Patterning - Winter
Exam 2 – Peer Review

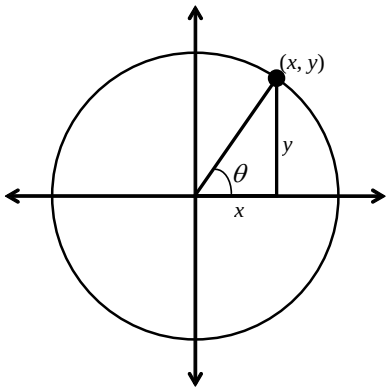
Name:_____

1. A velocipede travels at a constant angular speed around a circular track at a radius of 2.0 km. The velocipede completes 4 revolutions in 5 hours.

a) How long did the velocipede take to complete 3 revolutions?

b) What is the velocipede's linear (tangential) speed?

2. Given the unit circle to the right.



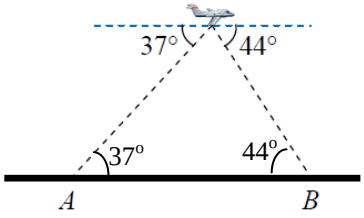
a) Which of the following are equal to $\cos\theta$? **Explain your reasoning.**

x $\quad \frac{1}{x}$ $\quad \sqrt{1-x^2}$ $\quad y$ $\quad \frac{1}{y}$ $\quad \sqrt{1-y^2}$

b) Which of the following are equal to $\sin\theta$? **Explain your reasoning.**

$1-\cos\theta$ $\quad \sqrt{1-\cos^2\theta}$ $\quad \sin(-\theta)$ $\quad \sin(\pi-\theta)$

11. A pilot is flying over a straight horizontal highway. Points A and B are 10.0 km apart. The angles from points A and B to the airplane are 37° and 44°, as shown in the figure (not to scale). Find the height of the plane above the highway.

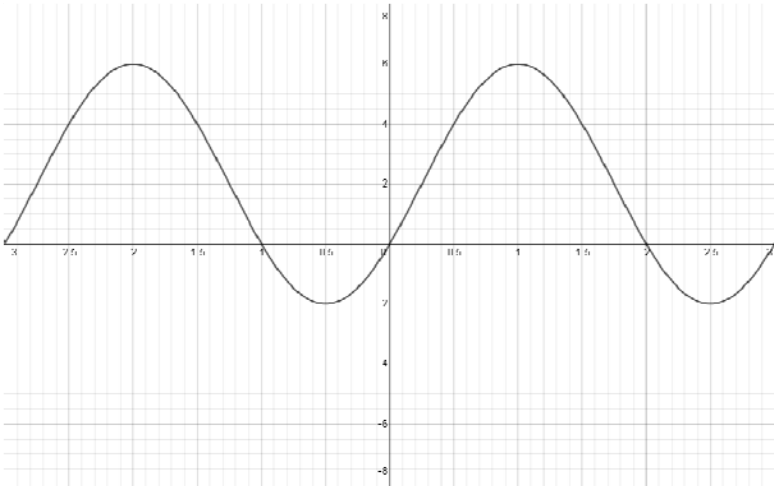


3. The Cartesian coordinate $(x, y) = (-4, 3)$ is converted to the polar coordinate (r, θ). What is θ, in degrees?

12. Sam is originally standing by a dead spider. He walks 50.0 meters in a direction 30° west of north, as shown in the figure (not to scale), where he runs into Gollum. Sam turns and runs 75.0 meters due west. He finds a Ring of Power, turns, and walks 100.0 meters due south, where he stops at his final position. Determine the magnitude and direction of the resultant displacement vector pointing from Sam's original position to Sam's final position.

4. The graph to the right is described by the function

$$y = A\cos\left(\frac{2\pi}{P}(x-h)\right)+k\,.$$



Determine A, P, k, and h (give the smallest positive value for h). **Explain your reasoning.**

13*. You are riding on a ferris wheel that moves at constant angular speed. At $t = 0$ minutes, you are at the very bottom of the ferris wheel. The function $h(t) = -10\cos\left(\frac{\pi}{5}t\right)+12$ gives your height h in meters above the ground t minutes after you were at the bottom.

a) Determine the radius of the ferris wheel, your minimum and maximum height above ground when on the ride, and the time for one full revolution. **Explain your reasoning.**

b) How high above the ground are you at $t = 5$ minutes?

c) When is the first time after $t = 0$ that you reach a height of 15 meters? Can you find another method to answer this question?

d) You realize that you are terrified of heights above 15 meters. In one full revolution, for how long are you terrified?

