Experiment # (1)
Measurements and Errors

Physical quantities:

1) Measured quantities (length, mass, and time).
2) Calculated quantities (volume, velocity, acceleration, ……………..)

Types of errors:

1) Personal error.
2) Systematic error (instrument error)
3) Random error.

*The error of measurement (Δx):

1) The smallest division for **digital** instruments.
Example: *Balance*: error = least count = 0.01g
2) Half smallest division for **non digital** instruments.
Example: *Ruler ,or meter stick*: least count = 0.1 cm → error = $\frac{0.1}{2}$ cm = 0.05 cm

1) if $z = x \pm y$ **then:** $\mathbf{\Delta z = \Delta x + \Delta y}$, where **x** and **y** are <u>measured</u> quantities, **z** is <u>calculated</u> quantity(The errors are cumulative.)

2) if $z = xy$ or $z = x/y$, **then:**

a. take normal logarithm to both sides: $Ln(z) = Ln(x*/ y) = Ln(x) \pm Ln(y)$

b. derive explicitly : $\dfrac{\Delta z}{z} = \dfrac{\Delta x}{x} + \dfrac{\Delta y}{y}$

3) $z = a\, x^n$,where **a**, and **n** are <u>constants</u> ,or <u>unmeasured</u> quantities.

$$\dfrac{\Delta z}{z} = n\, \dfrac{\Delta x}{x}$$

Any experimental value measured or calculated written as:

$x \pm \Delta x$, where x is the value and Δx is the error in this value.
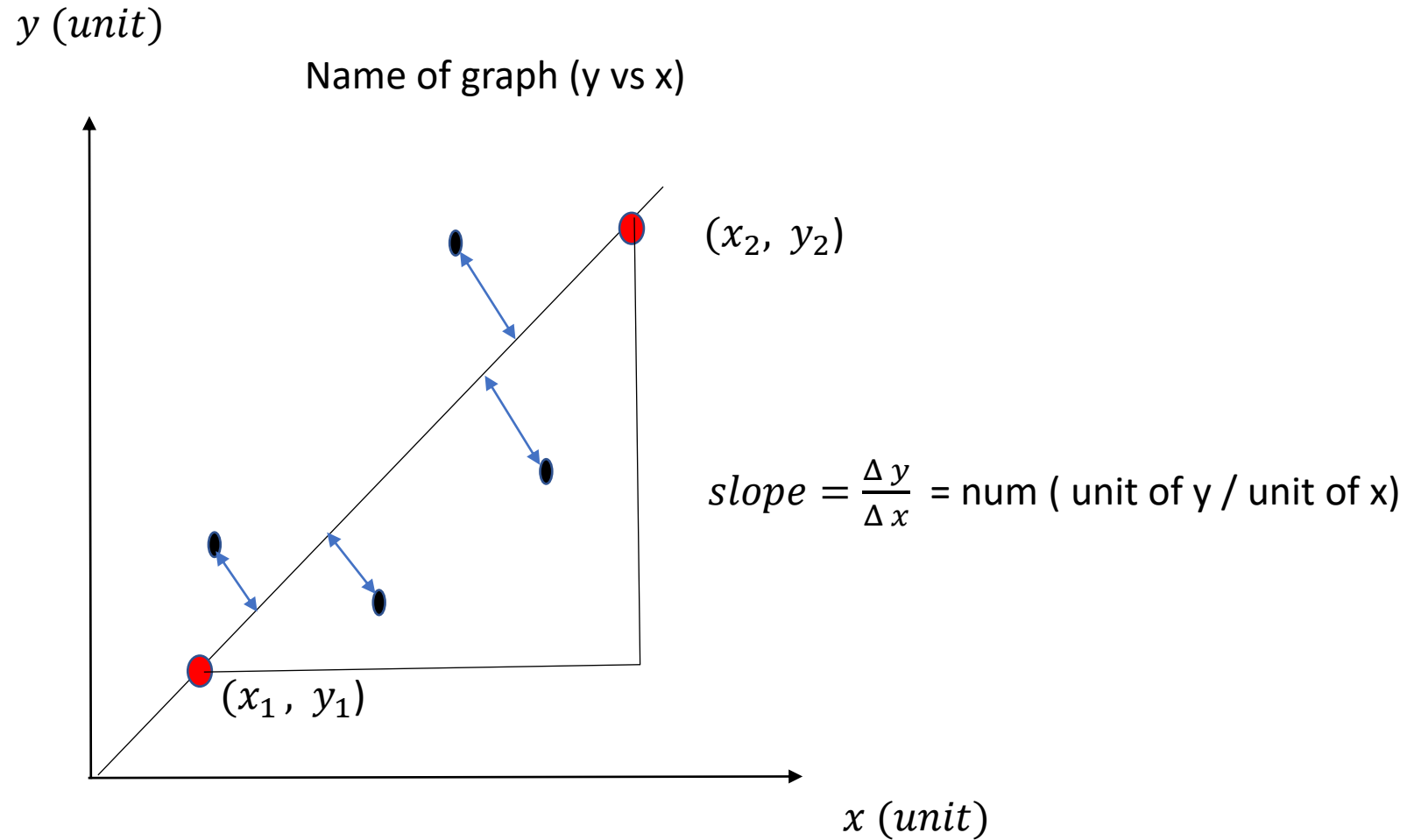
<u>Example</u> : Find the relative error in the volume of the cylinder?

