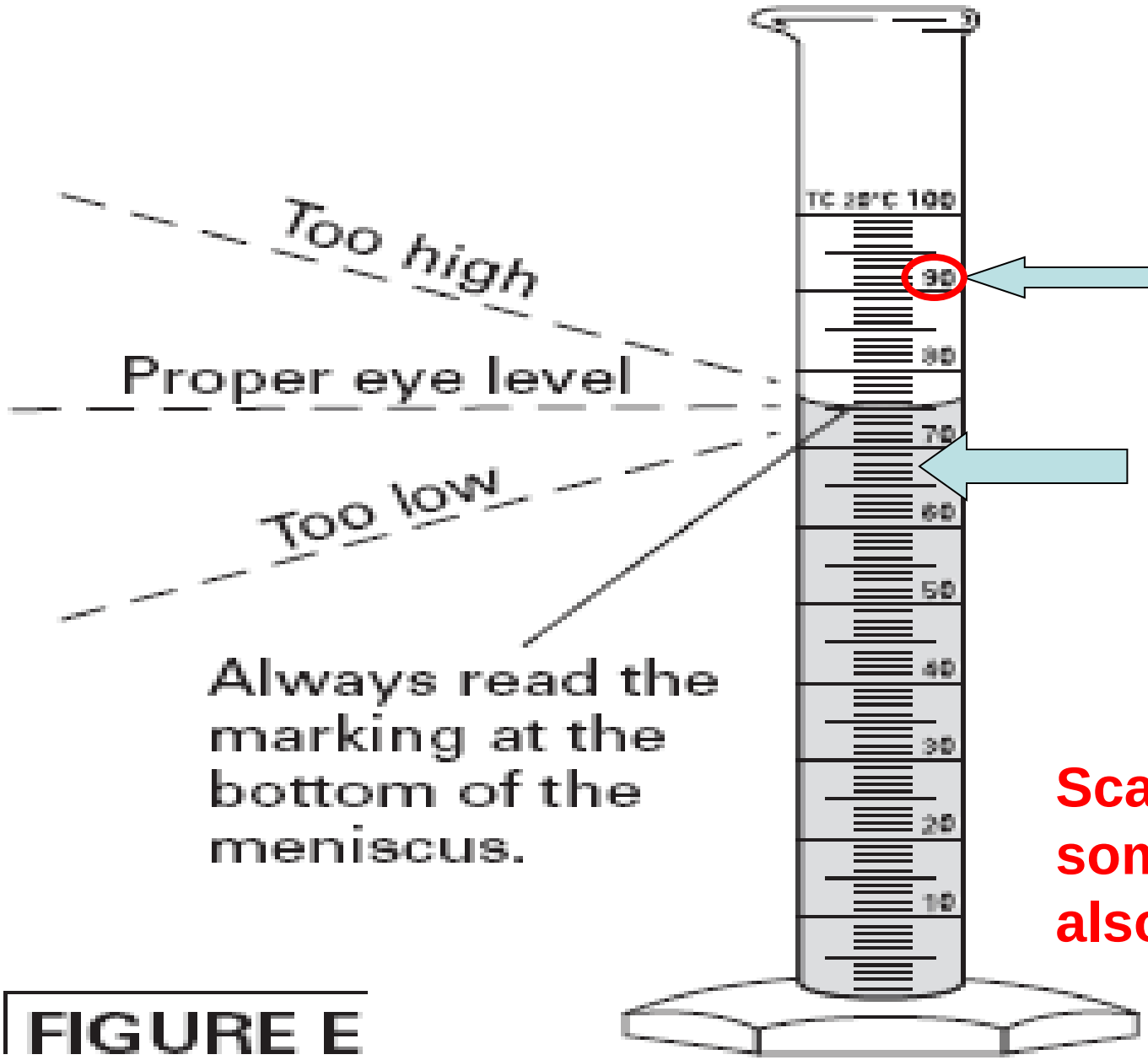
Mass and Volume

2014, S-2

Reading a Graduated Cylinder



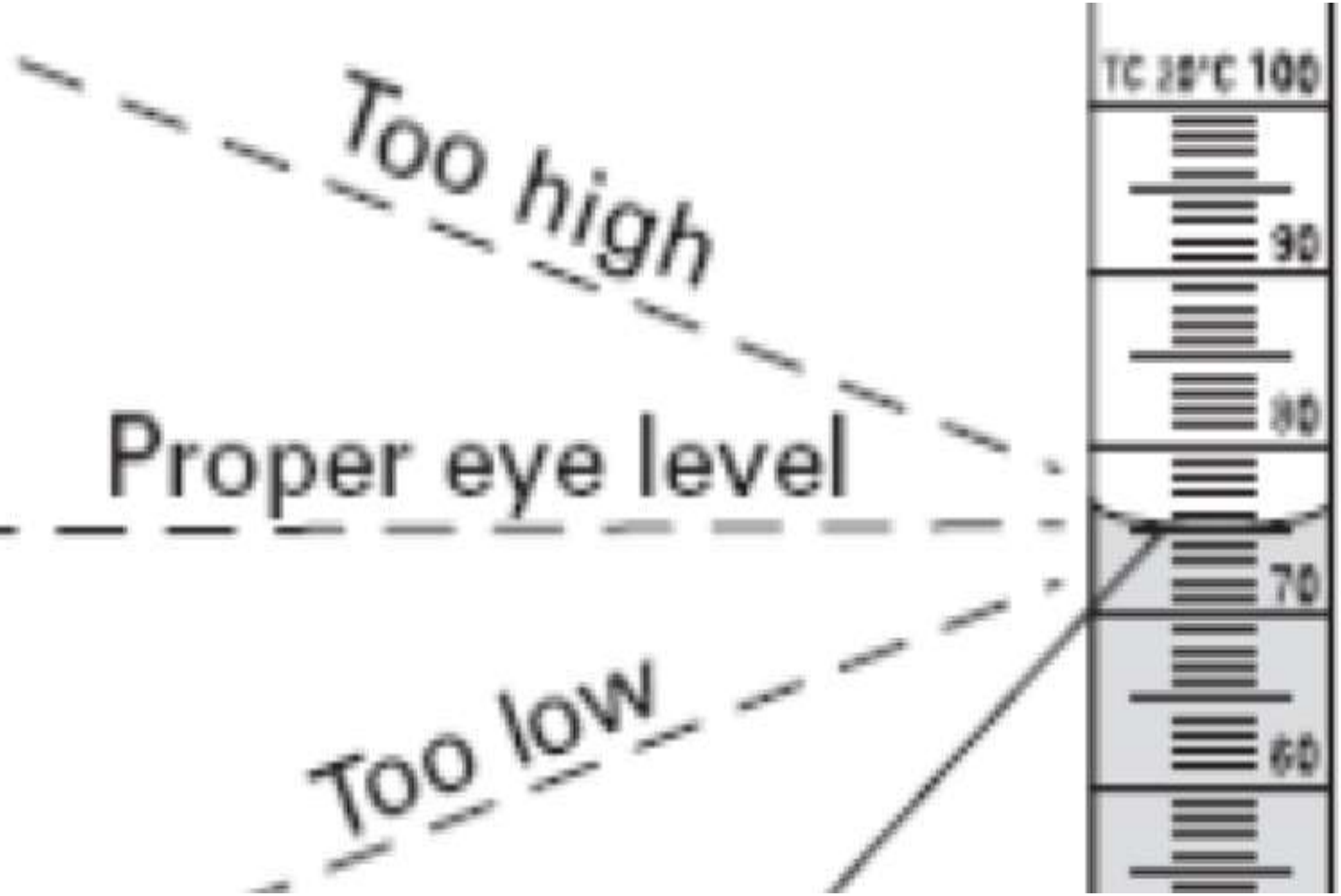
major divisions: numbers

minor divisions:

Marks without numbers

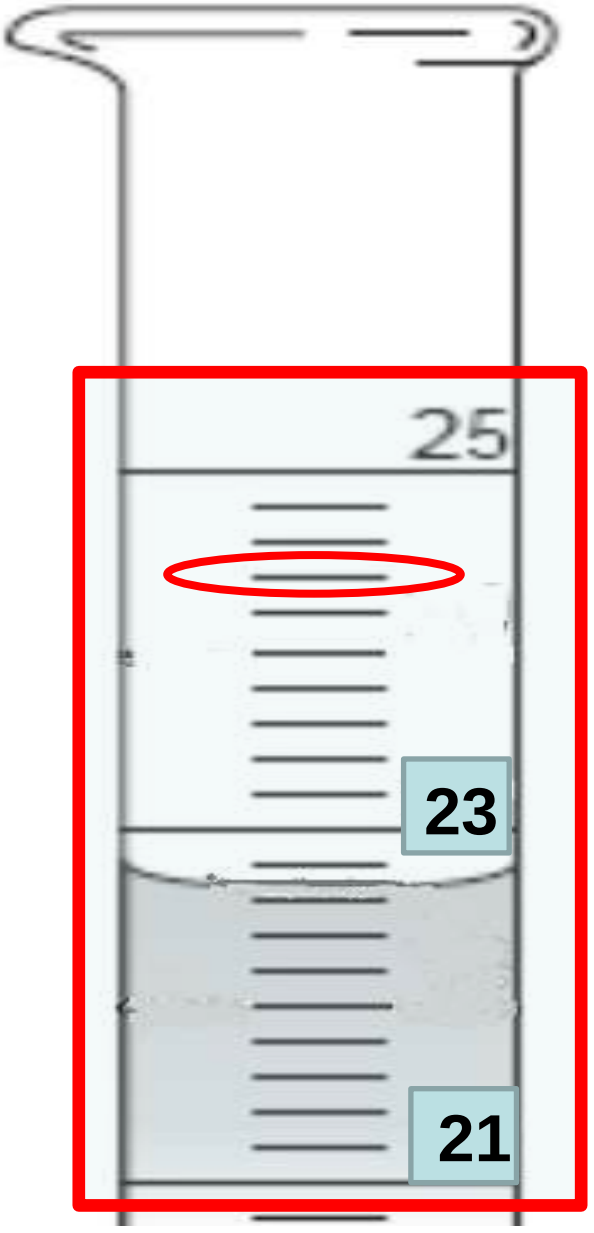
Scale read up and in some cylinders, down also

