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Introduction to Measurement Lab

Following parts need to be included

Title page

Experimental See Chapter T2-4

Raw Data, Results and Calculation

1) FIRST CHALLENGE

Determine the density of a known piece of plastic.

(*You have following tools available, ruler, graduated cylinder, vernier caliper, and an electronic balance. The objective is to find THE MOST PRECISE METHOD to determine the density. The standard deviation is an indicator for the precision of the experiment)*

This is a sample calculation. Use your own measurements.

Let's assume the piece of plastic (HDPE) is a rectangular box with the sides a, b, c.

Volume = a b c.

HDPE is a distinct kind of plastic.

Table 1 *(Used an electronic Balance and a Ruler)*

Trial	Volume [cm^3]	Mass [g]	Density [g/cm^3]
1	3.6	3.552	0.99
2	3.5	3.359	0.96
3	3.6	3.335	0.93

Average density = (0.99 + 0.96 + 0.03)/3 = 0.96 g/cm3

Density Standard Deviation = 0.03 g/cm^3 Do not forget the units.

VOLUME CALCULATIONS FOR TRIAL 1A

a = 1.1 cm, b = 2.2 cm, c = 1.5 cm

V = 1.1 cm * 2.2 cm *1.5 cm =3.6 cm^3, the final answer has 2 significant figures since all the measurement have 2 significant figures.

DENSITY CALCULATIONS FOR TRIAL 1A

Density = 3.552 g/3.6 cm^3 = 0.99 g/cm^3, in this case the result has only 2 significant figures.

Remember the least significant figure determines the number of significant figures in the result.

AVERAGE DENSITY AND STANDARD DEVIATION

See Chapter T3-3

EXAMPLE

Average Density = $\frac{0.99 + 0.96 + 0.93}{3}$ g/cm^3 = 0.96 g/cm^3

Density Standard Deviation = $\sqrt{\frac{(0.99 - 0.96)^2 + (0.96 - 0.96)^2 + (0.93 - 0.96)^2}{(3 - 1)}}$ g/cm^3

= 0.03 g/cm^3

Table 2 *(Used an electronic Balance and a Graduated Cylinder)*

Trial	Volume [cm^3]	Mass [g]	Density [g/cm^3]
1	3.5	3.452	0.99
2	3.5	3.365	0.96
3	3.6	3.435	0.95

Average density = 0.97 g/cm3

Density Standard Deviation = 0.02 g/cm^3 Do not forget the units.

VOLUME CALCULATIONS FOR TRIAL 1B

Take the difference in volume by immersing the plastic in a graduated cylinder.

It is important to know how precise the measurement is. The precision depends on the graduated cylinder used by your group.

DENSITY CALCULATIONS FOR TRIAL 1B

Density = 3.452 g/3.5 cm^3 = 0.99 g/cm^3, in this case the result has only 2 significant figures.

Remember the least significant figure determines the number of significant figures in the result.

AVERAGE DENSITY AND STANDARD DEVIATION TRAIL 1B

See Chapter T3-3

Table 3 *(Used an electronic Balance and a vernier caliper)*

Trial	Volume [cm^3]	Mass [g]	Density [g/cm^3]
1	3.517	3.361	0.9556
2	3.505	3.330	0.9502
3	3.615	3.434	0.9498

Average density = 0.9519 g/cm3

Standard Deviation = 0.0032 g/cm^3 Do not forget the units.

VOLUME CALCULATIONS FOR TRIAL 1C

a = 1.105 cm, b = 2.195 cm, c = 1.450 cm

V = 1.105 cm * 2.195 cm *1.450 cm = 3.517 cm^3, the final answer has 4 significant figures since all the measurement have 4 significant figures.

DENSITY CALCULATIONS FOR TRIAL 1C

Density = 3.361 g/3.517 cm^3 = 0.9556 g/cm^3, in this case the result has only 4 significant figures. Remember the least significant figure determines the number of significant figures in the result.

AVERAGE DENSITY AND STANDARD DEVIATION TRAIL 1C See Chapter T3-3

This example shows that the most precise measurement is obtained by using the electronic balance and a vernier caliper. Your results might be different and you need to quote your own findings. If you did not perform all the steps list only the findings that are required by your TA.

END OF FIRST CHALLENGE

2) SECOND CHALLENGE

Determine the density of the different pieces of plastic. Use the most precise measurement.

EXAMPLE

Table 4 Plastic PS *(Used an electronic Balance and a vernier caliper)*

Trial	Volume [cm^3]	Mass [g]	Density [g/cm^3]
1	3.520	3.653	1.038
2	3.503	3.650	1.042
3	3.603	3.744	1.039

Average density = 1.040 g/cm3

Standard Deviation = 0.0021 g/cm^3 Do not forget the units.

The procedure should be repeated with the remaining pieces of plastic.

END OF SECOND CHALLENGE

3) FINAL CHALLENGE

Find the identity of the unknown piece of plastic.

Table 5 Unknown plastic *(Used an electronic Balance and a vernier caliper)*

Trial	**Volume [cm^3]**	**Mass [g]**	**Density [g/cm^3]**
1	3.545	4.555	1.285
2	3.611	4.767	1.320
3	3.458	4.520	1.307

Average density = 1.304 g/cm3

Standard Deviation = 0.018 g/cm^3 Do not forget the units.

Based on this results the plastic is PET, its published density =1.29-1.4 g/ml.

Match it with your experimental density.

Remember ml = cm^3

Discussion

Discuss your results or answer the questions if posted.