Experiment title and number

EXPERIMENT 1

Date

M/D/2010

08

(0.3 pts)

Name

STUDENT NAME

Course	Section	Lab partner
113.1	L-#	NONE

PURPOSE : 4 sentences explaining / describing experiment

(2 pt)

(−1 pt), no section headings throughout

MATERIALS : ruler (in kit)
density set (from instructor)
electronic balance (in lab, use only balance assigned to my bench and only during allotted time)
caliper (from instructor, obtain only after finished with ruler)
safety glasses (ALWAYS WEAR!)

(pts) note: future examples will not contain

PROCEDURE:

(pts)

1. determine dimensions of objects with ruler. WATCH UNITS AND PRECISION!
2. determine mass. TARE balance and use weighing paper.
3. Bring notebook to instructor. Obtain calipers.
4. determine dimensions with calipers.

ADDITIONAL NOTES : NOT A REQUIRED SECTION. LIMITED TO 1 PAGE

- Balance operation
  - verify that balance is clean. If not, clean it.
  - tare balance. Let stabalize
  - place weigh paper on pan and retare.
  - place object on balance, record mass.
  - remove object, retare, weigh next object
- Reading ruler
  - precision should be to the closest 10% of the smallest graduation ⇒ 0.1 mm or 0.01 cm.

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0.1 pt

Name

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Course

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NONE

- Reading calipers
  - close jaws lightly
  - wiggle to make sure jaws are perpendicular to object
  - use zero on sliding scale to determine integer in mm.
  - tick that most closely aligns gives 0.10mm
  - if ticks do not align then measurement is 0.05 mm
  - final precision is 0.05 mm

DATA:

- Sample code: E01560 IDENTITY: teflon

1pt

- Description: cylinders, opaque, orange, plastic like

- From rulers. Mass determined using electronic balance B.

pts

SAMP	DIAMETER (cm)	LENGTH (cm)	MASS (g)
1	1.51	2.30	10.106
2	1.50	3.85	16.652
3	1.49	5.29	23.015
4	1.50	6.76	29.551

-0.2pts units -0.2 pts precision

- From calipers. Mass same as above.

pts

SAMP	DIAMETER (cm)	LENGTH (cm)	MASS (g)
1	1.600	2.305	~~10.116~~ 10.106*
2	1.595	3.845	16.652
3	1.605	5.290	23.015
4	1.600	6.760	29.551

-0.2 pt units -0.2 pt precision

* misread density from table above

If skips pages and does not put this -1 pt

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→ SEE PAGE 14 FOR RESULTS + CONCLUSION

Experiment title and number
EXPERIMENT 2

Date
M/D/2010

10
0.45 pts

Name
STUDENT NAME

Course
113.1

Section
L-#

Lab partner
NONE

PURPOSE : up to 4 sentences explaining / describing experiment.

4 pts

-1 pt no section headings throughout

MATERIALS : 100 mL graduated cylinder (in kit)
electronic balance (in lab, use only balance assigned to my bench and only during allotted time)
~~volume~~ two pieces of mineral 1
two pieces of mineral 2

2 pts

ADDITIONAL NOTES : NOT A REQUIRED SECTION

- Balance : reads to 0.001 g.
- Cylinder : - read bottom (or top) of miniscus
  - reads to 0.1 mL

DATA :

- ~~Mineal 1~~ Mineral 1 Code : E02503

* Description : royal blue with white lines. approximately 1" in size. somewhat squarish / cylinderical.

* Mass : Piece 1 - 0.449 g
Piece 2 - 0.943 g

2 pts

* Initial volume : 30.8 mL
* Final volume (after both pieces are added) : 31.4 mL

-0.2 pts units -0.2 pts precision

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EXPERIMENT 2

Date

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0.2pt

Name

STUDENT NAME

Course

113.1

Section

L-#

Lab partner

NONE

- Mineral 2 Code: E02506

* Description: royal blue with off-white splotches, square cylindrical in shape (roughly). Approximately 1" in size

2pts

* Mass: Piece 1 – 1.211g
  Piece 2 – 0.643 g

* Initial volume: 30.2 mL
* Final volume (after both pieces): 30.9 mL

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EXPERIMENT 2

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11/10/2010

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(0.2pt)

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STUDENT NAME

Course

113.1

Section

L-#

Lab partner

NONE

RESULTS :

- Mineral 1 (E02503)

(1 pt)

mass = 0.449 g + 0.943 g = 1.392 g

volume = 31.4 mL − 30.8 mL = 0.6 mL

Thus, ρ = 1.392g / 0.6 mL = 2.$\bar{3}$ g/mL

−0.1 units
−0.1 precision

- Mineral 2 (E02506)

(1 pt)

mass = 1.211g + 0.643 g = 1.854 g

volume = 30.9 mL − 30.2 mL = 0.7 mL

Thus, ρ = 1.854 g / 0.7 mL = 2.$\bar{6}$ g/mL

−0.1 units
−0.1 precision

(3 pts)

