Physics 1020
Physics for Future Leaders

General information: Physics 1020 is a one-semester physics course for non-scientists. The purpose of the course is to provide an introduction to aspects of physics that are relevant to public policy. The goal is for students to develop a sufficient background in these topics to make intelligent decisions as informed citizens and leaders. Students will also develop a facility with "order of magnitude" scientific estimates and simple statistics relevant to political issues. This course assumes no previous exposure to physics and no mathematics beyond high school algebra. There is an optional accompanying laboratory, Physics 1020L. Physics 1020 by itself satisfies the **non-laboratory** part of the AXLE natural science requirement. Taking both Physics 1020 and Physics 1020L satisfies the **laboratory** natural science component of AXLE. Note that Physics 1020L is organized and graded as a separate course. Any questions regarding 1020L enrollment should be directed to Dr. Brenda Fabela Enriquez (brenda.fabela.enriquez@vanderbilt.edu).

Instructor: Professor Alex Lupsasca
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Office hours: 12:30-1:15 Monday-Wednesday (i.e., immediately before class), or by appointment.

Schedule: The course will meet on Monday/Wednesday/Friday from 1:25 to 2:15 in Stevenson 5-211.

Required textbook: Richard A. Muller, *Physics and Technology for Future Presidents: An Introduction to the Essential Physics Every World Leader Needs to Know.* We will not cover everything in the book, and some topics we will cover are not in the book. Note that there is a similar book by the same author without "Technology" in the title. This is a popular-level book and is NOT the textbook for the course. In addition to the textbook, I will post supplementary material to the Brightspace "Content" section from time to time.

Homework sets: There will be periodic homework sets (multiple-choice), which I will assign through the quiz function on Brightspace. The scores on your homework will not count toward your final grade, but a significant number of homework problems will appear on each exam, and doing the homework will ensure that you keep up with the class. The correct answers to the homework problems will be available immediately after you submit them.

Exams: There will be three in-class exams, plus a comprehensive final exam that covers the entire semester. The dates and the material covered for the in-class exams will be announced at least one week in advance. The exams will be multiple-choice on bubble sheets. Exams will be closed book and with no notes, but I will provide a formula sheet for each exam with any necessary formulas or equations, and you may use a calculator. The exams will cover material from the lectures and the homework sets, but you are not responsible for material in the textbook that was not covered in class. You are responsible for material covered in class that is not in the textbook.

Grades: I will drop the lowest of your three in-class exam grades. Your final grade will be determined by your two best in-class exams ($2 \times 25\%$) and the final exam (50%).

Class attendance: I will not take attendance, but it is important to attend the lecture for a variety of reasons: (1) Some material will be discussed at greater length than is given in the textbook, and some lecture material will not be in the textbook at all, (2) you will have the opportunity to ask questions about anything that seems confusing, (3) you will be able to answer truthfully when your parents ask if you are attending class. **Please ask questions in class!** If something is confusing you, it is likely confusing everyone else as well, so you are doing everyone a service by asking about it. And the whole point of attending a university is being able to interact with your professors.

Course outline

1. Introduction: The nature of science. Scientific questions versus public policy questions. Review of scientific notation and units.
2. Energy: Conservation of energy, sources of energy, and trade-offs in generating energy. (Muller: Chapter 1)
3. How many piano tuners are there in Chicago? A guide to estimation problems in science and in real life.
4. Thermodynamics and heat: How do engines work? Can you build a perpetual motion machine? What is entropy and why does it keep increasing? (Muller: Chapter 2)
5. Introduction to statistics: The normal distribution. Counting statistics. What constitutes "evidence" in science? Applications to vaccine effectiveness and political polls.
6. Light and radiation: How safe are X-rays? How do night-vision goggles work? Why does the government own the radio spectrum? Do cell phones cause cancer? (Muller: Chapter 9)
7. The greenhouse effect and what causes it. Climate change and global warming. (Muller: Chapter 10)
8. Nuclei and radioactivity: Radiation safety and the uses of radioactive materials (Muller: Chapter 4)
9. Nuclear fission and the history of the atomic bomb. (Muller: Chapter 5)
10. Nuclear reactors: How do they work? How safe are they? (Muller: Chapter 5)
11. Nuclear weapons. (Muller: Chapter 5)
12. Quantum mechanics, semiconductors and the computer revolution, quantum computing. (Muller: Chapter 11)
13. Lies, damned lies, and science on the internet: how to tell sense from nonsense.
14. Why does the government fund science? Should it?
15. The space program: Why go into space? Should we send people or robots? Is it worth the money?
16. Existential threats: Giant asteroids, nuclear wars, and artificial intelligence. Should you be worried?