FIGURE E


Too high
Proper eye level
Too low
TC 28°C 100
90
80
70
60

25 mL Graduated Cylinder

Draw the cylinder



1. Determine the value of each minor mark

$$\frac{25-23}{10\ lines} = 0.2\ \text{mL}$$

2. What is the uncertainty?

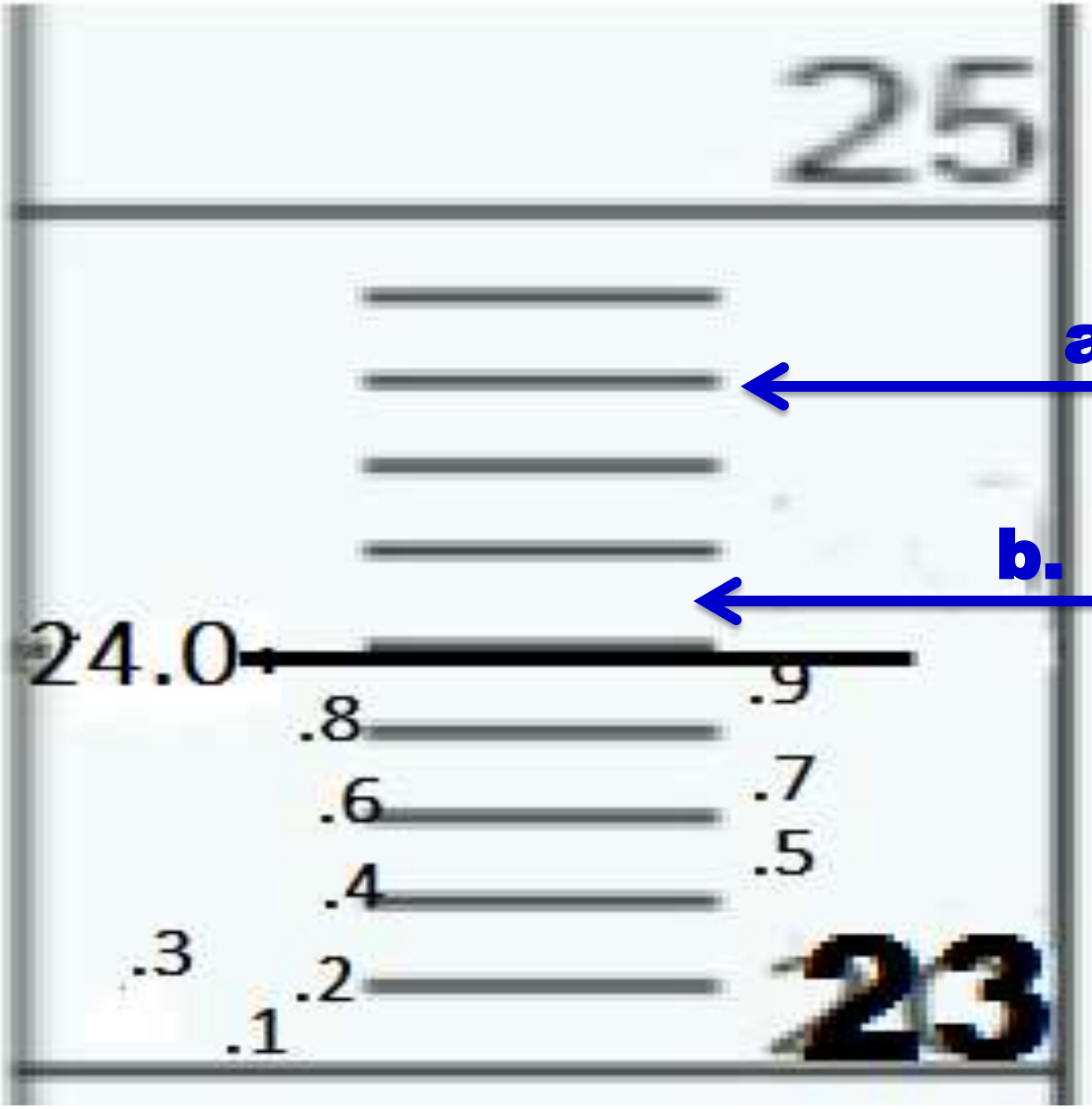
Estimation is ½ the minor mark, which is

$$\frac{0.2\ mL}{2} = 0.1\ \text{mL}$$

3. What is the measurement shown in cm^3?

22.7 cm^3

4. How many sig figs 3



a.

24.6 mL

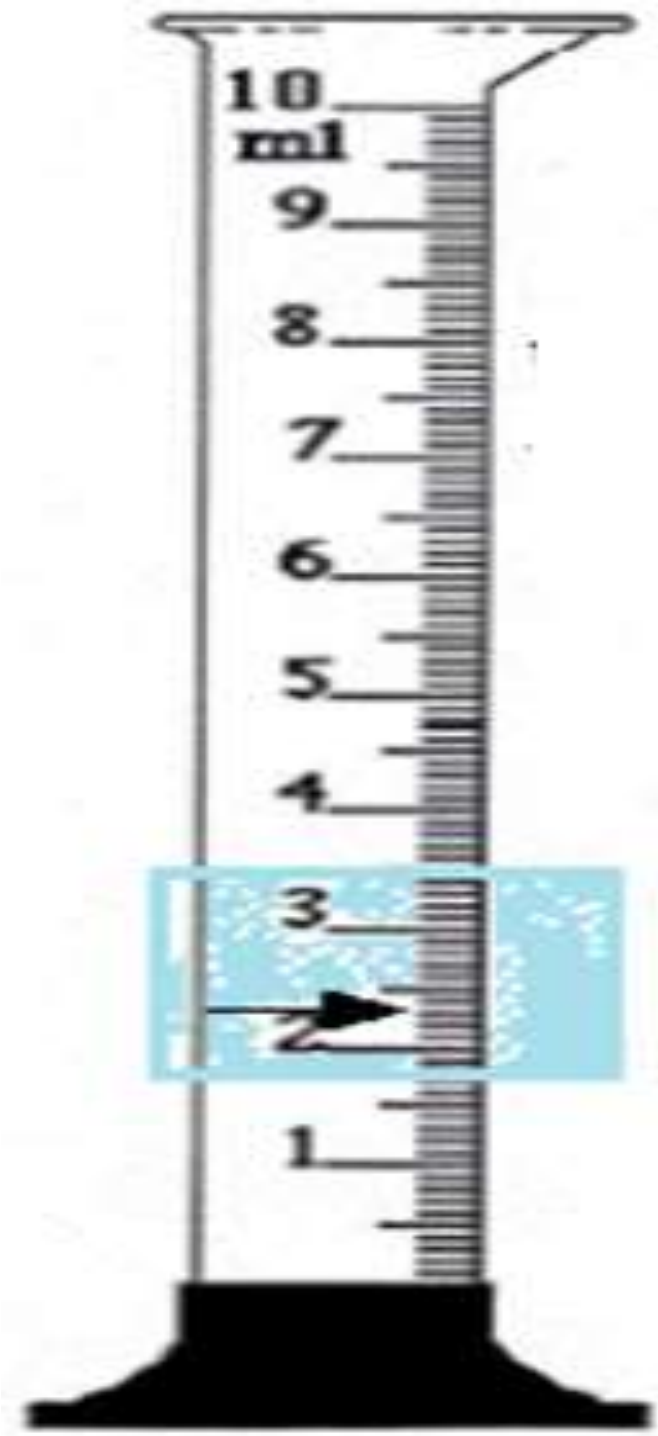
24.6 cm^3

b.

24.1 mL

24.1 cm^3

Report the measurements to three significant figures.


10
ml
9
8
7
6
5
4
3
2
1


3

The major marks are ____ mL

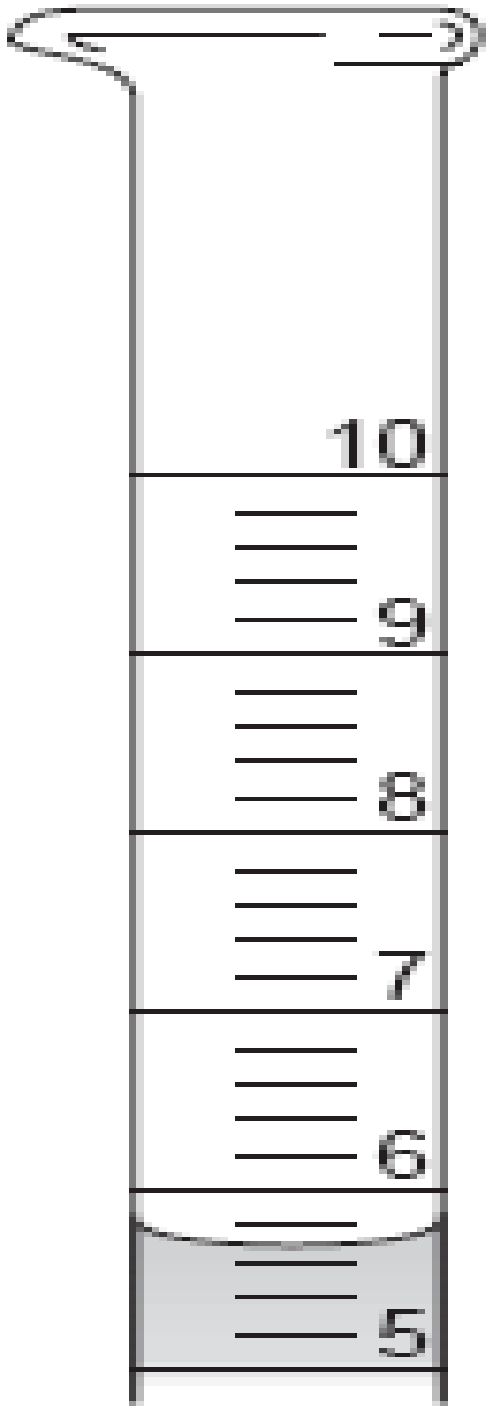
1 mL

The minor marks are ____ mL

0.2 mL

Estimation is ½ the minor mark, which is

0.1 mL



The measurement is

5.7 mL

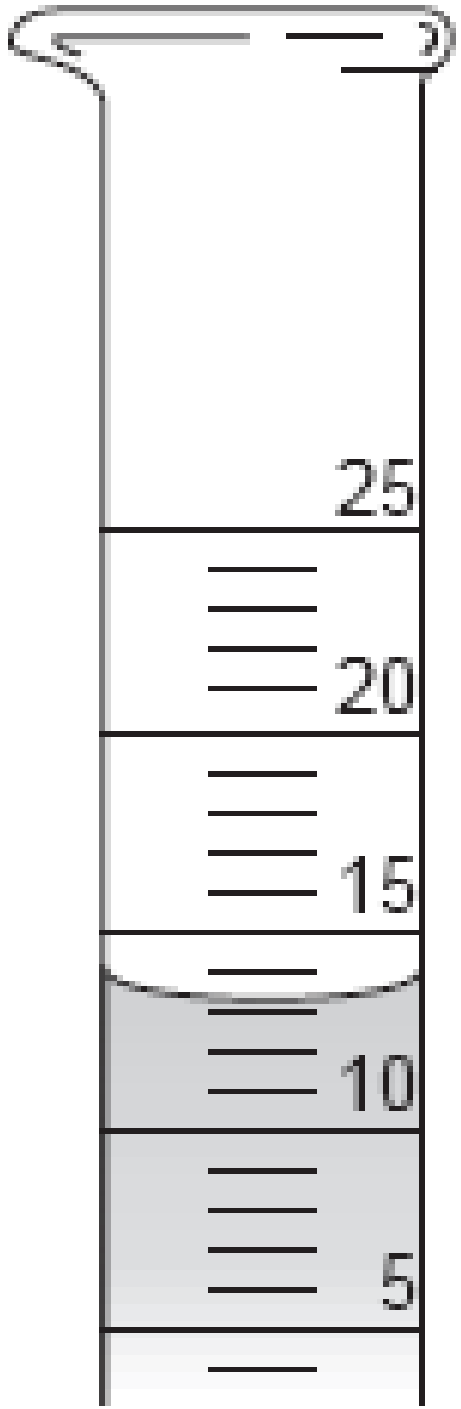
The uncertainty is

±0.1 mL

How many significant figures?

two

c.



