PHYSICAL QUANTITIES, UNITS & MEASUREMENT

SCALARS AND VECTORS, MEASUREMENT TECHNIQUES, UNITS AND SYMBOLS

HAMMADHUSAIN

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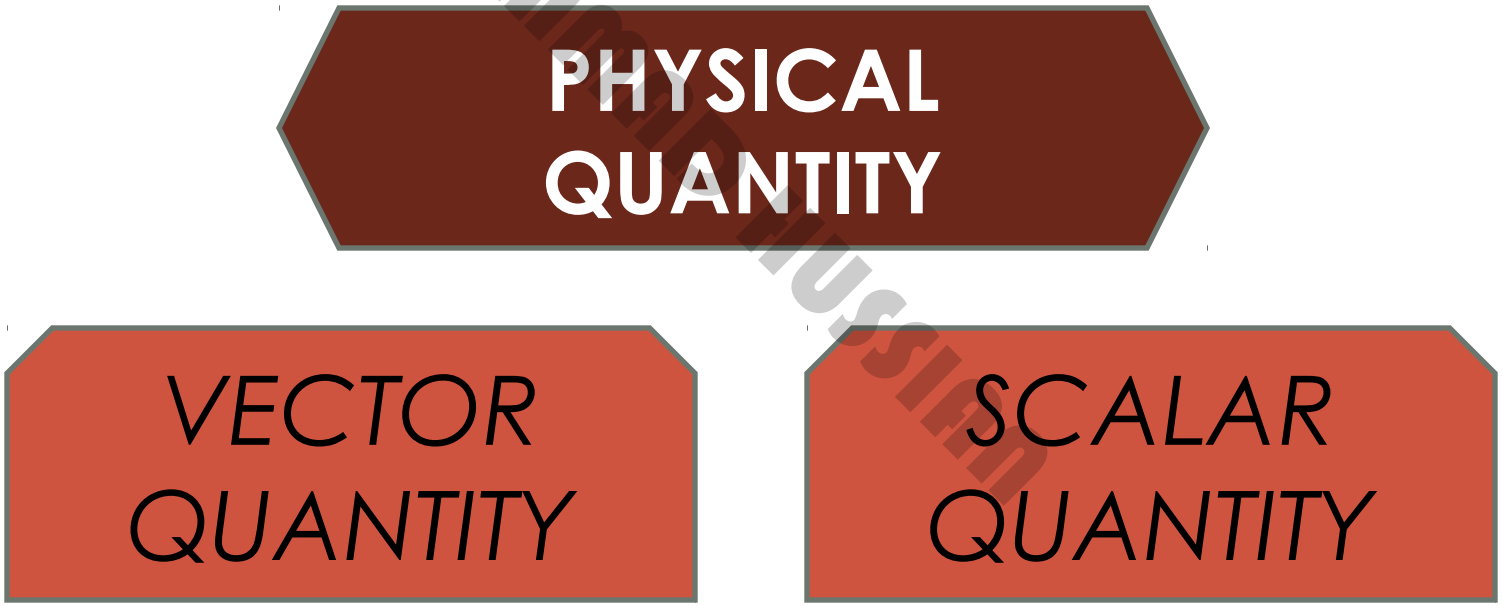
SCALARS AND VECTORS

DEFINE THE TERMS SCALAR AND VECTOR.

PHYSICAL DESCRIPTION

A **physical quantity** *is one that can be measured and that consists of numerical magnitude and unit.*

Tanmeem Hussain



SCALAR QUANTITY

Magnitude

NO Direction

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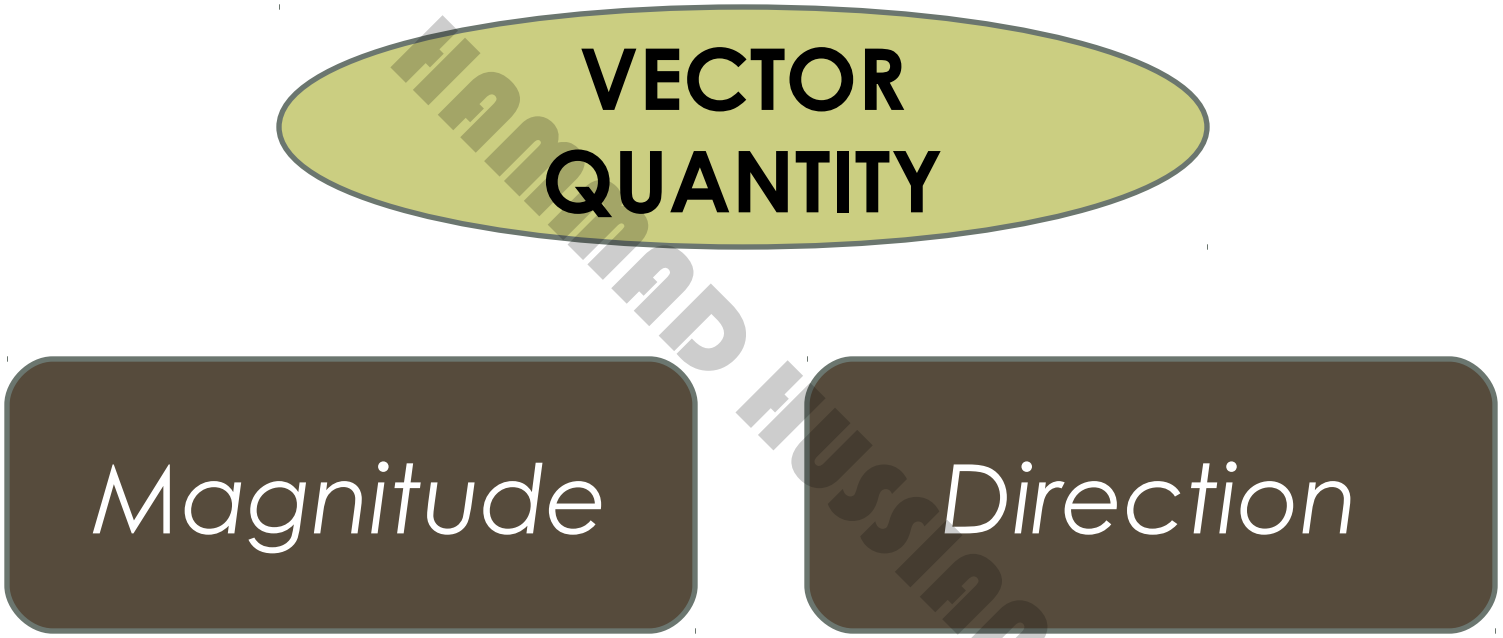

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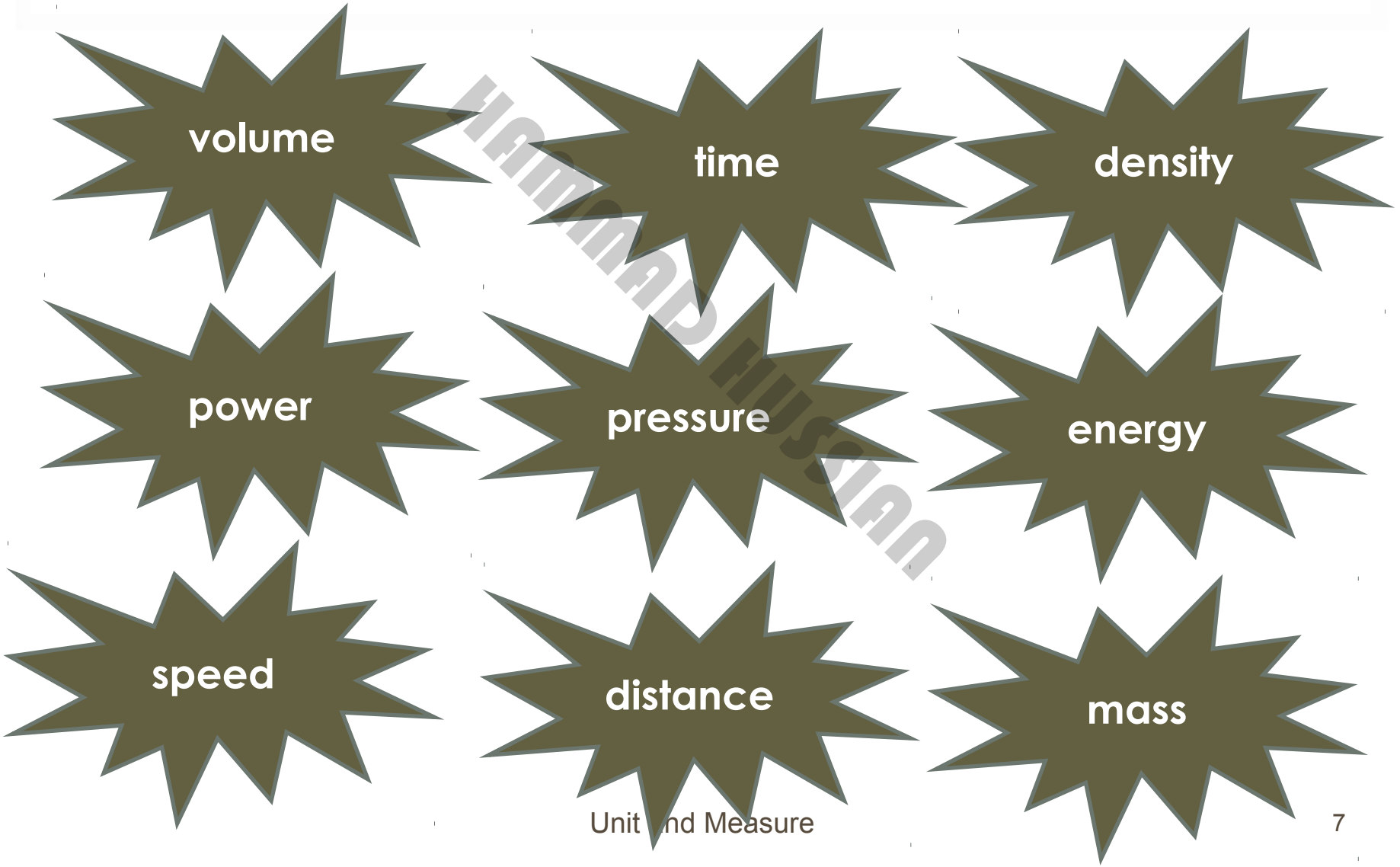
SCALARS AND VECTORS

LIST THE VECTORS AND SCALARS FROM DISTANCE, DISPLACEMENT, LENGTH, SPEED, VELOCITY, TIME, ACCELERATION, MASS AND FORCE.

EXAMPLE OF SCALAR



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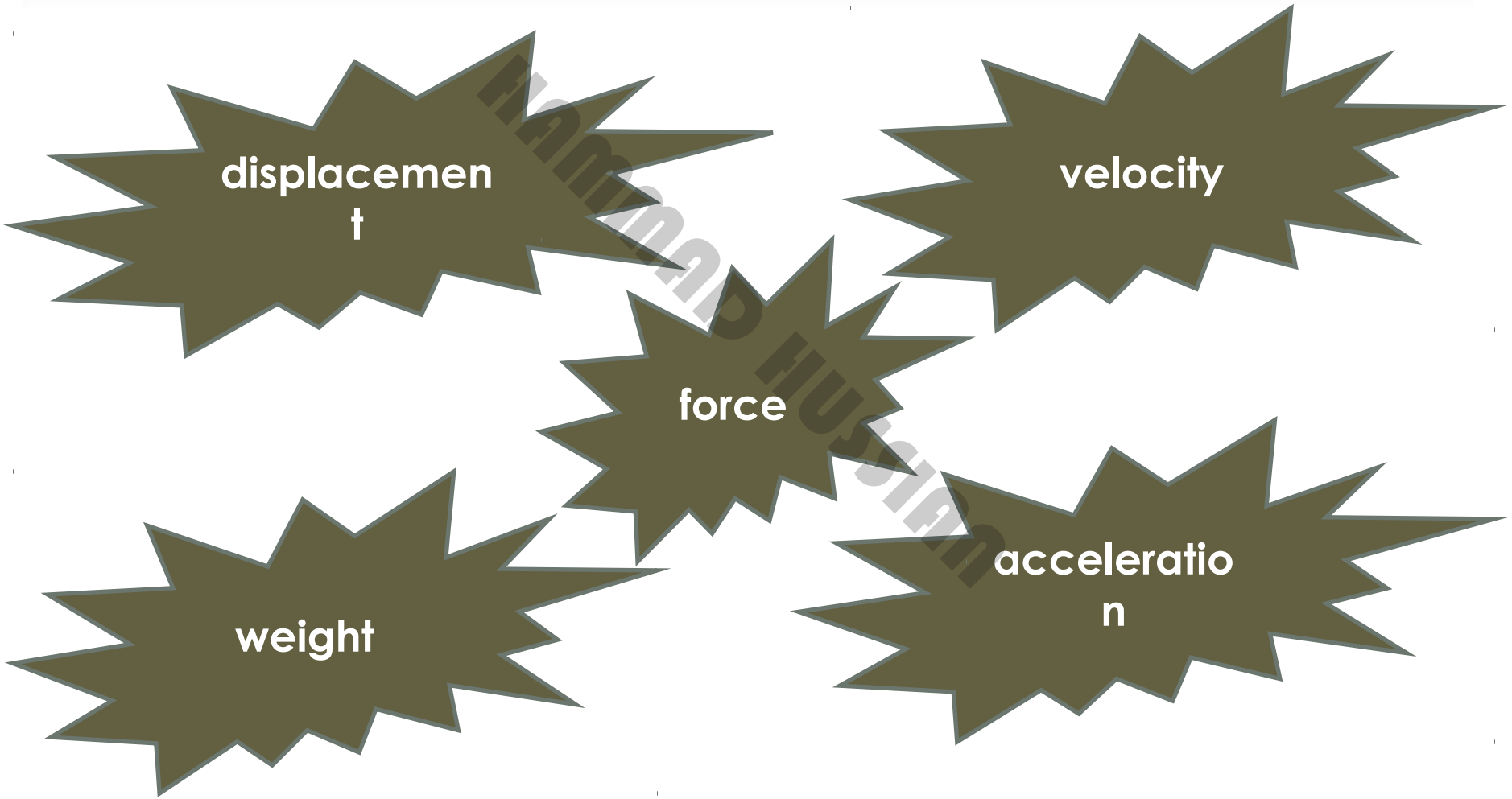
EXAMPLE OF VECTOR



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1. *Which statement about scalars and vectors is correct?*
   A. *A scalar has direction but no size.*
   B. *A scalar has size but no direction.*
   C. *A vector has direction but no size.*
   D. *A vector has size but no direction.*

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2. *Which of the following correctly lists one scalar and one vector quantity?*

	scalar quantity	vector quantity
A	displacement	work
B	energy	force
C	force	acceleration
D	velocity	mass

B

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3. *Which of the following groups of physical quantities consists only of scalars?*

   A. *acceleration, force, velocity*
   B. *acceleration, mass, speed*
   C. *force, time, velocity*
   D. *mass, speed, time*

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4. *Which list contains only scalar quantities?*

   A. *acceleration, displacement, mass*
   B. *acceleration, distance, speed*
   C. *displacement, mass, velocity*
   D. *distance, mass, speed*

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5. *Which is the correct statement about force and velocity?*

   A. *Force and velocity are both scalars.*
   B. *Force and velocity are both vectors.*
   C. *Force is a scalar, velocity is a vector.*
   D. *Force is a vector, velocity is a scalar.*

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6. *Which list contains only scalar quantities?*
   - A. *acceleration, displacement, velocity*
   - B. *distance, force, speed*
   - C. *force, length, time*
   - D. *length, mass, speed*

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7. *A student studies some equations.*

power = work / time

force = mass × acceleration

velocity = displacement / time

How many vector quantities are contained in the equations?

A *1* **B** *2* **C** *3* **D** *4*

D

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8. *The following statements are about motion.*
   1. *1 A plane flies due East for 600 km.*
   2. *A runner's average speed in a race around a track is 5 m/s.*
   3. *A snail crawls at 3 mm/s in a straight line towards a lettuce.*
   4. *A tourist travels 500 km on a journey.*
9. *Which statements describe vector quantities?*
   1. *1 and 2*
   2. *1 and 3*
   3. *2 and 3*
   4. *2 and 4*

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SCALARS AND VECTORS

DETERMINE THE RESULTANT OF TWO VECTORS BY A GRAPHICAL METHOD.

