SMARTLAB EDUCATION CENTRE
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Physics
Topic : Measurement (GP1) **Notes**

Focus Areas
(a) show understanding that all physical quantities consist of a numerical magnitude and a unit
(b) recall the following base quantities and their units: mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol)
(c) use the following prefixes and their symbols to indicate decimal sub-multiples and multiples of the SI units: nano (n), micro (μ), milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T)
(d) show an understanding of the orders of magnitude of the sizes of common objects ranging from a typical atom to the Earth
(e) state what is meant by scalar and vector quantities and give common examples of each
(f) add two vectors to determine a resultant by a graphical method
(g) describe how to measure a variety of lengths with appropriate accuracy by means of tapes, rules, digital micrometers and calipers
(h) describe how to measure a short interval of time including the period of a simple pendulum with appropriate accuracy using stopwatches or appropriate instruments

General Measurement

1. A numerical number together with a unit measure a **physical quantity**.

- For example a physical quantity of 100m would have '100' as the numerical value and 'm', which stands for metre as its unit. Without the numerical number or unit, the interpretation of a physical quantity in the context of physics would be incomplete.

Physical Quantity	*Measurement of*	*Numerical Number*	*Unit*
100m	Distance	100	m

- Unit can comprise a prefix and an SI unit.

Physical Quantity	*Measurement of*	*Numerical Number*	*Prefix*	*SI Unit*
100km	Distance	100	kilo	m

2. A **base quantity** is a physical **quantity** in a subset of a given system of **quantities** that is chosen by convention, where no **quantity** in the set can be expressed in terms of the others.

Basic Quantity	Base SI Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric Current	Ampere	A
Temperature	Kelvin	K
Amount of Substance	mole	mol
Luminous Intensity (not in syllabus)	candela	cd

3. System International **(S.I.) Units** for the measurement of the following physical quantities are as follows:

Quantity	SI Unit	Other possible units
Length	Metre / m	μm, mm, cm, km
Mass	Kilogram / kg	mg, g
Weight	Newton / N	kN, MN
Time	Second / s	min, hr, day, month, year
Electric Current	Ampere / A	μA, mA
Voltage	Volt / V	μV, mV
Temperature	Kelvin / K	^{0}C, ^{0}F
Density	Kilogram per metre cube kg / m^3	g/cm^3

More examples of SI units are as follows:

Quantity	*SI Unit*	*Quantity*	*SI Unit*
Force	Newton / N	Resistance	Ohm / Ω
Frequency	Hertz / Hz	Voltage	Volt / V
Pressure	Pascal / Pa	Electric Charge	Coulomb / C
Energy	Joule / J	Power	Watt / W

4. The base SI units are used together with physics formulae to get **derived units** for other physical quantities. For example:

Physical Quantity	*Physics Formula*	*Derived Unit in terms of Base Unit*
Speed of a moving object	Speed = $\frac{\text{Distance}}{\text{Time}}$	Derived unit for speed = $\frac{\text{base unit of Distance}}{\text{base unit of Time}}$ = ms^{-1}
Volume of a rectangular container	Volume = length x breadth x height	Derived unit for volume = (base unit of length)^3 = m^3
Flow rate of water	Flow rate = $\frac{\text{Volume}}{\text{Time}}$	Derived unit for speed = $\frac{\text{derived unit of Volume}}{\text{base unit of Time}}$ = m^3s^{-1}

5. Understanding Prefixes.

Prefix	*Symbol*	*Quantity*	*GCE O level Syllabus*	*Example*
Tera	**T**	**10^{12}**	**Yes**	**1Tm = 10^{12} m**
Giga	**G**	**10^{9}**	**Yes**	**1Gm = 10^{9} m**
mega	**M**	**10^{6}**	**Yes**	**1MW = 10^{6} W**
kilo	**k**	**10^{3}**	**Yes**	**1kg = 10^{3} kg**
deci	**d**	**10^{-1}**	**Yes**	**1dm = 0.1 m**
centi	**c**	**10^{-2}**	**Yes**	**1cm = 0.01 m**
milli	**m**	**10^{-3}**	**Yes**	**1mm = 0.001 m**
micro	**μ**	**10^{-6}**	**Yes**	**1μm = 10^{-6} m**
nano	**n**	**10^{-9}**	**Yes**	**1nm = 10^{-9} m**
pico	p	10^{-12}	No	1pm = 10^{-12} m
femto	f	10^{-15}	No	1fm = 10^{-15} m

6. Examples on unit conversion.

Physical Quantity	*Conversion Required*	*Calculations*
Area	Convert 1 km^2 into m^2	$1\ km^2 = 1\ km \times 1\ km$ $= 1000\ m \times 1000m$ $= 10^6\ m^2$
Volume	Convert 5 dm^3 into m^3	$5\ dm^3 = 5 \times 1\ dm^3$ $= 5 \times 1\ dm \times 1\ dm \times 1\ dm$ $= 5 \times 0.1m \times 0.1m \times 0.1\ m$ $= 0.005\ m^3$
Mass	Convert 7 mg into kg	$7mg = 7 \times 10^{-3}\ g$ [$1kg = 1000g \rightarrow 1g = 10^{-3}\ kg$] $= 7 \times 10^{-3} \times (10^{-3})\ kg$ $= 7 \times 10^{-6}\ kg$
Density	Convert 1 kgm^{-3} into gcm^{-3}	$1\ kgm^{-3}$ $= \frac{1\ kg}{1m^3} = \frac{1000g}{1m \times 1m \times 1m} = \frac{1000g}{100cm \times 100cm \times 100cm}$ $= 0.001\ gcm^{-3}$
Speed	Convert 3 km/h into m/s	$3\ km/h = \frac{3km}{1h} = \frac{3000m}{3600s} = 0.833m/s$

7. Scientists describe the magnitude or size of numbers using something called **order of magnitude**. An order of magnitude is **a factor of 10**. To be "within an order of magnitude," or to estimate a quantity "to order of magnitude," means that the estimate is roughly within a factor of 10 on either side. Scientific notation is to express a quantity to the standard form.