$V = \dfrac{\pi D^2 h}{4} \rightarrow \dfrac{\Delta V}{V} = \dfrac{2\,\Delta D}{D} + \dfrac{\Delta h}{h}$

*Graphics:

y =a x + b where a: the slope, and b:y-intercept.

y (unit)

Name of graph (y vs x)

(x_2, y_2)

$slope = \frac{\Delta y}{\Delta x}$ = num (unit of y / unit of x)

(x_1, y_1)

x (unit)

*<u>Conclusions:</u>

I) Compare between real values and experimental values, why the similarities/differences?

II) Are you investigate the objectives of the experiment, how?

III) The errors that being in the experiment.

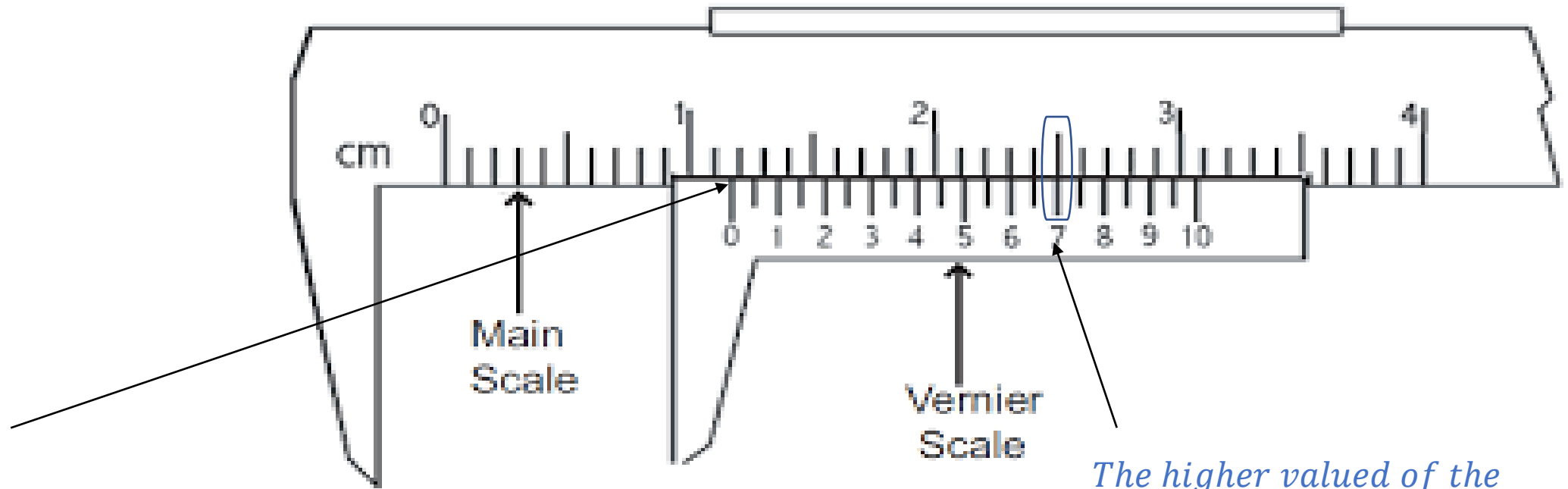IV)The relation between x and y is linear and the constant of proportionality is …..

I) *Vernier caliper*:

For measure diameter of the cylinder (D).

Least count = $\dfrac{1\,mm}{20}$ = 0.05 mm

Error= $\dfrac{0.05}{2}$ mm = 0.025 mm

Main Scale

Vernier Scale

The higher valued of the vernier scale mark lines up with the main scale is 7.