The major mark are ____ mL

5 mL

The minor marks are ____ mL

1 mL

Estimation is ½ the minor mark, which is

0.5 mL

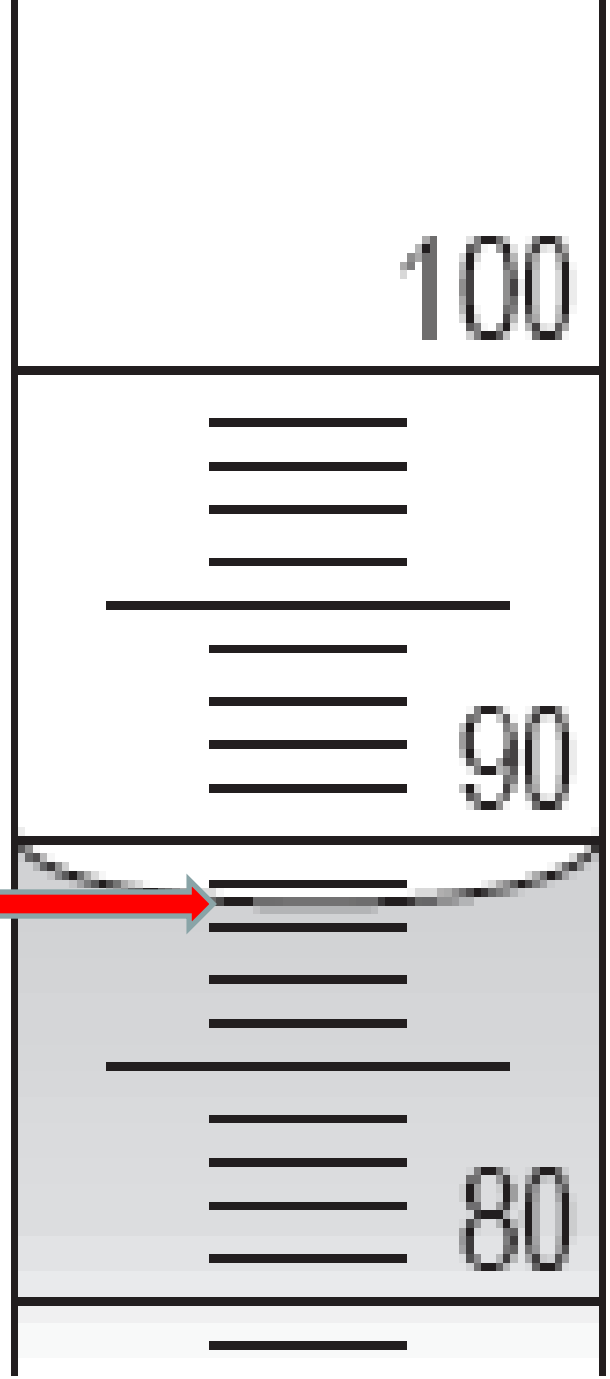
The measurement is

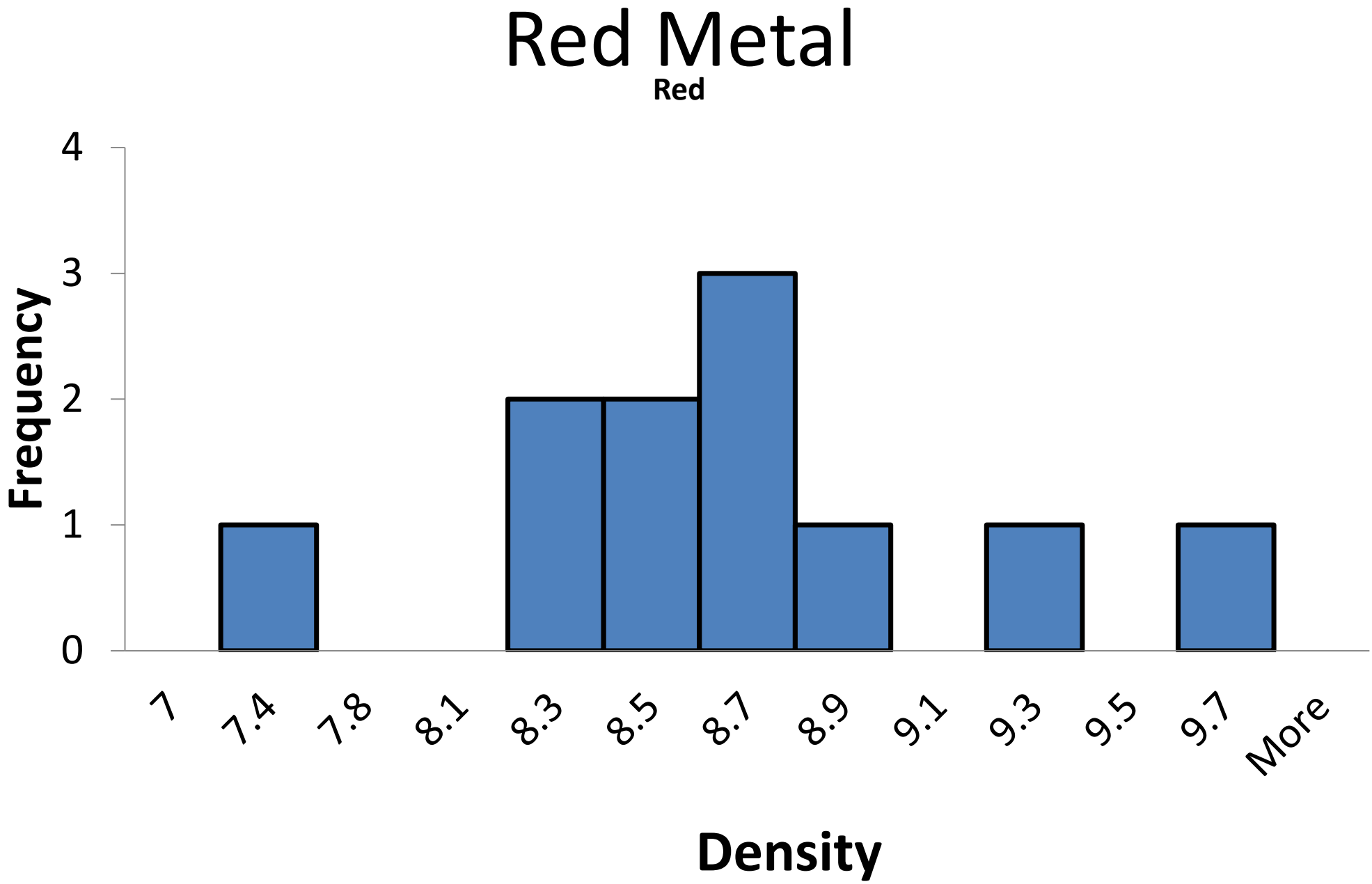
13.0 mL

How many significant figures?

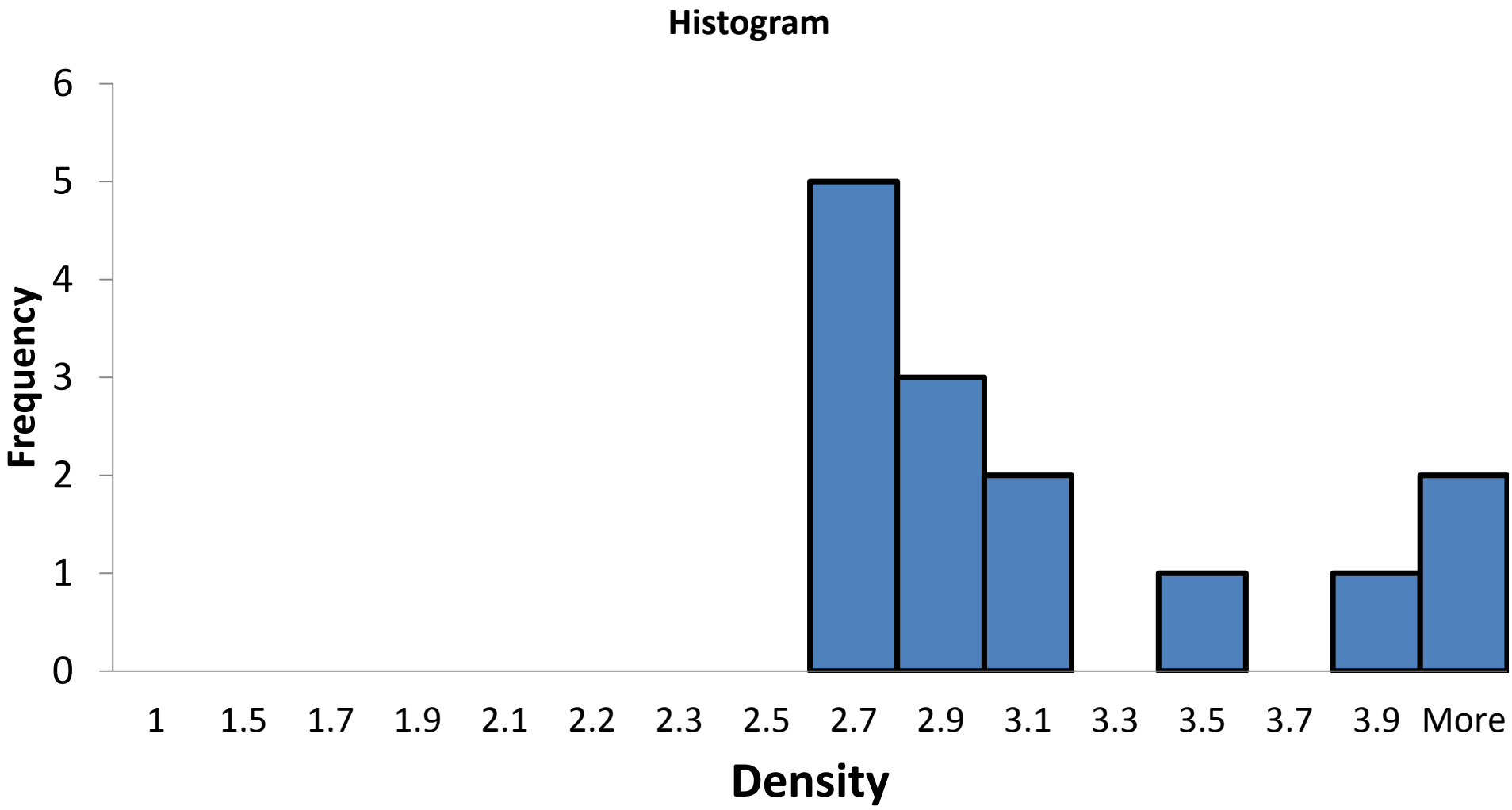
three

READ FROM THE BOTTOM OF THE MENISCUS




Red Metal
Red
Frequency
4
3
2
1
0
7
7.4
7.8
8.1
8.3
8.5
8.7
8.9
9.1
9.3
9.5
9.7
More
Density

Silver


Histogram
Frequency
6
5
4
3
2
1
0
1
1.5
1.7
1.9
2.1
2.2
2.3
2.5
2.7
2.9
3.1
3.3
3.5
3.7
3.9
More
Density

Accepted Values

Metal	Tin	Aluminum	Silver	Brass
Density (g/mL)	7.37	2.70	10.5	8.30
Metal	Copper	Gold	Zinc	Lead
Density (g/mL)	8.96	19.3	7.14	11.3

Accepted Value

$$\%\ \text{experimental error} = \frac{|\ accepted\ value - experimental\ value\ |}{accepted\ value}\ x\ 100$$

Experimental value = your average mass/volume value from your data table

Percent experimental error calculation

- From your data table, your average density for the your metal is 6.8 grams/ mL.
- **This is the experimental value.**
- You believe the metal is brass.
- The **accepted value** of density of brass is 8.30 g/ml

$$\%\ \text{experimental error} = \frac{|\,accepted\ value - \text{exp}erimental\ value\,|}{accepted\ value}\ x\ 100$$

$$\%\ experimental\ error = \frac{|\,8.3 - 6.8|}{8.3}\ \text{x}\ 100 = 18\%$$

Consider your results accurate if ***the percent error is equal or less than 5%.*** *Write in your lab book:*

Our results are/ are not accurate because _____.

	a	b	c	d	e
Sample	Mass of Sample, (g)	Initial Volume, (mL)	Final Volume, (mL)	Volume of sample, (mL) **(c -b)**	$\frac{mass}{volume}$ **(a ÷ d) Density**
1	**6.82**	**10.1**	**11.2**	**1.1**	**6.2**
2	**8.74**	**11.2**	**12.4**	**1.2**	**7.3**
3	**9.8**	**12.3**	**13.7**	**1.4**	**7.0**
				AVERAGE:	**6.8**

Experimental Value

Are Your Results Accurate?

