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PHYS 1225 Sec. 1
Desk # 9
Nov. 1, 2016

Measuring π

Purpose: Measure the value of π using the volume of spheres of different sizes.

Apparatus: 5 steel spheres (different sizes), Vernier caliper # 9, 2-pan balance # HT14, beaker, stand, magnet.

Data

Diameter and Volume of Spheres

Sphere	Diameter (cm)	Volume (cm^3)
# 1	0.64	0.14
# 2	1.27	1.08
# 3	1.90	3.60
# 4	2.23	5.82
# 5	2.55	8.73
Uncertainty	0.01	0.05

Calculations:

Plan for graphing: $V = \frac{\pi}{6} D^3$

So we will plot D^3 on x-axis, V on y-axis
therefore slope $= \frac{\pi}{6}$, we can calculate $\pi = 6(\text{slope})$

uncertainty $\frac{\delta\pi}{\pi} = \frac{\delta \text{ slope}}{\text{slope}}$

Graphing data:

Sphere #	$x = D^3$ (cm^3)	$\delta x = 3D^2 \delta D$ (cm^3)	$y = V$ (cm^3)	δV (cm^3)
1	0.26214	0.0123	0.14	0.05
2	2.0484	0.0484	1.08	0.05
3	6.859	0.1083	3.60	0.05
4	11.090	0.1492	5.82	0.05
5	16.581	0.1951	8.73	0.05

To find $\delta x = \delta(D^3)$: $\quad x = D^3$

$$\frac{\delta x}{x} = 3\frac{\delta D}{D}$$

so $$\delta x = \frac{3\delta D}{D} \cdot x = \frac{3\delta D}{D} D^3 = 3D^2 \delta D$$

See next page for graph and slope calculation

$$\text{slope}_{\text{best}} = 0.528$$

$$\pi = 6\,\text{slope}_{\text{best}} = 6 \times 0.528 = 3.168$$

Uncertainty Analysis

From the graph (next page), $\delta\,\text{slope} = 0.00886$, so

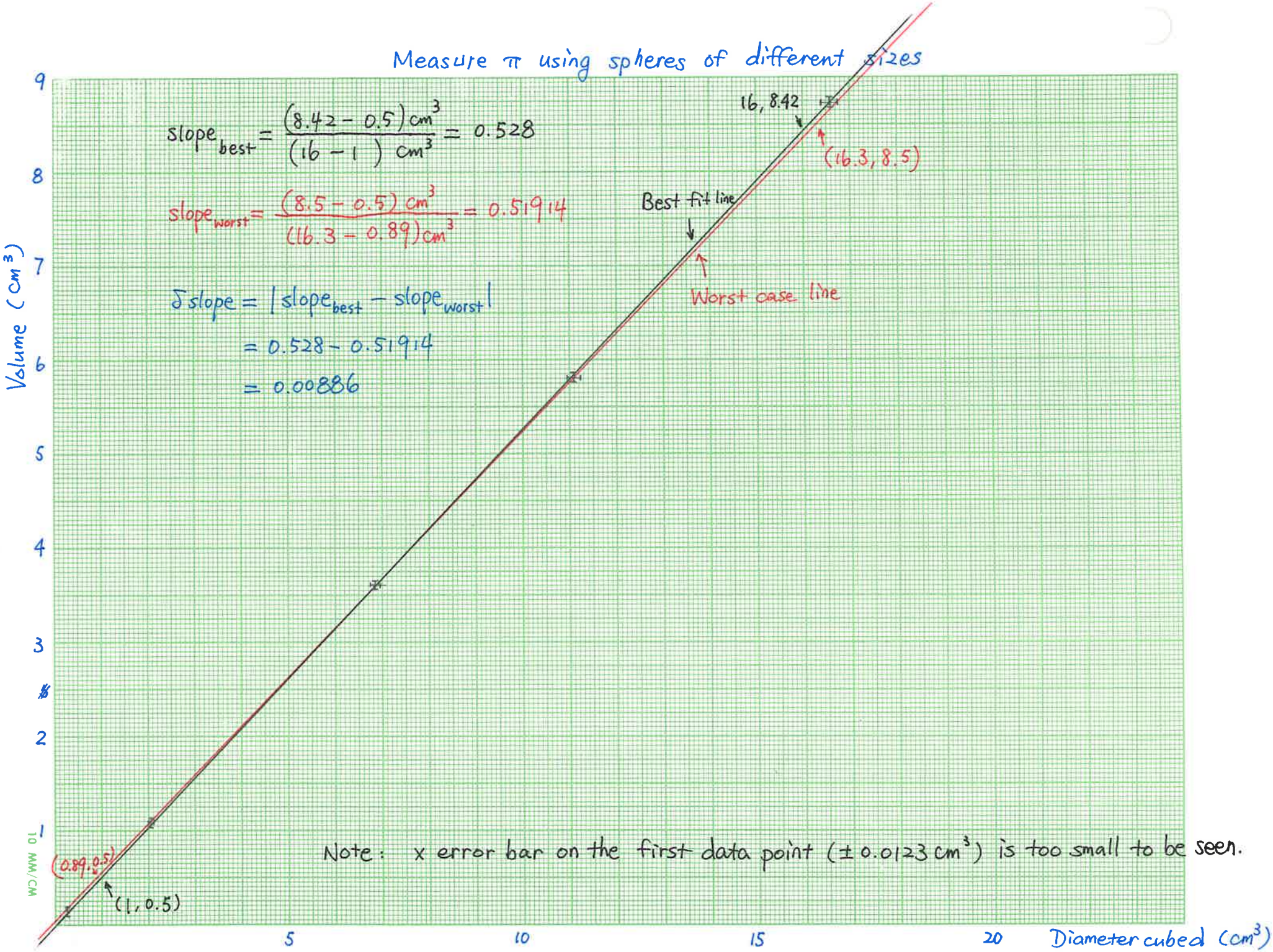
$$\frac{\delta\pi}{\pi} = \frac{\delta\,\text{slope}}{\text{slope}} = \frac{0.00886}{0.528} = 0.01678 \rightarrow 1.7\%$$