<u>**Example 1:**</u> The world population has an order of magnitude of 9 while the earth's surface's area has an order of magnitude of 8.

	Earth's Surface Area	**World's Population**	**People per Square Mile**
Standard number:	169,900,000	7,403,000,000	$\frac{7,403,000,000}{169,900,000}$
Scientific notation:	1.699×10^8	7.403×10^9	$\frac{7.403 \times 10^9}{1.699 \times 10^8}$

<u>**Example 2: Sizes of Common Objects**</u>

Common Object	*Size*	*Scientific notation (m)*	*Order of magnitude*
Atom	Diameter ~ 0.5 nm	5×10^{-10}	-10
Coronavirus	Diameter ~ 0.5 μm	5×10^{-7}	-7
Red colour	Wavelength ~ 400nm	4×10^{-7}	-7
Violet colour	Wavelength ~ 700nm	7×10^{-7}	-7
Bacteria	Diameter ~ 5 μm	5×10^{-6}	-6
Pollen Grain	Diameter ~ 15 μm	1.5×10^{-5}	-5
Human Hair	Diameter ~ 0.1 mm	1×10^{-4}	-4
A4 Paper	Thickness ~ 0.1 mm	1×10^{-4}	-4
Fly	Length ~ 1cm	1×10^{-2}	-2
Handphone	Length ~ 15cm	1.5×10^{-1}	-1
A4 Paper	Length ~ 3dm	3×10^{-1}	-1
Boy	Height ~ 1m	1×10^{0}	0

Common Object	*Size*	*Scientific notation (m)*	*Order of magnitude*
Ceiling	Height ~ 3m	3×10^{0}	0
Car	Length ~ 4-6m	4×10^{0}	0
Tree	Height ~ 10m	1×10^{1}	1
Low Bed trailer	Length ~ 10m	1×10^{1}	1
Private plane	Length ~ 10m	1×10^{1}	1
Basketball court	Length ~ 30m	3×10^{1}	1
Commercial plane	Length ~ 50m	5×10^{1}	1
Rocket	Length ~ 30-100m	3×10^{1}	1
Football field	Length ~ 100m	1×10^{2}	2
Container ship	Length ~ 400m	4×10^{2}	2
Moon	Diameter ~ 3.5 Mm	3.5×10^{6}	6
Earth	Diameter ~ 12 Mm	1.2×10^{7}	7
Earth to Moon	Distance~ 0.4 Gm	4×10^{8}	8
Earth to Sun	Distance~ 150 Gm	1.5×10^{11}	11

Example 3: More examples

Item	*Quantity*	*Scientific notation*	*Order of magnitude*
Speed of Sound	0.3 km/s	3×10^{2} ms^{-1}	2
Mass of A4 paper	5 g	5×10^{-3} kg	-3
Speed of Light	0.3 Gm/s	3×10^{8} ms^{-1}	8
Charge of electron	-1.6×10^{-10} nC	-1.6×10^{-19} C	-19

Exercise 1 – Conversion of unit

Convert the following to the respective unit given.

a. 25 km/h =______ m/s

b. 2000 mg/cm^3 = _______ kg/m^3

c. 2500 m/μs =_______km/min

d. 600 mg/dm^3 = ________g/cm^3

e. 200 GW = __________W

f. Tick which of the following physical quantity are base units and state their SI Units.

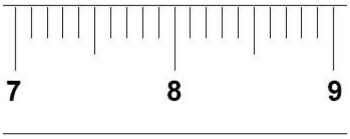
SI Unit	Base Units	SI Units
Length		
Mass		
Weight		
Time		
Electric Current		
Voltage		
Temperature		
Density		
Amount of Substance		

g. Which of the following representing the longest length?

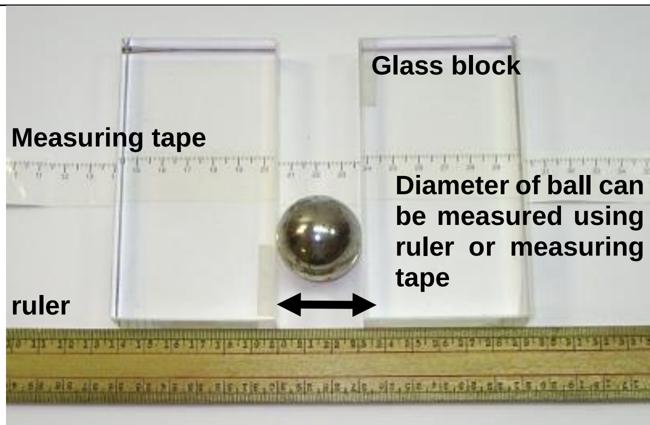
A. 400 μm
B. 0.004 Gm
C. 4 000 dm
D. 40 Mm

