Unit 1 *Homework Problems*

Learning Goals:

F.1a Given a measurement, determine the number of significant figures and implied uncertainty and perform unit conversions.
F.1b Add and subtract 2D vectors graphically and mathematically.
F.1c Find the components of a 2D vector given its magnitude and direction, and vice versa.

1-1) Estimate the average speed, in m/s, with which the hair on your head grows. Make this estimate from your own experience noting, for instance, how often you cut your hair and how much you trim. Express your result in scientific notation.

1-2) Determine the number of significant figures and the implied uncertainty for each number below.

(a) 214

(b) 81.60

(c) 7.03

(d) 0.03

(e) 0.0086

(f) 3236

(g) 8700

The *Galaxy Song* that was performed as part of a popular Monty Python movie provides a wonderful opportunity to practice changing units and expressing large numbers in scientific notation. Here are the words:

Galaxy Song

Just remember that you're standing on a planet that's evolving,
And revolving at **nine hundred miles an hour**,
That's orbiting at **ninety miles a second**, so it's reckoned,
A sun that is the source of all our power.
The sun and you and me and all the stars that we can see,
Are moving at a **million miles a day**,
in an outer spiral arm, at **forty thousand miles an hour**,
Of the Galaxy we call the Milky Way.
Our Galaxy itself contains a hundred billion stars.
It's **100,000 light years** side to side.
It bulges in the middle, **16,000 light years** thick
But out by us it's just **3,000 light years** wide

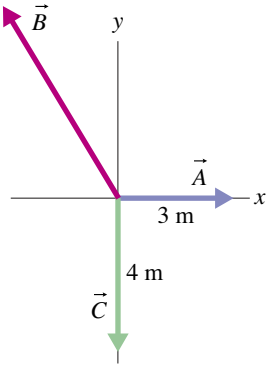
We're 30, 000 light years from galactic central point,
We go round every 200 million years.
And our Galaxy is only one of millions of billions
in this amazing and expanding Universe.
The Universe itself keeps on expanding and expanding
In all of the directions it can whizz
As fast as it can go, at the speed of light you know,
12 million miles a minute, and that's the fastest speed there is.
So remember when you're feeling very small and insecure,
How amazingly unlikely is your birth
And pray that there's intelligent life somewhere up in space,
Because there's bugger all down here on Earth.

You can listen to Eric Idle sing the Galaxy Song by following the link on the homework page, where you found this homework assignment.

1-3) The phrase "a hundred billion stars" in the first verse of the *Galaxy Song* can be written as 100 times 1,000,000,000 which can in turn be rewritten as 100×10^9 stars = 1.00×10^{11} stars. Find all the numbers in the First Verse of Galaxy Song that are printed in **bold letters** and write them in scientific notation with appropriate abbreviations for the units as shown in the back of the Activity Guide.

1-4) When Pheidippides ran from Marathon to Athens in 490 B.C.E. to bring word of the Greek victory over the Persians, he probably ran at a speed of about 23 rides per hour (rides/hr). The ride is an ancient Greek unit for length, as are the stadium and the plethron: 1 ride was defined to be 4 stadia, 1 stadium was defined to be 6 plethra, and, in terms of a modern unit, 1 plethron is 30.8 m. How fast did Pheidippides run in kilometers per second (km/s)? Don't forget to use the chain-link method to write out the factors as was used in the example in Section 1-5 of the Matter & Interactions textbook.

1-5) Consider the three position vectors – $\vec{A}$, $\vec{B}$, and $\vec{C}$ – shown in the figure.



(a) Write vector $\vec{A}$ in component form using unit vectors.

(b) Write vector $\vec{C}$ in component form using unit vectors.

(c) If $\vec{A} + \vec{B} + \vec{C} = (0\text{m})\hat{x} + (+1\text{m})\hat{y}$, what is vector $\vec{B}$? Write it in component form using unit vectors. (Notice that I put an explicit + sign in front of the 1m – I would encourage you to do that for all positive vector components.)

(d) Do any of the components of vector $\vec{B}$ relate to any of the components of vector $\vec{A}$?

(e) Add the vectors $\vec{A}$, $\vec{B}$, and $\vec{C}$ graphically by drawing them "head to tail" on a coordinate system. Check that the resultant vector matches the answer from part (c). Be sure to scale each vector and orient them correctly.

(f) Write vector $\vec{B}$ in magnitude and direction form (*i.e.*, give the angle the vector makes with the +*x*-axis).

(g) Consider a different coordinate system, *x*′*y*′, where vector $\vec{B}$ has only a *y*-component (*i.e.*, a coordinate system where vector $\vec{B}$ is parallel to the +*y*′ axis). What angle does the positive *x*′-axis make with the positive *x*-axis?

1-6) Problem 1.9.1 from the Activity Guide.

1-7) Remember from reading the syllabus that you will have an 8.5" × 11" piece of paper that you can write your own notes on for use with the Foundational and Advanced Skill assessments. Based on completing the Activity Guide and the homework, what key notes, equations, definitions, etc. will you add to your equation sheet for this unit? (Remember you'll need to fit 13 units worth of notes onto the front/back of the paper.)