$$\delta\pi = \frac{\delta\pi}{\pi} \cdot \pi = 0.01678 \times 3.168 = 0.05316 \rightarrow 0.05$$

Conclusion: We found π to be 3.17 ± 0.05, $\pm 1.7\%$.

Discussions: Our result of π is 3.17 ± 0.05, or 3.12 to 3.22, which agrees with the reference value 3.14159..... Our uncertainty is 1.7% which is not bad, but if we have spheres even bigger or smaller, we may get better result.

Measure π using spheres of different sizes



$$\text{slope}_{best} = \frac{(8.42 - 0.5)\,cm^3}{(16 - 1)\,cm^3} = 0.528$$

$$\text{slope}_{worst} = \frac{(8.5 - 0.5)\,cm^3}{(16.3 - 0.89)\,cm^3} = 0.51914$$

$$\delta\,\text{slope} = |\text{slope}_{best} - \text{slope}_{worst}|$$
$$= 0.528 - 0.51914$$
$$= 0.00886$$

Note: x error bar on the first data point ($\pm 0.0123\,cm^3$) is too small to be seen.

RAW DATA !

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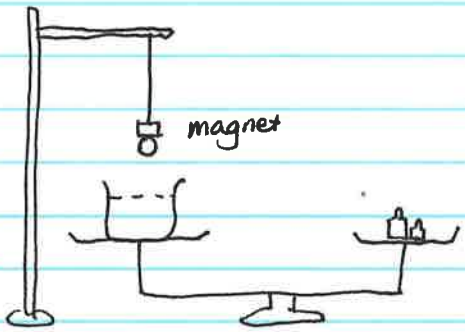
Apparatus: Vernier caliper #9, 2-pan balance #HT14,
5 spheres, — steel, not numbered, diff. sizes
beaker, stand, magnet



Because we used H_2O
$1\ g \leftrightarrow 1\ cm^3$

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	1	0.64	0.14
	2	1.27	1.08
	3	~~1.99~~ 1.90	3.60
	4	2.23	5.82
	5	2.55	8.73
		All: ± 0.01	All: ± 0.05

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