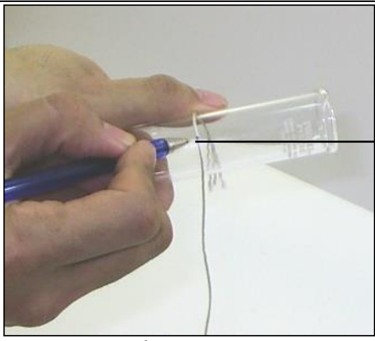
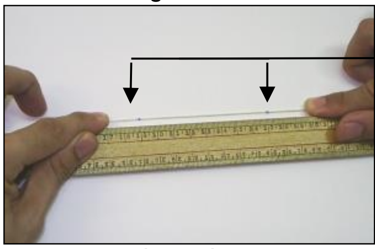
h. What is the order of magnitude for the size of an atom, a strand of hair and the diameter of earth?

8. Length measurements can be made by the following measuring instruments:

Measuring instrument	Accuracy	Maximum Range	Scale
Measuring ruler	0.1cm	Half-metre rule – 50.0 cm metre rule – 100.0 cm	Scale in cm  Fig 1-1
Measuring Tape	0.1cm	Up to 10.000m	Same as measuring rule
Digital Calipers	0.001cm or 0.01 mm	15.000cm	Digital Scale in mm  Fig 1-2
Digital Micrometer Screw Gauge	0.0001cm or 0.001mm	2.5000cm	Digital Scale in mm  Fig 1-3

9. A **ruler** is very useful in making linear measurement. It can be used together with other objects to enable accurate and better measurements of 3-dimensional objects as shown below.

Objects	*Measuring*	*Method*
Glass block (or wooden block)	Diameter of a sphere or a cylinder	 Fig 1-4

Objects	*Measuring*	*Method*
String	Circumference of a test tube or 3-dimensional object	 **A string is used to wrap tightly round the circumference of the test tube.** Fig 1-5a  **With markings made on the string, the circumference is measured with a ruler.** Fig 1-5b

10. **Digital Calipers** measure length up to an accuracy of **0.001cm**. Its limitations are: (1) it cannot be used in restricted space (i.e. the space is too small to accommodate the whole caliper) and (2) it measures up to **15.000cm**.

    - Digital calipers provide digital reading of the measurement on its digital screen. The zero error can be corrected with a press of a button.

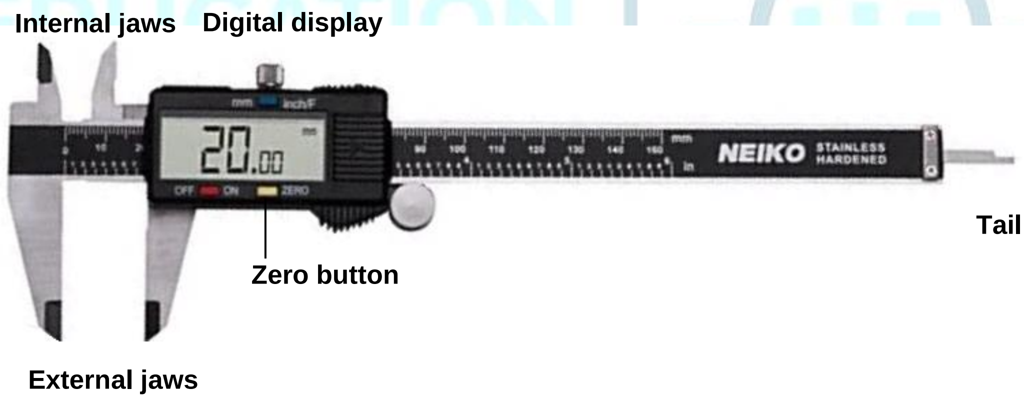


Fig 1-6

The external jaws to measure the external diameter of a test-tube. The internal jaws measure the internal diameter, while the tail measures its depth.

11. **Digital micrometer Screw Gauge** measures length up to an accuracy of **0.001mm**. The object to be measured is held between the anvil and the spindle. Each complete turn of the thimble moves the spindle by 0.50mm, similar to the way screws move with turning motion. The key limitation of the micrometer is that it measures up to **25.000mm**.

    - Digital micrometer screw gauge provides digital reading of the measurement on its digital screen. The zero error can be corrected with a press of a button.

Fig 1-7

Close the anvil and spindle about the object to be measured by turning the thimble. To avoid inaccurate measurement due to over-tightening, the last stage of the closing process is done by turning the ratchet instead of the thimble. Stop turning when you hear clicking sounds.

12. **Time** is commonly measured using the digital stopwatch.

Measuring instrument	*Diagram*	*Reading and Accuracy*
Digital stop watch	 Fig 1-13	Reading = 2 minutes 29.89 seconds = 120 seconds + 29.89 = 149.89 seconds = 149.9 seconds A stopwatch measures time to an accuracy of 0.01 seconds. Usually the reading is recorded to the nearest 0.1 seconds. But the action to stop the stopwatch is often based on human reaction, which is known to lag by about 0.3-0.5 seconds (varies from person to person).

13. **Pendulum measures time by its ability to repeat its motion in the same repetitive manner.**

- An **oscillation** is the movement of the pendulum from A to B and from B back to A (see Fig 1-14b). The time taken for one complete oscillation of the pendulum is called the **period**.