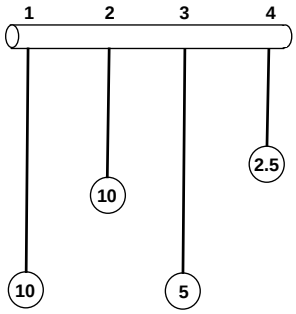
5. A population of bacteria grows in a jar. At 11:00 a.m. there is one bacterium in the jar. The bacteria divide once every minute so that the population doubles every minute. At 12:00 noon the jar is full. At what time was the jar half full? **Explain your reasoning.**

14*. A radioactive material decays at a daily rate of 10% per day. The approximate amount $A(t)$ of the radioactive material (in mg) after t days is given by the function $A(t) = 100(0.90)^t$. Give all answers accurate to 2 decimal places.

a) The daily decay rate of this material is 10% per day. What is the equivalent **<u>continuous</u>** decay rate of this material?
b) The half-life is the amount of time it takes for ½ of the radioactive material to decay. Determine the half-life.
c) How many days ago were there 102,400 mg of this material?

15*. $1000 is deposited into Bank Account A, which has an annual (compound) interest rate of 5% per year. At the same time, $900 is deposited into Bank Account B, which has an annual (compound) interest rate of 6% per year. Your goal in this problem is to determine when (accurate to 1 decimal place) the bank accounts have the same amount of money.
a) (graphical approach) If you had access to Desmos or other graphing device, how would you solve this problem?
b) (numerical approach) How would you solve this problem using a table?
c) (analytical approach) How would you solve this problem analytically?
d) Solve this problem analytically. See if you can find a simpler way to do the algebra.

7. The figure shows four pendulums. Pendulum 1 and Pendulum 3 are the same length. Pendulum 2 is shorter and Pendulum 4 is the shortest. A 10 gram mass is attached to the end of Pendulum 1 and Pendulum 2, a 5 gram mass is attached to Pendulum 3, and a 2.5 gram mass is attached to Pendulum 4.



a) Suppose you want to find out whether the length of the pendulum has an effect on the time it takes to swing back and forth. Which pendulums would you use to find out? **Explain your reasoning.**
b) Suppose you want to find out whether the mass of the pendulum has an effect on the time it takes to swing back and forth. Which pendulums would you use to find out? **Explain your reasoning.**

8 & 9. Identify the function which best models the following physical situations. For each situation, indicate whether the best function is linear, quadratic, sinusoidal, exponential, or none of these. **For each, identify the lab (or labs) where you observed/collected/analyzed the situation.**

The position vs. time for a battery powered tumble buggy moving in a straight line.

The position vs. time for a ball falling straight down only influenced by gravity.

The position vs. time for a mass on a spring moving up and down.

The x-component of position vs. time for a block sitting on a turntable that is rotating at a constant rate.

Sound pressure vs. time for a pure tone from a tuning fork.

Fundamental frequency vs. key number for notes played on a piano.

Temperature vs. time for hot water cooling in a beaker.

Period vs. length for a pendulum.

If your group finishes these questions, play with the following challenge problem.
You will be working on a job for a certain number of consecutive days. You have 2 choices for payment.

- Choice 1: You can earn $1000 on the first day, $2000 on the second day, $3000 on the third day, $4000 on the fourth day, etc. So by the end of the fourth day, you have earned $1000 + $2000 + $3000 + $4000 = $10000.
- Choice 2: You can earn $0.01 on the first day, $0.02 on the second day, $0.04 on the third day, $.08 on the fourth day, etc. So by the end of the fourth day, you have earned $0.01 + $0.02 + $0.04 +$0.08 = $0.15.

Is there a number of days when Choice 2 become better than Choice 1? If not, explain why. If yes, find that number.