- Write one of the following in your lab book depending on the outcome of your % error calculation:
- ***Our results are accurate because our % error is = < 5%.***
- ***Our results are not accurate because our % error is > 5%.***

	a	b	c	d	e
Sample	Mass of Sample, (g)	Initial Volume, (mL)	Final Volume, (mL)	Volume of sample, (mL) **(c -b)**	$\frac{mass}{volume}$ **(a ÷ d) Density**
1	**6.82**	**10.1**	**11.2**	**1.1**	**6.2**
2	**8.74**	**11.2**	**12.4**	**1.2**	**7.3**
3	**9.8**	**12.3**	**13.7**	**1.4**	**7.0**
				AVERAGE:	

Use This Calculation to see if Your Data Is Precise

Example:

- Value 1 = 6.2g/cm^3,
- value 2 = 7.0g/cm^3,
- value 3 = 7.3 g/cm^3

$$\% \text{ range} = \frac{\text{highest value - lowest value}}{\text{lowest value}} \times 100$$

$$\% \, range = \frac{7.3 - 6.2}{6.2} x \, 100 \quad = 17.7\%$$

Consider your values precise if the range is less than or equal to 10%.

Is Your Data Precise?

- Write one of the following in your lab book depending on the outcome of your % range calculation:
- ***Our data is precise because our % range is = < 10 %.***
- ***Our data is not precise because our % range is > 10%.***

What is bigger, the pillow or the battery?

What is heavier, the pillow or the battery

What is heavier, a ten pound puppy or a ten pound battery

What is bigger, the pillow or the battery?

What is heavier, the pillow or battery?

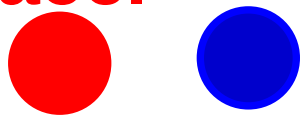
How can the battery have less volume than the pillow but have more mass?

There are more particles in the battery and/ or the particles of the battery are heavier than the pillow.

The battery is more dense than the pillow.

3. List some important properties of the particle model that help explain the different densities of different substances.

a) matter is comprised of particles that have mass and take up space.



Mass is a measure of the number of particles present.

Volume is a measure of the space the particles take up.

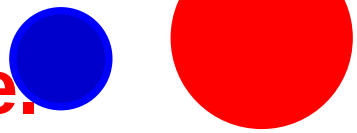
b) The particles cannot be divided.

c) Some particles have more mass than others particles,

1 mass unit

5 mass unit

d) and some particles take up more space.



Density is the amount of mass that 1 mL of cm^3 contains.

$$Density = \frac{mass}{volume}$$

- **Mass is the amount of particles that make up a particular sample of matter.**
- **Density is the mass of stuff that occupies one unit of volume.**

Examples: 1 g of water occupies 1 cm^3

The density is 1 g per cm^3 and is written

$$1\ \frac{g}{cm^3}$$ or 1 g/cm^3

$$1\ mL = 1cm^3$$

Slope

1. On a graduated cylinder what are major divisions and what are minor divisions

Major divisions are marks with number.

Minor divisions are marks without numbers.

2. What is the equation of a straight line? Define the variables.

$$y = mx + b$$

y = the y value

x = the x value

m = the slope $\left(\frac{rise}{run} = \frac{\Delta y}{\Delta x}\right)$

b = the y intercept

Slope

Write the linear equation (equation of a straight line) and define the variables:

$$y = mx + b$$

x & y are data points you measured

m = the slope $\left(\frac{rise}{run} = \frac{\Delta y}{\Delta x}\right)$ **b = the y-intercept**

Explain these this equation: y = 4.75x + 0.465

The equation is a linear equation because it has the form of y = mx +b.

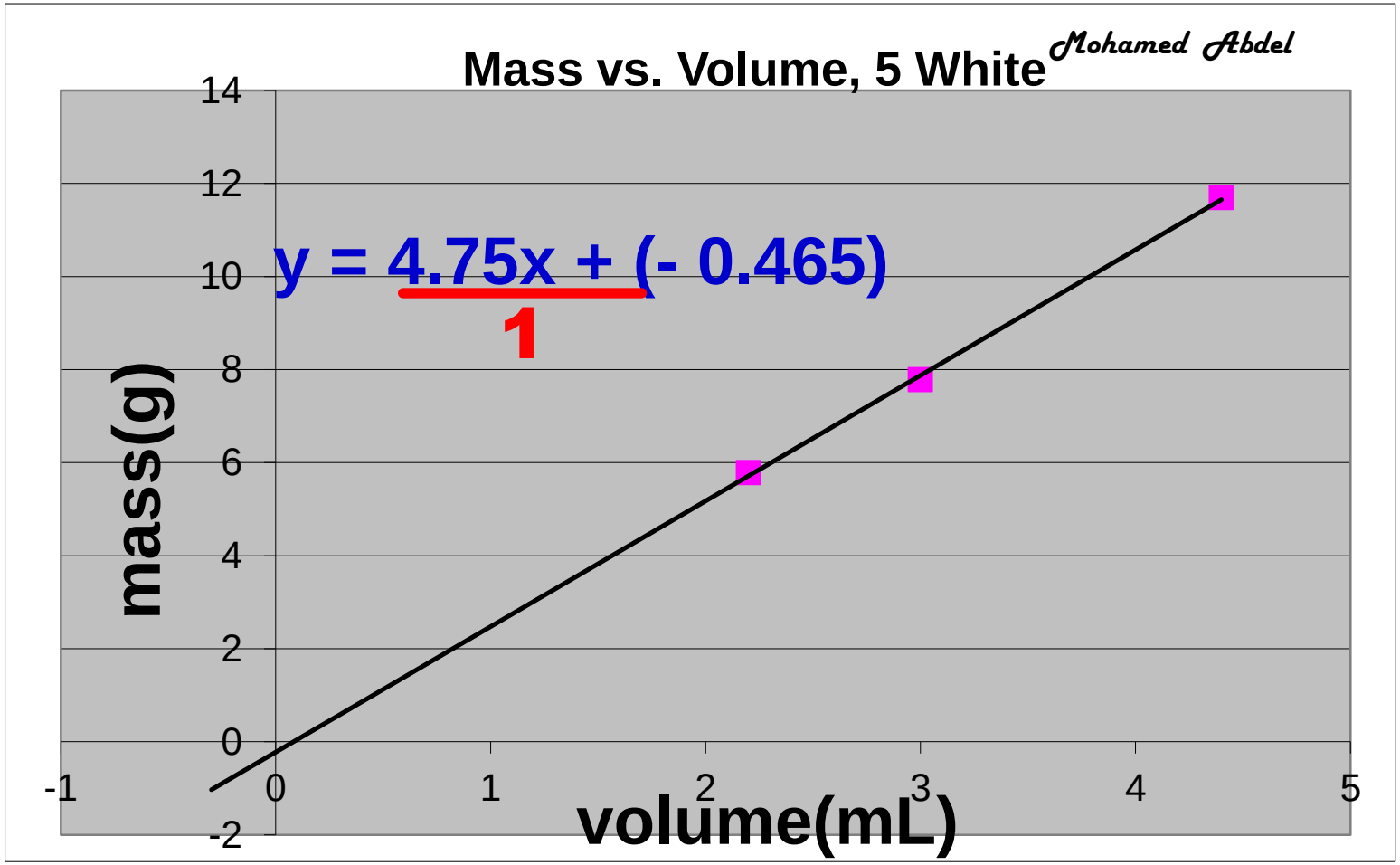
4.75 is the slope (m)

0.465 is where the line crosses the y axis (the y-intercept) (b)

y is a y coordinate on the line,

X is a x coordinate on the line,

Silver	
x,volume	y, mass
2.2	5.78
3	7.78
4.4	11.69
5% max y=	0.5845



Is the y-intercept on this graph negligible?

We must use the 5% rule.

5% Rule

The 5% rule?

If the absolute value of the y-intercept is less than (<) 5% of the of the greatest value of y in any ordered pair (or the greatest value of the dependent variable), then the y-intercept is negligible and is set = 0.

y = 4.75x - 0.465 Use the absolute value: + 0.465

Silver	
x,volume	**y, mass**
2.2	5.78
3	7.78
4.4	**11.69**

11.59 is the max y value.

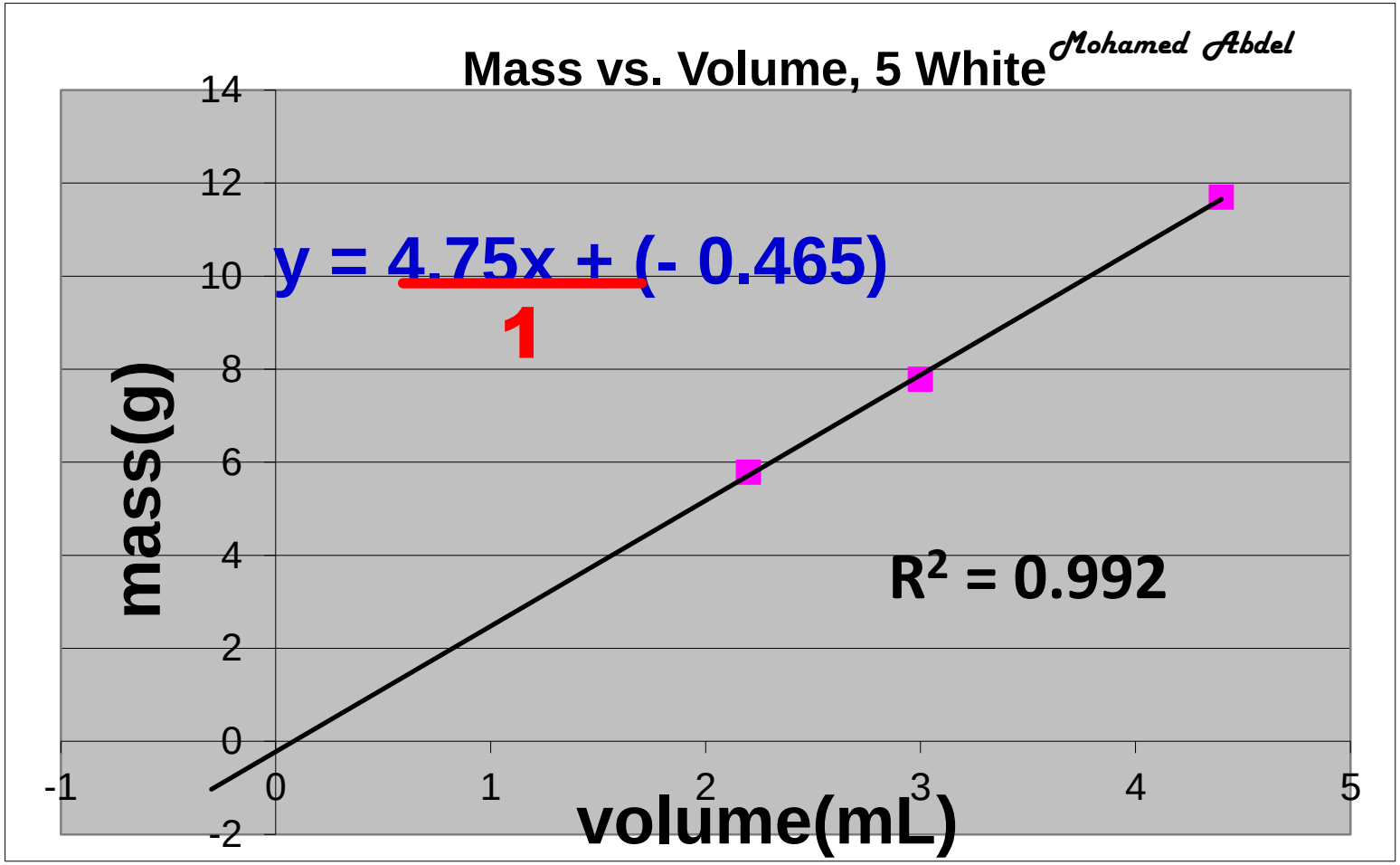
5% of 11.6 (0.05 x 11.6) = 0.579

0.465 < 0.579 . So,

the y-intercept is negligible and can b assumed to be zero

The y-intercept is a way to see if your graph is accurate. If the y-intercept is < or = to 5% max y value, the graph is accurate.

