PHYS 2211 M - Test 1 - Summer 2022

Please clearly print your name & GTID in the lines below

Name: _____ GTID: _____

Instructions

- This exam is closed internet/books/notes, except for the Formula Sheet which is included with the exam.
- You must work individually and receive no assistance from any person or resource.
- You are not allowed to post screenshots, files, or any other details of the test anywhere online, not even after the test is over.
- Work through all the problems first, then scan/upload your solutions after time is called.
  - Your uploaded files **must** be in either PNG, JPG, or PDF format.
  - Your uploaded files must be readable in order to be graded. Unreadable files will earn a zero.
  - You can upload a single file containing work for multiple problems as long as you upload the file for each problem individually.
  - Clearly label your work for each sub-part and box the final answers.
- To earn partial credit, your work must be legible and the organization must be clear.
  - Your solution should be worked out algebraically.
  - Numerical solutions should only be evaluated at the last step. Incorrect solutions that are not solved algebraically will receive an 80 percent deduction.
  - You must show all work, including correct vector notation.
  - **Correct answers without adequate explanation will be counted wrong.**
  - Incorrect work or explanations mixed in with correct work will be counted wrong. Cross out anything you do not want us to grade
  - Make explanations correct but brief. You do not need to write a lot of prose.
  - Include diagrams!
  - **Show what goes into a calculation, not just the final number, e.g.:** $\frac{a \cdot b}{c \cdot d} = \frac{(8\times10^{-3})(5\times10^{6})}{(2\times10^{-5})(4\times10^{4})} = 5 \times 10^{4}$
  - Give standard SI units with your numeric results. Your symbolic answers should not have units.

Unless specifically asked to derive a result, you may start from the formulas given on the formula sheet, including equations corresponding to the fundamental concepts. If a formula you need is not given, you must derive it.

If you cannot do some portion of a problem, invent a symbol for the quantity you can not calculate (explain that you are doing this), and use it to do the rest of the problem.

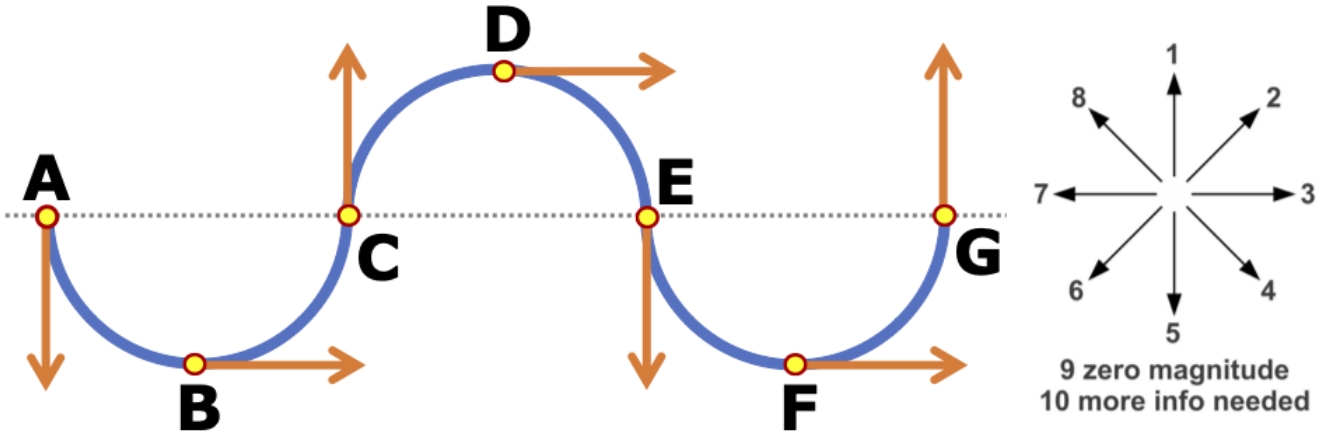
**"In accordance with the Georgia Tech Honor Code,
I have not given or received unauthorized aid on this test."**

_____

Sign your name on the line above

Vectors – Q2 in Gradescope [20 pts]

A football player practices his elusive maneuvers by running the following blue trajectory, which consists of three consecutive semicircles, all of which have the same radius and with their centers on the dotted line. He starts at location A, then moves along the trajectory to location B, then C, then D, then E, then F, and then G. At each location, an orange arrow indicates the player's **instantaneous velocity**. All the velocities have the same magnitude (speed).



Using the numbered directions shown by the rosette, indicate (by number) which arrow best represents the direction of the quantities listed below. If a quantity has zero magnitude or cannot be determined, indicate that using the corresponding number.

