Homework 1
Physics 1000
Preparatory Physics
Due: Friday January 17, 1997

Reading Assignment

Basic Technical Physics, by Tippens. Chapter 1, sections 2, 3, 4. Chapter 2, sections 1, 2, 3, 4, 6, 10.

Written Assignment

History and Scientific Methodology

1. The most important principles of physics include

(a) Newton's 3 Laws	(f) The Conservation of Weight
(b) Leibniz's 3 Laws	(g) The Conservation of Energy
(c) $F = ma$	(h) The Conservation of Angular Momentum
(d) $F = mb$	(i) The Conservation of Angular Force
(e) $F = mc$	

   Answer: The answer to this question is (a), (c), (g), and (h). Newton's 3 Laws include (c), which is Newton's 2nd Law. Answers (d) and (e) are just nonsense. Weight is not conserved. For example, if you'd go to the Moon your weigt would be about 1/6 of what it is on Earth. (A very effective diet, indeed!) There is no such thing as angular force. The three conserved quantities are energy, momentum, and angular momentum as discussed in Lecture 2.

2. Which of the following are hallmarks of the scientific method:

   (a) Scientific statements are falsifiable in principle.

   (b) Scientific theories and principles are immutable.

   (c) Observation and experiment are very important in science.

   (d) Statements made by scientific geniuses are invariably right.

   Answer: Both (a) and (c) are right. The word 'immutable' means unchangeable. Scientific theories are designed to change – if they are wrong – so (b) is incorrect. Of course, answer (d) is just silly.

Positive and Negative Numbers (Section 1-1 of Tippens)

3. Let distances above the ground be positive and distances below the ground be negative. If an object is dropped from 10 m above the ground into a 20 m deep hole, what is the difference between the initial and final positions? (That is, how far has the object dropped?)

   Answer: This problem is designed to test your ability to substract numbers in which one is negative. Let y_1 be the height the object is dropped from and y_2 be the depth it is dropped to. Then the distance, d, that the object has fallen is the absolute value of the difference between these two locations: $d = |y_1 - y_2|$. It is the absolute value of the difference between the two locations because the distance between two objects is always positive. Recall that the absolute value of number x, $|x|$, is always positive. It's equal to x if $x \geq 0$ and $-x$ if $x < 0$. We are told that $y_1 = +10$ m and $y_2 = -20$m. So $d = |10 - (-20)|$ m $= |10 + 20|$ m = —30—m = 30m.

Exponents and Scientific Notation (Sections 1-3 and 1-4 of Tippens)

4. True or False. A negative number when raised to an odd power is always negative.

   Answer: True! For example, let the number be -2 and the odd power be 3. Then (-2)(-2)(-2) = 4(-2) = -8. To see that it's true in general consider $(-a)^n$, where a is positive and n an odd integer. $(-a)^n = (-1a)^n = (-1)^n a^n$. Since a is postive, a^n must be postive. The number $(-1)^n$ is just the product of (-1) times itself n times. Write this such that you group pairs of (-1)'s as follows: $(-1)^n = [(-1)(-1)][(-1)(-1)]\ldots[(-1)(-1)](-1) = [1][1]\ldots[1](-1) = -1$. Since n is odd, there will be one -1 left over after all of the other -1's have been grouped together. Thus, $(-1)^n = -1$ if n is odd. Therefore, $(-a)^n = -a^n$ which is negative, since a^n is postive.

5. Write the following in scientific (or powers of 10) notation (e.g., $5,124 = 5.124 \times 10^3$; $0.00123 = 1.23 \times 10^{-3}$):

   (a) $123 = 1.23 \times 100 = 1.25 \times 10^2$

   (b) $1/4 = 0.25 = 2.5 \times 0.1 = 2.5 \times 10^{-1}$

   (c) $38,889/9 = 4321 = 4.321 \times 1000 = 4.321 \times 10^3$

   (d) $(3.156 \times 10^3)/0.25 = 3.156/0.25 \times 10^3 = 12.62 \times 10^3 = 1.262 \times 10^1 \times 10^3 = 1.262 \times 10^4$

   (e) $(4.23 \times 10^2)(8.14 \times 10^{-1}) = (4.23)(8.14) \times 10^2 \times 10^{-1} = 34.4 \times 10^{2-1} = 34.4 \times 10^1 = 3.44 \times 10^1 \times 10^1 = 3.44 \times 10^2$

Units Conversion (Sections 2-6 and 2-10 of Tippens)

6. Perform the following unit conversions in which all answers are expressed in scientific notation (powers of 10):

   (a) 4 m $\rightarrow$ feet: 4 m $\left(\frac{3.281 ft}{1m}\right) = 13.12$ ft.

   (b) 12 mi $\rightarrow$ km: 12 mi $\left(\frac{1.61km}{1mi}\right) = 19.3$ km.

   (c) 4.32 months $\rightarrow$ sec: 4.32 months $\left(\frac{30days}{1month}\right)\left(\frac{24h}{1day}\right)\left(\frac{3600s}{1h}\right) = (4.32)(30)(24)(3600)$ sec $= (4.32)(3.0)(2.4)(3.6) \times 10^{1+1+3}$ sec $\sim 112 \times 10^5$ sec $= 1.12 \times 10^{2+5}$ sec $= 1.12 \times 10^7$ sec.

   (d) 60 mi/hour $\rightarrow$ km/s: 60 mi/h $\left(\frac{1.61km}{1mi}\right)\left(\frac{1h}{3600s}\right) = \frac{(60)(1.61)}{3600}$ km/s $= (6.0)(1.61)(3.6) \times 10^{1-3}$ km/s $= 34.8 \times 10^{-2}$ km/s $= 3.48 \times 10^{1-2}$ km/s $= 3.48 \times 10^{-1}$ km/s.

   Note: Values for certain unit conversions are given on p. 33 of Tippens. In converting from one system of units to another, the point is to multiply by conversion factors such that the units cancel in the numerator and the denominator leaving the desired unit(s) uncancelled. In part (c), I used 30 days in a month. It would be fine to use any reasonable value for the number of days per month, such as 28 days or 29 days or 31 days or (365/12) days, etc.