AP HW 1: Prerequisites

Full Name - Period: **due: 8/13**

1 Look mom, I can do physics with no equations!

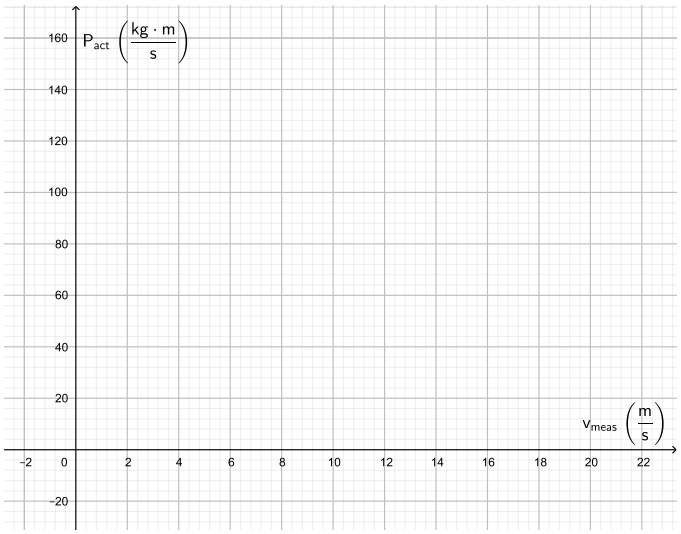
Use dimensional analysis to determine the electric potential (V) of a particle with charge q as a function of the distance from the particle. The units of electric potential are $\frac{\text{J}}{\text{C}}$.

1. Write an equation for the potential in terms of the Coulomb constant $k_c = 9 \times 10^9 \ \frac{\text{N}\cdot\text{m}^2}{\text{C}^2}$, the distance (R) and the charge (q). Answers that do not use dimensional analysis will not receive credit.

2. Evaluate your equation for a particle with a charge of 1 C at a distance of 1 m.

2 A first glimpse of what is to come

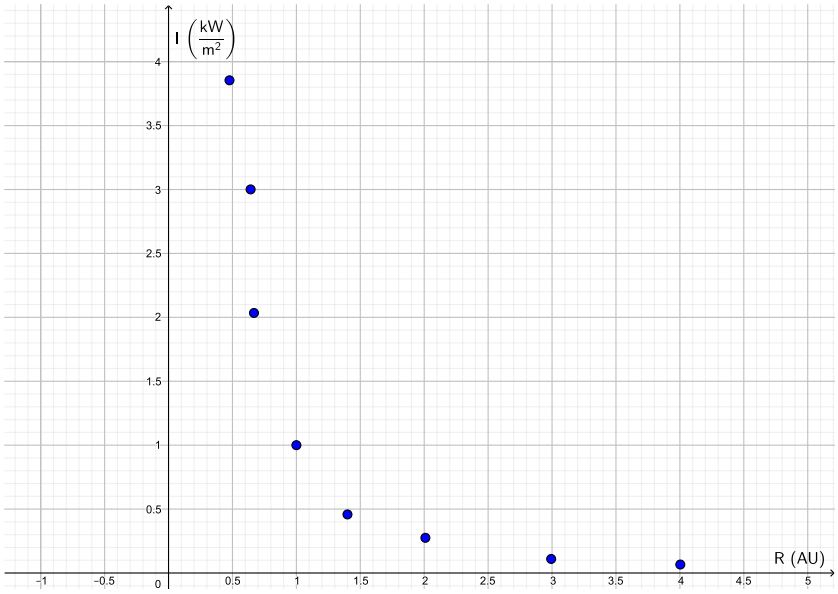
You measure the physics unicorn to have a velocity of 10 $\frac{\text{m}}{\text{s}}$ ± 1 $\frac{\text{m}}{\text{s}}$. It's mass is exactly 10 kg. Plot the measured velocity and actual momentum with appropriate error bars.



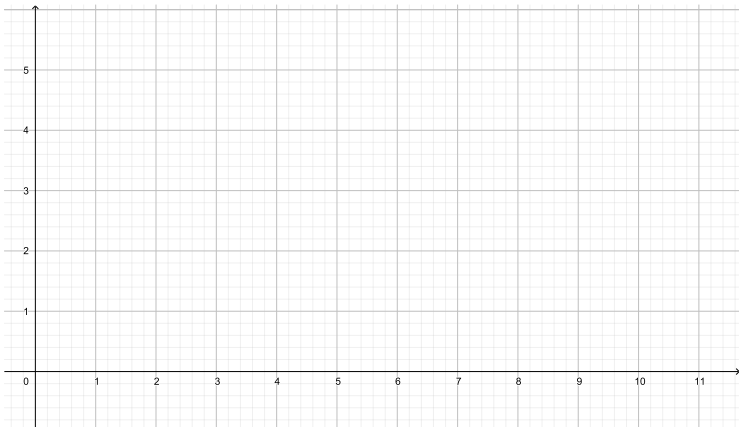
3 I'm so bright that I heat entire planets.

Below is a graph that represents the intensity of sunlight as a function of the distance away from the sun (imagine a probe traveling from Mercury to Pluto and recording the solar intensity). For reference, the general equation for intensity is

$$I = \frac{L}{4\pi R^2}$$



1. Find a way to linearize the data and plot the data on the axis below (hint, the resulting line should be almost straight!). Pay attention to the units, they might not be what you expect.

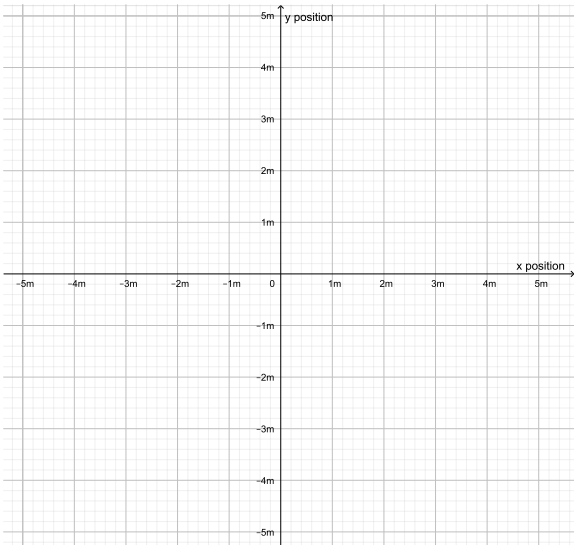


2. Draw a trend line and use it to find L. Record the value of L here:

4 Buried treasures and bad life choices

You unwisely allow a physicist to write the map to your buried treasure. Instead of a map, she writes the list of instructions given below. For readability she dropped the units, but all values are given in meters.
First walk $\vec{q} = 2\hat{x} + 1\hat{y}$
From there, walk $\vec{s} = -2\hat{x} - 3\hat{y}$
From there, walk $\vec{u} = -4\hat{x} + 1\hat{y}$
Finally walk $\vec{w} = 2\hat{x} - 3\hat{y}$

1. Graph the path on the axis below.



2. Write a single vector (in terms of $\hat{x}$ and $\hat{y}$) that represents the displacement to the treasure. Then graph that vector on the axis with the label $\vec{r}$.

3. How much longer was your distance traveled following the map than it would have been if you had simply walked along $\vec{r}$.

5 Challenge Problem (optional)

You walk with a position vector given by $\vec{r}(t) = A\cos(t)\hat{x} + A\sin(t)\hat{y}$ where A is some undetermined constant. At time $t = 2\pi$, find your displacement and distance traveled (you may leave your answer in terms of A where necessary).