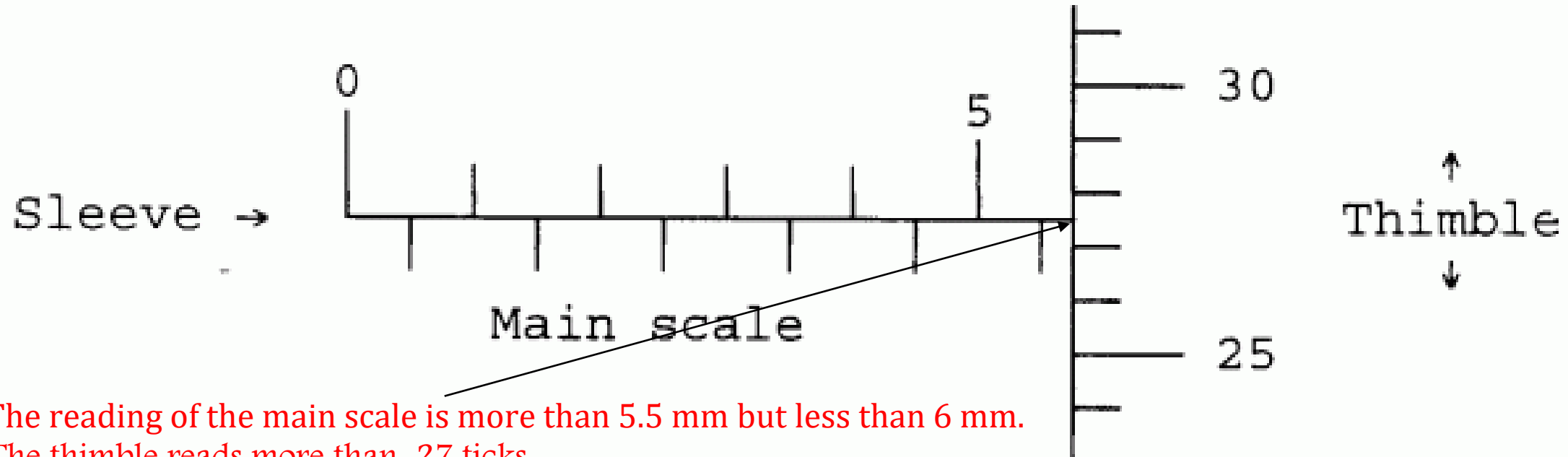**The reading of the Vernier caliper = 1.1cm+7 *0.1 mm = 11mm + 0.7 mm= 11.7 mm.**

II) _Micrometer_: (most accurate instrument to measure length)

For measure height of the cylinder (h).

Least count = $\dfrac{0.5 \text{ mm}}{50}$ = 0.01 mm

Error = $\dfrac{0.01}{2}$ mm = 0.005 mm

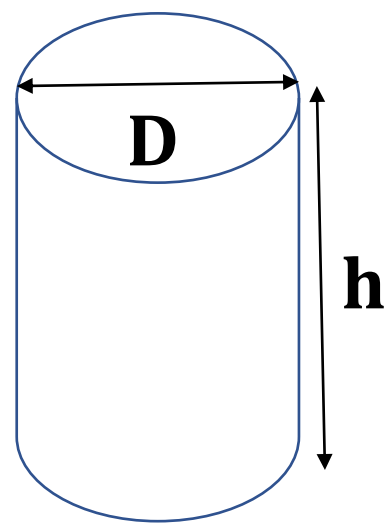The reading of the main scale is more than 5.5 mm but less than 6 mm.
The thimble reads more than 27 ticks.

The reading of the Micrometer = 5.5 mm + 27*0.01 mm = 5.77 mm.

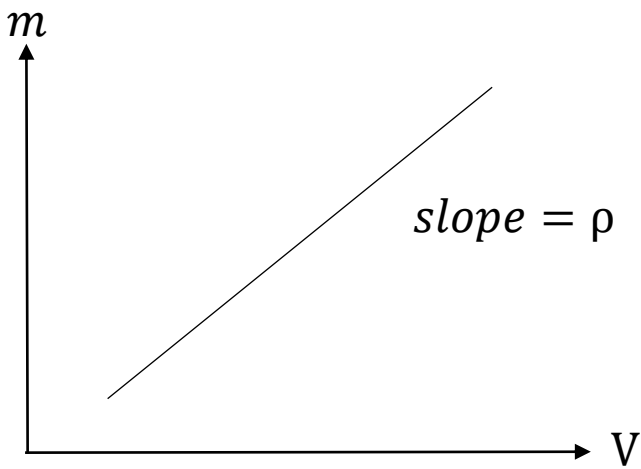*The density of the cylinder:*

Density $= \dfrac{\text{mass}}{\text{Volume}} \rightarrow \rho = \dfrac{m}{\dfrac{\pi D^2 h}{4}}$

#	h (mm) ± 0.005	D (mm) ± 0.025	V(cm^3)	m (g) ± 0.01
1				
2				
3				
4				

m

$slope = \rho$

V

THANK YOU