Name:_____ Peer-Leader:_____

Date: _____ _____

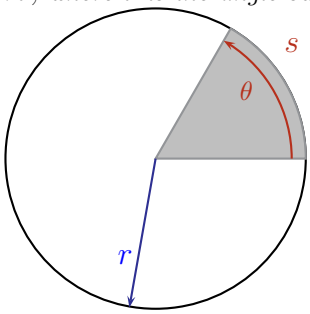
# Rotational Motion

This workshop focuses on the relationships between angular coordinates and rotational motion.

## Excercise 1:

## Angular Coordinates & Angular Frequency

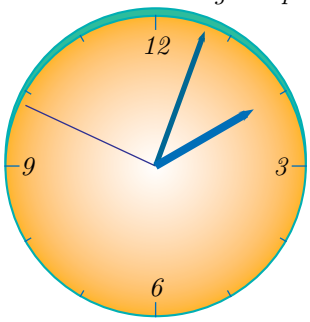
**Question 1.1** *The natural unit for angles is radians. There are $2\pi = 360^\circ$ radians in a circle. Use your knowledge of the circumference and proportionality to argue that the arc length $s$ is given by $s = r\theta$, where $\theta$ is the angle subtended by the arc-length $s$ at a distance $r$.*




**Question 1.2** *An object moves at a constant speed in a clockwise direction around the circle shown in problem one. If the object traverses a distance $\Delta s$ in a time interval $\Delta t$, write down a formula for the speed $v$ of the object in terms of these two quantities.*

*If we define the angular velocity as $\omega = \frac{\Delta\theta}{\Delta t}$, use your previous results to derive a formula for the speed $v$ in terms of $\omega$ and $r$.*

**Question 1.3** *Describe the angular position $\theta$ of the second hand as function of time.*

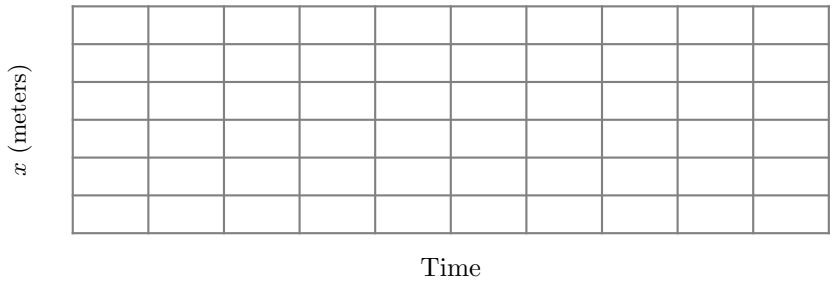


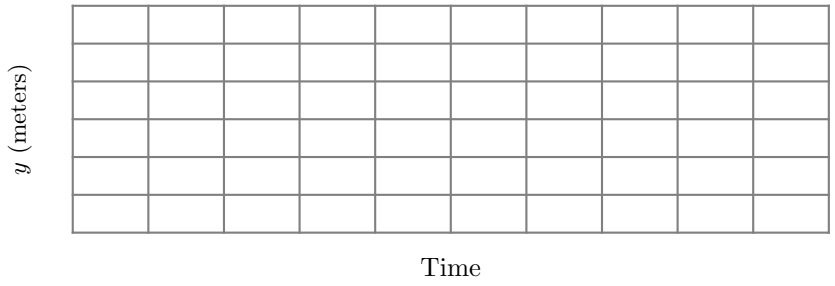
# Excercise 2:
# Graphing Position & Velocity

