PHY 140Y - FOUNDATIONS OF PHYSICS
2001-2002
Solutions for Tutorial Questions #1
September 17/18

The first tutorial session will be used to give you an introduction to the new PHY 140Y laboratory. ***You should go to room MP222 for the hour of your first tutorial on September 17/18.*** *This first set of questions will therefore not be fully covered in a tutorial class. Most of these questions should be review material - try them yourself and compare your answers with the solutions that will be posted on the WWW by September 24. If you need help with these questions, see Prof. Strong or ask your TA during your tutorial on September 24/25.*

Units and Dimensional Analysis

1. The metre is now defined as the length of the path travelled by light in vacuum during a time interval of 1/299,792,458 of a second.
   (a) What is the speed of light in m/sec?
   (b) What is the speed of light in km/hour?
   (c) What is the speed of light in miles/hour?

2. The speed of waves in deep water depends only on the gravitational acceleration g, which has dimensions L/T^2, and on the wavelength λ, which has dimension L. Which of the following could be the correct formula for the wave speed?
   (a) $v = \sqrt{g/\lambda}$ (b) $v = \lambda g^2$ (c) $v = \sqrt{\lambda g}$

3. Energy has dimensions ML^2/T^2. The energy U stored in a stretched spring is given by an equation of the form $U = \frac{1}{2} kx^{\alpha}$, where k is a constant with the dimensions M/T^2, and x is the stretch. What should be the value of the exponent α?

4. The number 3.6 has two significant figures, and represents a value that is closer to 3.6 than to 3.5 or 3.7. Thus, the actual value lies between 3.55 and 3.65. Show that the percentage uncertainty implied by two significant figure accuracy varies with the value of the number, being smaller for numbers beginning with 9 and larger for numbers beginning with 1. What is the percentage uncertainty implied by the following numbers?
   (a) 1.1 (b) 5.0 (c) 9.9

5. (a) Compare the values obtained for the following expressions by maintaining extra significant figures until the end and by rounding off at the intermediate step: $(17.8 + 0.06) \times 4.93$ and $(17.8 \times 4.93) + (0.06 \times 4.93)$.

(b) Do the same for the following expression. How many significant figures should be maintained in the final answer? $(0.9 + 0.06) \times 6.71$

Scalars and Vectors

6. Two vectors are given by $\vec{a} = 4\hat{i} - 3\hat{j}$ and $\vec{b} = -\hat{i} + \hat{j} + 4\hat{k}$. Find

(a) $\vec{a} + \vec{b}$

(b) $\vec{a} - \vec{b}$

(c) the magnitudes of $\vec{a}$ and $\vec{b}$, and the direction of $\vec{a}$ with respect to the x axis; sketch $\vec{a}$ and $\vec{b}$ in an x-y-z co-ordinate system

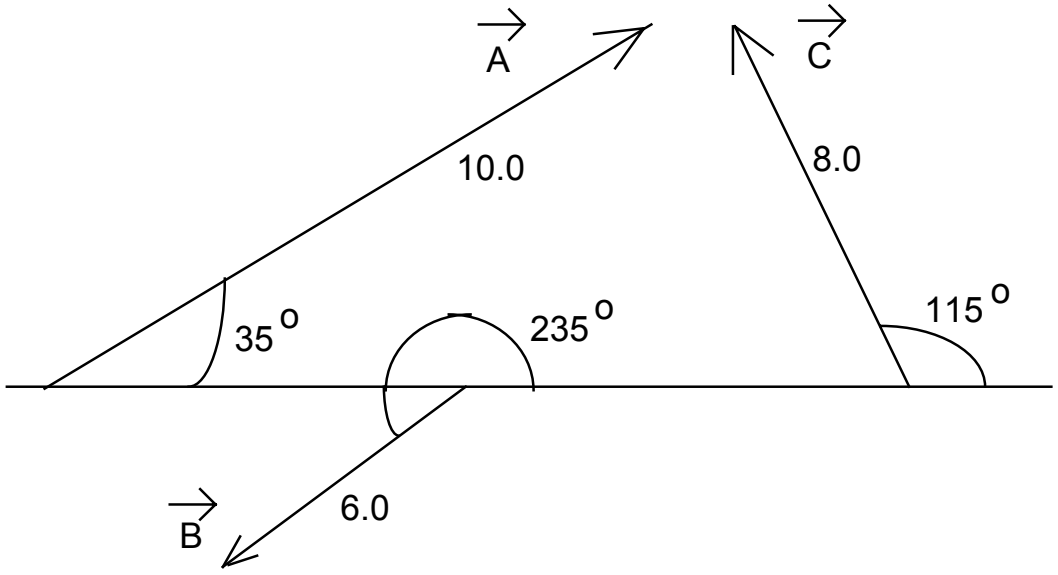
(d) a vector $\vec{c}$ such that $\vec{a} - \vec{b} + \vec{c} = 0$.

7. Given the vectors shown in the diagram below, calculate the x and y components, the magnitude, and the angle with respect to the x axis of the following combinations:

(a) $\vec{A} + \vec{B}$

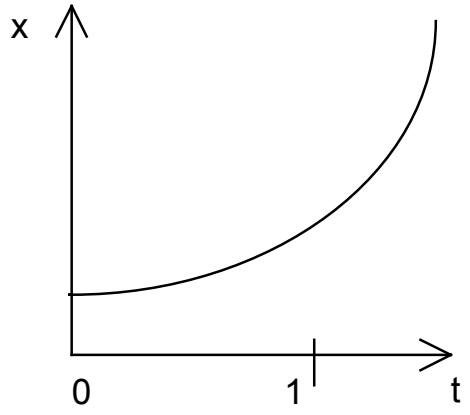
(b) $\vec{B} - \vec{C}$

(c) $1.5\vec{A} + 3.0\vec{B} - 1.7\vec{C}$.



Differentiation and Integration

8. The position of an object is given as a function of time t: $x = a + bt + ct^2 + dt^3$ where a, b, c, and d are constants. What is the speed, v, of the object as a function of time? A portion of the curve x vs. t is shown below. Sketch the geometrical representation of the average velocity for the interval 0 to 1, v(0), and v(1).



9. Given a function f(x) = x, what is the value of the definite integral $\int_a^b f(x)dx$?

Confirm this geometrically.

10. Given a function $f(x) = 3x^2 + 7e^{4x}$. Derive the expression for the indefinite integral $g(x) = \int f(x)dx$. If g(0) = 1.5, then what is the expression for g(x)?

11. What are (a) the derivatives $\frac{df(x)}{dx}$, and (b) the indefinite integrals $\int f(x)dx$, of the following common functions (assume that "a" is a constant)?
f(x)=a, f(x)=a x^n, f(x)=sin(x), f(x)=cos(x), f(x)=tan(x), f(x)=e^{ax}, f(x)=ln(ax), f(x)=1/x, f(x)=$1/(x^2 + a^2)$, and f(x)=$x/(x^2 \pm a^2)^{0.5}$.