ElCoM
ELECTRICAL COMPUTER MECHATRONICS

تقدم لجنة ElCoM الاكاديمية

ريبورتات لمختبر :

الفيزياء العامة العملية

Analysis

A. Measurement of π

Since C= πd (C is circumference, d is the diameter),you determine the value of π, report each measurement five times,

Trial No.	d(cm)	$(d-\bar{d})^2$	c (cm)	$(c-\bar{c})^2$
1	3.75	0.000081	11.7	0
2	3.72	0.000441	11.8	0.01
3	3.735	0.000036	11.7	0
4	3.77	0.000841	11.7	0
5	3.73	0.000121	11.6	0.01
Average	$\bar{d} = 3.741\ cm$		$\bar{c}$ = 11.7 cm	
	$\Delta\bar{d} = \pm\ 0.00871\ cm$		$\Delta\bar{c} = \pm\ 0.03162\ cm$	

1. Using your average measured values of $\bar{d}$ and $\bar{c}$, calculate $\bar{\pi}$.

$$\bar{C} = \bar{d}\,\bar{\pi}$$

$$\bar{\pi} = \frac{\bar{C}}{\bar{d}} = \frac{11.7\ cm}{3.741\ cm} = 3.1275$$

2. Calculate $\Delta\bar{\pi}$ $\left(\Delta\pi = \bar{\pi}\sqrt{\left(\frac{\Delta\bar{d}}{\bar{d}}\right)^2 + (\Delta\bar{c}/\bar{c})^2}\ \right)$

$$\Delta\pi = (3.1275)\sqrt{\left(\frac{0.00871}{3.741}\right)^2 + \left(\frac{0.03162}{11.7}\right)^2} = 0.011$$

3. Calculate the error $\Delta\bar{d}$, in measuring the diameter of the disk, and $\Delta\bar{c}$ in measuring the circumference and enter the values calculated in the table above.

To calculate ($\bar{d}$) :

$$\bar{d} = \frac{\sum d}{n} = \frac{(3.75+3.72+3.735+3.77+3.73)}{5} = 3.741 \text{ (cm)}$$

To calculate ($\bar{c}$) :

$$\bar{c} = \frac{\sum c}{n} = \frac{((11.7\times3)+11.8+11.6)}{5} = 11.7 \text{ (cm)}$$

To calculate ($\Delta\bar{d}$) :

$$\Delta\bar{d} = \sqrt{\frac{\sum_1^5 (d-\bar{d})^2}{5(5-1)}} = \sqrt{\frac{(0.000081 + 0.000441 + 0.000036 + 0.000841 + 0.000121)}{5 \times 4}} = 0.00871\ (cm)$$

To calculate ($\Delta\bar{c}$) :

$$\Delta\bar{c} = \sqrt{\frac{\sum_1^5 (d-\bar{c})^2}{5(5-1)}} = \sqrt{\frac{((0\times3)+(0.01\times2))}{5\times4}} = 0.03162 \text{ (cm)}$$

4. Which quantity contributes more to the error in the $\bar{\pi}$?
   $(\Delta\bar{d}/\bar{d}\ , \Delta\bar{c}/\bar{c})$

The ratio of $\left(\frac{\Delta\bar{c}}{\bar{c}}\right)$ is greater than the ratio of $\left(\frac{\Delta\bar{d}}{\bar{d}}\right)$, so it is $\left(\frac{\Delta\bar{c}}{\bar{c}}\right)$ that contributes the most to the error of $\bar{\pi}$.

$$\frac{\Delta\bar{c}}{\bar{c}} = \frac{0.03162}{11.7} = 0.0027$$

$$\frac{\Delta\bar{c}}{\bar{c}} > \frac{\Delta\bar{d}}{\bar{d}}$$

$$\frac{\Delta\bar{d}}{\bar{d}} = \frac{0.00871}{3.741} = 0.0023$$

5. Does the measured average value of $\bar{\pi}$ agree with the accepted value of $\pi(3.14159)$ **(percent error)**

$$P.E = \frac{|3.14159 - 3.1275|}{3.14159} \times 100\% = 0.44\%$$

B. Determination of the density:

Record your data in the following table

Trial No.	h(cm)	$(h - \bar{h})^2$	d (cm)	$(d - \bar{d})^2$
1	11.315	0.000484	0.603	0.00007056
2	11.37	0.001089	0.605	0.00004096
3	11.325	0.000144	0.616	0.00002116
4	11.325	0.000144	0.622	0.00011236
5	11.35	0.000169	0.611	0.00000016
Average	$\bar{h} = 11.337\ cm$		$\bar{d}$ = 0.6114 cm	
Error	$\Delta\bar{h} = \pm\ 0.0100747\ cm$		$\Delta\bar{d} = \pm\ 0.035\ cm$	
Mass	m = 45.63 g		$\Delta m = \pm\ 0.01\ g$	

1. Find **the average value** of the calculated densities and compare it with the standard value of this material density (ρ =8.65 g/cm³)? [find the percent error]

$$\bar{\rho} = \frac{4m}{\pi\bar{d}^2\bar{h}} = \frac{4 \times 45.63}{(3.1275)\times(0.6114)^2\times 11.337} = 13.77\ \ (\text{g/cm}^3)$$

$$P.E = \frac{|13.77 - 8.65|}{8.65} \times 100\% = 59.19\%$$

2. Calculate the error in the density ($\Delta\rho$) $(\Delta\bar{\rho} = \bar{\rho}\sqrt{(\frac{\Delta m}{m})^2 + (\frac{\Delta \bar{h}}{\bar{h}})^2 + (\frac{2\Delta \bar{d}}{\bar{d}})^2 + (\frac{\Delta \bar{\pi}}{\bar{\pi}})^2}$

$$\Delta\bar{\rho} = (13.77)\sqrt{\left(\frac{0.01}{45.63}\right)^2 + \left(\frac{0.0100747}{11.337}\right)^2 + \left(\frac{2(0.035)}{0.6114}\right)^2 + \left(\frac{0.011}{3.1275}\right)^2}$$

$$= 1.57721$$

3. Which quantity contributes more to the error in the density; the mass, the diameter or the height? Why? (see part A 4) $(\frac{\Delta m}{m}, \frac{\Delta \bar{h}}{\bar{h}}, \frac{2\Delta \bar{d}}{\bar{d}}, \frac{\Delta \bar{\pi}}{\bar{\pi}})$

$$\frac{\Delta m}{m} = \frac{0.01}{45.63} = 0.000219$$

$$\frac{\Delta \bar{h}}{\bar{h}} = \frac{0.0100747}{11.337} = 0.0008865$$

$$\frac{2\Delta \bar{d}}{\bar{d}} = \frac{2(0.035)}{0.6114} = 0.1144$$

$$\frac{\Delta \bar{\pi}}{\bar{\pi}} = \frac{0.011}{3.1275} = 0.00351$$

$\frac{2\Delta \bar{d}}{\bar{d}}$ is more contributes to uncertainty in density ($\bar{\rho}$) because ($\frac{2\Delta \bar{d}}{\bar{d}}$ is the largest one) .

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