Fig 1-14a

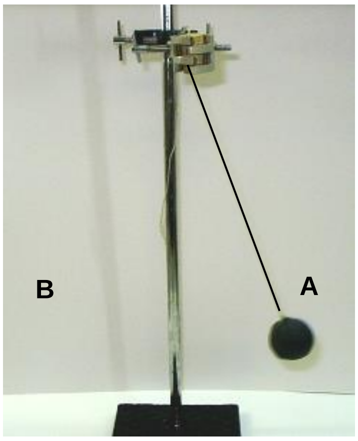


Fig 1-14b

The formula for the period of the pendulum is

$$T = 2\pi\sqrt{\frac{l}{g}}$$

where T is the period of the pendulum

l is the length measured from the point of suspension to the centre of the bob

g is a constant termed as the acceleration due to gravity or gravitational field strength [this will be covered in later chapter] which is equal to about $10ms^{-2}$

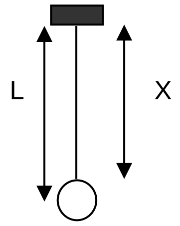
Period and length of Pendulum, g is the acceleration due to gravity
$T = 2\pi\sqrt{\frac{l}{g}}$

- For the formula to be applicable, the pendulum must be in simple harmonic motion, i.e. the object moves in repetitive identical cycles.

(1) The amplitude of the oscillation should be made small so that simple harmonic motion can occur.

(2) Oscillation must be stabilised and repetitive in nature prior to commencement of timing.

(3) Note that l should be from the centre of the bob to the point at which string is being secured. The length to be measured should be L and not X.



(4) There should be minimal air movements (caused by fan, etc) which can otherwise exert a force that may slow down the motion of the bob. Such environment is termed as draught free.

(5) Do not measure the time taken for one single oscillation. Instead, record the total time taken for a fixed number of oscillations such that the total time taken is at least 20 seconds. Then calculate the average time taken for each oscillation. This can keep the error caused by human reaction time, which is estimated at 0.1-0.5seconds, low.

14. **A ticker tape timer measures the distance moved by an object over fixed intervals of time.** This is achieved by attaching a tape on the moving object and through the ticker tape timer (see fig 1-15a). As the object moves, the tape is being pulled through the timer. A vibrator on the timer (see fig 1-15b) hits the tape at equal time intervals forming a series of dots on the tape. The study of the dots on the tape allows one to measure the speed of the moving object. More details are provided below.

- A ticker tape timer is powered by a battery. When the timer is turned on, a vibrating tib (see figure 1-15b) moves up and down at constant speed. When vibrating tib moves down, it hits a piece of carbon paper placed above the tape and causes a dot to be printed on the tape.

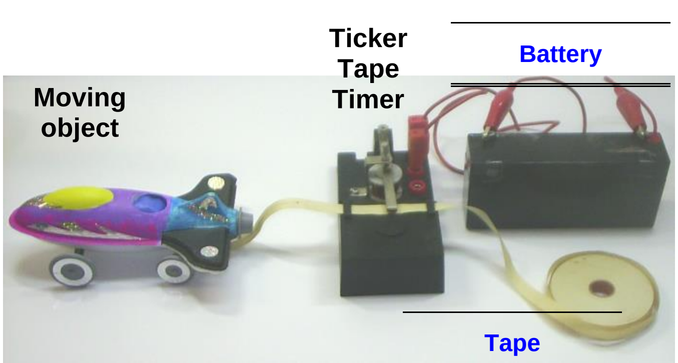


Fig 1-15a

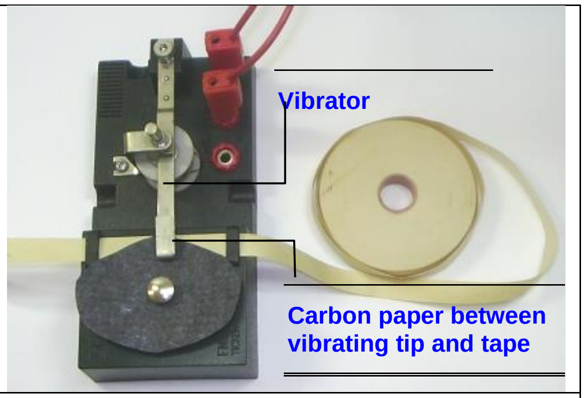


Fig 1-15b

- The vibrator moves at a fixed frequency, for example, 50 Hz. This means that in 1 second, 50 dots are imprinted on the tape. If the tape is being pulled by an object moving at constant speed with the ticker tape timer turned on, the dots imprinted on the tape is as shown in figure 1-16.

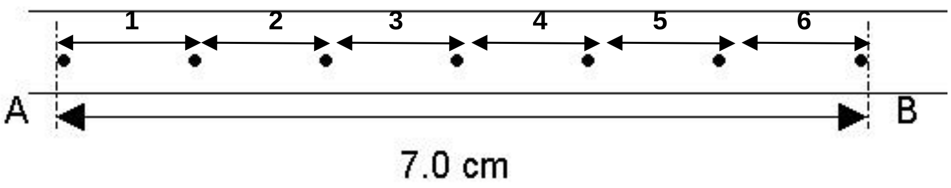


Fig 1-16

If the frequency of the ticker tape timer operates at 50 Hz, it means that for the moving object to move between adjacent dots, the time taken is $^1/_{50}$ seconds.

Therefore, to move a distance AB requires $^6/_{50}$ seconds, since there are 6 spacings from A to B (see Figure 1-20).