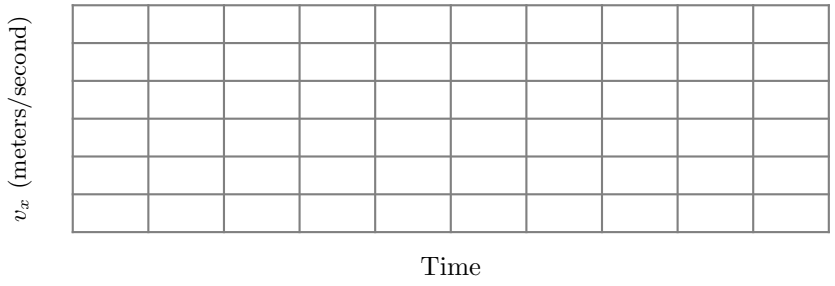
**Question 2.1** *Consider a bike which moves around a circular track of radius* 100 *m. Let the positive x direction be to the east, and the positive y direction be to the north. Write down a* **formula** *for the position* $(x(t), y(t))$ *of the bike if it travels counter-clockwise, moves at a constant speed of* $10\,\mathrm{m/s}$ *and and starts from a position of* $(100\,\mathrm{m}, 0)$ *at* $t = 0$

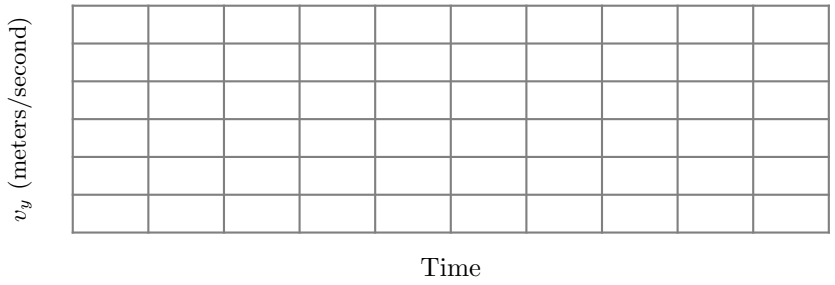
**Question 2.2** *For the same bike, write down a* **formula** *for the two components of the velocity* $(v_x(t), v_y(t))$

**Question 2.3** *Graph the two components of the position and velocity in the spaces provided below.*



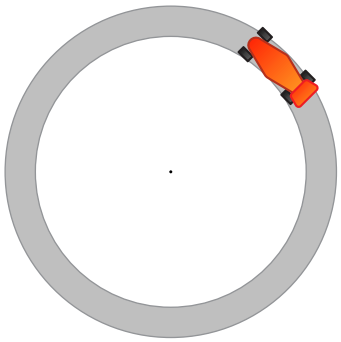



**Question 2.4** *Looking at the graphs from the previous problem. How does the slope of the x-position graph compare to the graph of $v_x$? How does the slope of the x-position graph compare to the graph of $v_y$?*

# Excercise 3:

# Angular Acceleration

**Question 3.1** *After graduation, your knowledge of physics lands you a job as a test car driver.*

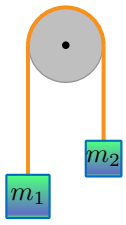


*You are driving around a circular track of radius 50 meters at a constant speed when one of your tires blows out. After the blowout your car slows down at a constant rate and comes to a stop after completing on quarter of a lap. What was your angular acceleration $\alpha$ after the flat?*

# Excercise 4:

# Torque

**Question 4.1** *Two masses $m_1 = 10$ kg and $m_2 = 5$ kg hang from Atwood's machine as shown below. The pulley is a solid cylinder of mass 2 kg and radius 10 cm. The pulley is frictionless, and the mass of the cord is negligible.*




*Find the linear acceleration of the masses and the angular acceleration of the pulley.*

# Excercise 5:
# Rotational Energy

**Question 5.1** *For the previous problem. Design a replacement pulley so that as the system accelerates, the rotational energy of the pulley is equal to the kinetic energy of the two masses.*

**Question 5.2** *Two five pound objects each rotate about their axis at an angular speed of* 100 *radians per second. One is a hollow cylinder and the second is a solid cylinder. Which object has more kinetic energy? Explain your result in as many ways as you can think of.*