Silver	
x,volume	y, mass
2.2	5.78
3	7.78
4.4	11.69
5% max y=	0.5845

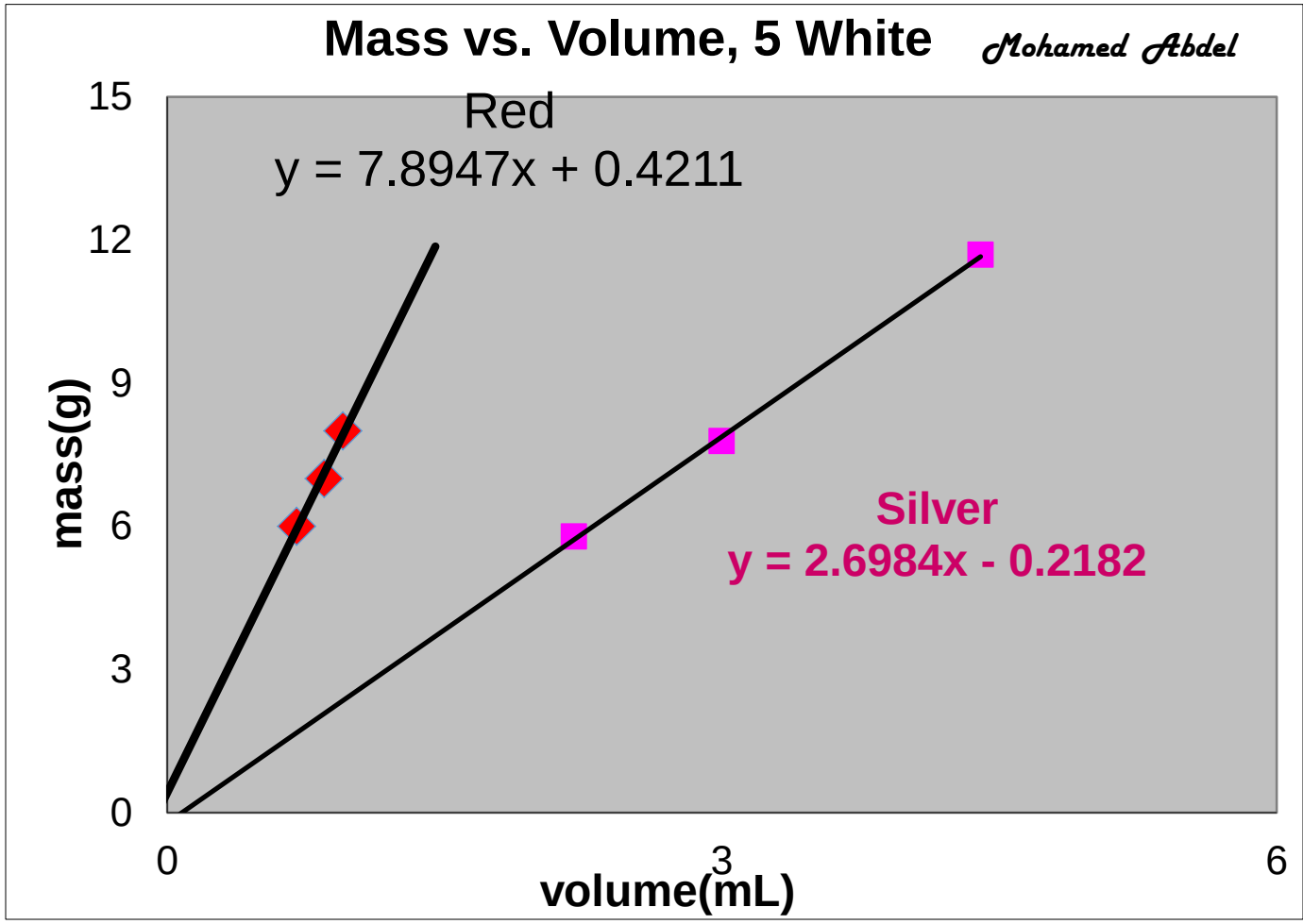


You would redraw this graph with the line going through zero and rewrite the equation:

$$y = 4.75\,x + 0 \quad \text{or}$$

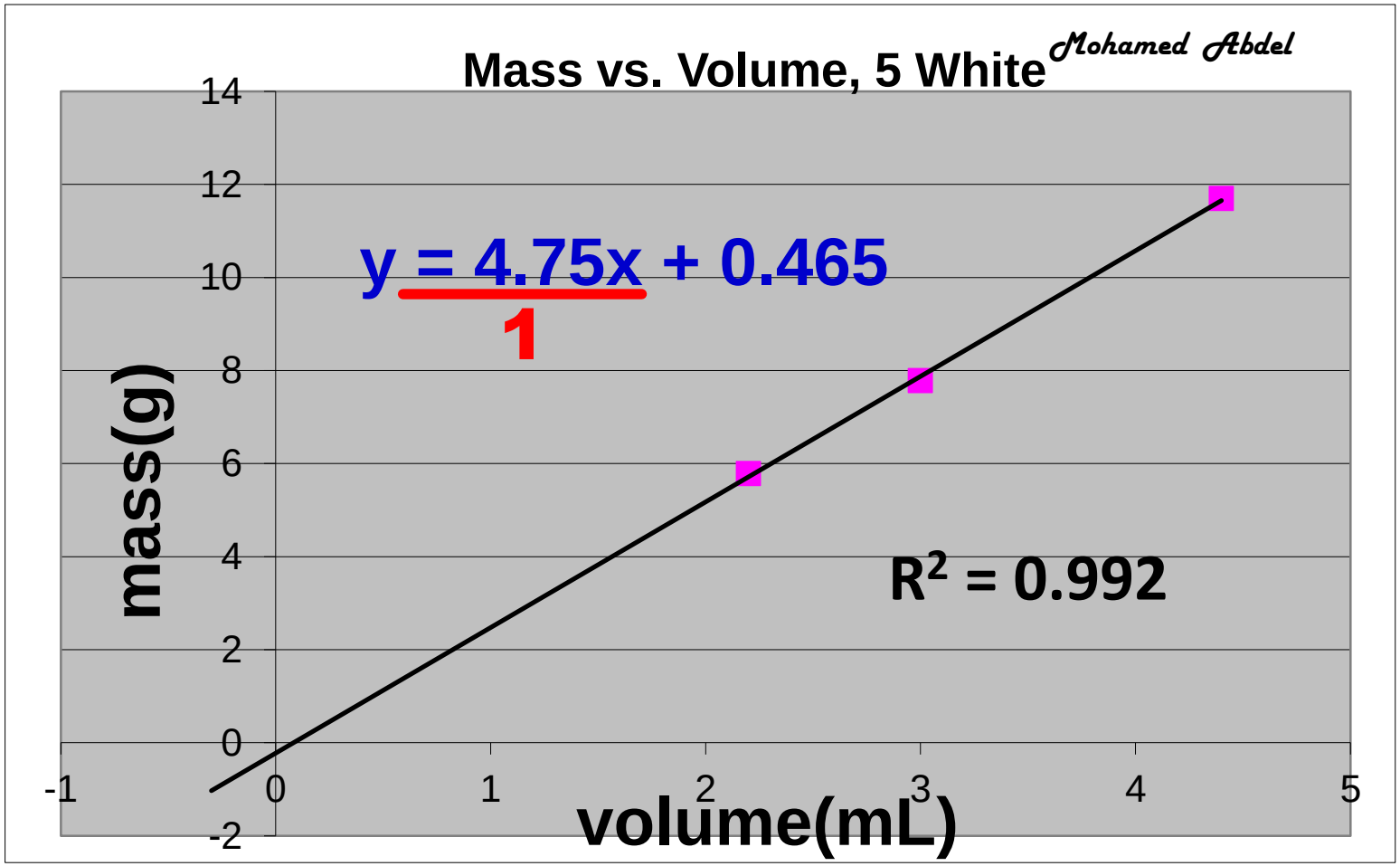
$$y = 4.75\,x$$

Red Metal	
x,volume	y, mass
0.7	6.00
0.85	7.00
0.95	8.00
Silver	
x,volume	y, mass
2.2	5.78
3	7.78
4.4	11.69



When y = mass & x = volume, the slope of the line = density.