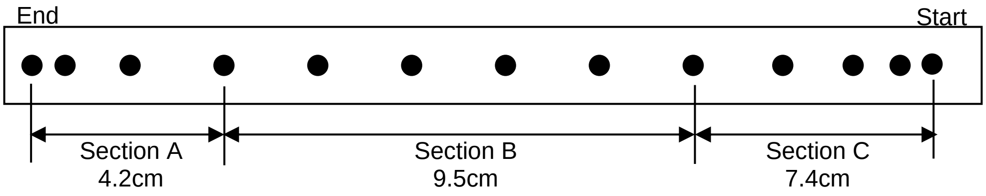
Constant speed moves by the object is distance AB divided by total time taken. Hence speed = 7.0 cm ÷ $^6/_{50}$ second = 42 cm/s

- The general formula for calculating the time taken between any 2 points on a ticker tape is:

Ticker Tape Timer
Time = Number of spacing x time interval between consecutive dots **i.e., Time = Number of spacing ÷ frequency of ticker tape timer**

Exercise 2

(a) A ticker-tape was attached to a toy car. The tape was passed through a ticker-timer that printed a dot on the tape every $\frac{1}{50}$ of a second. The toy car was made to move, pulling the tape along. The figure below shows the tape produced.



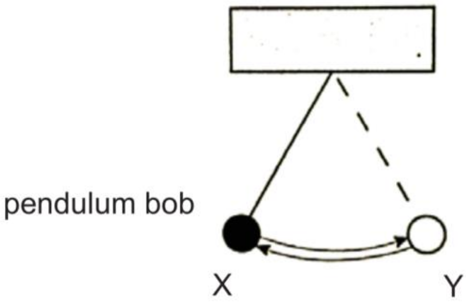
For each of the sections labeled A, B and C, determine the speed of the toy car at the respective section.

(i) Section A in km/h
(ii) Section B in m/s
(iii) Section C in cms^{-1}

(b) What is the order of magnitude of the diameter of an atom?

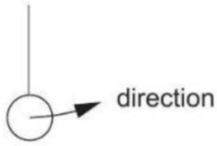
A. 10^{-7} cm
B. 10^{-7} mm
C. 10^{-7} nm
D. 10^{-7} μm

(c)
The diagram below shows a simple pendulum. Using a stopwatch, which would be the most accurate way to measure the period of the pendulum?

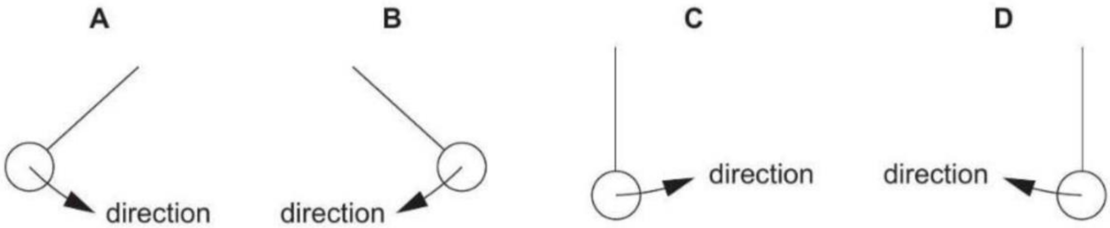


A. Time the motion from X to Y and back to X.
B. Time the motion from X to Y and double it.
C. Time the motion from X to Y and back to X for 20 cycles and divide by 20.
D. Time the motion from X to Y and back to X again for 20 cycles and multiply by 20.

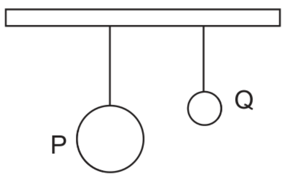
(d)
A pendulum has a period of 1.0s. A stopwatch is started when the pendulum is vertical and is moving to the right as shown.



Which diagram shows the position and direction of the pendulum 2.5 s later?



(e) P and Q are two different pendulums made of the same material but with different lengths and sizes.



Which of the following is **true**?

	period	reason
A	T_P is longer than T_Q	length of pendulum P is longer
B	T_P is longer than T_Q	length of pendulum Q is longer
C	T_P is shorter than T_Q	P has a bigger mass
D	T_P is shorter than T_Q	P has a smaller mass

(f) What instruments can be most suited to accurately measure the following

Experimental measurement	Apparatus
Diameter of a thin copper wire	
Depth of a test tube	
Size of a classroom	
Length of a strand of hair	
Circumference of a basketball	

15. **Accuracy** is a measure of how close the measured reading is when compared to the true value.

If the arrows represent measured readings while the bull eye is the actual value of the physical quantity, figure 1-16a would have given accurate measured readings, while figure 1-16b would have provided less accurate measured readings.

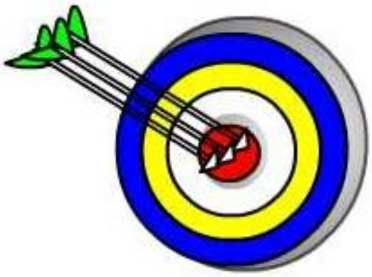


Fig 1-16a

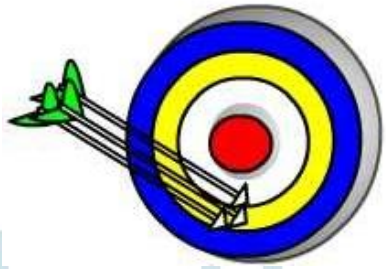


Fig 1-16b

16. **Precision** is a measure of the closeness of the various measured readings with respect to each other.