ADDING VECTOR

- *In adding two vectors we need to consider the direction of the vector quantities.*

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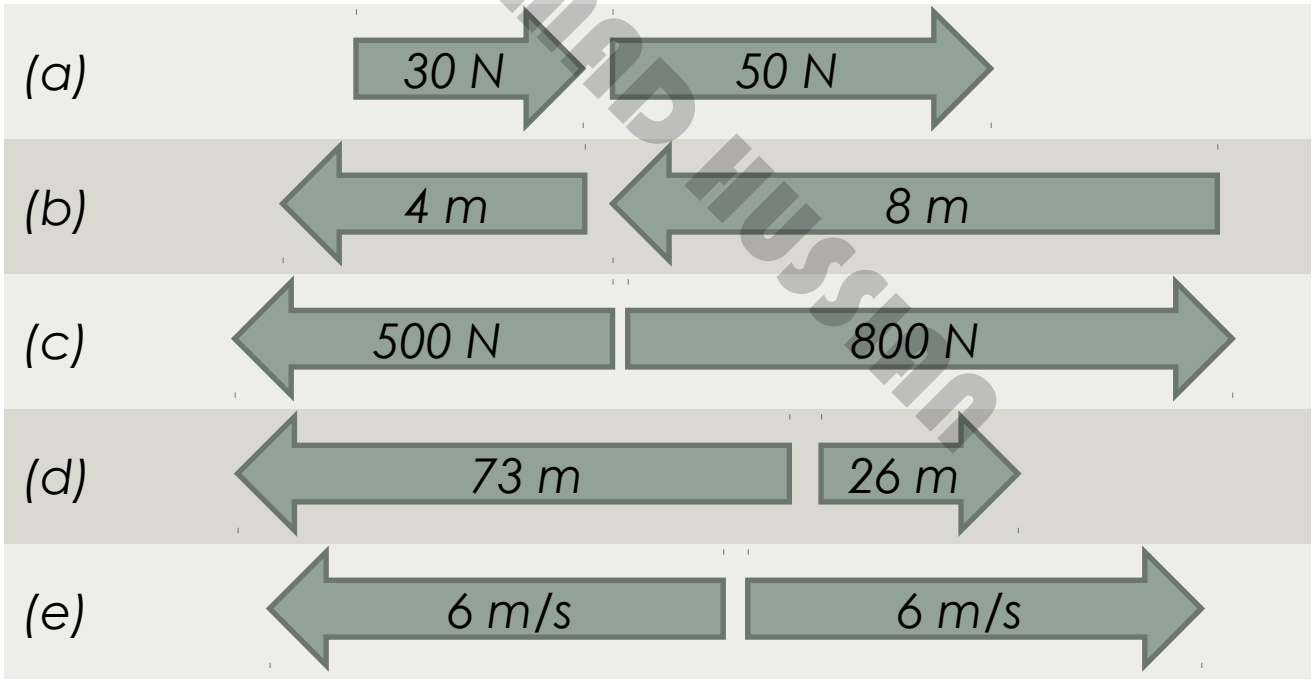
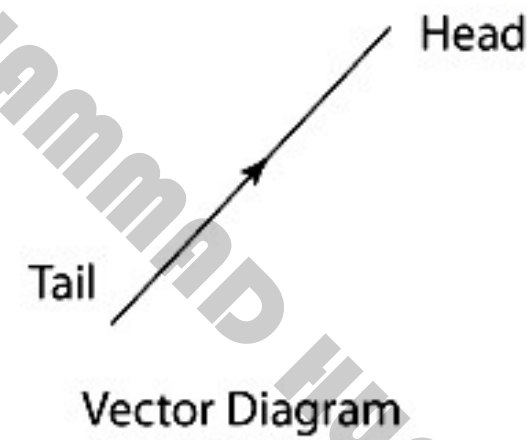


VECTOR DIAGRAM



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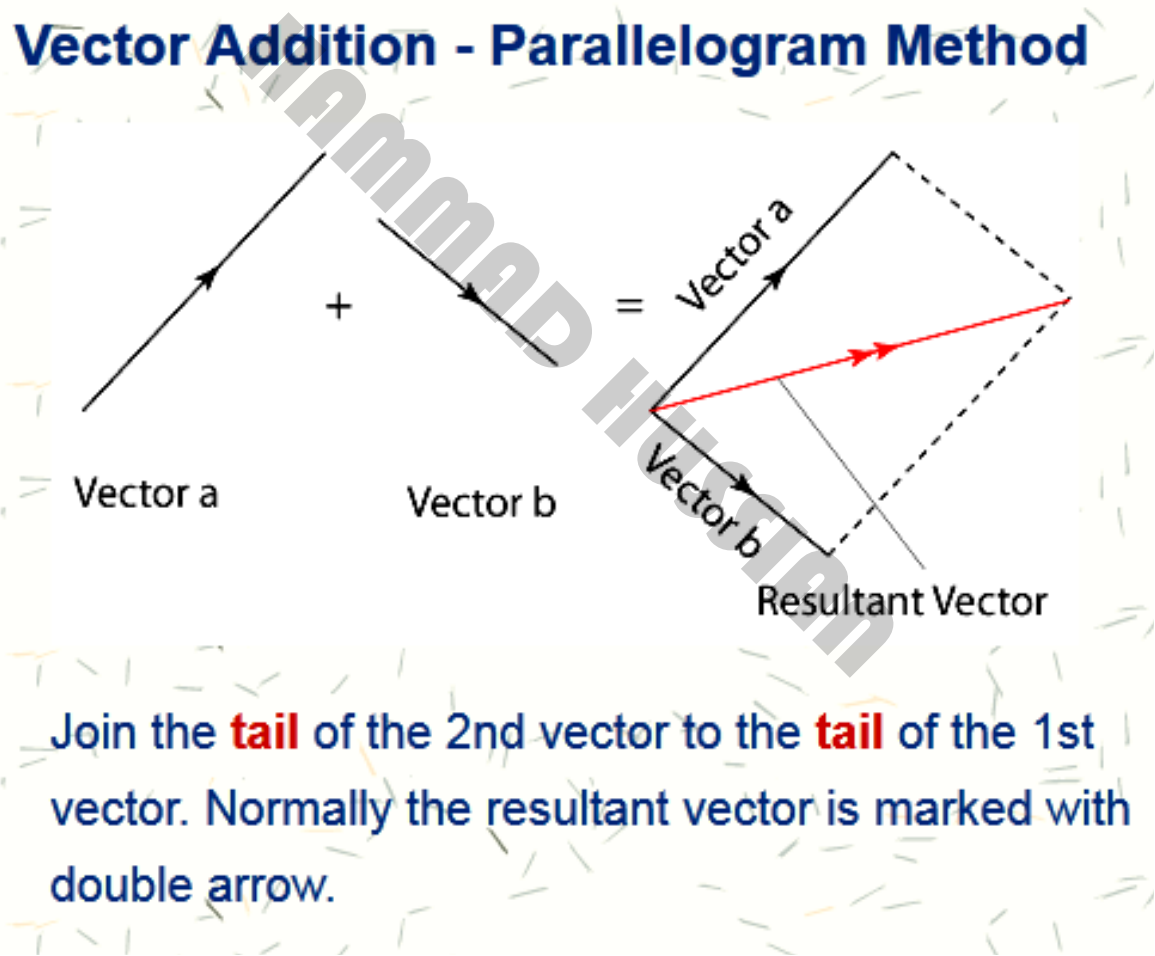
The arrow shows the direction of the vector.

The length representing the magnitude of the vector.

PARALLELOGRAM METHOD



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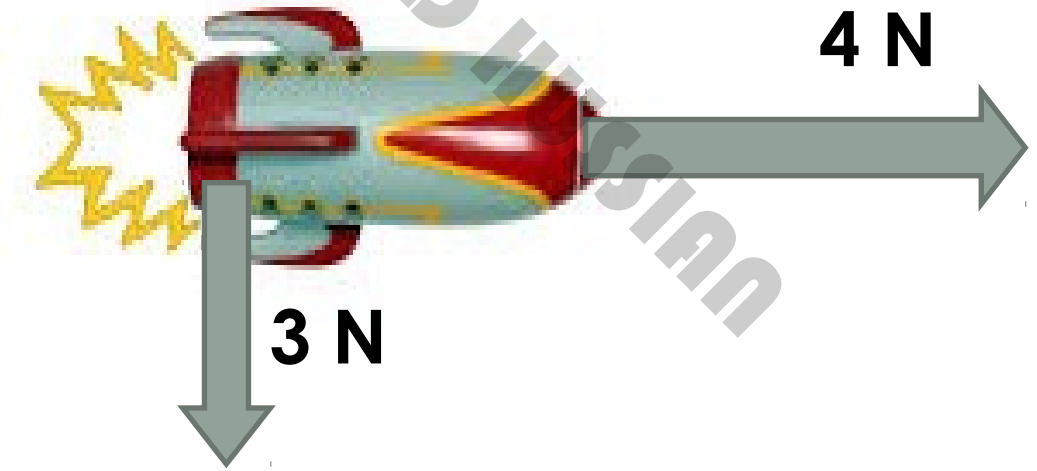
WORKED EXAMPLE

Find the resultant force acting on the rocket shown below. State the direction of this resultant force.



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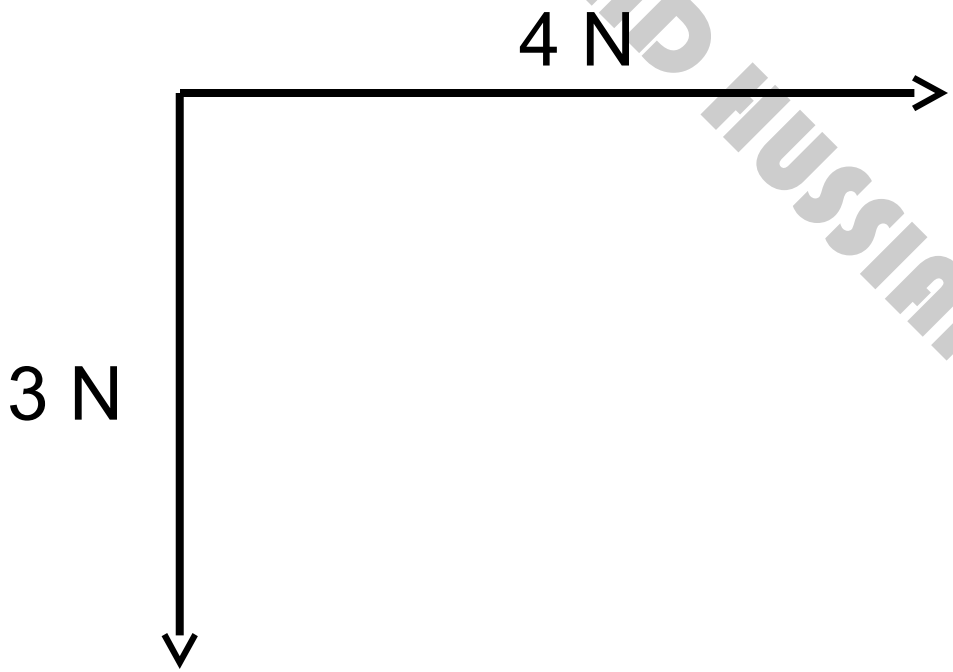
1. *Set the scale of your drawing*
   - *1 cm to represent 1 N*
1. *Draw your two labelled vectors*



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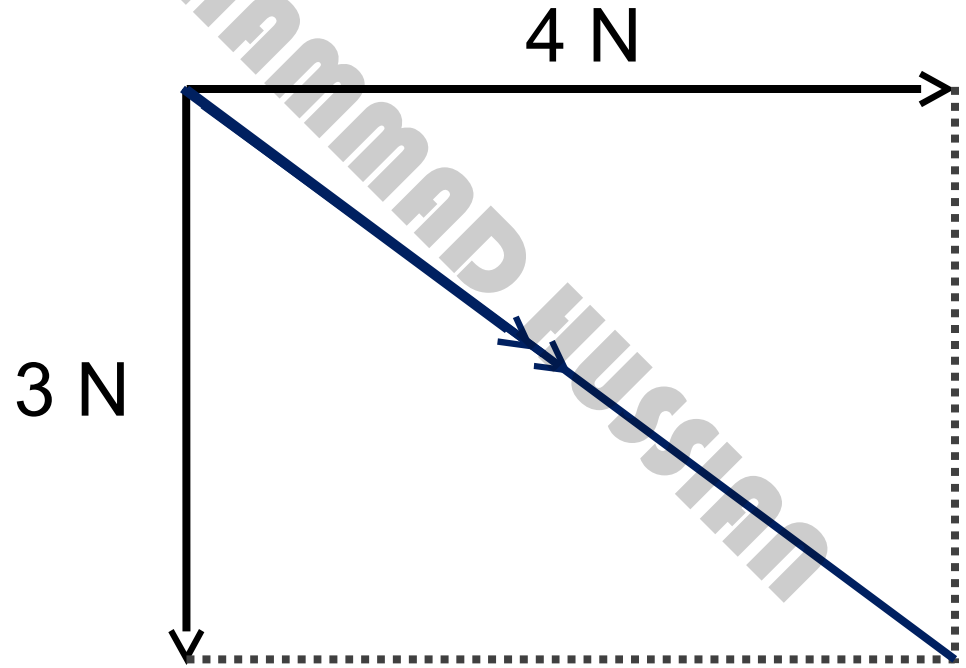
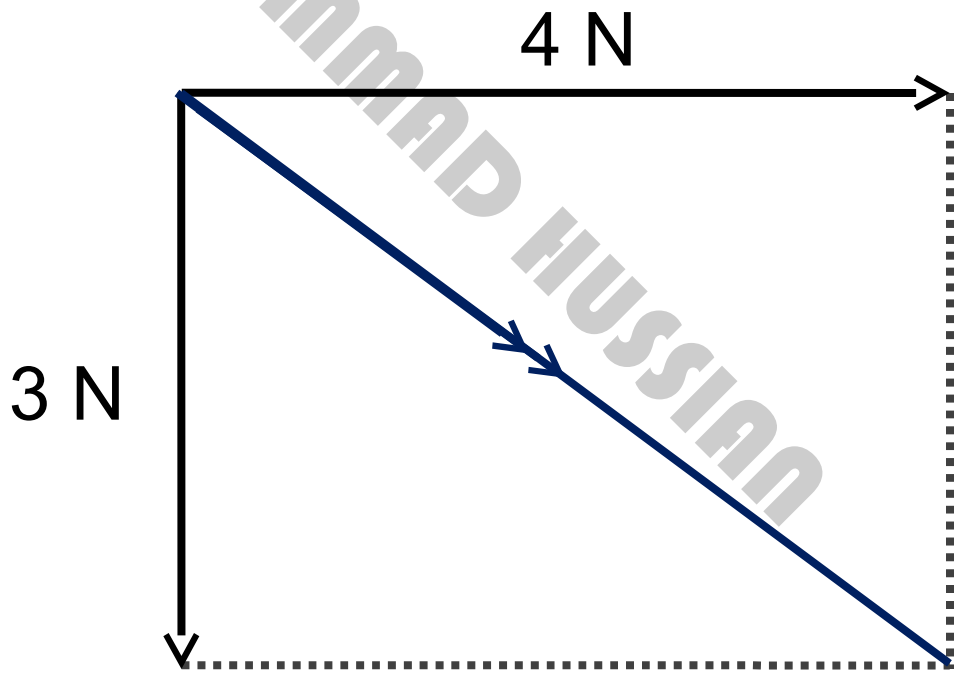
3. *Complete your rectangle*



4. *Draw your resultant vector*

5. *Measure your resultant vector and the direction*



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EXAMPLE

1. *You walk 7 m south and then 3 m west. What is your displacement from your starting point?*
2. *A toy car is moving 12 m eastwards. A child then pushes it 2.6 m northward. What is the resulting displacement of the car.*

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3. *An aircraft can fly at a top speed of 600 km/h.*

   a) *What will its speed be if it flies into a head-wind of 100 km/h? (A head-wind blows in the opposite direction to the aircraft.)*

   b) *The pilot directs the aircraft to fly due north at 600 km/h. A side-wind blows at 100 km/h towards east. What will be the aircraft's resultant velocity? (Give both its speed and direction.)*

