it is in contact with the pottery wheel (radius $27.0\ cm$) without slipping.
   a. Calculate the angular acceleration of the pottery wheel.

   b. Calculate the time it takes the pottery wheel to reach its required speed of $60.\ rpm$.

7. The flywheel of an engine is rotating at $25.0\ rad/s$. When the engine is turned off, the flywheel decelerates at a constant rate and comes to rest after $20.0\ s$.
   a. What is the angular acceleration of the flywheel in rad/s^2?

   b. What is the angular displacement of the wheel as it comes to rest in rad?

   c. What is the number of revolutions made by the flywheel in coming to rest?

8. A pulley wheel that is $8.0\ cm$ in diameter has a $5.6\ m$ long cord wrapped around its periphery. Starting from rest, the wheel is given a constant angular acceleration of $1.5\ rad/s^2$. The cord does not slip on the wheel.
   a. Through what angle must the wheel turn for the cord to unwind?

   b. How long does it take?

9. An astronaut is being tested in a centrifuge. The centrifuge has a radius of $10.\,m$ and, in starting from rest, rotates with uniform angular acceleration according to $\omega = 0.60t$ where t in seconds gives ω in rad/s. When $t = 5.0\,s$, what are the astronaut's

   a. angular velocity,   b. linear speed,   c. angular acceleration (compare to the 1st Kinematic Equation)

   c. tangential acceleration,   d. and radial acceleration.

10. A spaceship negotiates a circular turn of radius $3220\,km$ at a constant speed of $29\,000\,km/h$. What are the spaceship's

    a. angular speed in rad/hr,   b. radial acceleration,

    c. and tangential acceleration.