If the arrows represent measured readings while the bull eye is the actual value of the physical quantity, figure 1-17a would have provided measured readings with a higher precision that those obtained in figure 1-17b.

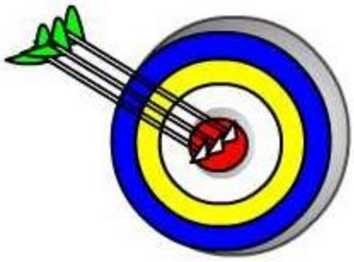


Fig 1-17a

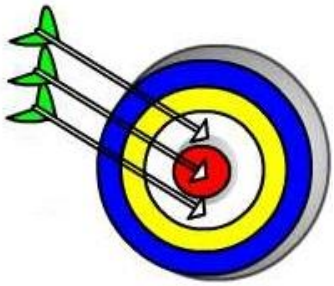


Fig 1-17b

17. **Precise readings are not necessarily accurate readings** (as represented in fig 1-16b). The measured readings may be very close together to give high precision, but the accuracy of the readings may be poor due to reasons like zero error.

18. **Random errors** are errors, which can potentially be positive, or negative in value, and the size of the errors are irregular and random. These are errors that cannot be precisely determined as they vary from time to time. Some examples are as follows:

    a. **Parallax error** of the eye when taking physical measurements. See figure 1-18.

    b. Error due to the reaction time of the observer as the stopwatch is stopped is another example of random error.

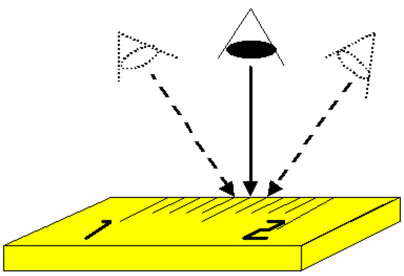


Fig 1-18

19. **Random error** can be **minimised** by the following methods:

a. Take a large number of readings and find its average – the positive and negative random errors will neutralize each other to some extent, giving a more accurate measurement.

b. Use graph to obtain a curve/line of best fit and in the process, minimize the random error.

20. **Systematic errors** are errors, which are roughly constant throughout different measurements, and the measurements obtained are consistently higher than or lower than the actual value.

a. Flaws in the measuring instruments can cause systematic errors, e.g. **zero errors**.

b. They can also be errors incurred due to an incorrect assumption made. An example is when the acceleration due to gravity on earth is inappropriately rounded to 10 ms^{-2}, when the actual value is 9.81 ms^{-2}.

21. **Precision of a measuring instrument** is the smallest unit the instrument can measure. When a more precise instrument is used for the measurement, the reading will be more accurate provided there is no zero error.

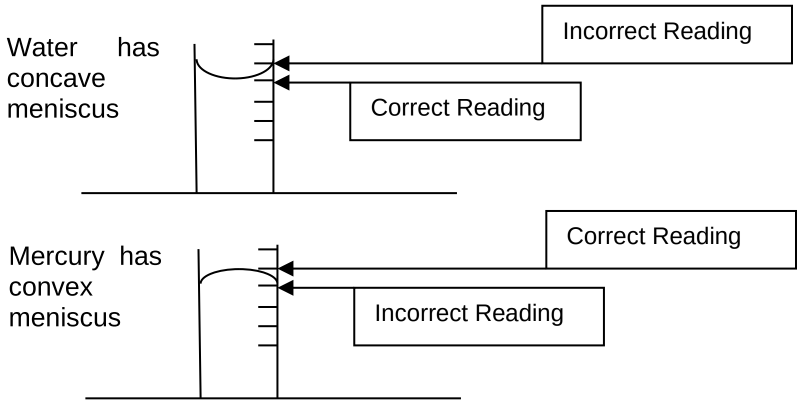
Measuring instrument	Precision	Maximum Range
Measuring ruler	0.1cm	Half-metre rule – 50.0 cm metre rule – 100.0 cm
Measuring Tape	0.1cm	Up to 10.000m
Digital Calipers	0.001cm or 0.01 mm	15.000cm
Digital Micrometer Screw Gauge	0.0001cm or 0.001mm	2.5000cm
Digital Stop watch	0.01s	-

22. **Measuring Area**

a. Using mathematical formula. Some of the formulae are as follows:
(1) Area of rectangle = length x width
(2) Area of square = length x length
(3) Area of trapezium = $^1/_2$(a+b) x height
(4) Area of circle = π x (radius of circle)^2

b. Estimation method - counting squares.

23. **Measuring Volume –** The curving of the liquid level in liquid container is called the meniscus. The narrower the neck of the cylinder, the more curved the meniscus is. Note that the meniscus of mercury is convex instead of water, which is concave.



Method of measuring volume

a. For Liquid, use measuring cylinder, graduated flask, pipette or burette

b. For regular shaped solid, use Mathematical formulae like
   (1) Volume of block = length x width x height
   (2) Volume of sphere = $^4/_3\ \pi$ x (radius of sphere)^3
   (3) Volume of cylinder = π x (radius of circle)^2 x height

c. For irregular shaped solid, use Eureka Can/Displacement Can or Measuring Flask

24. **Measuring Mass**

a. Mass is defined as the amount of matter/quantity of matter in an object.
b. Instruments used to measure mass are the electronic and lever balance (kg).

