Introduction to Mechanics

This brief introduction includes problem-solving techniques, dimensions and units, fundamental forces, Newton's laws of motion and gravitation, kinetic energy, and momentum.

A. Read the **syllabus**, and the following selections on the web page:
students, **Weiman**, **Lang**, **Sivjee**, **Hubsch**, and **Reynolds**.

B. Read these **sections** in *Fundamental Physics*: 1-1 through 1-3, 5-1, 5-3, 7-1, 9-3, 13-1

C. Read the selections by **Pannekoek**, **French**, and **Peterson**.

Problems

D. Understand (be able to solve) the following **Sample Problems** in *Fundamentals of Physics*: 5.01, 7.01

E. Solve the problems below.

1. How many zeptoliters in a 12 oz glass of water?

2. You push a 40-kg table horizontally across a frictionless floor with a force of 20 N. (a) What is the table's acceleration? (b) Calculate the rate of change of the table's momentum, dp/dt.

3. You have a mass of 75 kg. If you stand on a scale, what downward force does your feet exert on the scale? What upward force does the scale exert on your feet?

4. Calculate the magnitude of the gravitational force between two people — each weighing 700 N — if they are 2 m apart.

5. Calculate the kinetic energy and the magnitude of the momentum of a baseball (0.145 kg) thrown at 100 mph. Express your answers in SI units.

6. One tropical year is 365.2422 days long (one day is, of course, defined as 86,400 s, and a tropical year is the year of the seasons). A good approximation, however, is $\pi \times 10^7$ s. (a) Calculate the percent error of this approximation. (b) Calculate the difference (in days, hours, minutes, and seconds) between the approximation and the actual length of the year.

7. The two stars nearest to the Sun are Proxima Centauri (4.24 light years away) in the constellation Centaurus, and Barnard's star (5.96 light years away) in the constellation Ophiucus. The apparent angle between them is 77.9 degrees. Calculate the straight line distance between these two stars.

8. Calculate (a) the speed of a point on the Earth's equator due to the Earth's spin around its axis, (b) the speed of the Earth due to its orbit around the Sun, and (c) the speed of the Solar System due to its orbit around the center of the Milky Way galaxy.

9. A proton is approximately a sphere with a diameter of about 1.2 fm (1 fm = 10^{-15} m), and a mass of approximately 1.67×10^{-27} kg. What is the density of a proton? Is this more dense or less dense than water?