CHAPTER 1: INTRODUCTION TO PHYSICS

1.1 Physical Quantities

1.1.1 Quantities and Units

Physical quantity: A property ascribed to phenomena, objects, or substances that can be quantified

Base quantity: Physical quantity that cannot be defined or derived from any other physical quantity

Derived quantity: Physical quantity obtained through a combination of base quantities via multiplication or division

The five base quantities:

	Quantity	**Symbol**	**SI Units**	**Units (Symbol)**
1.	Length	*l*	meter	m
2.	Mass	*m*	kilogram	kg
3.	Time	*t*	second	s
4.	Temperature	*T*	Kelvin	K
5.	Electric current	*I*	Ampere	A

1.1.2 Scientific Notation (Standard Form)

$$A \times 10^n$$

where $A \leq 1 < 10$ and n = integer

The value of A should always be rounded to 3 or 4 significant numbers.

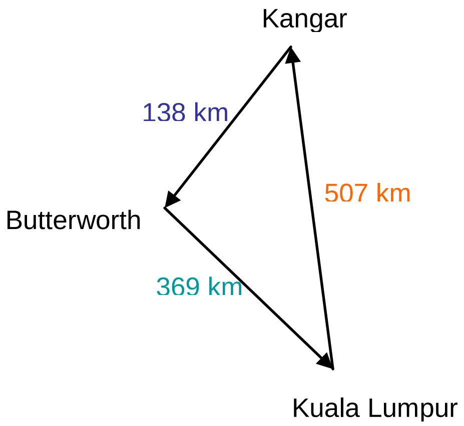
1.1.3 Prefixes

Prefix	**Value**	**Standard form**	**10^n where n is**	**Symbol**
Tera	1 000 000 000 000	10^{12}	12	T
Giga	1 000 000 000	10^{9}	9	G
Mega	1 000 000	10^{6}	6	M
Kilo	1 000	10^{3}	3	k
Hecto	100	10^{2}	2	h
Deca	10	10^{1}	1	da
Deci	0.1	10^{-1}	-1	d
Centi	0.01	10^{-2}	-2	c
Milli	0.001	10^{-3}	-3	m
Micro	0.000 001	10^{-6}	-6	μ
Nano	0.000 000 001	10^{-9}	-9	n
Pico	0.000 000 000 001	10^{-12}	-12	p

1.2 Scalar and Vector Quantities

Scalar Quantities	Vector Quantities
Physical quantities with **magnitude** only	Physical quantities with **magnitude** and **direction**
EXAMPLES	
Distance	Displacement
Speed	Velocity

Example: Distance vs Displacement



Fauziah travelled from Kuala Lumpur to Kangar, a distance of 507 km. After that she continued her journey to Butterworth, a distance of 138 km. From Butterworth, Fauziah then travelled back to Kuala Lumpur, a distance of 369 km.

Distance is the TOTAL DISTANCE TRAVELLED BY THE OBJECT.
Therefore, distance = 507 + 138 + 169 = **1 014km**

Displacement is the DIRECT DISTANCE BETWEEN THE STARTING AND ENDING POINT.
Because Fauziah's final location is the same as her starting location, her final displacement = **0 km**

Example: Speed vs Velocity

Although both cars are traveling at the same **speed**, i.e. 60 km/h, they are traveling at different **velocities** because the directions are different.