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4. *A motorboat moved across a stream that flows at 3.5 m/s. In still water the boat can do 4.6 m/s. Find*

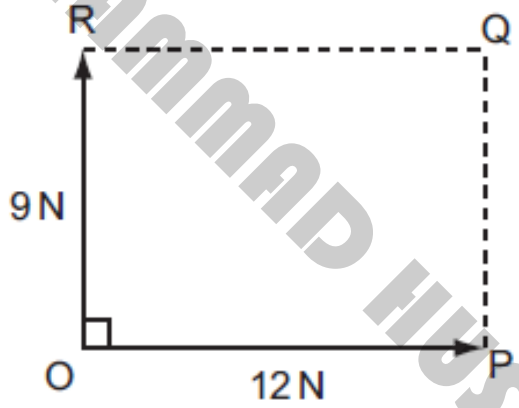
   a) *the angle stream at which the boat must be pointed,*
   b) *the resulting speed of the boat in the cross-stream direction.*

Hamad Hussain

5. *By using a geometrical instrument, find the resulting vector for each of the following;*
   a) *A displacement of 5 m and 7 m acting at 45° to one another.*
   b) *A velocity of 6 m/s and 8 m/s acting at 60° to one another.*
   c) *A force of 5 N and 4 N acting at 90° to one another*
   d) *Two forces of 4 N and 6 N acting on a body with an angle of 50° between them.*

Ahmad Hussin

1. *Two forces act at right angles at a point O as shown.*



1. *What is the resultant of the forces?*

	magnitude	direction
A	15 N	OQ
B	15 N	PR
C	21 N	OQ
D	21 N	PR

A

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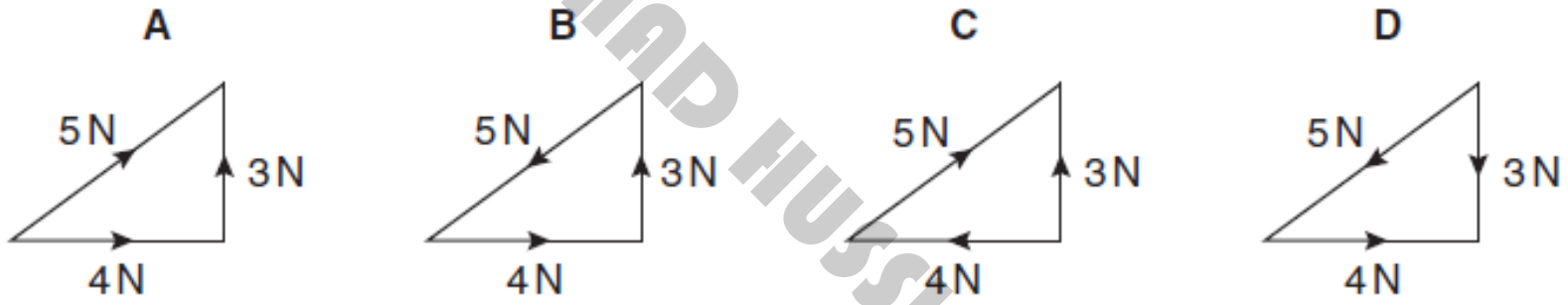
2. *Which diagram correctly shows the addition of a 4 N and a 3 N force?*



A

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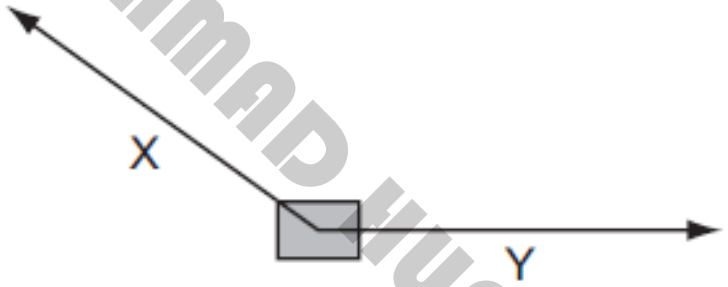
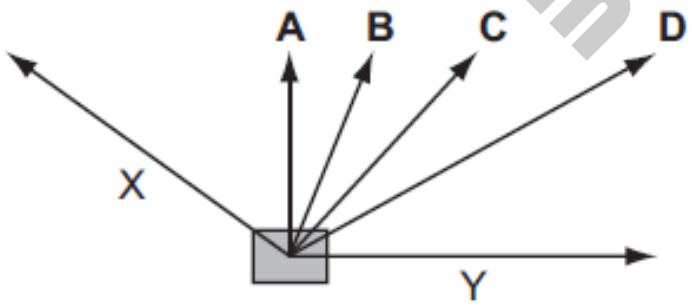
3. *Forces X and Y act on a block in the directions shown on the scale diagram.*



1. *In which direction is the resultant force acting?*



B

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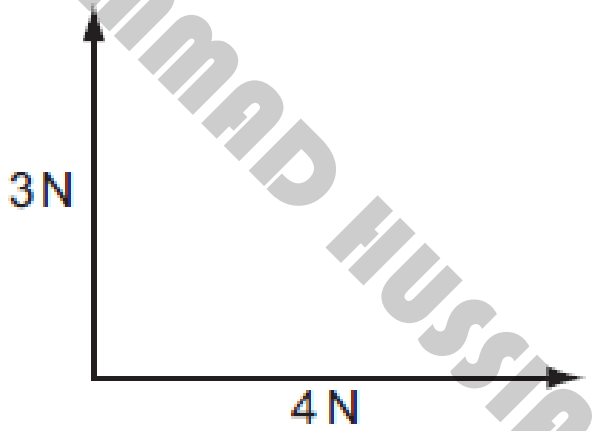
4. *Forces of 3 N and 4 N are acting as shown in the diagram.*



1. *Which diagram may be used to find the resultant R of these two forces?*

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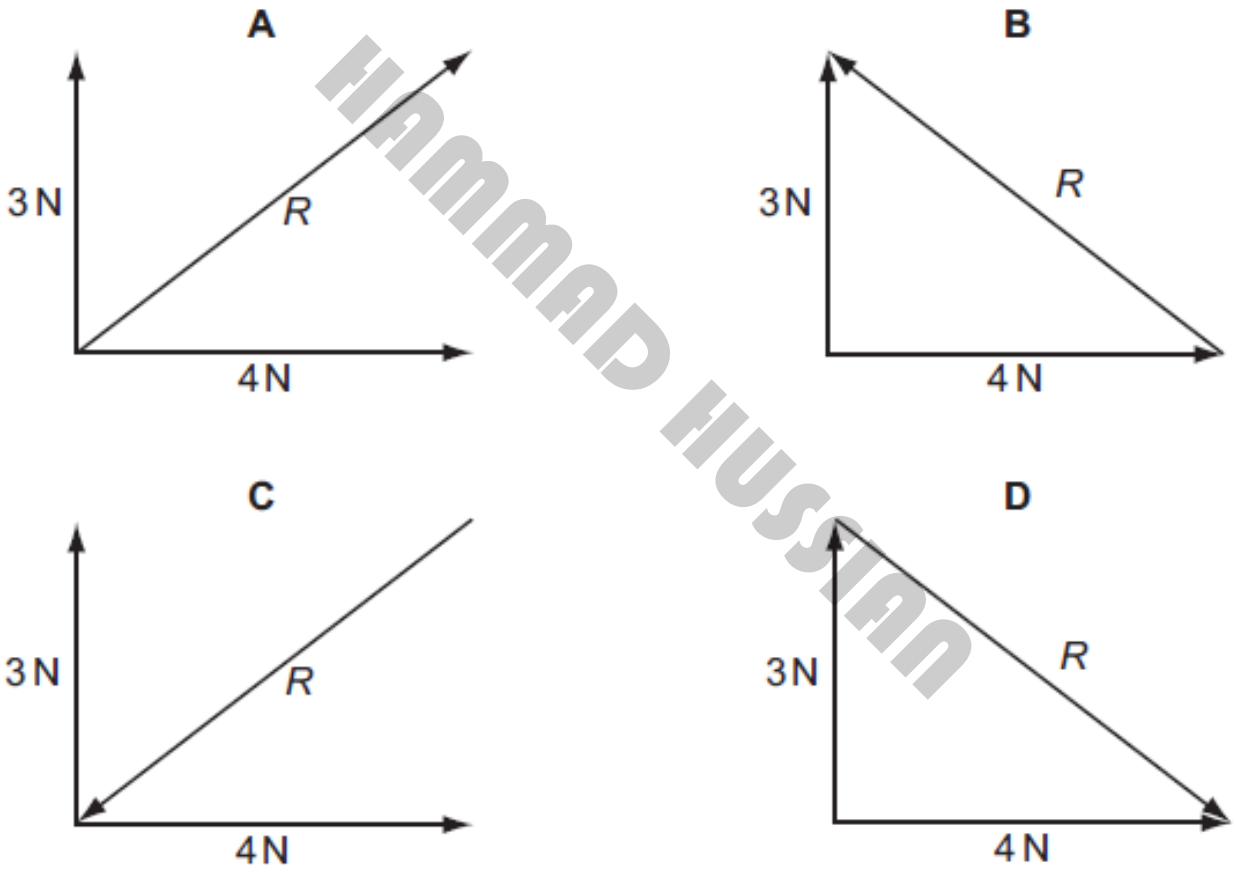

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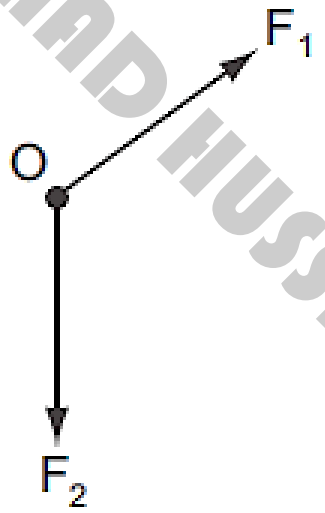
A

5. *Two forces F_1 and F_2 act on an object O in the directions shown.*



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1. *What is the direction of the resultant force?*

D

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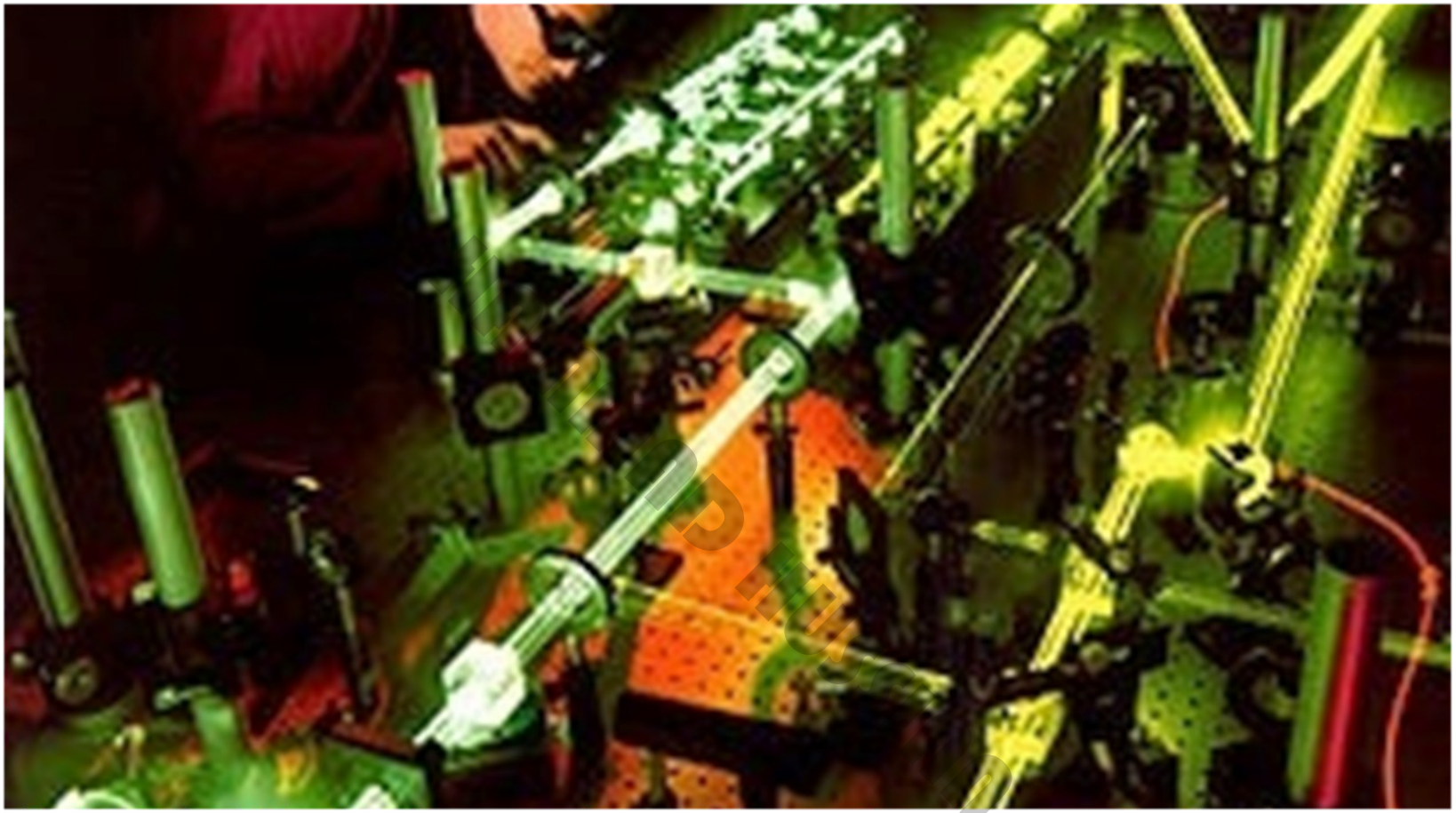
MEASUREMENT TECHNIQUES

DESCRIBE HOW TO MEASURE A VARIETY OF LENGTH WITH APPROPRITATE ACCURACY USING TAPES, RULES, MICORMETERS AND CALIPERS

PLATINUM-IRIDIUM BAR

FROM 1889 TO 1960, THE METER WAS DEFINED TO BE THE DISTANCE BETWEEN TWO SCRATCHES IN A PLATINUM-IRIDIUM BAR.

