# Physics 211 Exam 3, Question 1

## Instructions for this exam:

This exam is in *five separate parts*. **This is not the whole exam; this is part 1 of 5.** It contains the instructions, an academic integrity affirmation, and some short answer questions.

You will download each part separately and submit it separately. All parts must be submitted to Blackboard in the same way that you submit your homework before 1 PM on Wednesday, April 8 (Syracuse time: Eastern Daylight Time, UTC -4:00).

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

This is *not* a "Blackboard exam" – you do not need to maintain a connection to Blackboard while working on it.

If there is anything interfering with your ability to submit your responses on time, please notify us as soon as possible.

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 the Virtual Physics Clinic, WeChat, and Discord.)
- Make use of Google Calculator or similar tools to do arithmetic

You may not:

- Provide assistance to anyone else in our class on this exam
- Consult online references other than the OpenStax textbook (for example, Chegg and Coursehero) regarding the material on the exam after the exam period begins

Regardless of format, please copy the following text 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 exam."*

We discussed "measurement bias" as an example of the failure of the process of science in class. This happens when measurements are made on a limited and thus biased set of data, and thus result in drawing erroneous conclusions.

The United States was unprepared in many ways for the COVID-19 pandemic; one of those ways is the *shortage of test kits* to determine if people had contracted the SARS-CoV-2 virus that causes this disease. We thus can only test a limited set of people for the SARS-CoV-2 virus.

Among people who contract the SARS-CoV-2 virus that causes COVID-19:

- Some will have no symptoms
- Some will have only minor symptoms that do not require treatment in a hospital
- Some people will have serious symptoms that lead them to seek treatment in a hospital
- Some small fraction will die

Suppose that a given city in the USA has only very limited access to SARS-CoV-2 testing. Since they have only a limited number of tests available, they only test people who come to a hospital complaining of serious symptoms. Suppose that SARS-CoV-2 testing and treatment in this city has the following outcomes:

- The city's hospitals have given 2000 tests to people with serious symptoms who have come to the hospital
- 500 of these tests have come back "positive", meaning that the patient has the virus
- 10 out of these 500 people have died

Someone writes the following about these statistics: *"In our city, there are 500 people with SARS-CoV-2. Out of these cases, 10 people have died. This means that this virus has a 2% mortality rate."*

This person has made two claims:

*(i)* that 500 people in the city have SARS-CoV-2, *(ii)* that the virus kills 2% of the people who contract it

**a) Are each of these claims accurate? If not, explain in a few sentences how measurement bias has affected their accuracy, and explain whether the true figure (for the number of cases and for the mortality rate) is likely to be higher or lower. (***8 points***)**

*(This question continues on the next page.)*

Epidemiologists are scientists who study the spread of infectious disease, trying to understand how diseases spread and how many people have them, in an effort to design better ways to stop their spread and focus resources in the right places.

Even though the USA has only a very limited number of SARS-CoV-2 tests, some epidemiologists have suggested that instead of primarily giving tests to people who are sick in hospitals, we should use some fraction of our tests to *test people chosen at random*, even those who do not appear sick.

**b) What advantages would this have, and what might we learn from it? If we have only a limited number of tests to give, why would epidemiologists want to "waste" some of them by testing people who are not seriously sick? Explain in a few sentences.** *(7 points)*

**c) Describe briefly how the conservation of momentum is a consequence of Newton's laws of motion. You may do this either in mathematics, in words, or in a combination of the two.** *(10 points)*