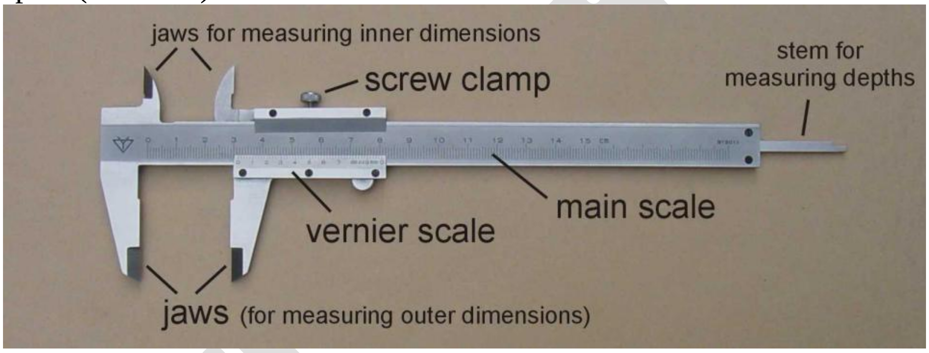
1.3 Measurements

1.3.1 Precision, Accuracy and Sensitivity

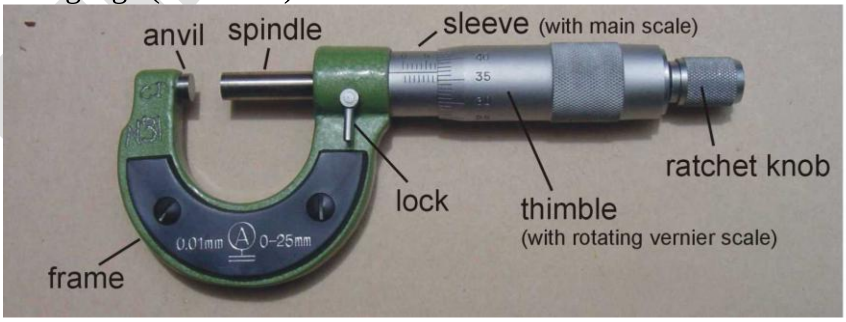
Precision	**Accuracy**	**Sensitivity**
The degree of uniformity of reproducibility of the measurements (consistency)	The degree of closeness of the measurements to the true or accepted value	The ability of a measuring instrument to detect small changes of the physical quantity measured
To increase precision: - use a magnifying glass when reading the scale - avoid parallax errors	To increase accuracy: - use more sensitive equipment - repeat readings taken - avoid parallax errors - avoid zero errors or end edge errors	To increase sensitivity of a mercury thermometer: - thinner wall of bulb - narrower capillary tube - smaller bulb size - thicker wall of glass tube

1.3.2 Measuring Apparatus

Vernier calipers (±0.01cm)



Micrometer screw gauge (±0.01mm)



1.3.3 Errors

Systematic Errors	Random Errors
Systematic errors are errors that can consistently affect readings. It *cannot be reduced* by taking the average of multiple readings.	Random errors happen when one reading deviates from the others. It *can be reduced* by taking the average from multiple readings.

Systematic errors are usually caused by errors within the measuring instrument. For example:
• Zero errors
• End error
• Incorrect scale calibration
	Examples:
	• Parallax errors
	• Unavoidable small changes in the surrounding
	• Outside disturbances that cannot be taken into account
	• Lack of sensitivity of the measuring instruments
	• Human errors, e.g:
	  ○ Counted wrong number of oscillations
	  ○ Readings with inconsistent time intervals
	  ○ Volume of liquid was measured after some was unknowingly and unintentionally spilt

1.4 Scientific Investigation

Making an inference

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Making a hypothesis

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Identifying the variables

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Conducting the experiment

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Recording and tabulating the data