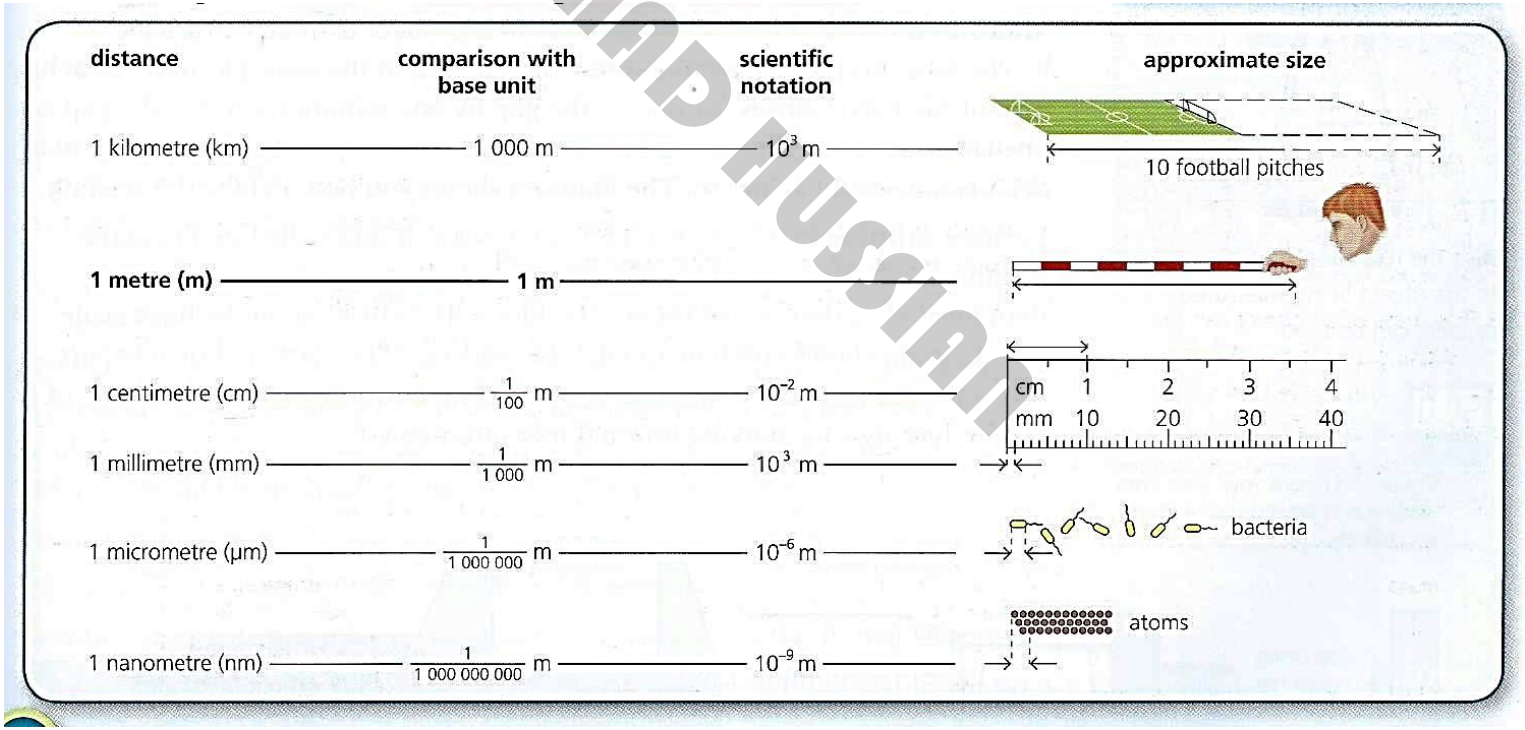


ORANGE-RED LINE OF KRYPTON-86 PROPAGATING IN A VACUUM

THE METRE IS DEFINED SUCH THAT THE SPEED OF LIGHT IN FREE SPACE IS EXACTLY 299,792,458 METRES PER SECOND (M/S)

THE METRE

- *The* **metre** *or* **meter** *is a base unit of length in the metric system used around the world for general and scientific purposes.*



HOMAP HUSSAIN

MEASUREMENT OF LENGTH

- *Metre rule is used to measure length of object.*
- *Precaution to be taken when using a ruler:*
  - *Avoid parallax error – the position of eye must be in line with the reading to be taken.*
  - *Avoid zeros errors and end errors – if the ends of the ruler are worn-out, it is advisable that measurements should start from the 1 cm mark of the scale*

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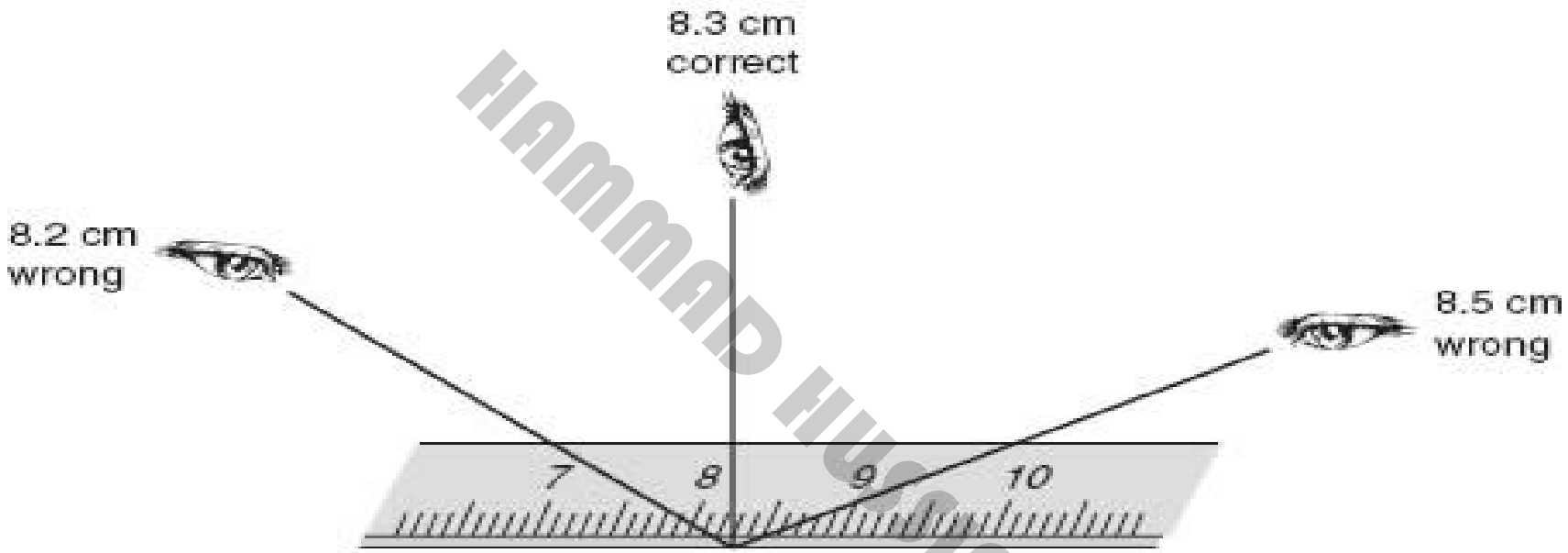

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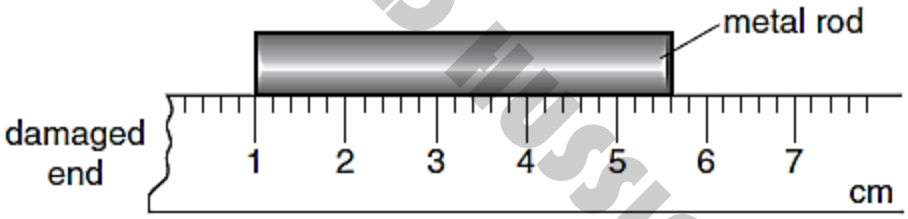
- *Any instrument that are out of adjustment or with some minor fault is still accurate as long as the zero error is added or subtracted form the reading shown on the scale.*

EXAMPLE

1. *A girl uses a rule to measure the length of a metal rod. Because the end of the rule is damaged, she places one end of the rod at the 1 cm mark as shown.*



How long is the metal rod?

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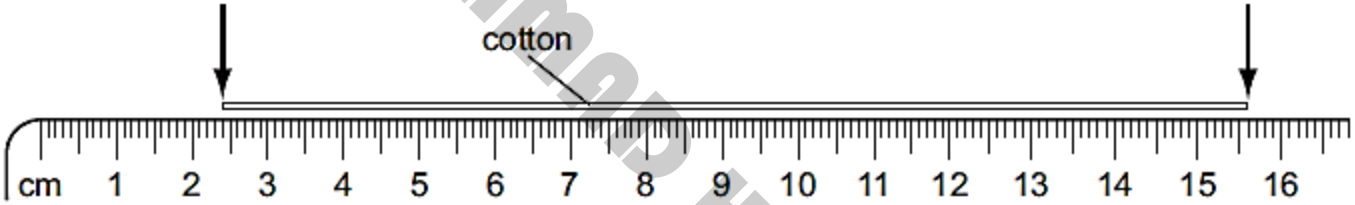
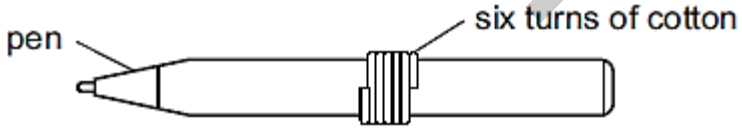
2. *A piece of cotton is measured between two points on a ruler.*



When the length of cotton is wound closely around a pen, it goes round six times



What is the distance once round the pen?

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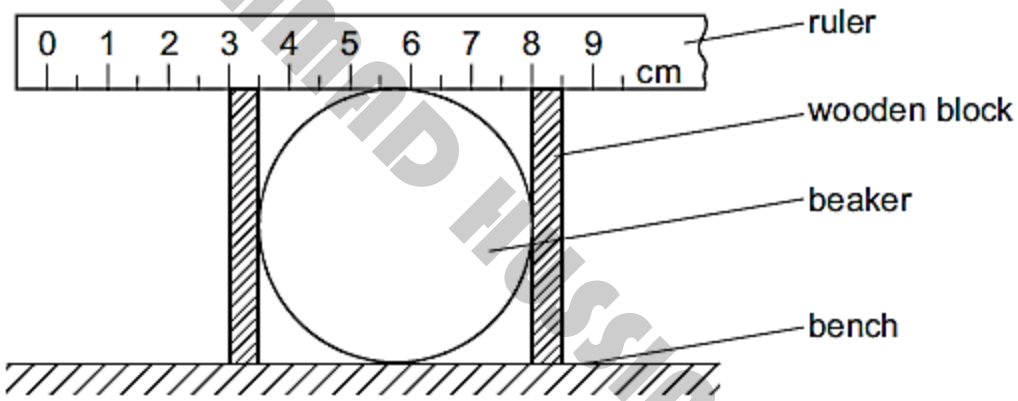
3. *The diagram shows one method of measuring the diameter of a beaker.*



What is the diameter of the beaker?

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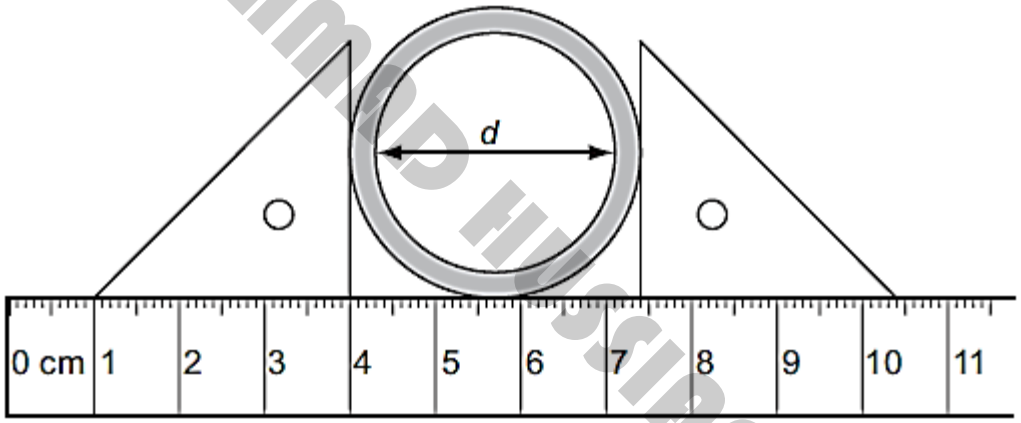
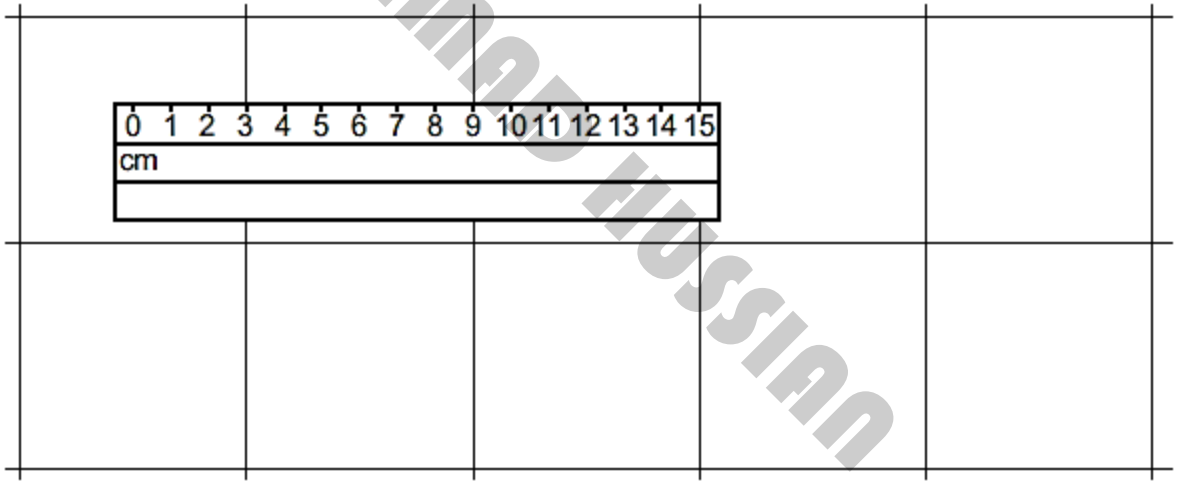
4. *The diagram shows a thick-walled tube. The thickness of the wall is 3 mm.*



What is the internal diameter d of the tube?

IGNMAP HTS.GIN

5. *A floor is covered with square tiles. The diagram shows a ruler on the tiles.*



How long is one tile?

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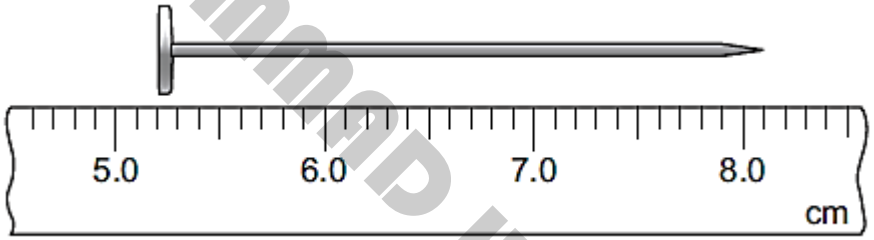
6. *A ruler is used to measure the length of a nail.*



What is the length of the nail?

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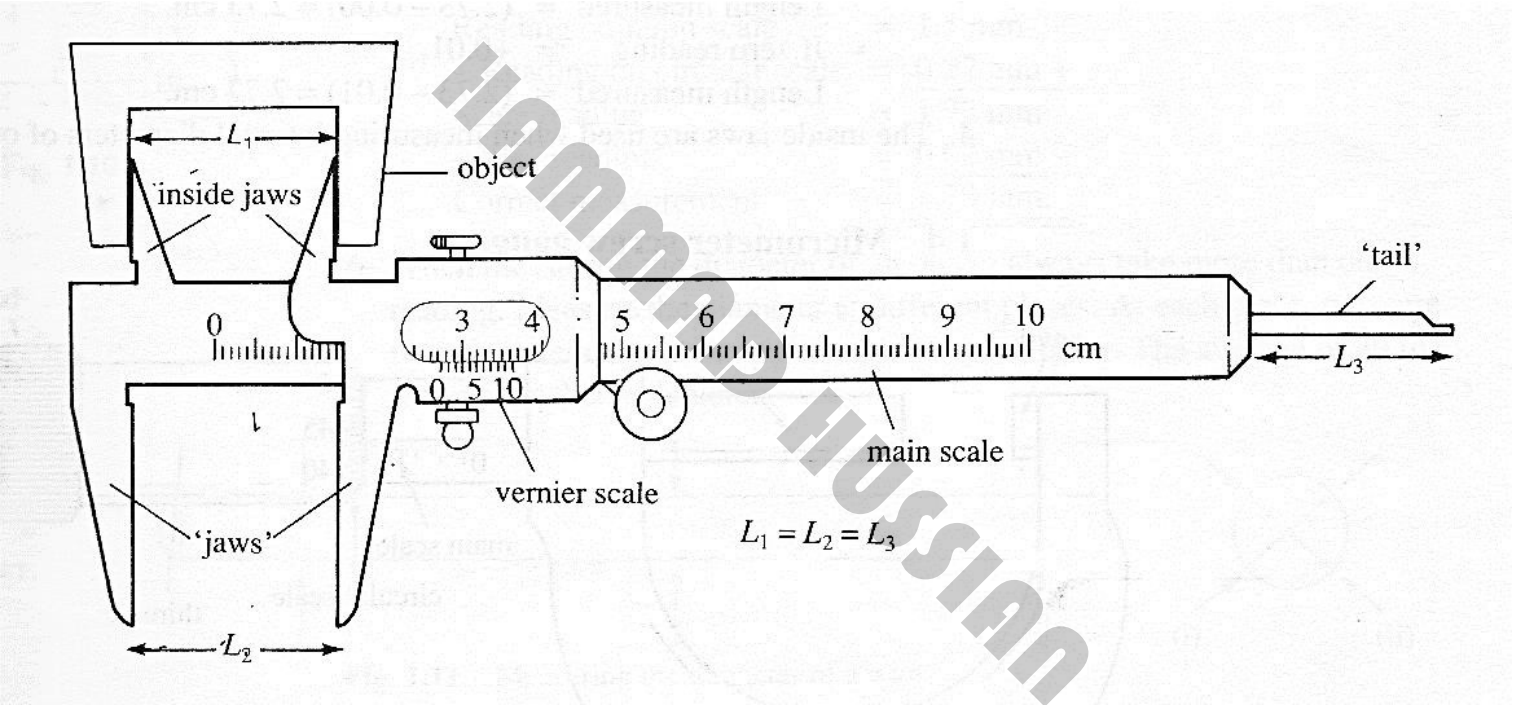
VERNIER CALIPER



