LAB NUMBER 1

VERNIERS, MICROMETERS AND UNCERTAINITIES

INSTRUCTIONS FOR EXPERIMENTS

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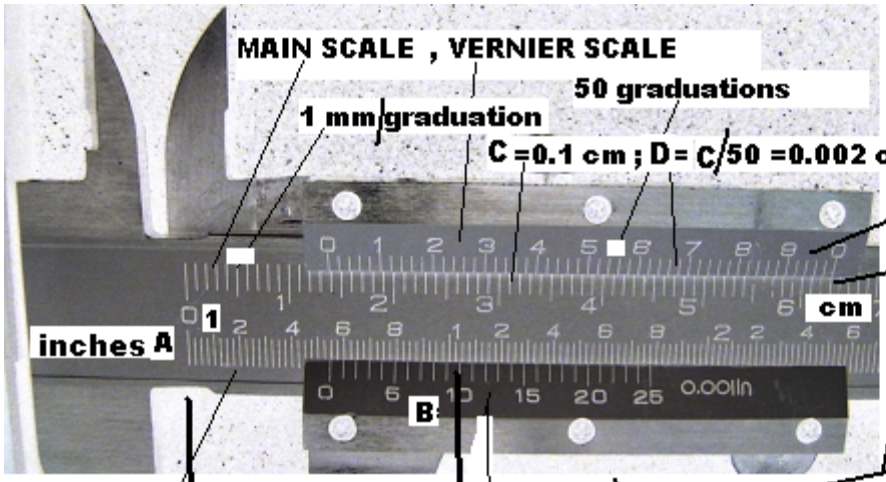
VERNIER CALIPER



A= 0.1 / 4 inches ;

A= 0.025 inches

B= A/ 25 =0.001 inches

SUPPOSE WE HAVE

READING = 1 + 3A + 9B

= 1+ (3 X 0.025) + (9 X 0.001)

= 1 + 0.075 + 0.009 = 1.084 inches

C=0.1 cm ; D = C/50 =0.002 cm

SUPPOSE WE HAVE

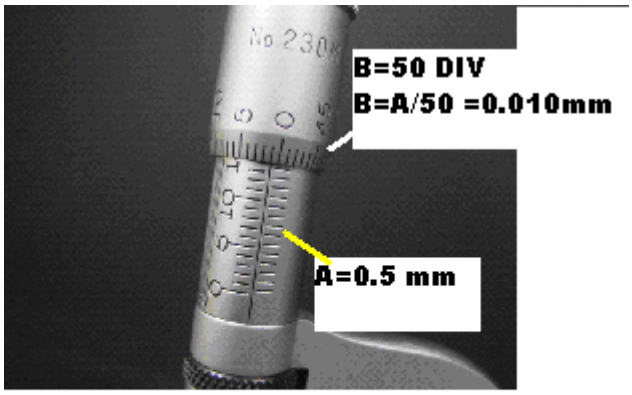
READING = 2 + 3 C + 20 D

= 2+(3 X 0.1) + (20 X 0.002)

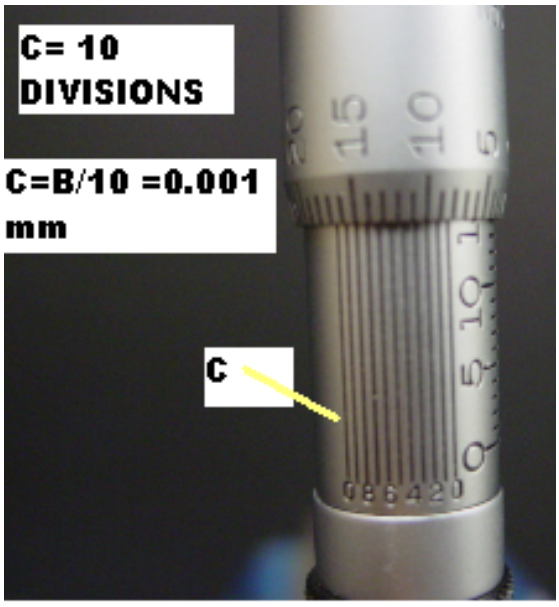
= 2 +0.3 +0.04

= 2.340

MICROMETER READINGS



READING = 2.0 + 1XA +42 X B + 9 X C
= 2.0 + 0.5 + 0.42 +0.009
=2. 929 mm



CALCULATING UNCERTAINTIES IN EXPERIMENTS

The algebra is as follows:

A Quality Measured
U_A **Uncertainity Per Unit of A**

Suppose there are several measurements - A, B, C, D.....then

Addition

1) $A\angle U_A \pm B\angle U_B$
$= (A+B)\angle(U_A + U_B)$

SUBTRACTION

2) $A\angle U_A - B\angle U_B$
$= (A-B)\angle(U_A + U_B)$

MULTIPLICATION

3) $(A\angle U_A)\times(B\angle U_B)$
$= (AB)\angle(U_A + U_B)$

DIVISION

4) $\frac{A\angle U_A}{B\angle U_B} = \left(\frac{A}{B}\right)\angle(U_A + U_B)$

5) A constant has zero uncertainty. For example, the acceleration due to gravity,

$g = 9.81 m/s\text{^}2$
$g\angle(Ug = 0)$

HOW TO EXPRESS UNCERTAINTY

Let us look at the following instruments for measurements.

Lab #1 Uncertainties

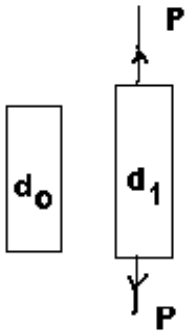
Metrology: The science of measurement.

Length Measurements:

	Range	Resolution Smallest Main Scale Graduation	Repeatability Uncertainty
Rule	0-300 mm	1 mm	± 1 mm
Vernier Caliper	0-150 mm	0.05 mm	± 0.05 mm
Micrometer	0-25 mm	0.002 mm	± 0.002 mm

Examples:

length of 10 mm (ruler) = 10 mm ± 1 mm **or** 10 mm ± 10%



EXAMPLE

Let us look at the application of the above in the measurement of Stress-Strain curve. The readings are as follows:

d_0	d_1	Load	Instrument	Instrument
1.2	1.1	4000kg	Micrometer Resolution (0.002)	Balance Resolution (1kg)

$$\text{strain} = \frac{d - d_o}{d_o} = \frac{(1.1) - (1.2)}{1.2} = \frac{-0.1}{1.2}$$

$$\frac{\left\{1.1\angle\left(\frac{0.002}{1.1}\right)\right\} - 1.2\angle\left(\frac{0.002}{1.2}\right)}{1.2\angle\left(\frac{0.002}{1.2}\right)}$$

$$\frac{\left(1.1\angle 0.0001818\right) - 1.2\angle 0.001666}{1.2\angle\left(0.001666\right)}$$

$$= 0.08333\angle\left(0.005138\right)$$

$$\text{stress} = \frac{force}{Area} = \frac{400\angle\left(\frac{1}{400}\right) \times 9.81\angle 0}{\pi\frac{d^2{}_o}{4} = \frac{3.1416}{4} \times (1.2^2 L(2 * 0.00166)}$$

$$= \frac{3924\angle\left(0.0025 + 0\right)}{0.7854 \times \left\{\left(1.2\angle 0.0016\right)\left(1.2\angle 0.0016\right)\right\}}$$

$$= 4996\angle\left(0.0025 + 0 + 0.0016 + 0.0016\right)$$

$$= 4996\angle 0.0057 \qquad \frac{N}{m^2}$$

$$\text{Modulus of Elasticity} = \frac{Stress}{Strain} = \frac{4996\angle 0.0057}{0.0833\angle 0.005738}$$

= (4996/0.08333) ∠ (0.0057 + 0.005138)

= 59954.39818 ∠ 0.010838

It can also be expressed as

= 59954.39818 ± [(59954.39818) x(0.010838)]

= 59954.39818 ± [**649.7857675]**

= **60604.18395** Maximum ; **59304.61241** Minimum