In [1]:
```
from algebra_with_sympy import *
import JPSLUtils
JPSLUtils.record_names_timestamp()
# Initialization -- Computer: jonathan-XPS-13-7390 | User: jonathan | Ti
# Partners: Completion Example
```

Initialization -- Computer: jonathan-XPS-13-7390 | User: jonathan | Time: Mon Sep 27 20:15:28 2021

Practice Measuring

Solid metal blocks containing 1 mole of atoms

From the four samples provided on your bench each pair should choose one small sample and one large sample. Record the element each sample is made of in the table below. Use the "Table Actions" menu to edit the table. Save after making entries.

Information in Table 1 (2.5 pts)

Table 1: Measurement of solid blocks

Table Acti	Element	Length (cm)	Width (cm)	Height (cm)	Initial water volume (mL)	Final water volume (mL)	Mass (g)
Sample #1	Al	6.20	1.27	1.28	25.0	35.0	27.01
Significant Digits (#1)	XXXX	3	3	3	3	3	4
Decimals (#1)	XXXX	2	2	2	1	1	2
Sample #2	Fe	4.45	1.26	1.28	20.5	27.8	55.85
Significant Digits (#2)	XXXX	3	3	3	3	3	4
Decimals (#2)	XXXX	2	2	2	1	1	2

Liquid water near room temperature

Use the table below to record your measurements on water.

Information in table 2 (2 pts)

Table 2: Measurements of water

Table Actic	Volume in Grad. Cyl. (mL)	Mass in Cyl. (g)	Buret Initial (mL)	Buret Final (mL)	Mass water delivered (g)
Measurement	9.72	9.70	15.05	27.32	12.23
Significant Digits	3	3	4	4	4
Decimals	2	2	2	2	2

Calculations for the metal blocks

1. (1 pt) Calculate the volume of the metal blocks based on the ruler measurements. `V = l*w*h` , where V = volume, l = length, w = width and h = height. Use the code cell immediately below. **Include Units**. If you ran the example cells since opening this notebook the units of `cm` and `m` are already defined. You recorded the dimensions you need in Table 1

In [13]:
```
# Use this cell to calculate the volume of sample 1.
6.20*cm*1.27*cm*1.28*cm
```

Out[13]: $10.07872cm^3$

In [14]:
```
# Use this cell to calculate the volume of sample 2.
4.45*cm*1.26*cm*1.28*cm
```

Out[14]: $7.17696cm^3$

2. (0.5 pts) Calculate the density of the metal blocks based on your mass measurement and the volume calculated from the ruler measurements. `D = m/V` , where D = density, m = mass and V = volume. You will have to define the `g` symbol for the units of grams. Use comments to indicate which block you are doing the calculation on. Note that `1 cm**3 = 1 mL` .

In [15]:
```
var('g',positive=True)
# density block 1 Al
27.01*g/(10.1*cm**3)
```

Out[15]: $\frac{2.67425742574257g}{cm^3}$

In [16]:
```
# density of block 2 Fe
55.85*g/(7.18*cm**3)
```

Out[16]: $\frac{7.77855153203343g}{cm^3}$

3. (0.5 pts) Calculate the volume of the blocks measured by water displacement (difference

between the final and initial volumes). *You will need to define the unit of mL*.

In [17]:
```
var('mL', positive=True)
# displacement volume block 1 Al
35.0*mL - 25.0*mL
```

Out[17]: $10.0mL$

In [19]:
```
# displacement volume block 2 Fe
27.8*mL - 20.5*mL
```

Out[19]: $7.3mL$

4. (0.5 pts) Calculate the density of the metal blocks using the volume measured by water displacement. Note that `1 cm**3 = 1 mL` .

In [20]:
```
# displacement density block 1 Al
27.01*g/(10.0*cm**3)
```

Out[20]: $\frac{2.701g}{cm^3}$

In [21]:
```
# displacement density block 2 Fe
55.85*g/(7.3*cm**3)
```

Out[21]: $\frac{7.65068493150685g}{cm^3}$

Calculations for water (1 pt)

1. Calculate the density of the water using your graduated cylinder measurements. If you need additional *code cells* you can add them using the "Insert" menu. Your data is in [Table 2](#).

In [22]:
```
# Water density volume from graduated cylinder
9.70*g/(9.72*mL)
```

Out[22]: $\frac{0.997942386831276g}{mL}$

2. Calculate the volume of water delivered from the buret.

In [23]:
```
# delivered from buret
27.32*mL - 15.05*mL
```

Out[23]: $12.27mL$

3. Calculate the density of the water using your buret measurements.

In [24]:
```
# water density from buret
12.23*g/(12.27*mL)
```

Out[24]: $\frac{0.996740016299919 g}{mL}$

Results summary

Information in table 3 (2 pts)

Table 3: Results of calculations for solid blocks.

Table Actions	Element	Mass (g)	V using ruler (mL)	V using grad. cyl. (mL)	D using ruler (g/mL)	D using grad. cyl. (g/mL)
Sample 1	Al	27.01	10.1	10.0	2.67	2.70
Sample 2	Fe	55.85	7.18	7.3	7.78	7.7

Information in table 4 (1 pt)

Table 4: Density of water calculations.

Table Actions	Mass of water (g)	V of water (mL)	Density (g/mL)
Using grad. cyl.	9.70	9.72	0.998
Using buret	12.23	12.27	0.9967

Post lab questions

1. (1 pt) For the metal blocks which measurement methode gave the moste precise value for the density? Explain your reasoning.

The most precise is the least uncertain (the most decimal places). For the Fe (smaller) block this is the measurement using the ruler. For the Al (larger) block the volume has similar precision.

2. (1 pt) Do you think any of your measurements of the metal block were erroneous? If so, which ones and what do you think the error was?

The densities determined via displacement and measurements are consistent for each sample. Thus it is unlikely that there was an erroneous measurement.

3. (1 pt) Which method produced the most precise density for water? Explain your reasoning.

Measuring the volume using the buret gave the most precise density for water. The calculated density had the most decimals and significant figures.

4. (1 pt) Compare your water densities with the literature value. Which method produced the most accurate density for water?

At 21 C the density for water according to the USGS is 0.99802 g/mL. The density measurement using the graduated cylinder was closest to this and thus the most accurate, despite being less precise than the buret method. This suggests an error was made reading the buret.

Prepare this document to turn in

To convert this notebook to a lab report to turn in you need to hide the majority of the instruction and informational cells and make a .pdf document.

1. Your instructor has already chosen the cells they want hidden. To hide them select "Hide Cells" from the JPSL Tools menu.
2. To make a pdf you must use the Browser's print capabilities. In most user interfaces this option is hidden in the little collapsed menu at the upper right of the browser window. On a macintosh it can be found in the file menu. Select "Print" and then set the destination to "Save to PDF". Make sure to save the file in a location you can find (your "Desktop" or maybe "Documents" directory). **Do Not use the options in the Jupyter "File" menu.**
3. It is a good idea to open the created document to make sure it is OK.
4. When everything is OK, save this document one more time and then close it using the "Close and Halt" option in the Jupyter "File" menu.
5. Turn in both the pdf and ipynb version of this notebook.

NB: Currently, the print to pdf output from Chrome is a little closer to what is displayed on the webpage. Unfortunately, which browser renders the best pdfs changes quite rapidly.