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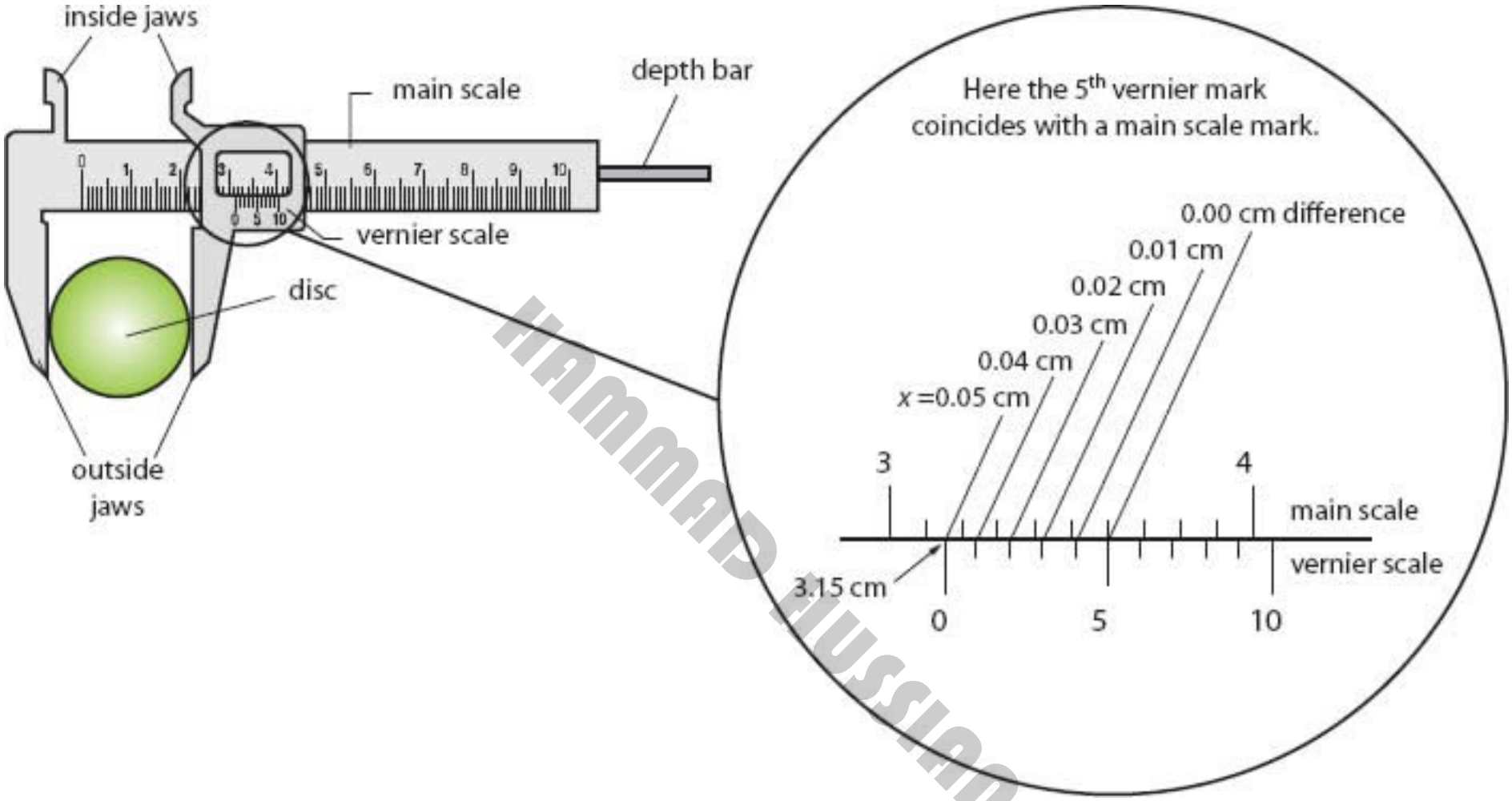
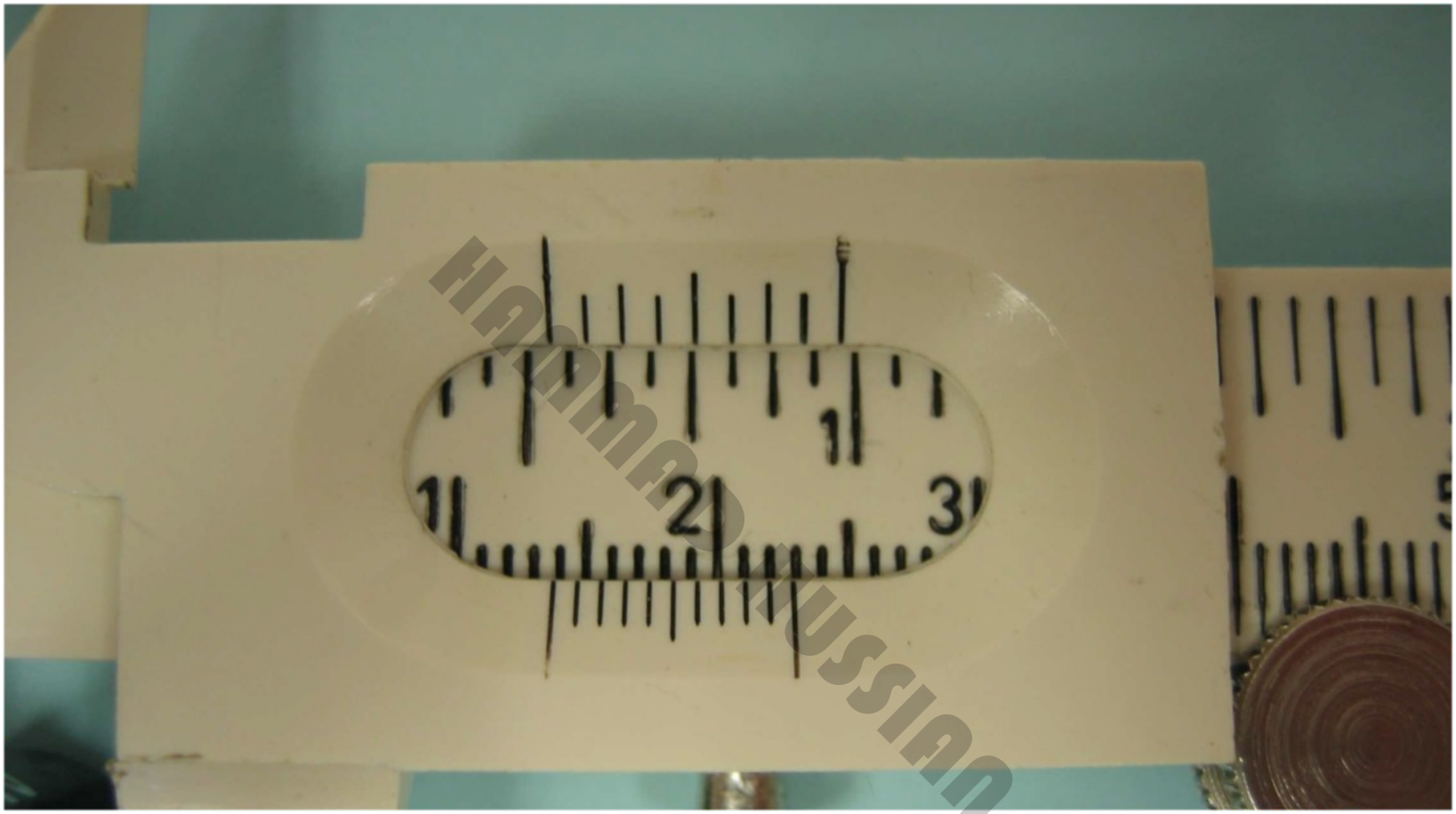
Measure thickness or diameter of object correct to 2 decimal places of decimals of a centimetre



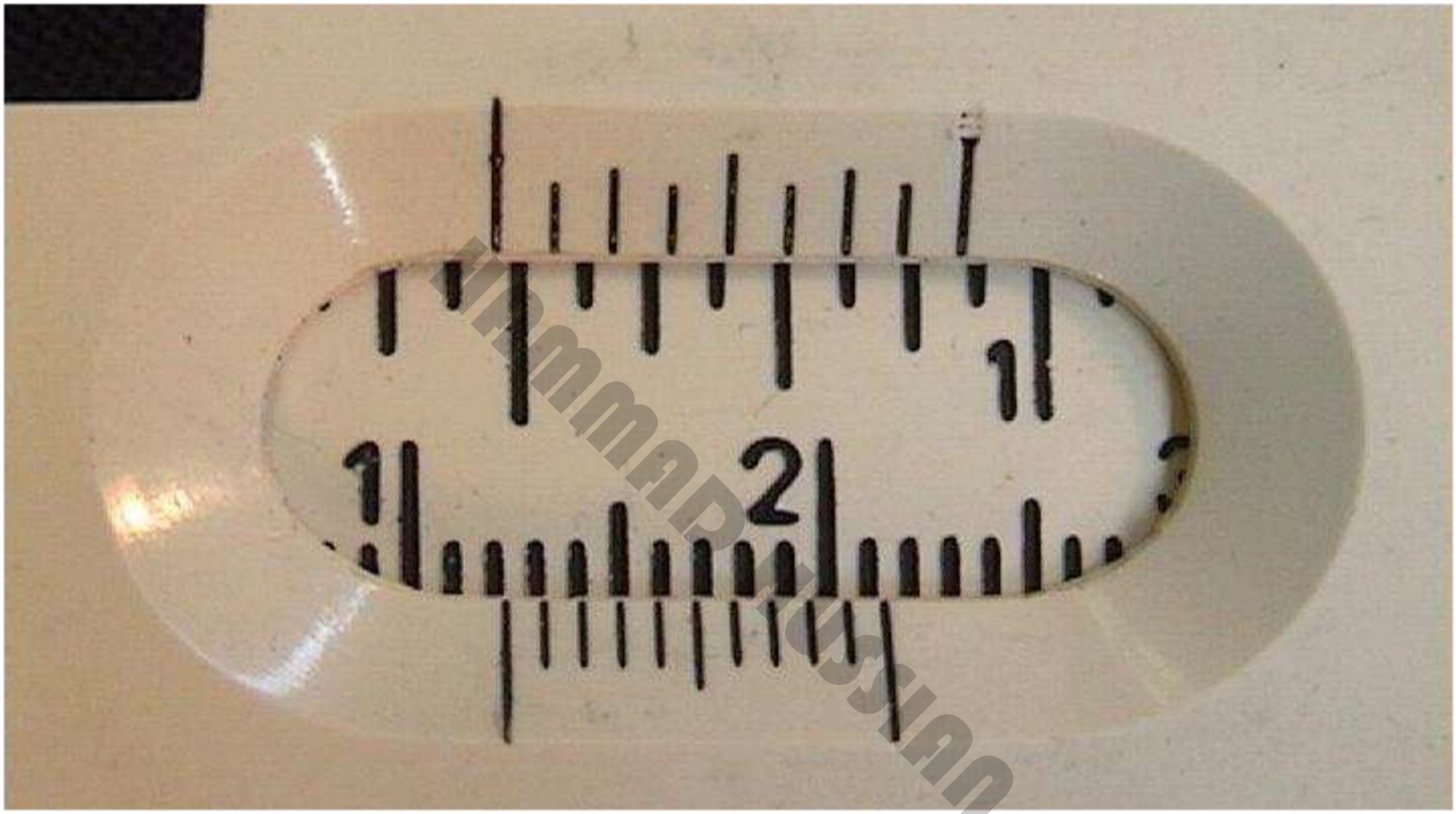
- *The inside jaws which can be used to measure the internal diameters of tube and containers.*
- *The depth bar at the end is used to measure the depth of a container.*



Unit and Measure

Unit and Measure

Unit and Measure

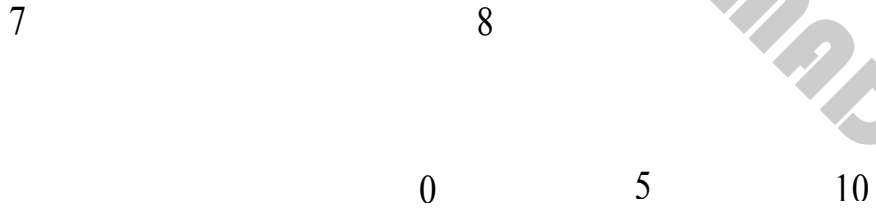


Unit and Measure

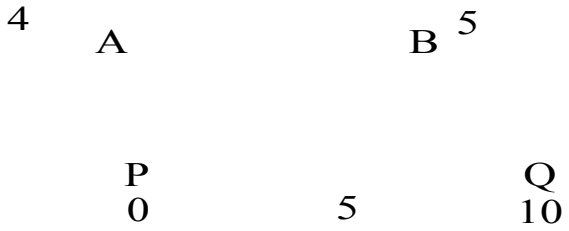
EXAMPLE

Write down the reading shown by the following

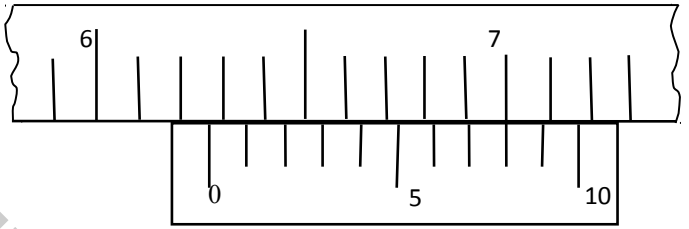
(a)



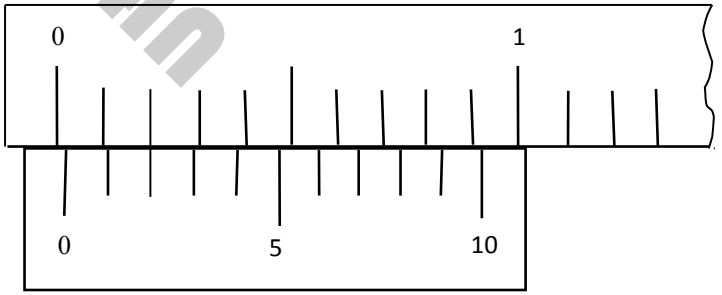
(b)



(c)



(d)