Silver	
x,volume	y, mass
2.2	5.78
3	7.78
4.4	11.69
5% max y=	0.5845

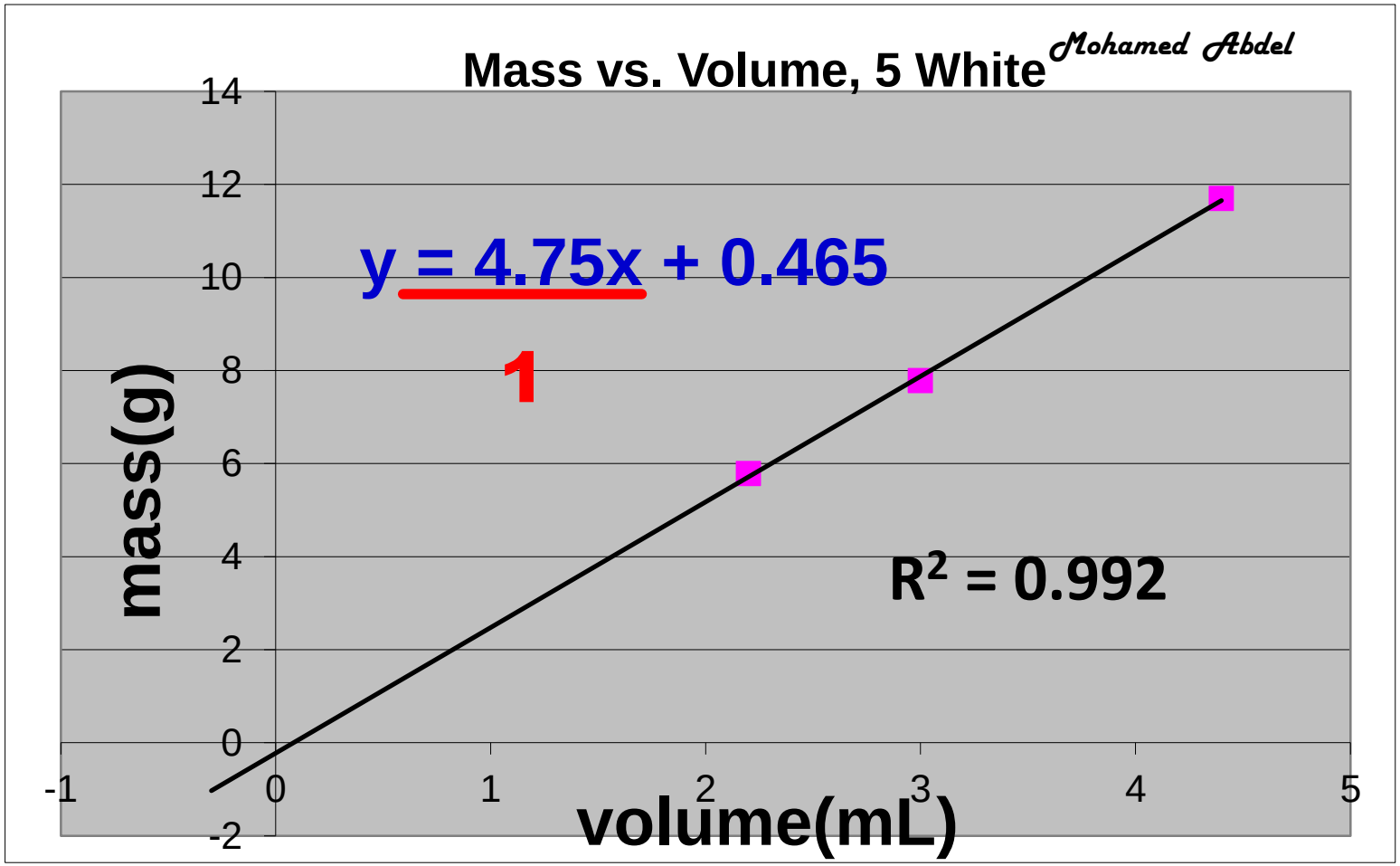


For a piece of silver metal, what does a slope of 4.75 mean?

What does the y-intercept of 0.465 mean?

Is the y-intercept on this graph negligible?

Silver	
x,volume	y, mass
2.2	5.78
3	7.78
4.4	11.69
5% max y=	0.5845

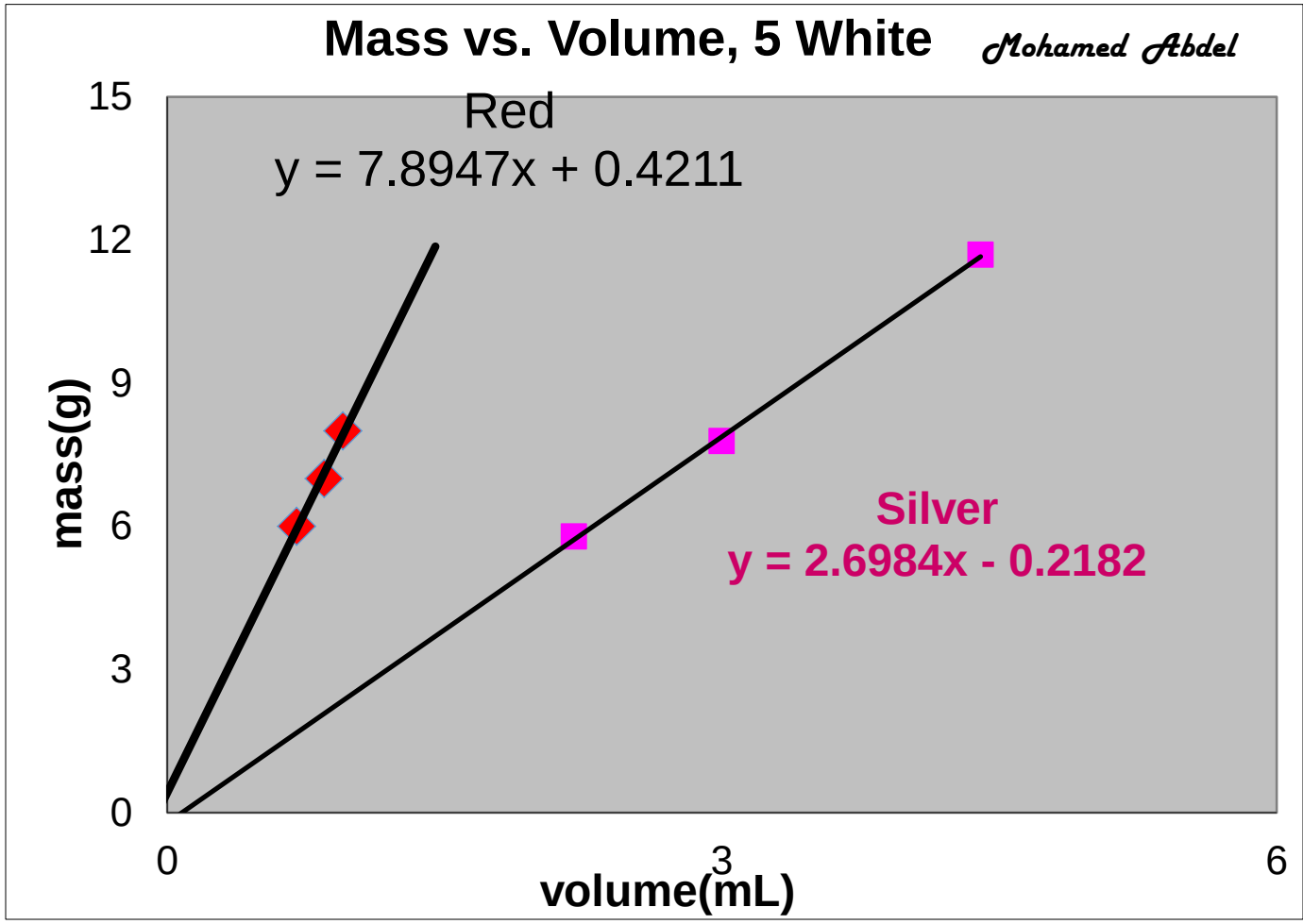


For a piece of silver metal, what does a slope of 4.75 mean?

What does the y-intercept of 0.465 mean?

Is the y-intercept on this graph negligible?

Red Metal	
x,volume	y, mass
0.7	6.00
0.85	7.00
0.95	8.00
Silver	
x,volume	y, mass
2.2	5.78
3	7.78
4.4	11.69



Write your data as shown.
Sketch & label your graph as shown
Write the linear equations as shown.
Determine if your y-intercept is negligible.

Characteristic Properties

- **Properties that are unique to the identity of the substance can be used to i.d. a substance:**
- **Density – amount of mass per unit volume**
- **Boling Point – temp that the stuff boils**
- **Melting/ Freezing Point- temp that the stuff melts/ freezes**
- Electrical conductivity- amount electricity conducted
- Heat conductivity- amount heat conducted
- Reflection or absorption of light – amount of light reflected or refracted
- Absorption/ emission if light - amount of light absorbed or emitted
- ----More-----

Figure 1

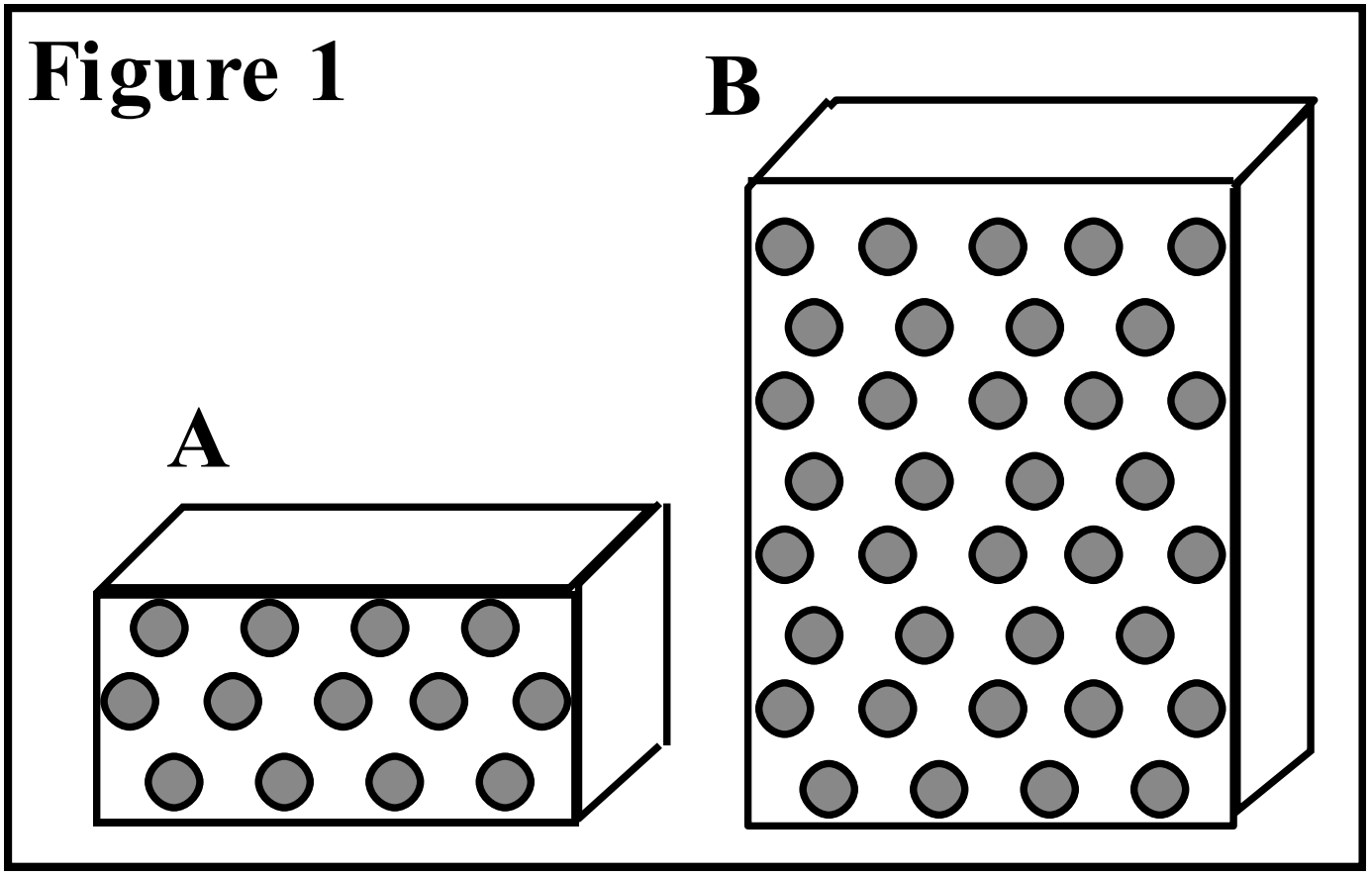
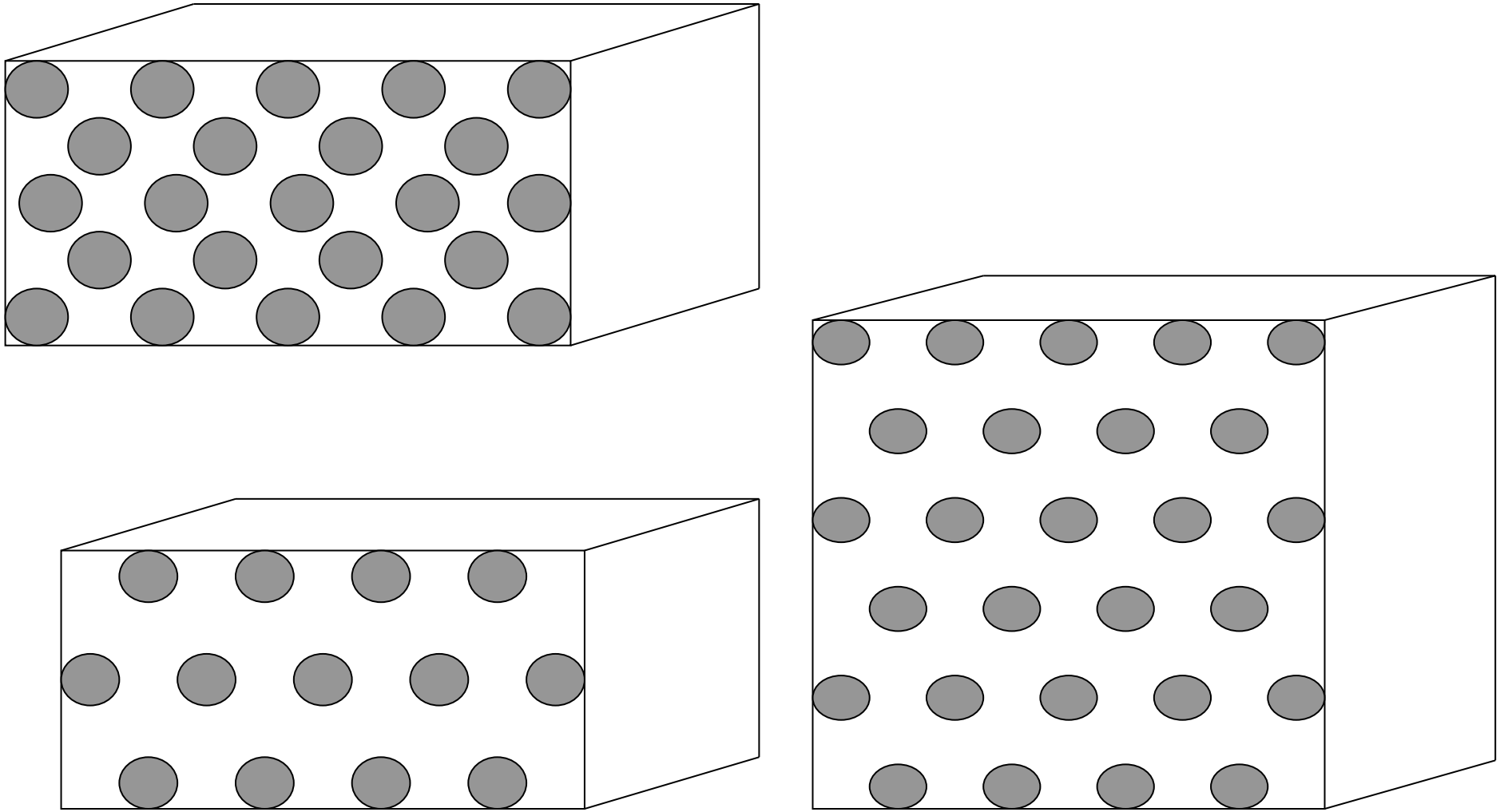