25. **Scalar and Vector**

a. Measurements can be in **scalar or vector**.

b. **A scalar quantity only has magnitude but no direction**. Examples of scalar quantities are as follows: density, energy, mass, and time.

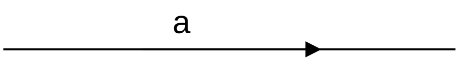
c. When scalar quantities are added to or subtracted from one another, only the magnitudes need to be considered, bearing in mind that the units must be consistent before applying the basic mathematical method. Examples:

(1) 3 kg and 4 kg may be summed as 3 kg + 4 kg = 7 kg
(2) The difference between two lengths, 2 m and 5 m, is 3 m

However, scalar quantities with different units cannot be added nor subtracted in the same manner. Examples:
(a) 7 mangoes + 1 mangosteen $\neq$ 8 mangoes
(b) 5 pineapples $\neq$ 1 pine + 4 apples
(c) 7 m + 1 cm $\neq$ 8 m
(d) 5Nm $\neq$ 1 N + 4 m

d. **A vector quantity has both magnitude and direction.** Examples of vector quantities are displacement, acceleration, moment, force and velocity. A vector may be expressed symbolically as "(F)", or "(<u>F</u>)"

e. A vector may be represented in uppercase or lowercase. (A or a). A vector may be represented in a diagram by an arrow. The length of the arrow is an indication of its magnitude while the arrow-head indicates its direction.



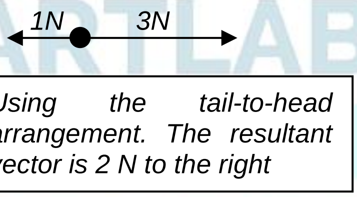
26. Vector Diagram (Tool)

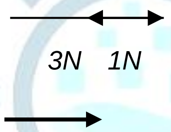
a. Vector diagram is used for the summation of forces. They can be expressed in the form of vectors as shown, where R is the net resultant force. This tool is essential when it is used to solve problems.

b. For the vectors diagram to be meaningful, both the magnitudes and the directions of the vectors need to be specified. The length of the arrow is scaled to be proportional to the magnitude of the vector. For example, a 1cm length could represent 5 N force. The magnitude of the resultant vector would be represented by the length of the resultant vector.

c. <u>1 – Dimensional Vector</u>

<u>Example</u>: A constant forward force of 3 N is applied to a block. If the frictional force on the block is 1 N, what is the resultant force acting on the block?

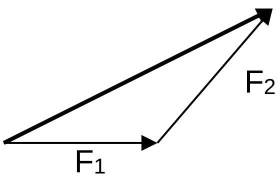




Net Force = 3-1 = 2N (from right to left)

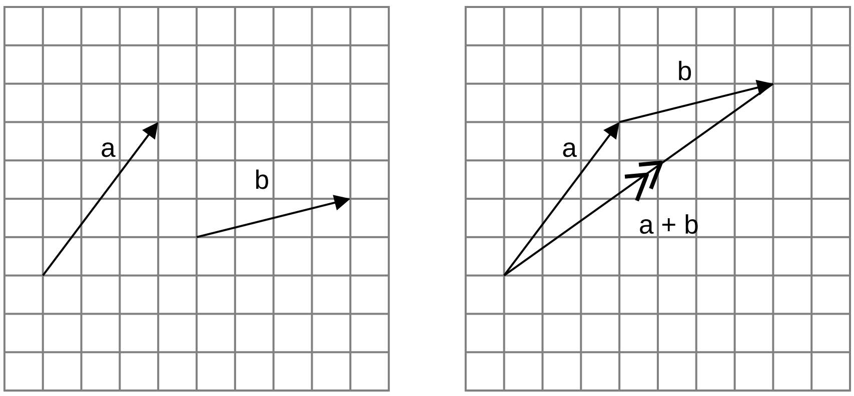
d. <u>2 – Dimensional Vector</u>

Adding two vector quantities involve both their magnitudes and direction. Because of the need to consider direction of the vectors, a vector diagram is drawn, indicating the direction of the vector as well as their relative magnitudes.

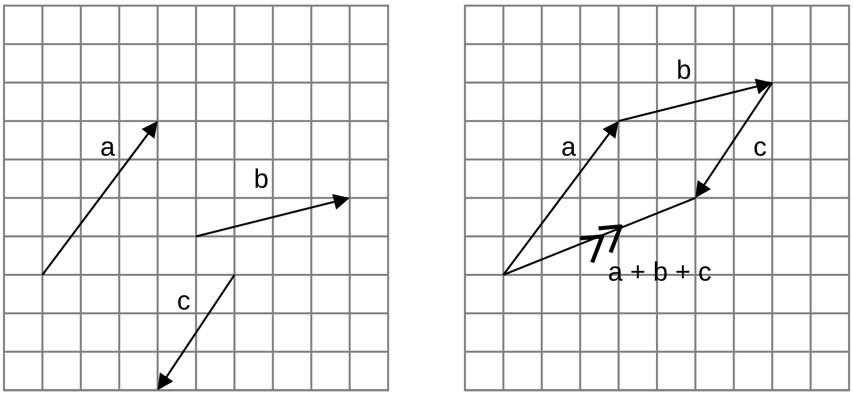


$\vec{R} = \vec{F_2} + \vec{F_1}$

(1) **<u>Triangle method</u>**, the vectors to be added are arranged by joining the head of one vector to the tail of the other.