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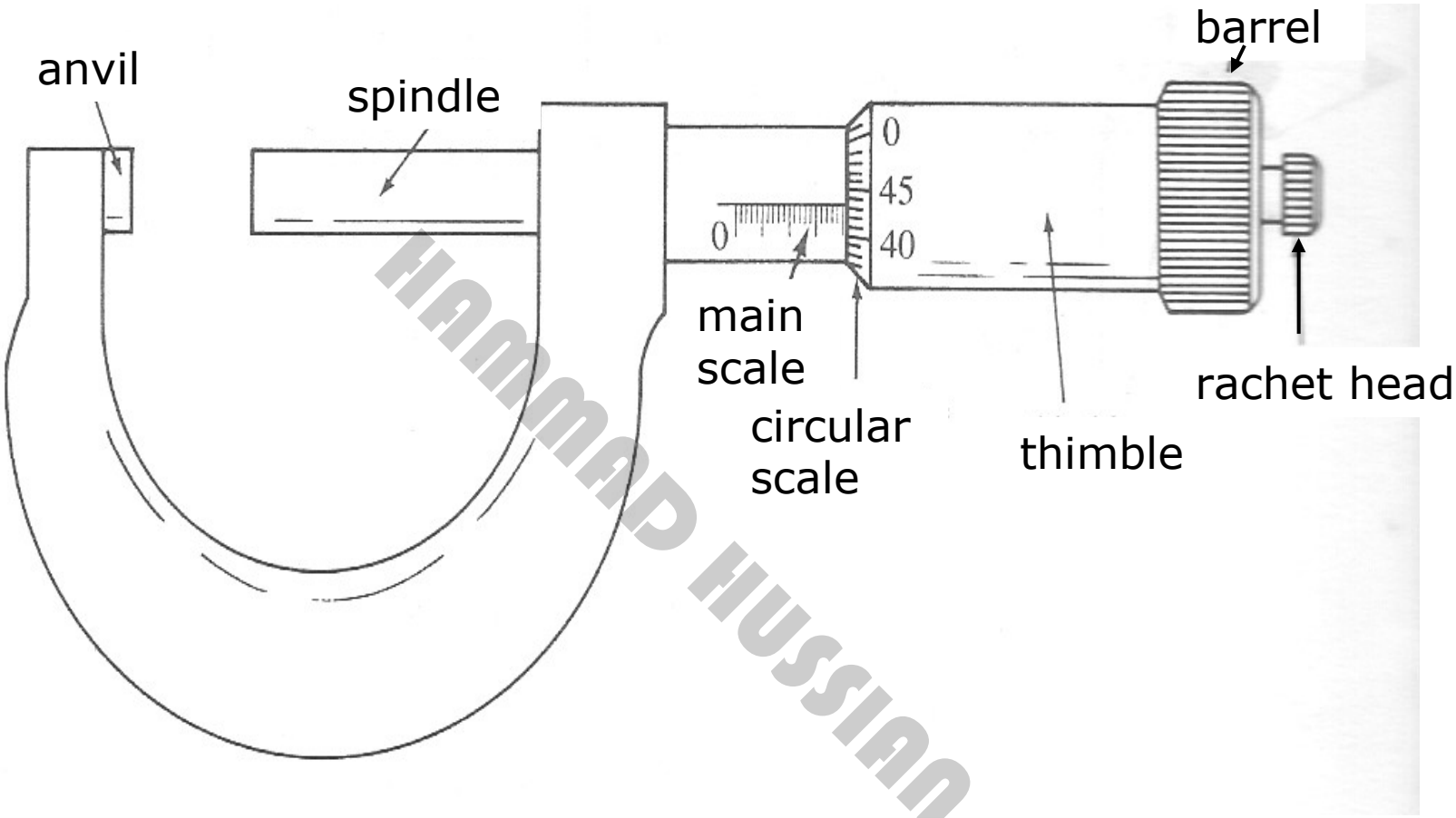

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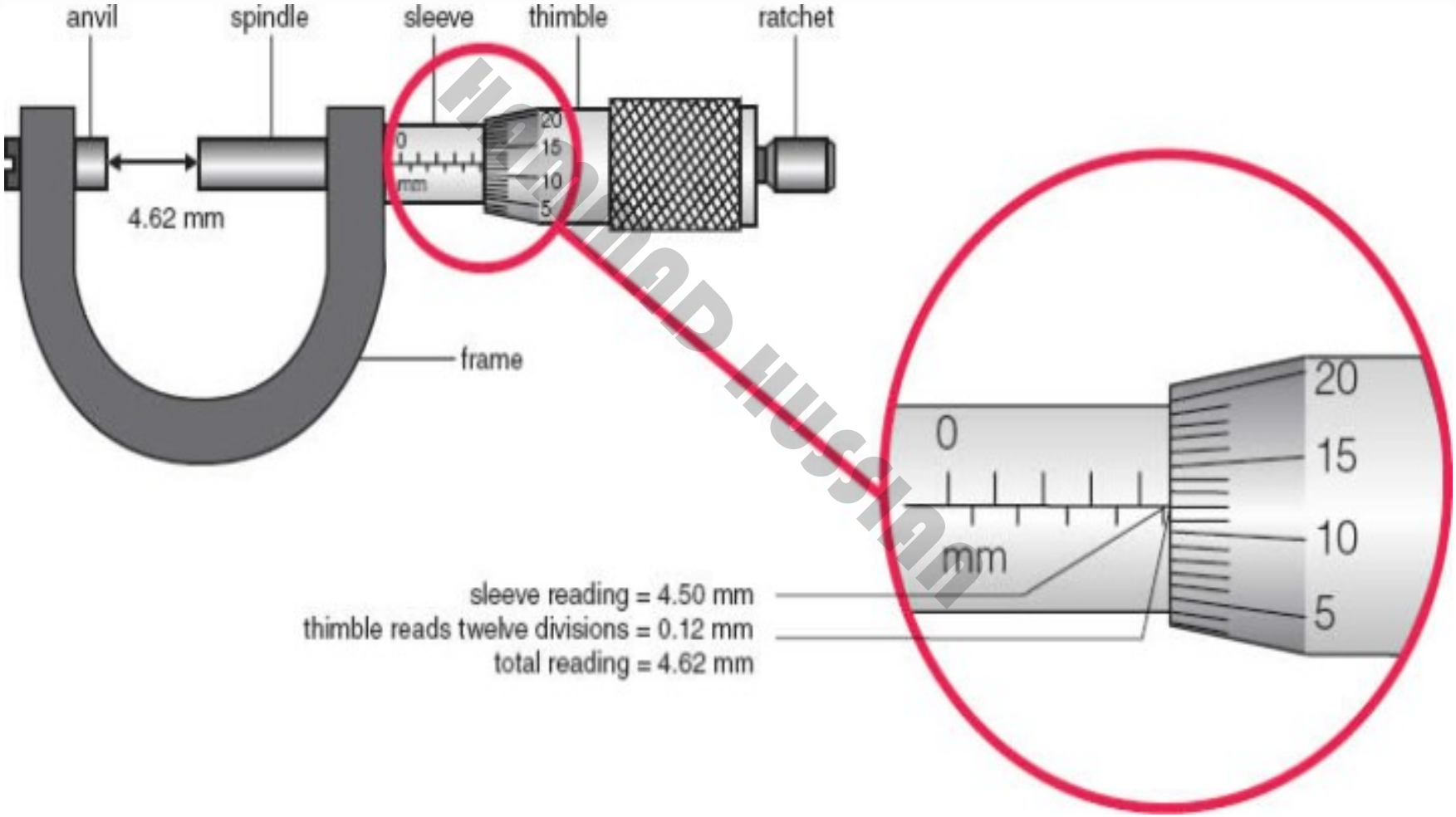
MICROMETER SCREWGAUGE

Measure diameter of wire or thin rod correct to 3 decimal places of centimetre

- *Micrometer screwgauge is used to measured the diameter of fine wires, the thickness of paper and similar small lengths.*
- *It has two scales: the main scale on the sleeve and the circular scale on the thimble which have 50 divisions. One complete turn of the thimble moves the spindle by 0.50 mm.*
- *Hence each divisions represents a distance of*

$$\frac{0.50\,\text{mm}}{50} = 0.01\,\text{mm}$$

Mohammad Hussain



Hanlap Hussain

Hamid Hussain

Unit and Measure

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Unit and Measure

HAMDAN HUSSAIN

Unit and Measure

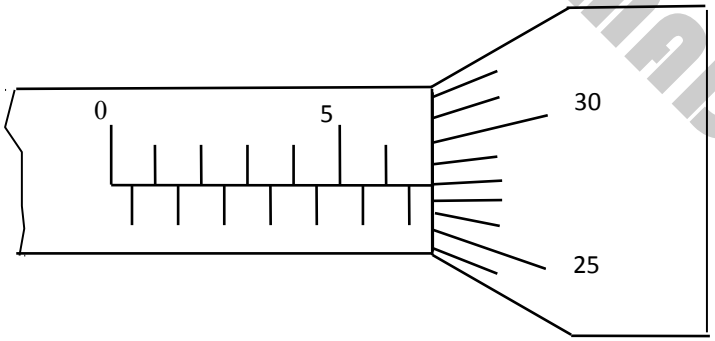
- *There are number of* **precautions** *one should take when using a micrometer:*
  - *The thimble should never be tightened too much.*
  - *Clean the ends of the anvil and spindle before making a measurement.*
  - *Check for systematic error by closing the micrometer when there is nothing between its anvil and spindle.*

Nizamuddin Hussain

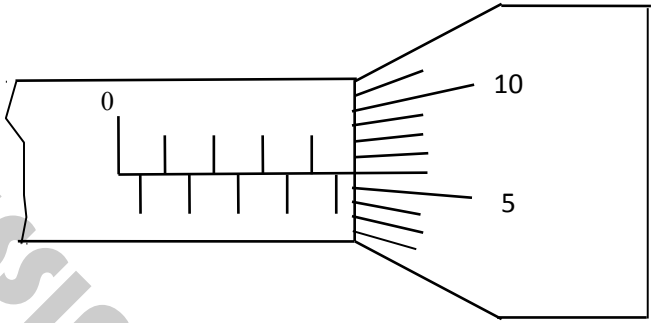
EXAMPLE

1. *Write down the reading shown by the micrometer screw gauge.*

(a)



(c)



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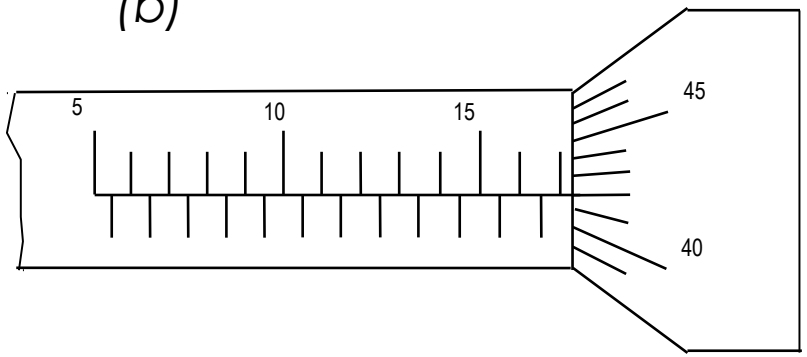

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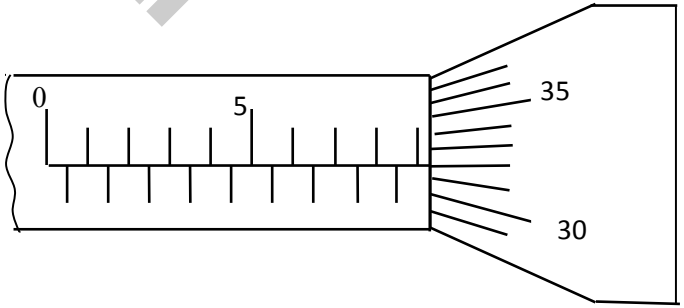

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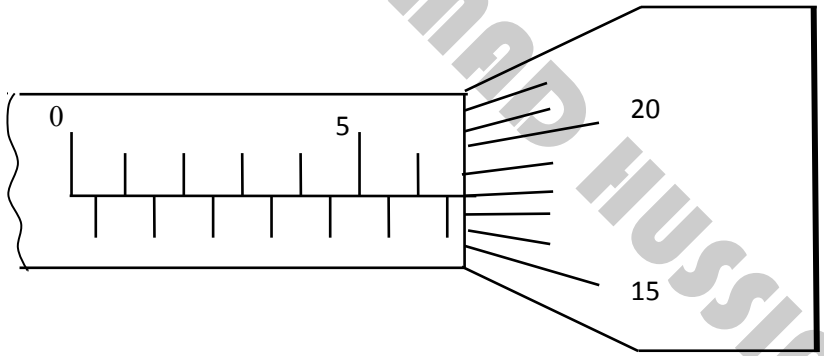
2. *Determine the reading of the following micrometer screw gauge*

(a)



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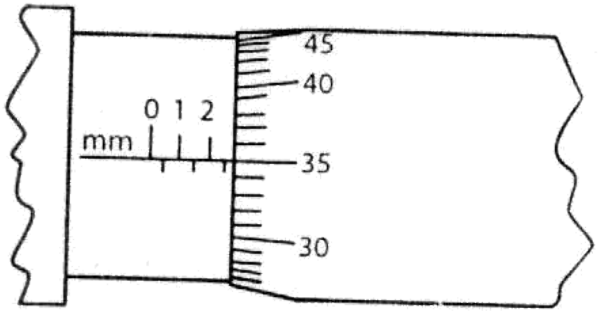

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RANGE & PRECISION

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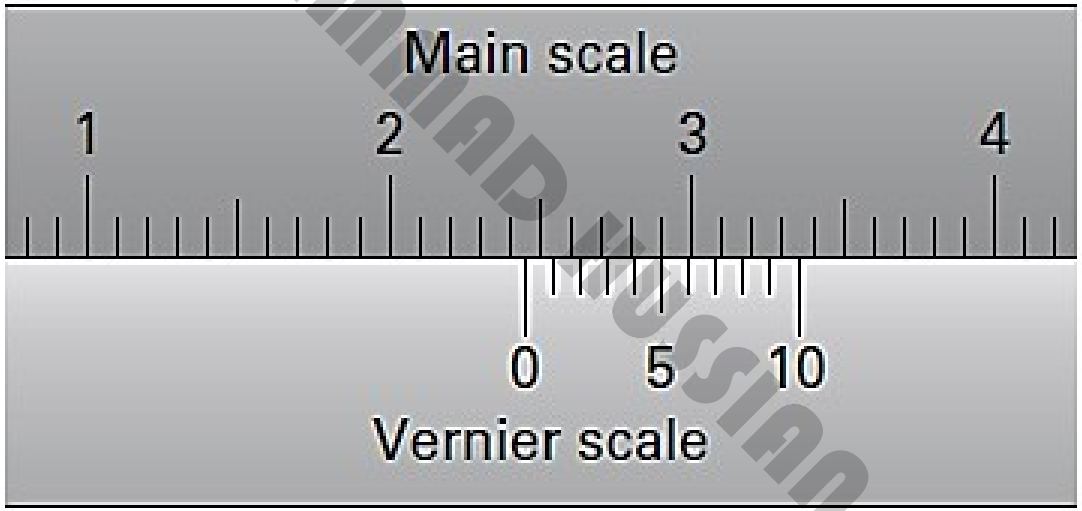
Instrument	Range of measurement	Precision
Measuring tape	*0 – 5 m*	*0.1 cm*
Metre rule	*0 – 1 m*	*0.1 cm*
Vernier calipers	*0 – 15 cm*	*0.01 cm*
Micrometer screw gauge	*0 – 2.5 cm*	*0.001 cm*

REVISION 1



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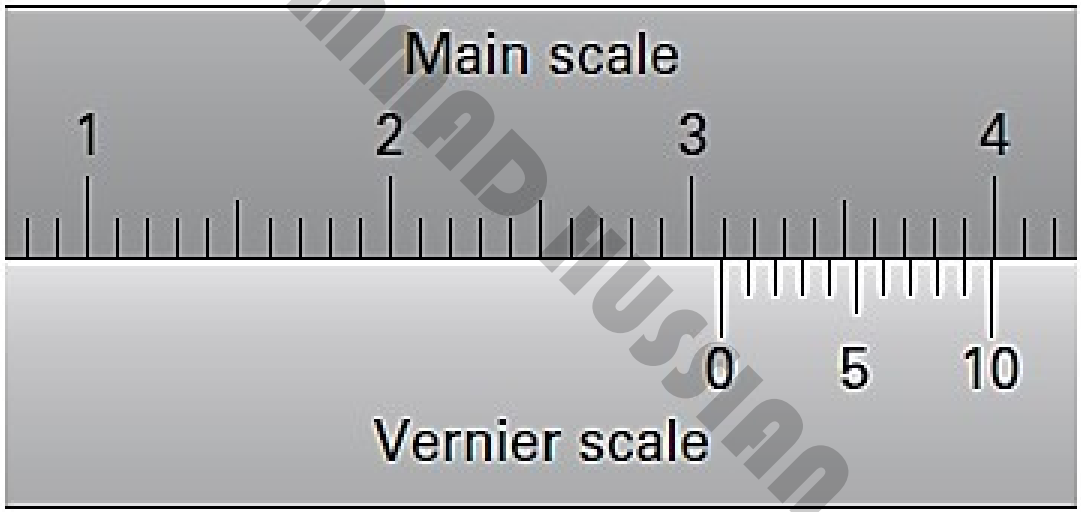
REVISION 2