FIGURE 2

A **B**



Density , 2013

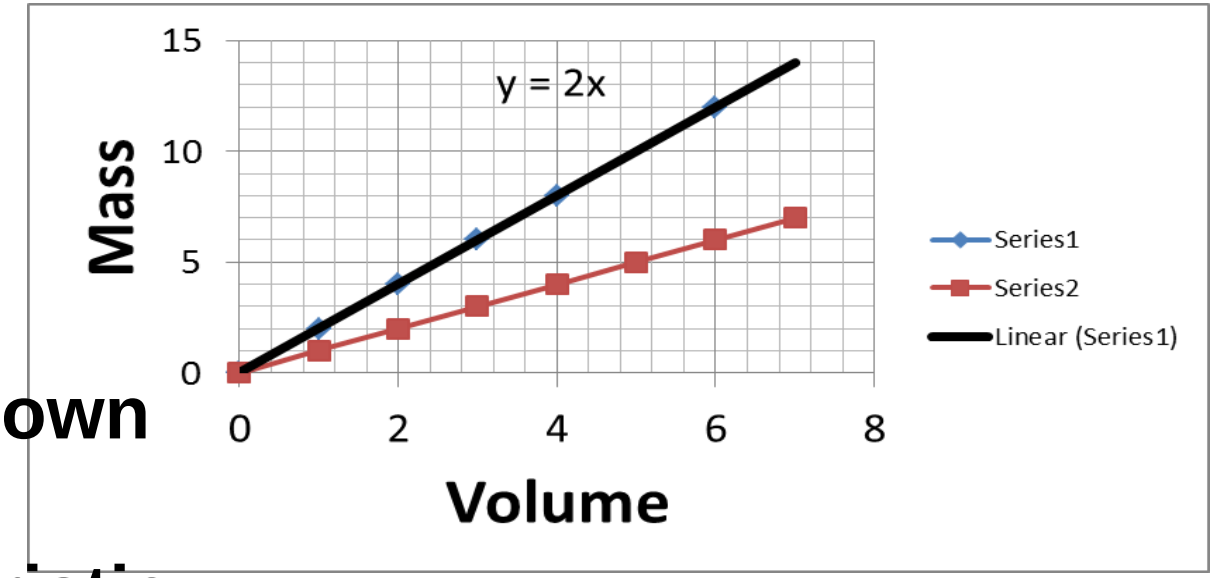
Density is how much mass an object has for each cubic centimeter of its volume .

$$Density = \frac{mass}{Volume}$$

D = density
m = mass
v = volume

$$D = \frac{m}{V}$$

$$DV = m \qquad V \propto m$$



Slope = density

Each substance has its own unique density.

- **Density is a characteristic property.**

Density

$$Density = \frac{mass}{volume}$$

What is the density of a substance that occupies a volume of 2 cubic centimeters and has a mass of 6.4 grams?

$$D = \frac{m}{V}$$

- **Mass = 6.4g**
- **Volume = 2 cm^3**

$$= \frac{6.4\,g}{2\,cm^3} = 3.2\,g/cm^3$$

1. Find the density of a material, given that a 7.75 g sample occupies 2.25 mL.

Round answer to two decimal places.

$$D = \frac{m}{V}$$

m = 7.75 g

V = 2.25 mL

D = ?

$$D = \frac{7.75\ \text{g}}{2.25\ \text{mL}}$$

D = 3.44 g/mL

1.

$$D = \frac{m}{V}$$

m = 7.75 g

V = 2.25 mL

D = ?

$$D = \frac{7.75\,\text{g}}{2.25\,\text{mL}}$$

D = 3.44 g/mL

2. What is the <u>mass</u> of a sample of material that has a volume of 55.1 cm^3 and a density of 6.72 g/cm^3?

Round answer to the nearest whole number.

m = ?

V = 55.1 cm^3

D = 6.72 g/cm^3

$$D = \frac{m}{V}$$

$$6.72\ g/cm^3 = \frac{m}{55.1\ cm^3}$$

$$\frac{6.72\ g/cm^3}{1} = \frac{m}{55.1\ cm^3}$$

$$6.72\ g/cm^3 \bullet 55.1\ cm^3 = 1 \bullet m$$

m = 370.272 g

= 370 g

2.

$$D = \frac{m}{V}$$

m = ?

V = 55.1 cm^3

D = 6.72 g/ cm^3

$$\mathbf{6.72\ g/\ cm^3 = \frac{m}{55.1\ cm^3}}$$

$$\frac{\mathbf{6.72}\ \mathrm{g/\ cm^3}}{\mathbf{1}} = \frac{\mathbf{m}}{\mathbf{55.1\ \ cm^3}}$$

$$\mathbf{6.72\ g/cm^3 \bullet 55.1\ \ cm^3 = 1 \bullet\ m}$$

m = 370.272 g = 370 g

3. The density of gold is 19.3 g/cm^3**.** What is the volume, in cubic centimeters, of a sample of gold that has a mass of 715 g?

ROUND YOUR ANSWER TO ONE DECIMAL PLACE

3. D = 19.3 g/cm^3

V = ?, cm^3

m = 715 g?

$$D = \frac{m}{V}$$

$$\mathbf{19.3\ g/cm^3 = \frac{715\ g}{V}}$$

$$\mathbf{\frac{19.3\ g/cm^3}{1} = \frac{715\ g}{V}}$$

37.046 cm^3

37.0 cm^3

Bell Work, Thursday, Oct 17, 2013

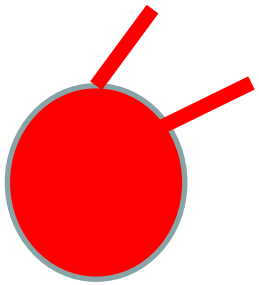
1. Use the data below to answer Wednesday's questions

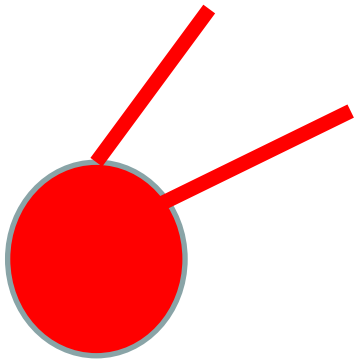
Substance	*Density (g/cm^3)*
Gas - CO_2	0.0021
liquid - water	1.00
Solid - Aluminum	2.70

2. How does the density of the liquid compare to the solid?

Smaller, 2.7 x smaller

3. Using particle diagrams, represent samples of a cold gas and a hot gas. Speed is shown by the length of the whooshies.





Densities of Solids , Liquids, & Gases

1. **What is the density of the CO_2 gas from Mr. B's demo?**

   0.0020 – 0.0021 g/ mL

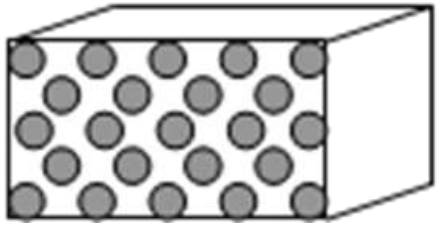
2. **Most liquids have densities between 0.6 g/ mL and 1.5 g/ mL. How does the density of the gas compare to the liquids?**

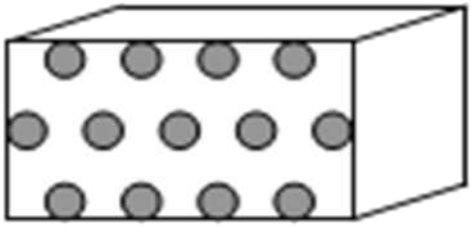
   A lot smaller? 500 x smaller

3. **How does the density of the gas compare to the solids, like aluminum (density = 2.70 g/mL)?**

   A lot smaller? 1250 – 1400 x smaller

4. **Using what you know about density, draw a picture of a solid, a liquid, and a gas using particle drawings in a box.**





Densities of Solids , Liquids, & Gases

5. What do we know about how our particles arrange themselves in solids, liquids & gasses ? What is this property called?

- **The solid particles are very close together (very dense).**
- **The liquid particles are not as dense as a solid but are still close together, and the gas particles are very spread out.**

This property is called density.

Densities of Solids , Liquids, & Gases

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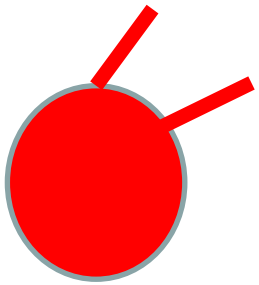
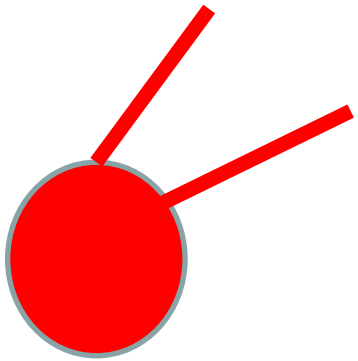
3. Using particle diagrams, represent samples of a cold gas and a hot gas. Speed is shown by the length of the whooshies.