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Analysing the data

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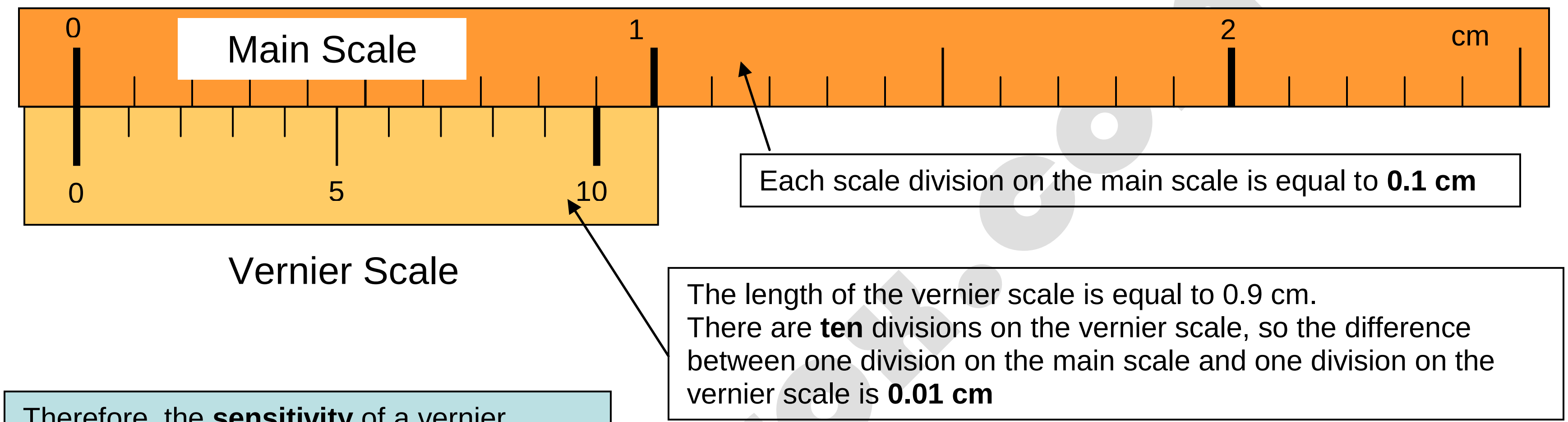
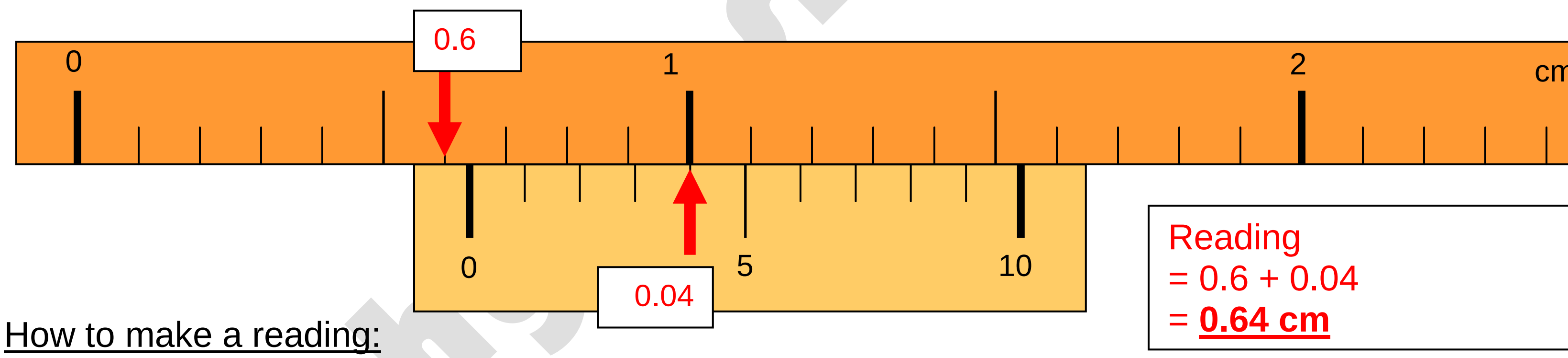
Forming a conclusion

Using vernier calipers:



Therefore, the **sensitivity** of a vernier caliper is **0.01 cm**

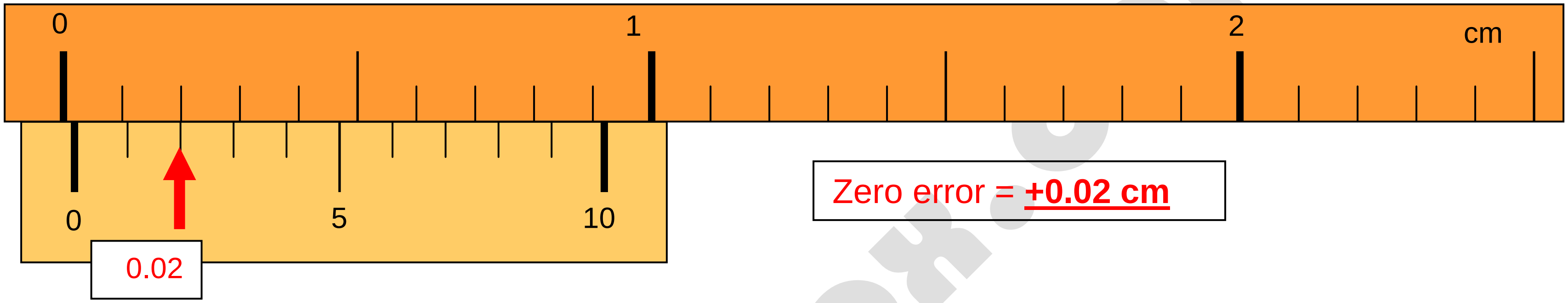


How to make a reading:

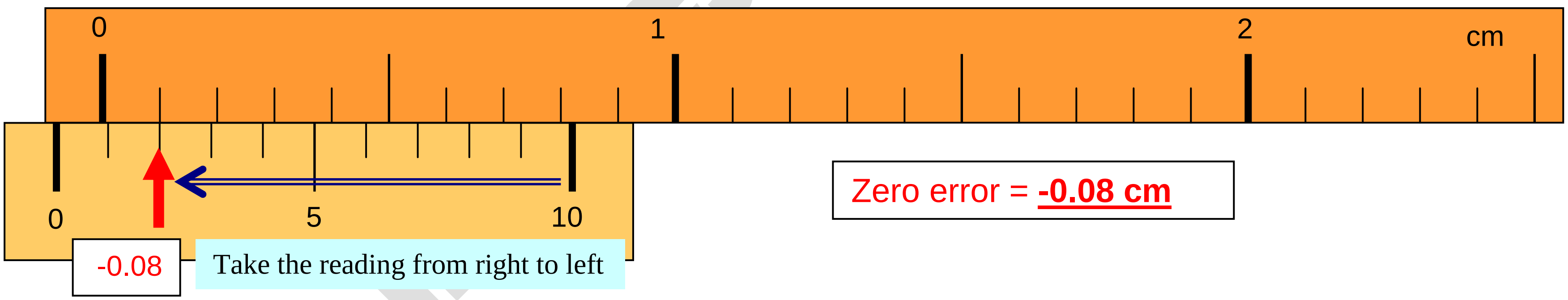
- First, note down the value on the main scale just before the '0' mark on the vernier scale.
- Next, observe which mark on the vernier scale is in line with the main scale.

<u>Reading the zero error values on vernier calipers:</u>

When the jaws are closed: If the ‘0’ on the vernier scale is *after* the ‘0’ on the main scale, this is a ***positive zero error***. The value is obtained by taking the reading from left to right.



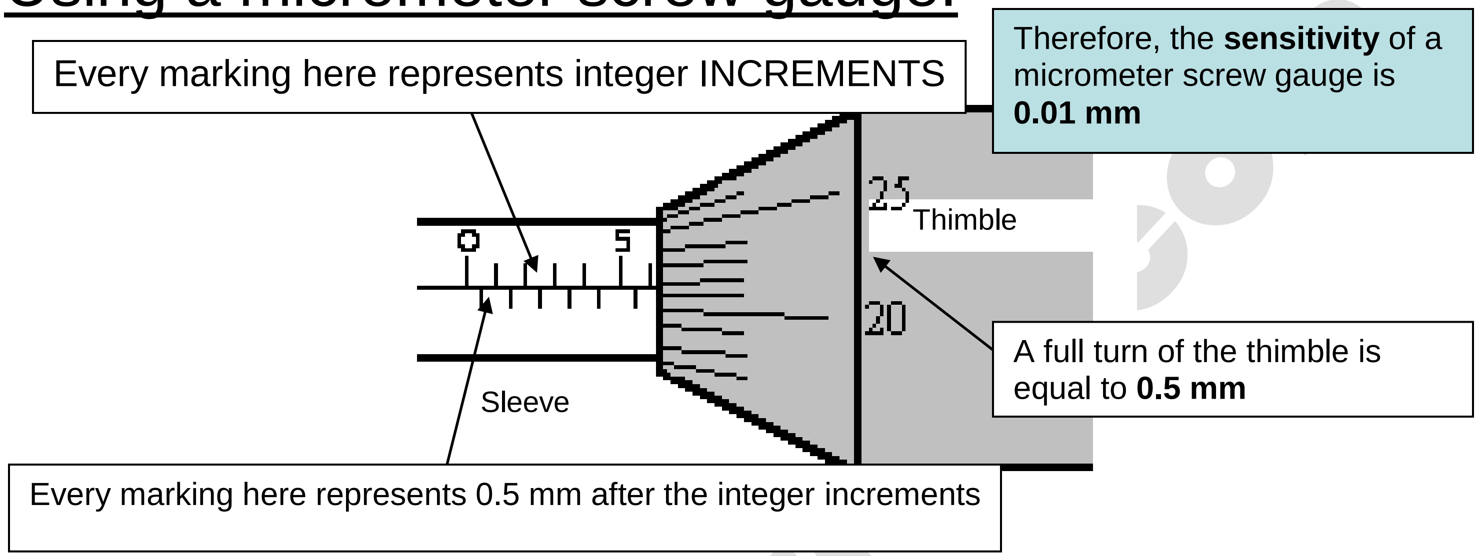
When the jaws are closed: If the ‘0’ on the vernier scale is *before* the ‘0’ on the main scale, this is a ***negative zero error***. The value is obtained by taking the reading from right to left.