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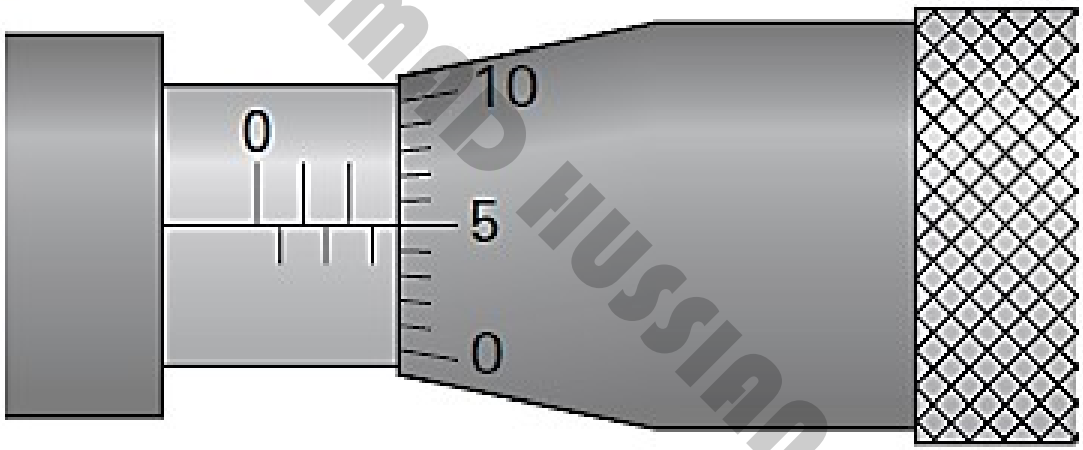
REVISION 3



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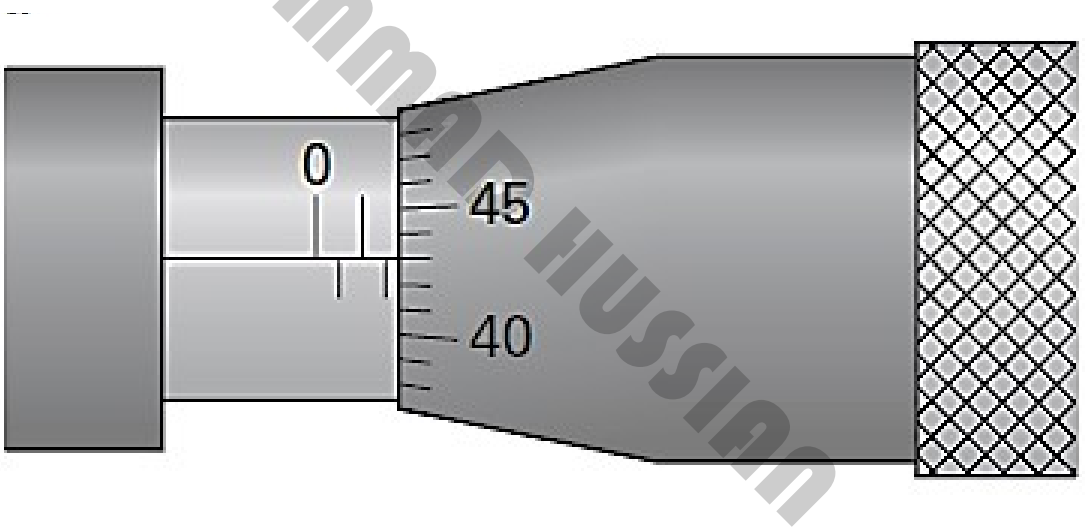
REVISION 4



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MEASUREMENT TECHNIQUES

DESCRIBE HOW TO MEASURE A VARIETY OF TIME INTERVALS USING CLOCK AND STOPWATCHES

Unit and Measure

TIME

- *Time is measured in years, months, days, hours, minutes & seconds.*
- *The* **second** *is the SI unit of time.*
- *All timing devices make use of some regular process such as regularly repeating motions called* **oscillations**.
- *One regular oscillations is referred to as the* **period** *of the oscillation.*

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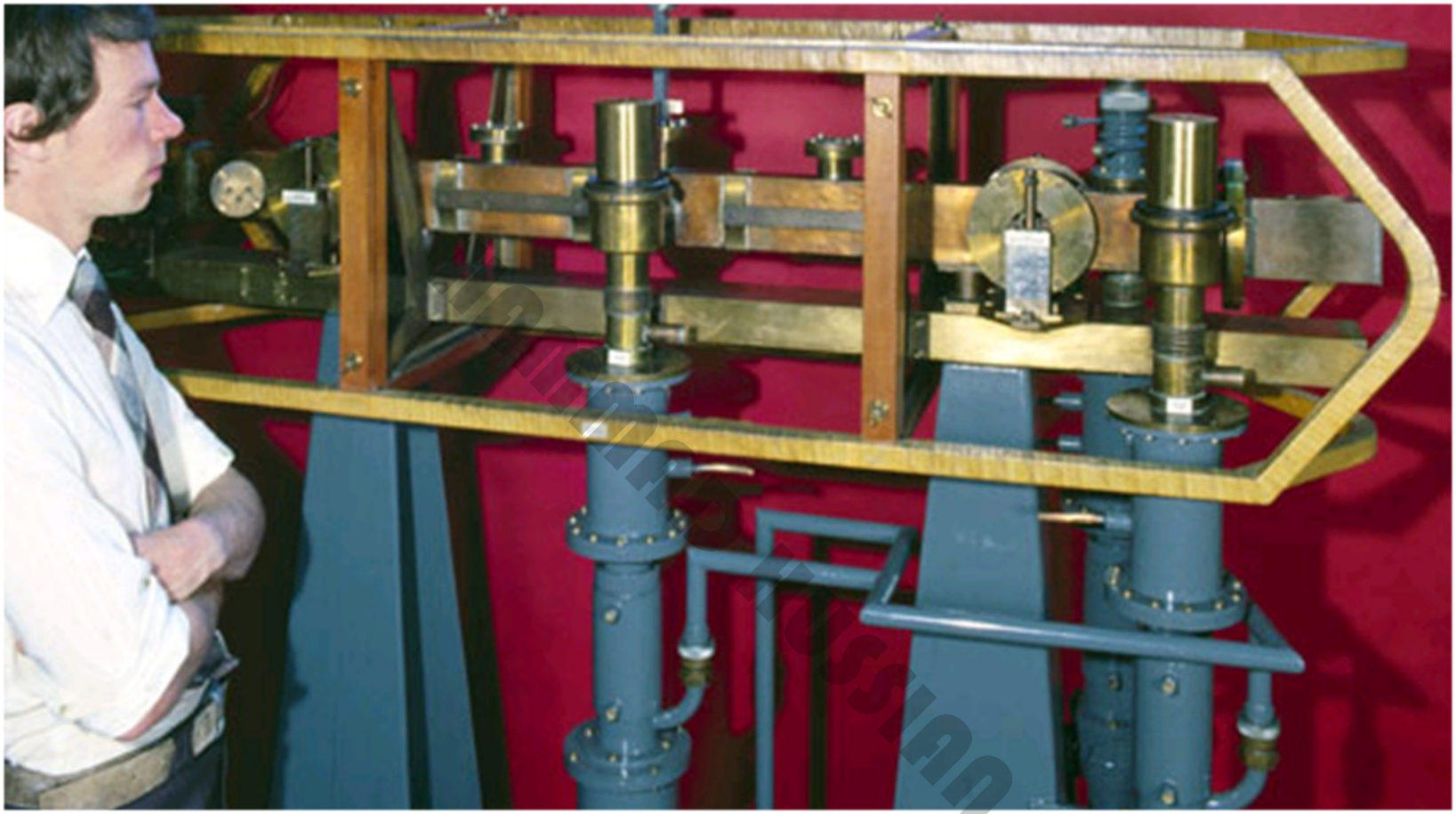

CAESIUM ATOMIC CLOCK

THIS CLOCK DEPENDS ON THE OSCILLATION OF CAESIUM-133 ATOM.
THE ACCURACY IS TO 1 SECOND LOSS OR GAIN IN EVERY 20 MILLIONS YEAR.

STOPWATCH

- **Stopwatches** *are used to measure short intervals of time.*
- *There are two types; the digital stopwatch and analog watch.*
- *The digital stopwatch is more precise as it can measure time intervals of 0.01 seconds while the analogue stopwatch measures in intervals of 0.1 seconds.*
- *One common error in using stopwatches is the* **reaction time** *in starting and stopping the watch which is few hundredths of a second (typically 0.3 s)*

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PRECISION

Measuring Instrument	Smallest Division	Precision	Examples
Analogue stopwatch	*0.1 s*	*0.1 s*	*25.1 s, 25.2 s, 25.3 s*
Digital stopwatch	*0.1 s*	*0.1 s*	*25.1 s, 25.2 s, 25.3 s*
	0.01 s	*0.01 s*	*25.12 s, 26.13 s, 26.14 s*

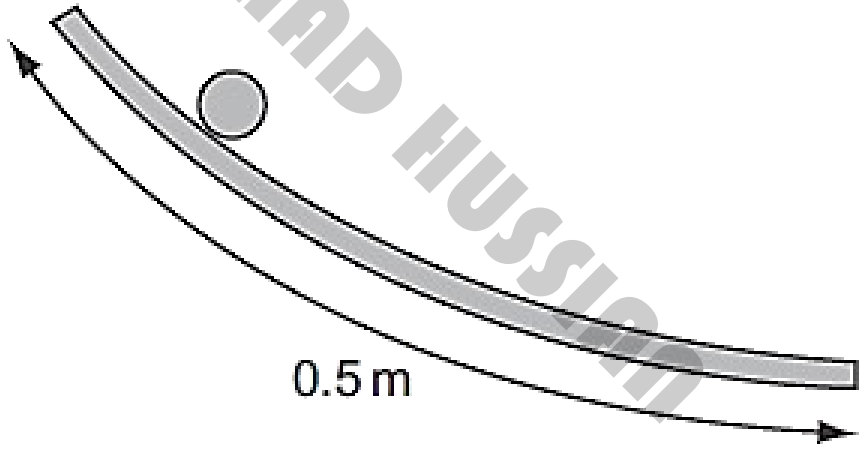
HAMMAD HUSSAIN

1. *A metre rule is used to measure a length.*
2. *Which reading is shown to the nearest millimetre?*

   A. *0.7 m*
   B. *0.76 m*
   C. *0.761 m*
   D. *0.7614 m*

IFHMAD HUSSIAN

2. *In an experiment, a ball is rolled down a curved track that is about half a metre long.*



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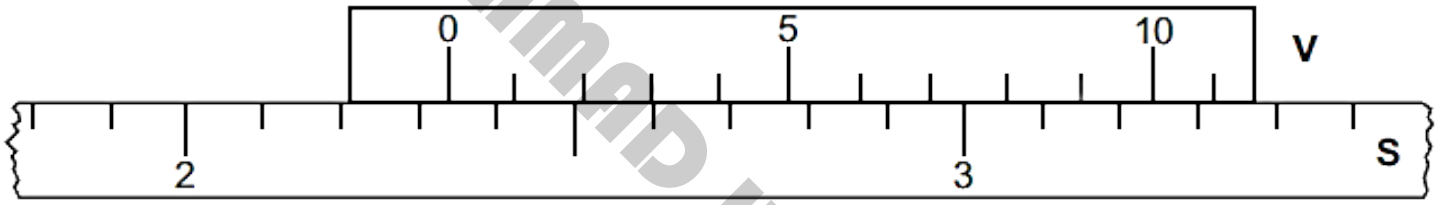
1. *Which measuring device should be used to measure the length accurately?*

   A. *metre rule*
   B. *micrometer*
   C. *tape measure*
   D. *vernier calipers*

MUHAMMAD HUSSIAN

3. *The diagram shows a vernier V placed against a scale S.*

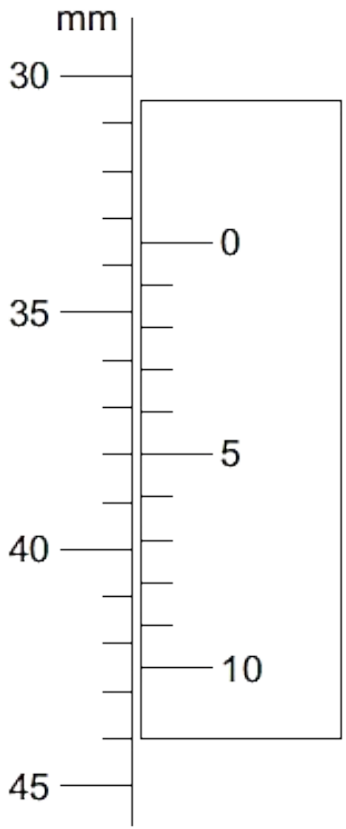


1. *What is the vernier reading?*

A. 2.23
B. 2.26
C. 2.33
D. 2.36

HAMMAD HUSSIAN

4. *The diagram shows part of a vernier scale.*



What is the correct reading?

A. *30.5 mm*

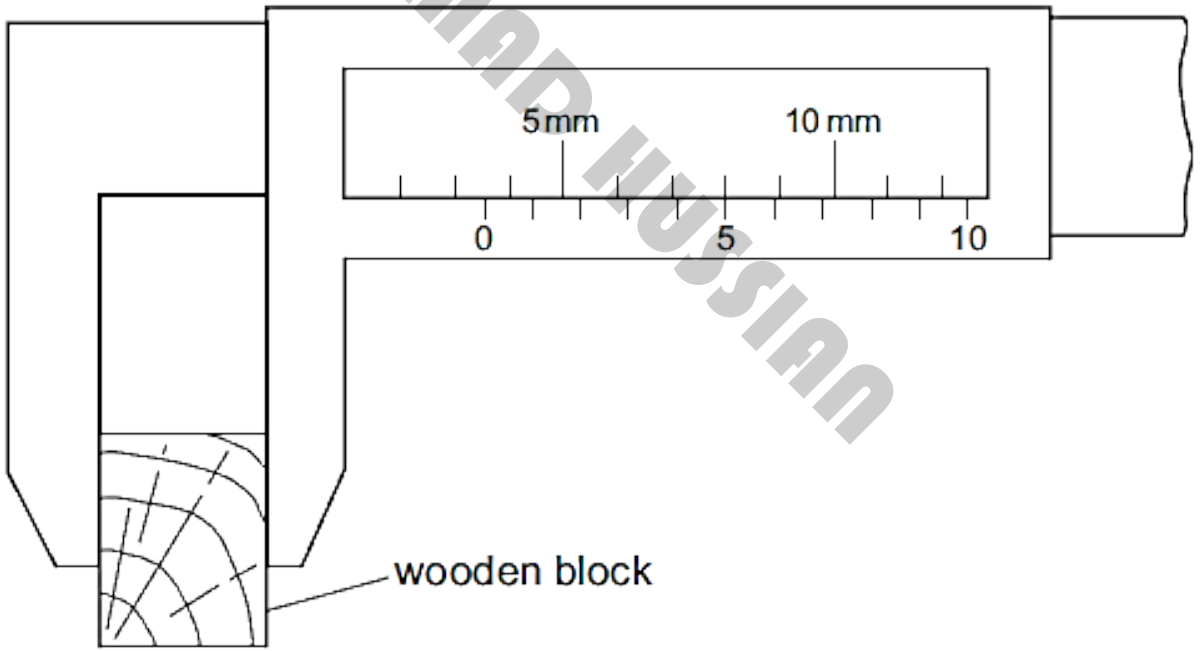
B. *33.5 mm*

C. *38.0 mm*

D. *42.5 mm*

HAMMADRUSLAN

5. *The width of a wooden block is measured using vernier calipers.*



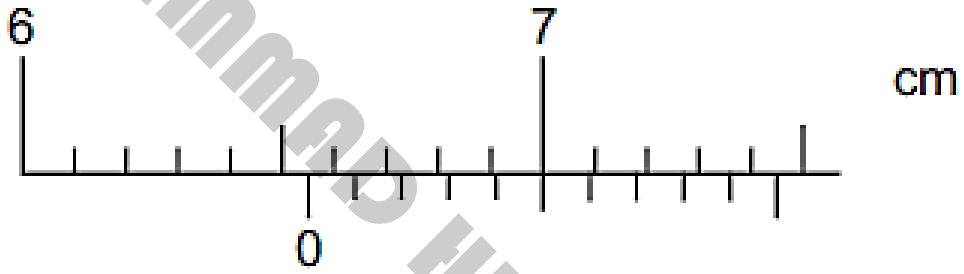
HAMMAD HUSSAIN

1. *What is the width of the block?*

   A. *3.5 mm*
   B. *5.3 mm*
   C. *8.0 mm*
   D. *8.5 mm*

MUHAMMAD HUSSIAN

6. *The diagram shows a vernier scale.*



1. *What is the reading on the vernier scale?*
   - A. *6.50 cm*
   - B. *6.55 cm*
   - C. *7.00 cm*
   - D. *7.05 cm*