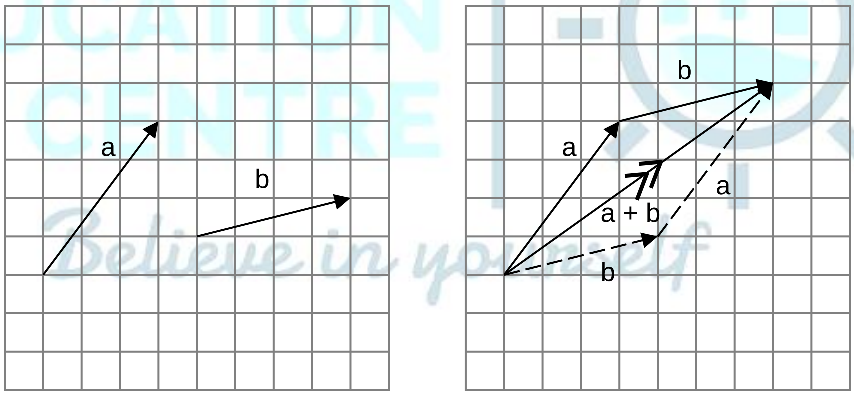


(Note that the resultant vectors (a + b) and (b + a) are equal; they have the same magnitude and point to the same direction). If more vectors are to be summed, the same head-to-tail arrangement can be used. For example, the sum of a, b and c is a + b + c



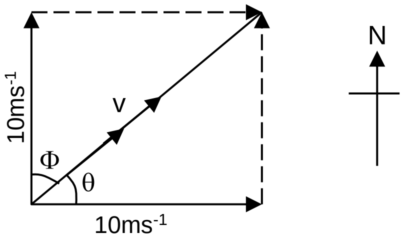
This (a+b+c) is commonly referred to as a <u>polygon</u> of vectors. Generally, a polygon of vectors is obtained by adding three or more vectors together (in a tail -to-head arrangement).

(2) **<u>Parallelogram method</u>** is another method of finding the resultant vector. In this method, the tails of two vectors have a common point. A parallelogram is set up using the two vectors as sides of the parallelogram and the resultant is the diagonal of this parallelogram. Note that this resultant vector also has its tail at the same point as the tails of the two vectors.



<u>Example</u>: A simple jet propels a hovercraft Northward with a velocity of $10.ms^{-1}$. The hovercraft experiences a crosswind to the East at $10.ms^{-1}$. What is the resultant velocity of the craft?

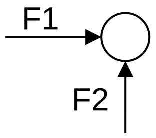
Using the parallelogram method, the magnitude of the resultant velocity v is found to be 14 ms^{-1}



To state the direction of the vector, either θ or Φ must be found. If the vector diagram is drawn to scale, a protractor may be used to obtain their values. In this case, both are found to be 45^0 north of east or in the northeast direction.

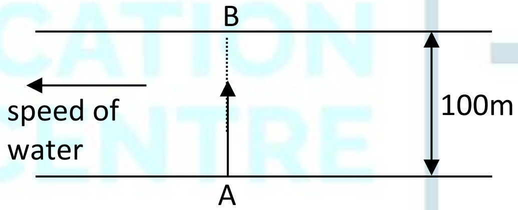
Exercise 3

(a) A 1.0 kg object is subjected to 2 forces of size 5.0N. By drawing a scaled vector diagram, determine the resultant force acting on the object.



(b) Determine the maximum and minimum resultant force that is applied on object by the 2 forces given that their directions of applications can vary, and their magnitudes remain as 5.0N.

Exercise 4 A man swims across a river at a velocity of 5.0m/s as shown in diagram below. If the river current is sweeping at a velocity of 5.0m/s, what is the resultant velocity of the man? Determine the time taken for the man to swim across the river. Calculate the distance away from point B when the man he had swum across the river.



Exercise 5 A man runs 500m towards the east and then followed by 500m towards the North. Determine the distance of the man from the start point.

Exercise 6

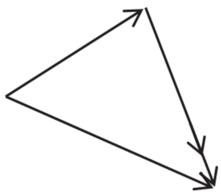
(a)
Two forces 6.0 N and 10.0 N act on object at the same time.

Which force **cannot** be the resultant force on the object?

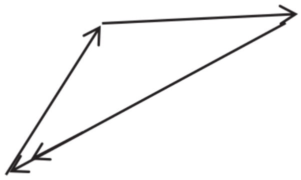
A. 8.0 N
B. 10.0 N
C. 14.0 N
D. 18.0 N

(b)
Which of the following vector addition shows correctly the addition of two forces?

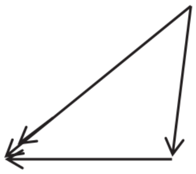
A



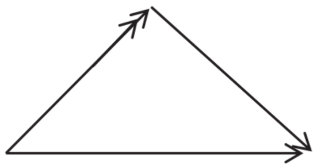
B



C



D



Arrow ——►► represents the vector of the resultant force that is equal to the sum of the two forces

Exercise 8

a) The size of a virus is approximately the size of ultraviolet wavelength.

State the wavelength of the ultraviolet in metres.

b)

i. Given that the thickness of a hair is about 10^2 times more than size of a virus, state a suitable apparatus to accurately measure the thickness of hair.

ii. State two necessary steps needed to ensure that accurate readings are obtained when reading the thickness of hair.