~~Using~~ According to Table 2 ~~on~~ p. __ of the laboratory manual, two minerals are royal blue with white inclusions : lapis and sodalite. However, sodalite is a deeper blue. Moreover, sodalite has a density of 2.29 g/mL, while lapis has a density of 2.75 g/mL. Thus,

Mineral 1 (E02503) is probably sodalite, while

Mineral 2 (E02506) is probably lapis lazuli

DISCUSSION

(4 pts)

Although the colors of the two samples where very close, the densities of the two minerals where distinct. Thus, we were able to uniquely distinguish the two samples. However, lapis is a mixture of several minerals ~~and~~ that always has a small amount of pyrite [1], while sodalite is a pure mineral containing no pyrite. Since pyrite contains iron, a test for iron content

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0.2 pt

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Section — L-#
Lab partner — None

would confirm the identification.

1 pt [1] Lapis lazuli, Wikipedia. http://en.wikipedia.org/wiki/Lapis (accessed Jan. 18, 2010).

a reference is required because of the discussion

CONCLUSION

4 pts We used the difference in density to determine that sample E02503 was propably sodalite and E02506 was propable lapis lazuli. Based on this identification, our error in the density of sodalite was 0.4%. The error in the density for lapis lazuli was 5%. The larger error in the lapis lazuli density is probably caused by the purity of the sample. Lapis lazuli is rare and impure samples are often dyed to improve color [1]. According to [1], this dying process usually produces a very dark blue color with a greyish cast. My physical description is not detailed enough to determine if my sample was indeed dyed (and therefore a very impure lapis lazuli). Some of the error could be removed by increasing the precision of the graduated cylinder.

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(0.1 pt)

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CONTINUED FROM PAGE 9.

RESULTS: Since the objects are cylindrical, the volume can be determined from

$$V = \pi r^2 h$$

$\pi = 3.1416$ h = height (cm)
radius $r = d/2$, where
d = diameter

(1 pt)

then $\rho = \frac{m}{V} = \frac{m}{\pi r^2 h} = \frac{4m}{\pi d^2 h}$

An example calculation from the ruler is

~~$\rho_{rul} = \frac{4(16.652)}{(3.1416)(1.50)^2}$~~ no units written

(0.5 pt)

$$\rho_{rul} = \frac{4(16.652\,g)}{(3.1416)(1.50\,cm)^2(3.85\,cm)} = 2.45\,g/cm^3$$

for sample 2

The same calculation using the caliper data is

(0.5 pt)

$$\rho_{cal} = \frac{4(16.652\,g)}{(3.1416)(1.595\,cm)^2(3.845\,cm)} = 2.167\,g/cm^3$$

(−0.1 pt prec. and units)

IN THE TABLE BELOW, the complete data set for the ruler measurements is given

(1 pt)

Sample	Diameter (cm)	Length (cm)	Radius (cm)	Volume (cm^3)	Mass (g)	Density (g/cm^3)
1	1.51	2.30	0.755	4.12	10.106	2.45
2	1.50	3.85	0.750	6.80	16.652	2.45
3	1.49	5.29	0.745	9.22	23.015	2.50
4	1.50	6.76	0.750	11.9	29.551	2.47

−0.1 pt prec. and −0.1 pt units

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(0.1 pt)

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NONE

Similarly, the caliper data set is in the table below

(1 pt)

Sample	Diameter (cm)	Length (cm)	Radius (cm)	Volume (cm^3)	Mass (g)	Density (g/cm^3)
1	1.600	2.305	0.8000	4.634	10.106	2.181
2	1.595	3.845	0.7975	7.683	16.652	2.167
3	1.605	5.290	0.8025	10.70	23.015	2.150
4	1.600	6.760	0.8000	13.59	29.551	2.174

−0.1 pt prec.

−0.1 pt units

The average ~~uncertainty~~ density for the ruler set is

$$\rho = \frac{1}{4}(2.45 + 2.45 + 2.50 + 2.47)\ g/cm^3 = 2.47\ g/cm^3$$

The standard deviation is

$$s = \frac{1}{\sqrt{3}}\left[(2.45-2.47)^2 + (2.45-2.47)^2 + (2.50-2.47)^2 + (2.47-2.47)^2\right]^{1/2} \times 1\ g/cm^3$$

$$= \frac{1}{\sqrt{3}}\left[(0.02)^2 + (0.02)^2 + (0.03)^2\right]^{1/2} g/cm^3 = 0.02\ g/cm^3$$

0.8% uncertainty

A very precise data set will have all points within a standard deviation. In this lab, our data set is considered precise if all points fall within two standard deviations, or

$$\rho = 2.47 \pm 0.04\ g/cm^3$$

1.6% uncertainty

−0.1 pt units
−0.1 pt prec.
−0.1 pt uncert.

(1 pt)

All of our points fall within this limit. Thus, the data set is precise.

