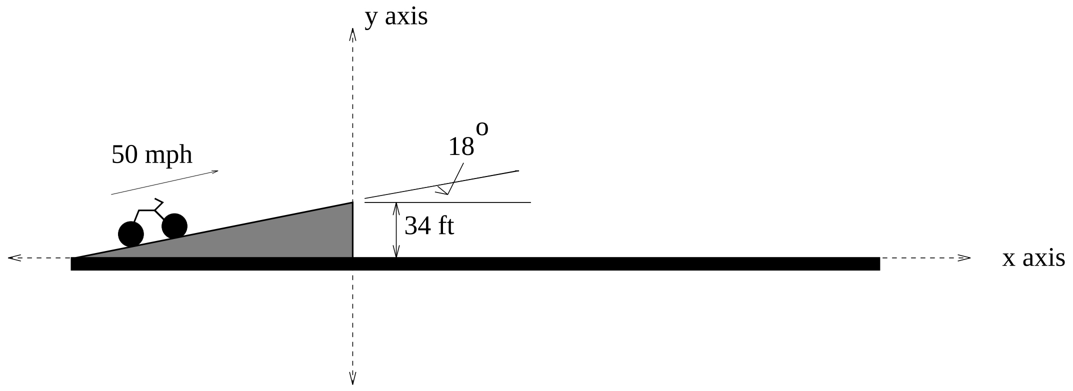
Math 120
Final Exam

Questions 1-6 refer to the following situation: *Dirtbike Magazine* has contracted you to answer five questions related to the motion of the wheels on a new brand of motorcycle. The radius of each wheel on the cycle is 12 inches. Impose a coordinate system as below, so the rider starts heading to the right on an elevated level ramp. The ramp drops off 34 feet as indicated. Assume the rider is traveling at a constant speed of 50 mph up the ramp and the angle of incline of the ramp is 18^o above horizontal.



1. What is the rotational speed of the rear wheel?

2. Let t represent time in seconds after the rear wheel leaves the ramp. Let $(x_c(t), y_c(t))$ be the xy-coordinate of the CENTER of the rear wheel t seconds after the center of the wheel crosses the y-axis (this is the same as t seconds after the rear wheel leaves the ramp.) Find the parametric equations for $x_c(t)$.

3. Let t represent time in seconds after the rear wheel leaves the ramp. Let $(x_c(t), y_c(t))$ be the xy-coordinate of the CENTER of the rear wheel t seconds after the center of the wheel crosses the y-axis (this is the same as t seconds after the rear wheel leaves the ramp.) Find the parametric equations for $y_c(t)$.

4. Find the xy-coordinate of the center of the rear wheel when $t = 1.2$ seconds.

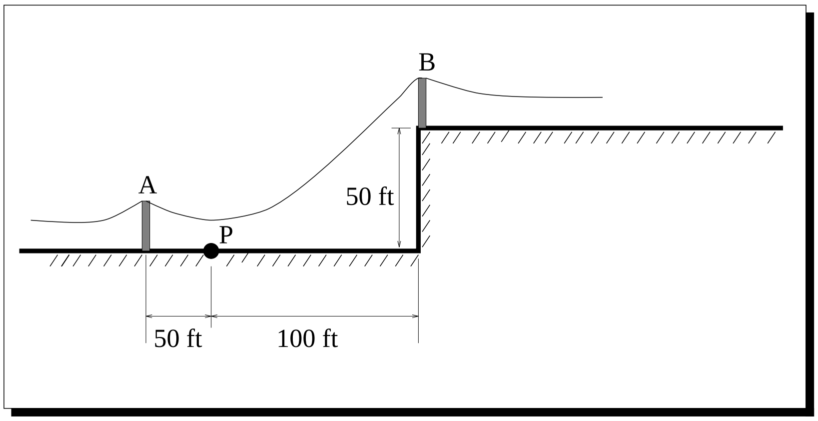
5. What is the maximum height of the center of the real wheel above the ground?

6. Let t represent time in seconds after the rear wheel leaves the ramp. Find the time t when the rear wheel lands on the ground.

Questions 7-10 refer to the following situation: *Potomac Power Co.* needs to install a new powerline from the top of a cliff to the level ground below, as pictured. If we impose a coordinate system so that the origin is at the base of pole "A", the hanging cable is modeled by a portion of the graph of

$$f(x) = 100cosh(\frac{x-50}{100}) - 80.$$

At the position labeled "P", the powerline is exactly 20 feet above the ground, which is the minimum distance from the ground to the cable.



7. Find the height of poles "A" and "B".

8. What portion of the powerline is at least 25 feet above the level ground?

9. What portion of the cable is above the level of the cliff top?

10. What is the horizontal distance from the base of pole "B" to the cable?

Questions 11-13 refer to the following situation: Your Grandfather purchased a house for \$55,000 in 1952 and it has increased in value according to a function $y = v(x)$, where x is the number of years owned. These questions probe the future value of the house under various schemes.

11. Suppose the value of the house is \$75,000 in 1962. Assume $v(x)$ is a linear function.

(a) Find a formula for $v(x)$.

(b) What is the value of the house in 1995?

(c) When will the house be valued at \$200,000?

12. Suppose the value of the house is \$75,000 in 1962 and \$120,000 in 1967. Assume $v(x)$ is a quadratic function.

(a) Find a formula for $v(x)$.

(b) What is the value of the house in 1995?

(c) When will the house be valued at \$200,000?

13. Suppose the value of the house is \$75,000 in 1962. Assume $v(x)$ is a function of exponential type.

(a) Find a formula for $v(x)$.

(b) What is the value of the house in 1995?

(c) When will the house be valued at \$200,000?

Questions 14-17 deal with the following situation: The "Jitterbug Output Emitter Splitter" circuit (the "JOES" circuit) controls the voltage output according to the formula $J(x) = 2^{cos(t)}$, where $t \geq 0$ represents time in seconds.

14. The largest possible value of $J(t)$ is

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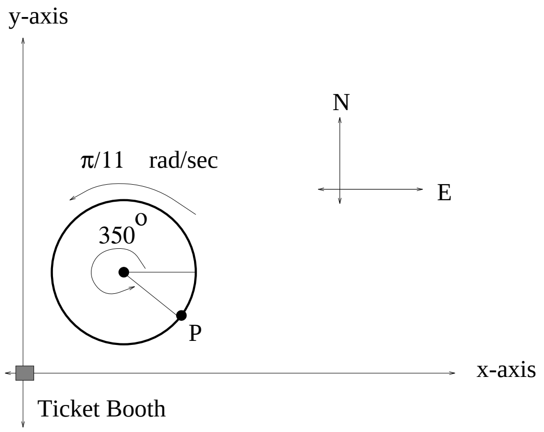
16. How many times does the JOES circuit have a voltage output of 1.5 volts during the first 2π seconds?

17. How many times does the JOES circuit have a voltage output of 2.5 volts during the first 2π seconds?

Questions 18-20 deal with the following situation: A rider jumps on a merry-go-round of DIAMETER 30 feet at the pictured location "P". The ride rotates at the constant angular speed of $\omega = \frac{\pi}{11}$ radians/second counterclockwise. The center of the platform is located 20 feet East and 20 feet North of the ticket booth for the ride.



18. What are the parametric equations describing the location of the rider?

19. Where is the rider after 18 seconds have elapsed?

20. How far from the ticket booth is the rider after 18 seconds have elapsed?