1. [2 pts] _____ The position vector $\vec{r}$ at location D.
2. [2 pts] _____ The (instantaneous) momentum $\vec{p}$ at location F.
3. [2 pts] _____ The change in position (displacement, $\Delta\vec{r}$) between location B and location D.
4. [2 pts] _____ The change in position (displacement, $\Delta\vec{r}$) between location A and location C.
5. [2 pts] _____ The change in velocity $\Delta\vec{v}$ between location C and location G.
6. [2 pts] _____ The change in velocity $\Delta\vec{v}$ between location B and location E.
7. [2 pts] _____ The change in momentum $\Delta\vec{p}$ between location A and location B.
8. [2 pts] _____ The change in momentum $\Delta\vec{p}$ between location E and location G.
9. [2 pts] _____ The acceleration $\vec{a}$ between location D and location E.
10. [2 pts] _____ The net force $\vec{F}_{\text{net}}$ between location F and location G.

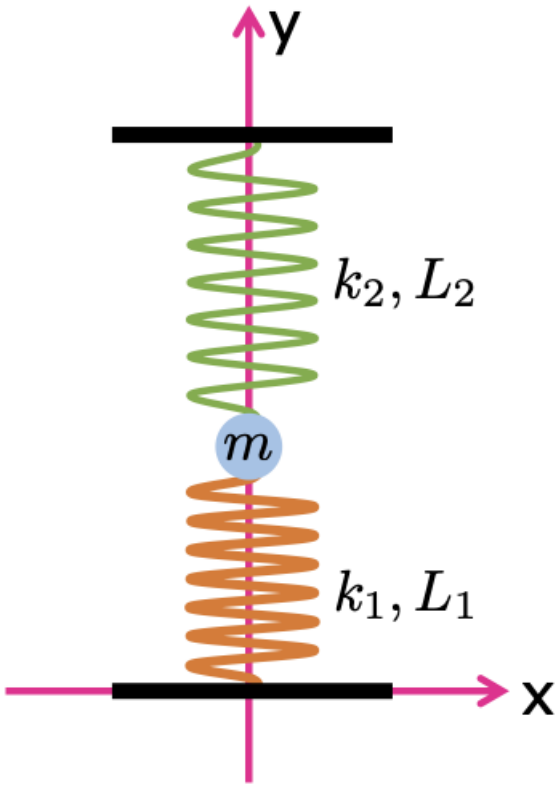
Springs – Q3 in Gradescope [40 pts]

A ball of mass $m = 5$ kg is held motionless at $t = 0$ between two vertical springs. Both springs have relaxed length $L_0 = 3$ m. The springs connect to each other at the center of the ball.

The spring on the bottom (orange) has its fixed end on the floor (at the origin of the coordinate system), has stiffness $k_1 = 300$ N/m, and is currently **compressed** to a length $L_1 = 2.5$ m.

The spring on the top (green) has its fixed end on the ceiling, has stiffness $k_2 = 100$ N/m, and is currently **stretched** to a length $L_2 = 4.5$ m.

The ceiling is at a height $h = L_1 + L_2 = 7$ m above the floor. Gravity points straight down.



1. [5 pts] What is $\vec{F}_g$, the force on the ball due to the Earth, at $t = 0$? Your answer must be a vector with appropriate units.

2. [5 pts] What is $\vec{F}_1$, the force on the ball due to the bottom spring, at $t = 0$? Your answer must be a vector with appropriate units.

3. [5 pts] What is $\vec{F}_2$, the force on the ball due to the top spring, at $t = 0$? Your answer must be a vector with appropriate units.

4. [10 pts] You now let go of the ball. Determine the velocity of the ball at time $t = 0.1$ seconds after letting go. Your answer must be a vector with appropriate units.

5. [15 pts] Determine the position of the ball at time $t = 0.1$ seconds. Your answer must be a vector with appropriate units.

ElectroGrav – Q4 in Gradescope [40 pts]

Two protons (mass $m = 1.7 \times 10^{-27}$ kg, electric charge $q = 1.6 \times 10^{-19}$ C) live in the xy plane. Proton 1 is located at position $\vec{r}_1 =< 1 \times 10^{-6}, 0, 0 >$ m, and Proton 2 is located at position $\vec{r}_2 =< 0, -1 \times 10^{-6}, 0 >$ m.

1. [15 pts] Find the position vector $\vec{r}$ that points from Proton 1 to the Proton 2, its magnitude $|\vec{r}|$, and its unit vector, $\hat{r}$.

2. [10 pts] What is the **vector gravitational force on Proton 2** due to Proton 1?

3. [10 pts] What is the **vector electric force on on Proton 2** due to Proton 1?

4. [5 pts] If nothing else is interacting with the two protons, will they move towards each other or away from each other? **Explain your reasoning**. You do not have to do any new calculations.