Physics 211 Quiz 1

Instructions for this quiz:

This quiz has two questions, each worth 50 points, with a possibility of 10 points extra credit. It begins at 11:20 and runs until the end of class. We anticipate that it will take you no more than an hour to complete. You may have an extra ten minute grace period to scan and submit your work; if for any reason you are not able to submit your work by 12:30, please contact Walter or Mario.

Exception: Students who receive an extra-time accommodation through the Center for Disability Resources may take that extra time. If you receive 1.5x time for the quiz, you should complete by 12:50 and submit by 1:00; if you receive double time, you should complete it by 1:20 and submit by 1:30. If this timetable does not work for you or you require additional accommodations, please contact Walter or Mario immediately.

- **You must show your reasoning to receive credit**. Where appropriate you should make use of words and diagrams, alongside equations and numbers, to show your reasoning.
- You may use $g = 10\,\mathrm{m/s^2}$ throughout to minimize arithmetic.

You may either:

- Write on this document electronically, using a stylus and tablet
- Print this document out and write on it, and submit scans or photographs of it
- Write the answers on your own paper, and submit scans or photographs of it

If you submit scans or photographs, please ensure that you are submitting JPEG or PDF files. Do not submit "Live Photos" (from newer iOS devices) or .HEIC files.

You may:

- Consult any materials on the course website, video library, any of your notes, or the OpenStax textbook for reference
- Contact teaching staff to ask for clarification on any portion of the exam. (We will try to provide quick responses to emails and monitor Blackboard Collaborate and Discord during this time for your questions. Proctors will also be monitoring Blackboard Collaborate for questions.)
- Use a graphing calculator to do arithmetic or graph functions
- Make use of Google Calculator, Desmos, or similar tools to do arithmetic or graph functions
- Use a translation tool or dictionary to translate anything to your native language

You may not:

- Provide assistance to anyone else in our class on this quiz while they are taking it
- Seek assistance from anyone other than teaching staff on this quiz while you are taking it
- Use a computer program or calculator to do algebra for you
- Consult online references outside the class other than the OpenStax textbook (for example, Chegg and Coursehero) regarding the material on the quiz after the quiz period begins

Regardless of format, please copy the following text below, or write it in your submission, and sign your name to it:

> *"I affirm that my answers represent my own work and understanding, and that I have not given or received unauthorized help on this quiz."*

Reference

The quadratic formula: the equation

$$Ax^2 + Bx + C = 0,$$

has solutions

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}.$$

If acceleration a is constant, an object moving with an initial velocity v_0 starting from position x_0 will have:

$$\begin{aligned} x(t) &= \frac{1}{2}at^2 + v_0 t + x_0 \\ v(t) &= at + v_0 \end{aligned}$$

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}} \qquad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}} \qquad \tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

An obscure trigonometric identity that may be helpful, but is not necessary:

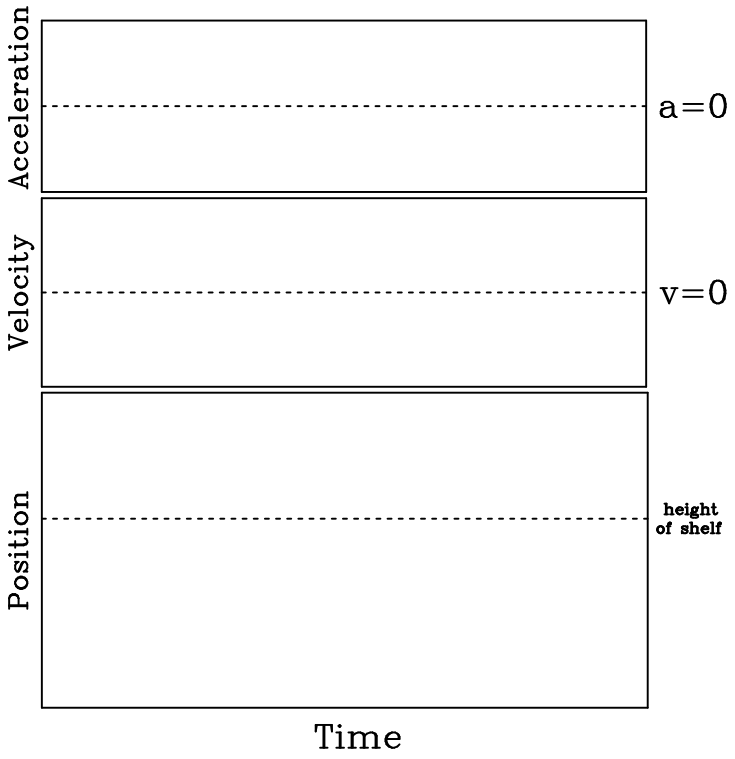
$$2\sin\theta\cos\theta = \sin 2\theta$$