Actual reading = Reading taken – zero error

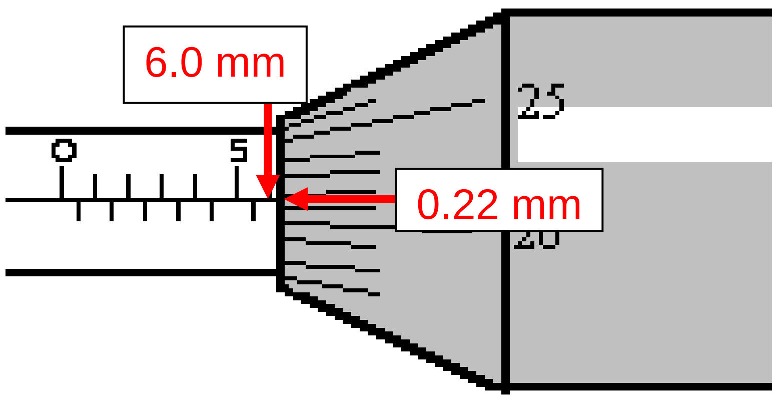
For example, if the reading taken is 0.64 cm:
If the zero error is 0.02 cm, **actual reading = 0.64 – 0.02 = <u>0.66 cm</u>**
If the zero error is -0.08 cm, **actual reading = 0.64 – (-0.08) = <u>0.72 cm</u>**

Using a micrometer screw gauge:



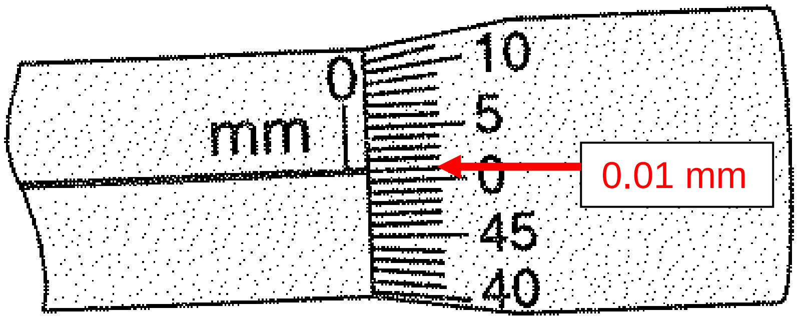
How to take a reading:

- Record the marking on the sleeve just before the thimble
- Observe the marking on the thimble that is in line with the middle line on the sleeve



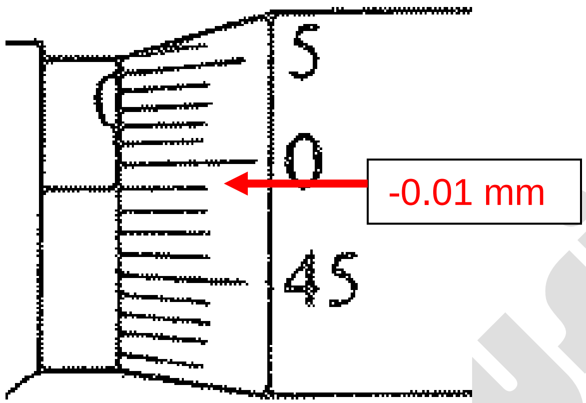
Reading
= 6.0 + 0.22
= **6.22 mm**

Reading the zero error values on a micrometer screw gauge:



When the anvil and spindle are closed: If the ‘0’ marking on the main scale is visible and the position of the thimble is *after* the ‘0’ marking, this is a ***positive zero error***. The value is taken by reading it upwards.

Zero error = **+0.01 mm**



When the anvil and spindle are closed: If the ‘0’ marking on the main scale is not visible and the position of the thimble is *before* the ‘0’ marking, this is a ***negative zero error***. The value is taken by reading it downwards.

Zero error = **-0.01 mm**

END OF CHAPTER