

# Physics 121 - Test 1

July 2, 2009

You have 90 minutes to complete this test. You may use your calculator and one 3" x 5" notecard of equations. Please show ALL of your work to receive full credit (free body diagrams, equations, etc.). Include units in your answers where appropriate. Try all parts of the questions, if you get stuck, write as much information as you know (concepts, equations, etc.) and what you think you should do. Partial credit available!

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1. Equation 1 describes the position of an object as a function of time.  $V_{0x}$  is the initial velocity and  $\tau$  is a constant.

$$x(t) = V_{0x}\tau(1 - e^{-t/\tau}) \quad (1)$$

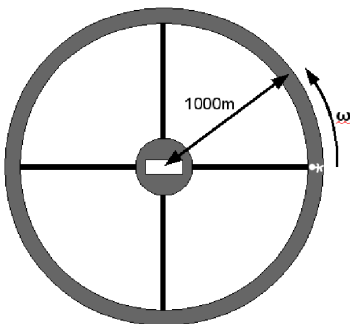
- Find an equation,  $v(t)$  that describes the objects velocity as a function of time.
- Now, find an equation,  $a(t)$  that describes the objects acceleration as a function of time.
- If  $\tau = 6.3s$  and  $V_{0x} = 25m/s$ , what is the acceleration of the object after 15 seconds?

2. The Chateau Gaillard was a castle built by Richard the Lionheart. Its defenses consisted of three walls as shown below. In 1204 A.D. King Philip of France laid siege to the castle. King Philip launches his projectiles at a  $45^\circ$  angle from an initial height of 5m and with an initial velocity of 35m/s (ignore air resistance).



- First, find out how long the projectiles are in the air.
- Now, ignoring the walls for the moment, use your answer from part a) to determine if King Philips projectiles travel far enough to land inside the castle (past the 3rd wall).
- The walls are each 10m tall. Do the projectiles clear the third wall?

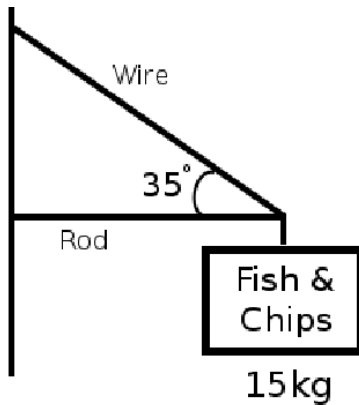
3. The figure below shows a space station like the one in the movie "2001: A Space Odyssey". It has a radius of 1000m and is rotating at some constant angular rate  $\omega$ .



- Draw a free body diagram for a person standing on the outside edge of the station with their head pointing towards the center, (imagine they are walking on the inside of a car tire) when they are located where the cross member meets the wheel on the right side of the drawing.
- If we want the person walking to experience a force equivalent to half of that felt on the surface of the earth, what rate (in revolutions per minute) must the station spin?

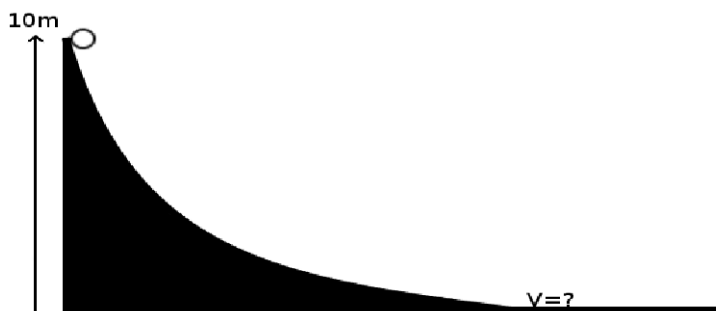
4. You are a roofer, re-shingling a roof that is at a  $35^\circ$  angle. Your hammer has a mass of 0.8kg. What is the minimum coefficient of static friction required for your hammer to stay on the roof and not slide off?

5. A sign is hanging above the door to a restaurant. It has a mass of 15kg. Ignoring the mass of the rod and wire, what is the tension in the wire and the force the rod exerts on the top of the sign?



6. A rope pulls a box a horizontal distance of 23m. If the rope tension is 120N, and if the rope does 2500J of work on the box, what angle  $\theta$  does the rope make with the horizontal?

7. A baseball has a mass of 0.145kg and is allowed to roll down the ramp shown below. The balls starting point is 10m above the floor level. What is the speed of the baseball when it reaches the floor?



8. In which of the following situations can you use Newton's laws of motion to analyze a ball tossed straight up in the air? (possibly more than one correct answer)

- a) Inside an elevator traveling up at a constant velocity.
- b) Sitting on a merry-go-round.
- c) In an airplane during takeoff.
- d) In a space ship traveling to Mars at a constant velocity.
- e) all of the above

9. On a horizontal tabletop is a curved barrier that exerts a force on a ball, guiding its motion in a circular path as shown. After the ball leaves the barrier, which of the dashed paths shown does it follow?