Question 1

Toby the Cat is sitting on a high shelf, at a height of $h = 2$ m off of the ground. Her owner is lying on the floor in front of the shelf when she throws a toy ball straight upward at $v_0 = 6.5$ m/s. As soon as the ball passes the level of the shelf (2 m off of the ground), Toby tries to catch it. She can grab the ball as long as it is above the level of the shelf. If Toby does not grab the ball, it falls back down where her owner catches it again.

In this problem, you will calculate how much time Toby has to grab the toy before it falls back below the shelf.

a) Assuming that Toby doesn't grab the toy out of the air, sketch graphs of the ball's position, velocity, and acceleration as a function of time, from the time her owner throws it to when she catches it again. Indicate the height of the shelf on the position vs. time graph. You do not need to show precise numbers on your graphs, just their shape. Draw these graphs on the axes below. *(10 points)*



Toby the Cat and her blue toy ball. She is 15 years old and spoiled rotten by her mommy, as you can tell by all the cat toys she's surrounded by.

b) Write down algebraic expressions for the position and velocity of the ball as a function of time. *(10 points)*

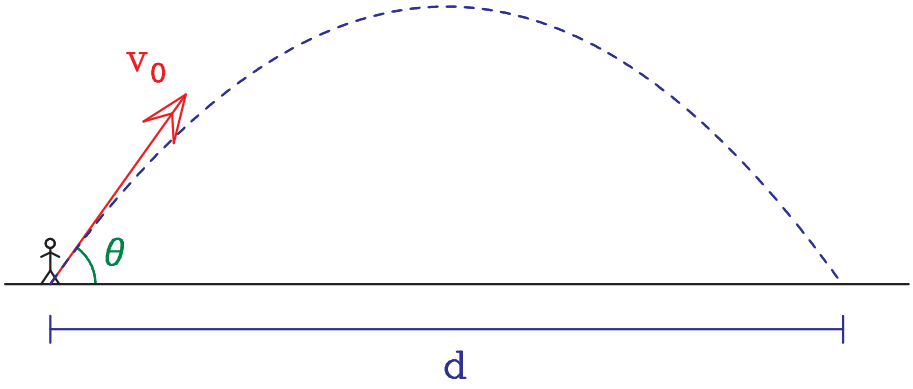
Question 1, continued

c) How much time does Toby have to grab the ball? (This is the total amount of time that it is above the level of the shelf.) *(20 points)*

d) Suppose that her owner instead throws the ball upward with a starting velocity of 5 m/s rather than 6.5 m/s. In this scenario, how much time will Toby have to grab the ball? *(10 points)*

Question 2

Our former TA Ohana is playing fetch with Rum the Physics Dog. Since he has a tendency to slobber on his ball, she kicks it for him to fetch. She kicks the ball from ground level at an initial speed v_0, directed at an angle θ above the horizontal.



Ohana's dog Rum (pronounced "room"). He is an expert in the conservation of bleps.

In this problem, you will calculate the distance d that she throws the ball in terms of v_0, θ, and g. There are *no* numbers in this problem.

a) Determine the $x-$ and $y-$components of the initial velocity of the ball in terms of v_0 and θ. *(10 points)*

b) Write down expressions for $x(t)$ and $y(t)$ that describe the ball's position as a function of time, and expressions for $v_x(t)$ and $v_y(t)$ that describe its velocity as a function of time, in terms of v_0, t, θ, and g. *(10 points)*

Question 2, continued

c) Write a sentence in terms of your algebraic variables that allows you to answer the question "How far away from Ohana does the ball land?" *(10 points)*

d) In terms of v_0, θ, and g, determine the amount of *time* that the ball spends in the air before it lands. *(10 points)*

e) In terms of v_0, θ, and g, determine the *distance* from its starting point where the ball lands. *(10 points)*

f) Based on your result in (e), argue that a 45° angle produces the maximum distance traveled. There are multiple ways that you can argue this; any sound argument is fine. *(10 points extra credit)*