Generally useful constants (MKS):

```
amu = 1.6605 (10^-27) kg
NA = 6.02221 (10^23) / mole
k = 1.38066 (10^-23) J / K
me = 9.1094 (10^-31) kg
h = 6.62608 (10^-34) J s
q = 1.6022 (10^-19) C
c = 2.9979 (10^8) m / s
```

1.6605×10^{-27} kg

$\frac{6.02221 \times 10^{23}}{\text{mole}}$

$\frac{1.38066 \times 10^{-23}\ \text{J}}{\text{K}}$

9.1094×10^{-31} kg

6.62608×10^{-34} J s

1.6022×10^{-19} C

$\frac{2.9979 \times 10^{8}\ \text{m}}{\text{s}}$

Problem 1.11 (Engel)

Graph these data (taken from photoelectric experiment on potassium metal).

10^{19}Kinetic Energy (J)	λ (nm)
4.49	250
3.09	300
1.89	350
1.34	400
0.700	450
0.311	500

Use these data to obtain 1) potassium's work function, and 2) an estimate of *h*.

Solution

Strategy. First, convert λ to ν. Then plot KE vs. ν. We expect the data to fall on a line, $h\nu$ - ϕ. Thus, the negative of the y-intercept gives the work function, and the slope is h.

Execution. Define λ as a list variable

```
λ = {250, 300, 350, 400, 450, 500} nm

{250 nm, 300 nm, 350 nm, 400 nm, 450 nm, 500 nm}
```

Convert nm to m

```
λ = λ (m / (10^9 nm))
```

$$\left\{\frac{m}{4000000}, \frac{3\,m}{10000000}, \frac{7\,m}{20000000}, \frac{m}{2500000}, \frac{9\,m}{20000000}, \frac{m}{2000000}\right\}$$

Calculate λ to ν

```
ν = c / λ
```

$$\left\{\frac{1.19916\times10^{15}}{s}, \frac{9.993\times10^{14}}{s}, \frac{8.56543\times10^{14}}{s}, \frac{7.49475\times10^{14}}{s}, \frac{6.662\times10^{14}}{s}, \frac{5.9958\times10^{14}}{s}\right\}$$

Define KE as a list variable

```
KE = {4.49, 3.09, 1.89, 1.34, 0.700, 0.311} (10^-19) J
```

$$\{4.49\times10^{-19}\,J, 3.09\times10^{-19}\,J, 1.89\times10^{-19}\,J, 1.34\times10^{-19}\,J, 7.\times10^{-20}\,J, 3.11\times10^{-20}\,J\}$$

Combine ν and KE into data pairs, remove units, and ListPlot (note: ListPlot wants raw numbers, not number-symbol combinations).

```
ν
KE
```

$$\left\{\frac{1.19916\times 10^{15}}{s}, \frac{9.993\times 10^{14}}{s}, \frac{8.56543\times 10^{14}}{s}, \frac{7.49475\times 10^{14}}{s}, \frac{6.662\times 10^{14}}{s}, \frac{5.9958\times 10^{14}}{s}\right\}$$

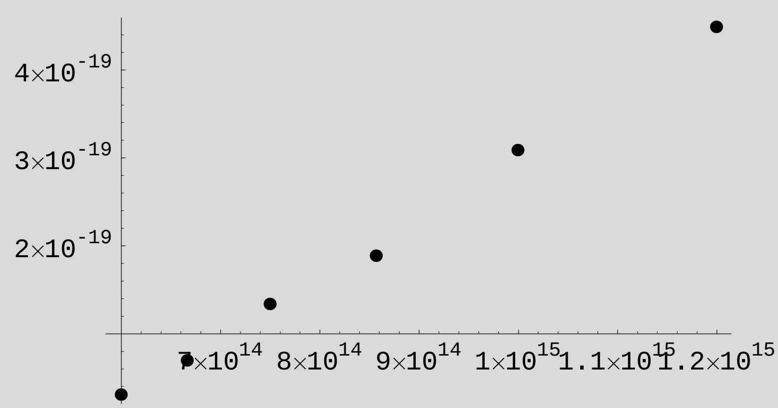
$$\{4.49\times 10^{-19}\ J,\ 3.09\times 10^{-19}\ J,\ 1.89\times 10^{-19}\ J,\ 1.34\times 10^{-19}\ J,\ 7.\times 10^{-20}\ J,\ 3.11\times 10^{-20}\ J\}$$

The data is a list of {x,y} pairs, i.e., it is a list of lists

```
data = {{1.19916`*^15, 4.49`*^-19},
  {9.993`*^14, 3.0899999999999995`*^-19},
  {8.565428571428571`*^14, 1.89`*^-19},
  {7.49475`*^14, 1.34`*^-19}, {6.662`*^14,
   6.999999999999999`*^-20}, {5.9958`*^14, 3.11`*^-20}}
```

$$\{\{1.19916\times 10^{15}, 4.49\times 10^{-19}\}, \{9.993\times 10^{14}, 3.09\times 10^{-19}\}, \{8.56543\times 10^{14}, 1.89\times 10^{-19}\}, \{7.49475\times 10^{14}, 1.34\times 10^{-19}\}, \{6.662\times 10^{14}, 7.\times 10^{-20}\}, \{5.9958\times 10^{14}, 3.11\times 10^{-20}\}\}$$

```
ListPlot[data, PlotStyle → PointSize[0.02]]
```




```
- Graphics -
```

Since all of the points pretty much fall on a line, you might estimate the slope by comparing the positions of any two points. Obtaining the negative of the *y*-intercept is more difficult because it requires extrapolation to the left. Another, more reliable, and very convenient way to approach this problem is to use *linear regression*. This technique finds the best straight line fit to the data and gives you numerical estimates of the slope and *y*-intercept.

First load the linear regression package.

```
<< Statistics`LinearRegression`
```

Next fit the data to a line

```
Fit[data, {1, x}, x]
```

$-3.95831\times10^{-19}+7.01559\times10^{-34}\,x$

The *y*-intercept is in J. Work functions are more commonly expressed in eV. The conversion factor is $1\,\text{eV} = 1.6022\times10^{-19}\,J$. Use copy-and-paste to copy intercept from Out[38] to new In[39].

```
3.9583105841352746`*10^-19 J*(1 eV / (1.6022 (10^-19) J))
```

2.47055 eV

Comment

These values agree plausibly well with accepted values for *h* and the work function (2.3 eV at http://environmentalchemistry.com/yogi/periodic/K.html)

```
h
```

6.62608×10^{-34} J s