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0.1 pt

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The average density for the caliper set is

$$\rho = \frac{1}{4}(2.181 + 2.167 + 2.150 + 2.174)\ g/cm^3 = 2.168\ g/cm^3$$

The standard deviation is

$$s = \frac{1}{\sqrt{3}}\left[(0.013)^2 + (0.001)^2 + (0.018)^2 + (0.006)^2\right]^{1/2} g/cm^3$$

$$= 0.022\ g/cm^3$$

This data set is very precise since all data points fall within a single deviation, or

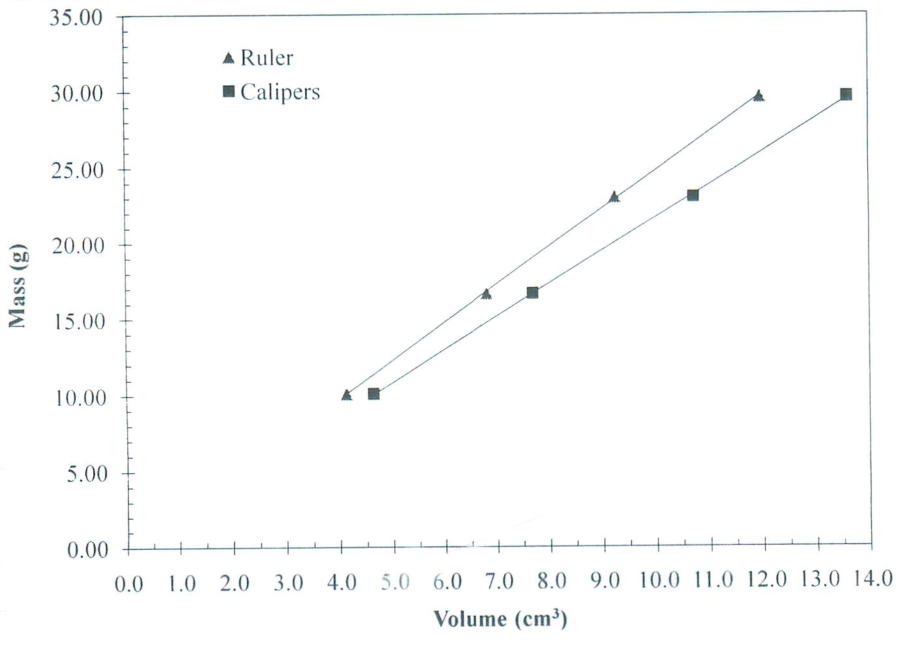
$$\rho = 2.168 \pm 0.022\ g/cm^3$$

1.0% uncertainty

1 pt

-0.1 pt units
-0.1 pt prec.
-0.1 pt uncert

A graph of mass vs volume is shown below.



pts total

-0.5 pts ea. unreadable axis, non-linear axis, no labels on axis

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0.1 pt

Name

STUDENT NAME

Course

113.1

Section

L-#

~~NONE~~

Lab partner

NONE

a linear regression was performed in Excel using the information in Technical brief 9 from the laboratory manual. The results are below for the ruler data

RULER

Linear regression

Sample	V^2 (cm^6)	m V (g cm^3)	m_p (g)	$(m_p - m)^2$ (g)
1	17.0	41.6	10.5	0.144
2	46.3	113	17.2	0.289
3	85.1	212	23.2	0.048
4	143	353	30.0	0.229
Sum	**291**	**720**		**0.710**

Slope	2.50	plus or min	0.02	g/cm^3
Intercept	-0.20	plus or min	0.88	g

for the caliper data

CALIPER

Linear regression

Sample	V^2 (cm^6)	m V (g cm^3)	m_p (g)	$(m_p - m)^2$ (g)
1	21.5	46.8	10.0	0.010
2	59.0	128	16.6	0.003
3	114.5	246	23.1	0.015
4	185	402	29.4	0.026
Sum	**380**	**823**		**0.054**

Slope	2.164	plus or min	0.004	g/cm^3
Intercept	0.024	plus or min	0.239	g

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(0.1 pt)

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From the graphical analysis

ruler: $\rho = 2.50 \pm 0.02\ g/cm^3$

caliper: $\rho = 2.164 \pm 0.004\ g/cm^3$

(1 pt)

−0.1 pt units
−0.1 pt prec.

The published value of the density [Lab manual]

$$\rho = 2.20\ g/cm^3$$

Thus, the accuracy of the data is

$$\%\ error = \frac{|2.20\ g/cm^3 - 2.50\ g/cm^3|}{2.20\ g/cm^3} \times 100 = 13.6\% \quad \text{ruler}$$

(1 pt)

$$\%\ error = \frac{|2.20\ g/cm^3 - 2.164\ g/cm^3|}{2.20\ g/cm^3} \times 100 = 1.64\% \quad \text{caliper}$$

−0.1 pt units
−0.1 pt prec.

DISCUSSION

Answer the questions in the discussion section using complete sentences.

(4 pts)

CONCLUSION

Write a concluding paragraph. Use your data to decide which measuring method is the best and explain why. Use your data to explain the difference between averaging and a graphical analysis. Which is better? Why?

(4 pts)

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0.1 pt

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Lab partner

NONE

CONCLUSION (continued)

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