Density of Solids, Liquids & Gasses

1. **What is the density of the CO_2 gas from Mr. B's demo?**

   0.0020 – 0.0021 g/ mL

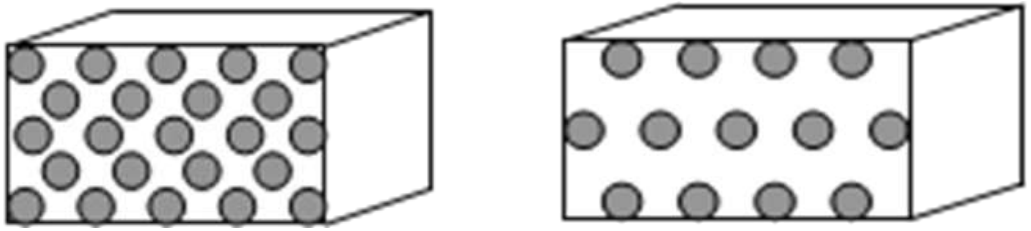
2. **Most liquids have densities between 0.6 g/ mL and 1.5 g/ mL. How does the density of the gas compare to the liquids?**

   A lot smaller? 500 x smaller

3. **How does the density of the gas compare to the solids, like aluminum (density = 2.70 g/mL)?**

   A lot smaller? 1250 – 1400 x smaller

4. **Using what you know about density, draw a picture of a solid, a liquid, and a gas using particle drawings in a box.**



Densities of Solids , Liquids, & Gases

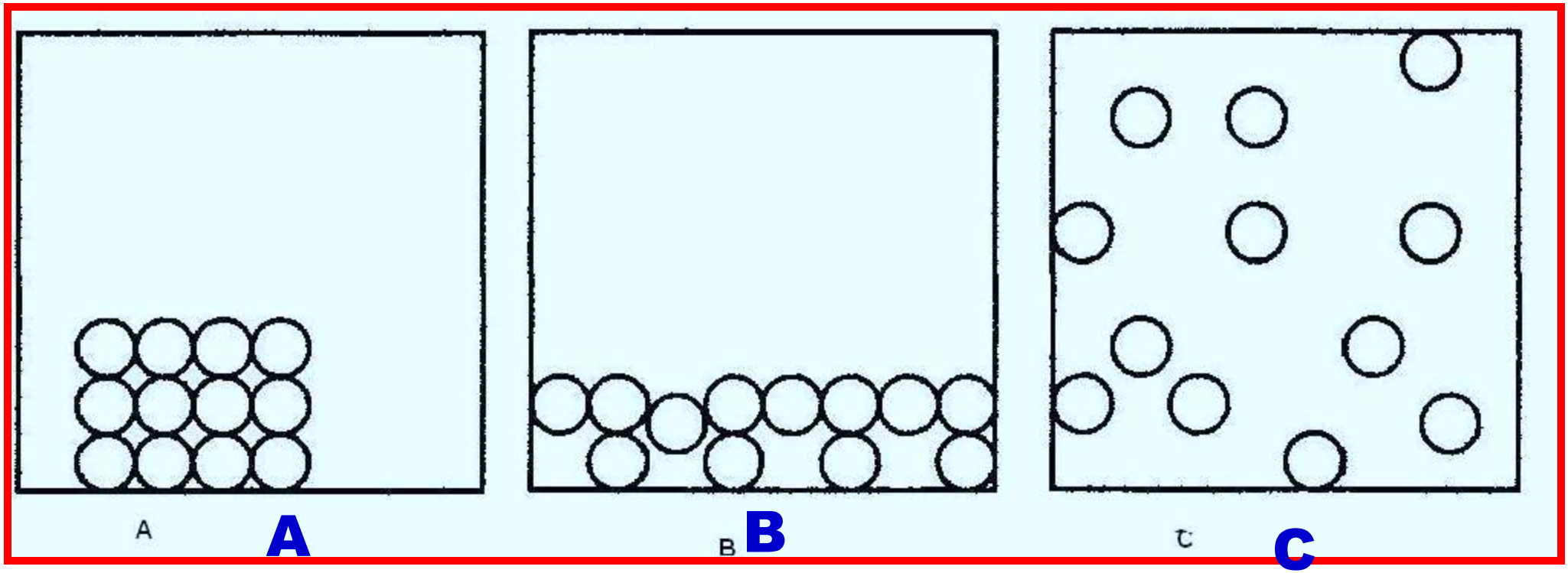
5. What do we know about how our particles arrange themselves in solids, liquids & gasses ? What is this property called?

- **The solid particles are very close together (very dense).**
- **The liquid particles are not as dense as a solid but are still close together, and the gas particles are very spread out.**

This property is called density.

States of Matter

1. Which diagram represents the solid state, the liquid state and the gas state of matter. Explain your answer.

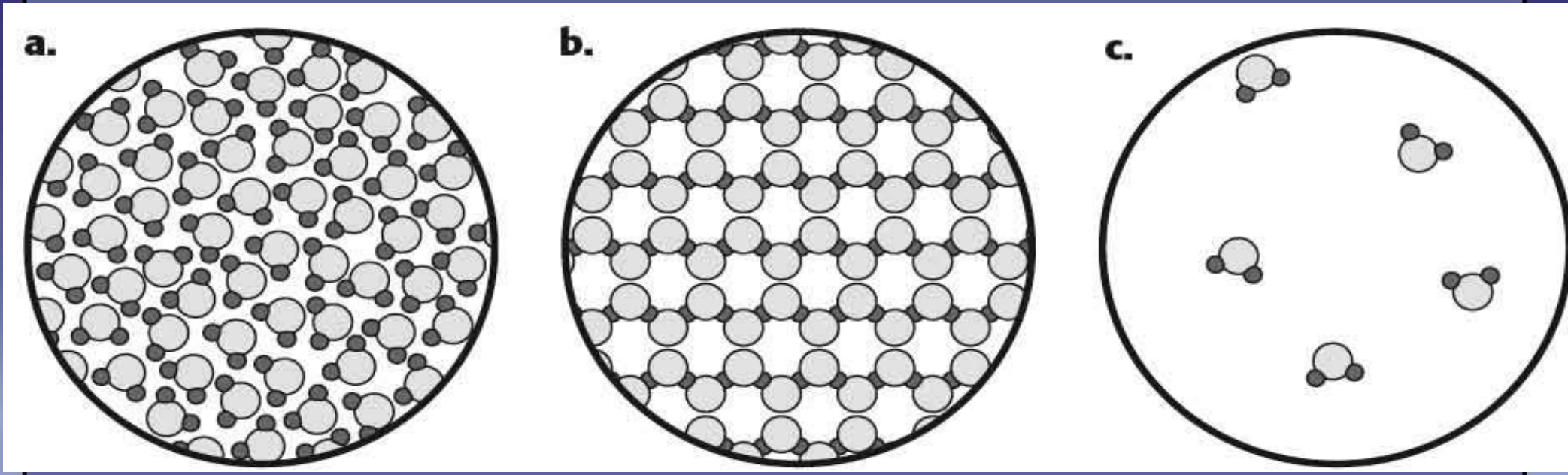


Solid - definite shape & volume.

Liquid - no definite shape but definite volume.

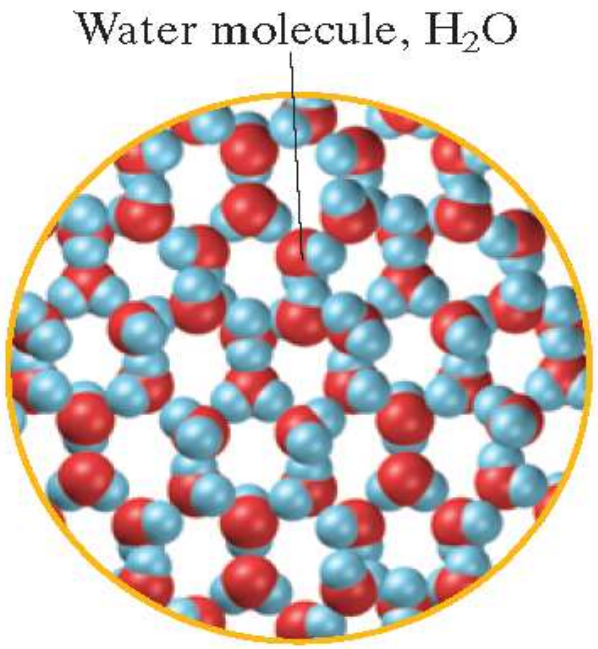
Gas - no definite shape, no definite volume.

Water, State of Matter

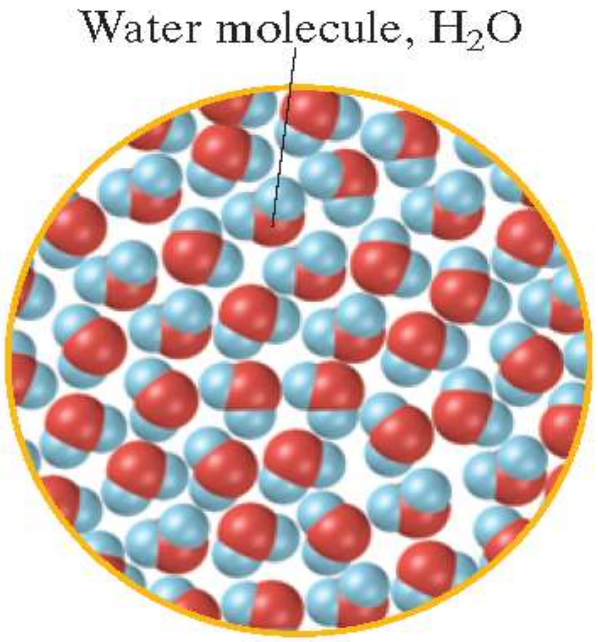


A. Liquid (water)
B. Solid (ice)
C. Gas (vapor)

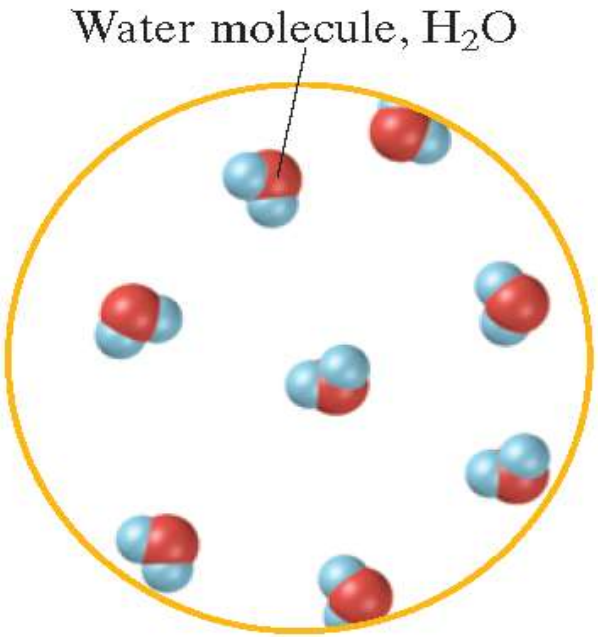
Water in Three States



Solid



Liquid



Gas

Particles in a:

- **gas are well separated with no regular arrangement.**
- **liquid are close together with no regular arrangement.**
- **solid are tightly packed, usually in a regular pattern.**

Simulations

States of Matter - PhET

States of Mater, Purdue University