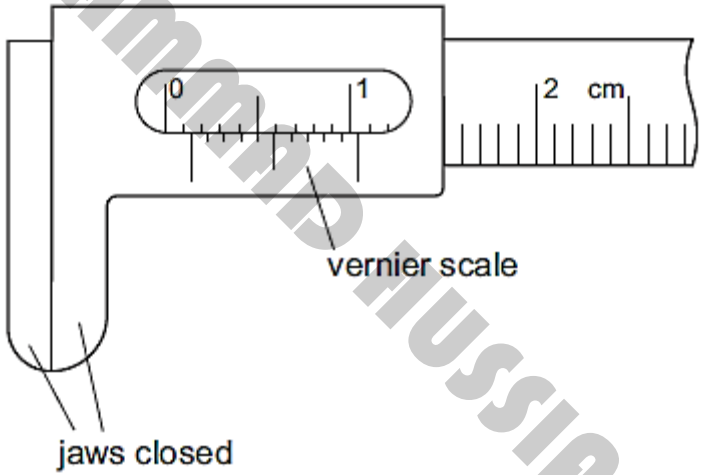
HAMMAD HUSSAIN

7. *Vernier calipers read to one tenth of a millimetre.*
8. *Which reading shows this precision?*

   A. *3.3 cm*
   B. *3.31 cm*
   C. *3.310 cm*
   D. *3.312 cm*

MUHAMMAD HUSSIAN

8. *Vernier calipers are shown with the jaws closed.*



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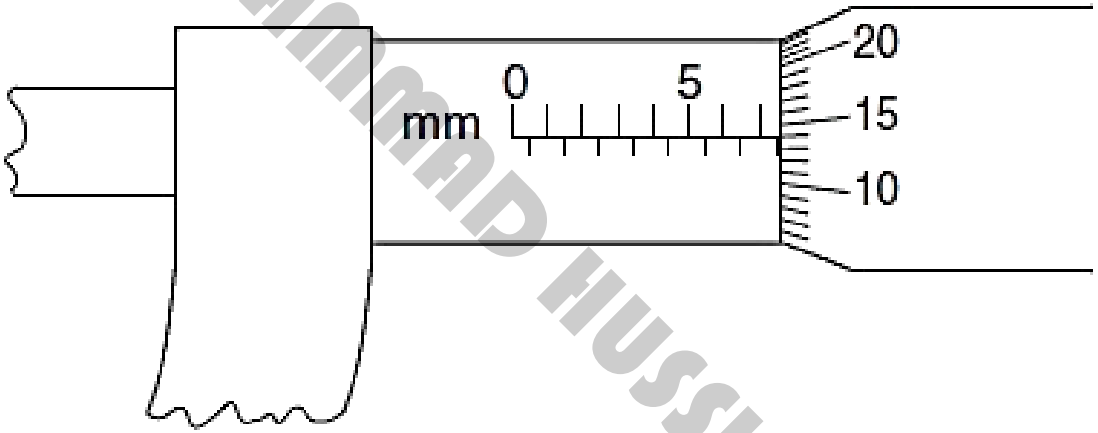
1. *What is the zero error?*

   A. *0.04 cm*
   B. *0.05 cm*
   C. *0.14 cm*
   D. *0.15 cm*

MUHAMMAD HUSSIAN

9. *The diagram shows a micrometer scale.*

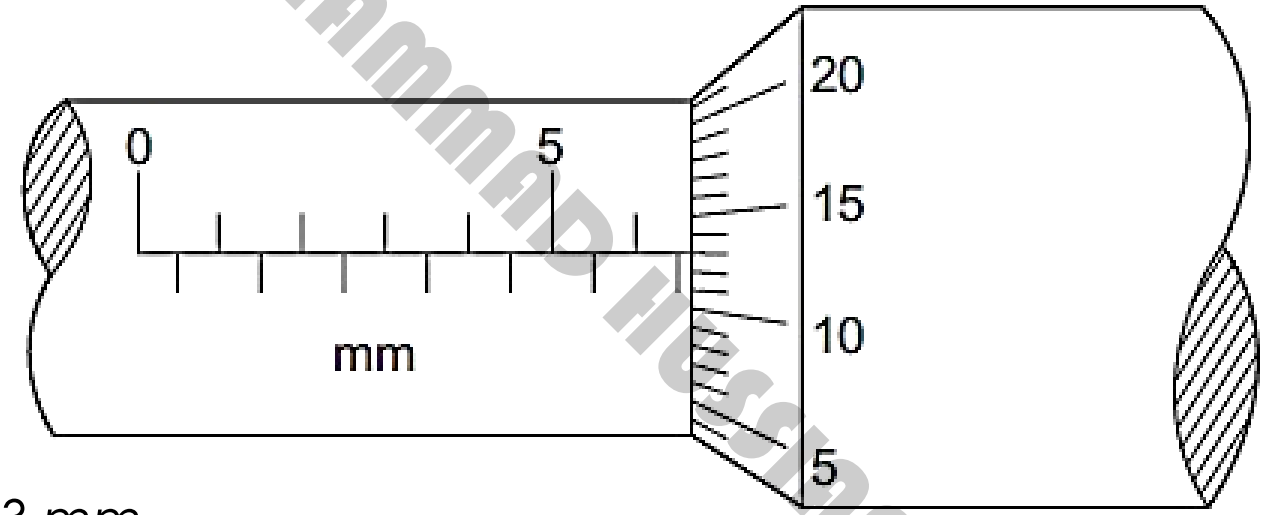


1. *Which reading is shown?*

A. *5.64 mm*
B. *7.14 mm*
C. *7.16 mm*
D. *7.64 mm*

HAMMAD HUSSIAN

10. *What is the reading on this micrometer?*



A. *5.43 mm*
B. *6.63 mm*
C. *7.30 mm*
D. *8.13 mm*

HAMMAD HASSAN

11. *Which instrument is used to measure the internal diameter of a pipe with a single measurement?*

A. *manometer*
B. *measuring cylinder*
C. *micrometer*
D. *vernier calipers*

MUHAMMAD HUSSIAN

12. *A student has been asked to determine, as accurately as possible, the volume of a piece of wire.*
13. *The wire is about 80 cm long and about 0.2 cm in diameter.*

HAMMAD HUSSIAN

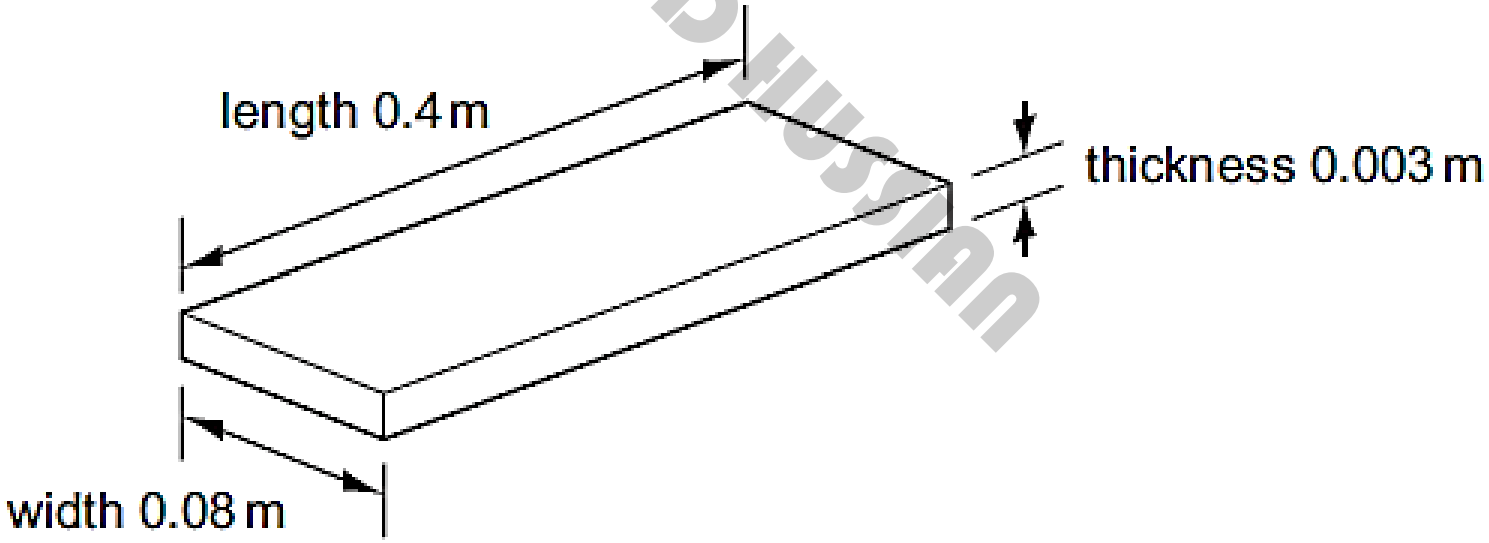
1. *Which measuring instruments should the student use?*

	length	diameter
A	metre rule	micrometer
B	metre rule	vernier callipers
C	micrometer	vernier callipers
D	vernier callipers	micrometer

A

AMMAP Fusion

13. *A manufacturer needs to measure accurately the dimensions of a wooden floor tile.*
14. *The approximate dimensions of the tile are shown.*



HOMEWORK

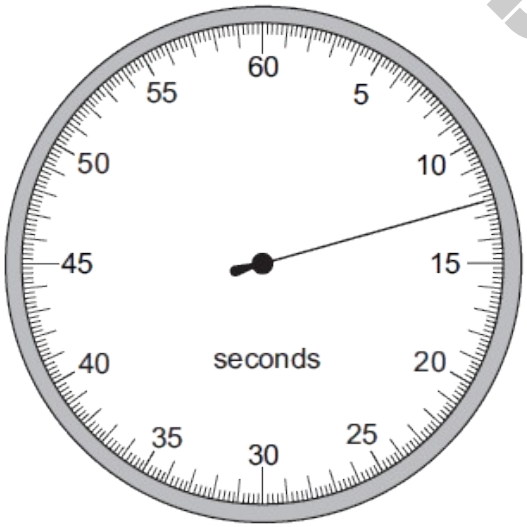
1. *Which instruments measure each of these dimensions accurately?*

	length	thickness	width
A	metre rule	micrometer	vernier calipers
B	metre rule	vernier calipers	micrometer
C	micrometer	metre rule	vernier calipers
D	vernier calipers	micrometer	metre rule

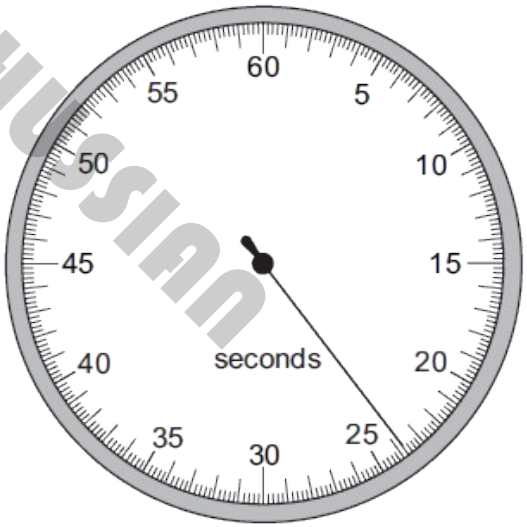
A

HAMMAD HUSSAIN

14. *A stopwatch is used to time an athlete running 100 m. The timekeeper forgets to reset the watch to zero before using it to time another athlete running 100 m.*



stopwatch at end of first athlete's run



stopwatch at end of second athlete's run

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1. *How long does the second athlete take to run 100 m?*

   A. *11.2 s*
   B. *11.4 s*
   C. *12.4 s*
   D. *23.8 s*

HAMMAD HUSSIAN

15. *Two digital stopwatches X and Y, which record in minutes and seconds, are used to time a race.*
16. *The readings of the two stopwatches, at the start and at the end of the race, are shown.*

Hanafi Hussin

1. *Which statement about the time of the race is correct?*

   A. *Both stopwatches record the same time interval.*
   B. *Stopwatch X recorded 10 s longer than stopwatch Y.*
   C. *Stopwatch Y recorded 10 s longer than stopwatch X.*
   D. *Stopwatch Y recorded 50 s longer than stopwatch X.*

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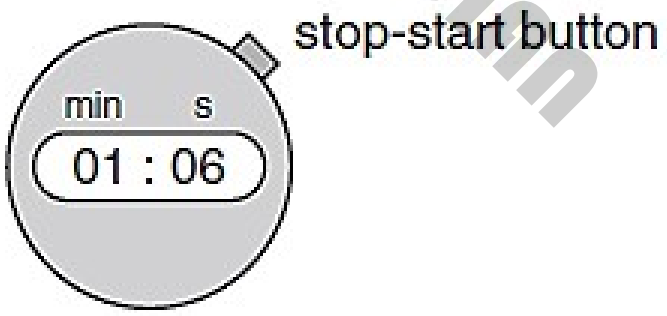
16. *The diagram shows a stopwatch, originally set at 00:00.*
17. *When a car was first seen, the stop-start button was pressed. When the car passed the observer, the stopwatch showed 01:06.*



HAMIDRIUSSIM

1. *How long did the car take to reach the observer?*
   A. *1.06 seconds*
   B. *6 seconds*
   C. *66 seconds*
   D. *106 seconds*

MUHAMMAD HUSSIAN

17. *A student uses a stopwatch to time a runner running around a circular track. The runner runs two laps (twice around the track). The diagrams show the reading on the stopwatch when the runner starts running, at the end of the first lap, and at the end of the second lap.*

reading when runner starts

reading at end of first lap

reading at end of second lap

MOHAMAD HUSSIAN

1. *What is the time taken for the runner to run the second lap?*

   A. *0 min 50 s*
   B. *1 min 10 s*
   C. *1 min 13 s*
   D. *2 min 03 s*

MUHAMMAD HUSSIAN

18. *Four athletes run twice around a track. The table shows their times at the end of each lap.*

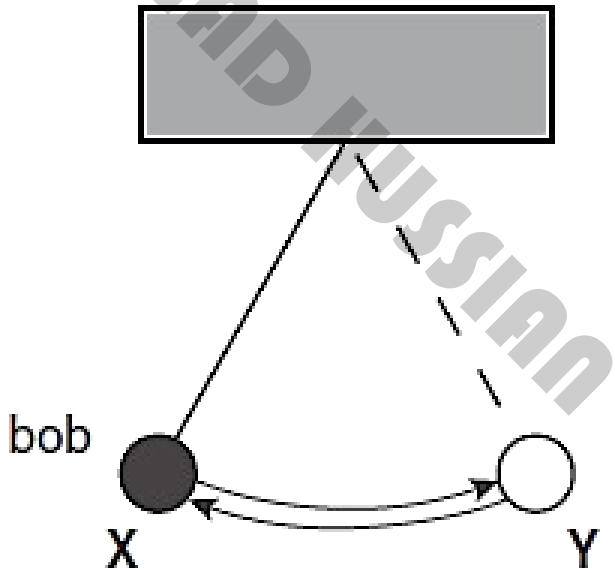
19. *Which athlete runs the second lap the fastest?*

athlete	time at end of first lap / s	time at end of second lap / s
A	22.99	47.04
B	23.04	47.00
C	23.16	47.18
D	23.39	47.24

D

HAMIMAPHYSICS

19. *One oscillation of a swinging pendulum occurs when the bob moves from* **X** *to* **Y** *and back to* **X** *again.*



MUHAMMAD HUSSIAN

1. *Using a stopwatch, which would be the most accurate way to measure the time for one oscillation of the pendulum?*

   A. *Time 20 oscillations and multiply by 20.*
   B. *Time 20 oscillations and divide by 20.*
   C. *Time one oscillation.*
   D. *Time the motion from **X** to **Y**, and double it.*

HAMMAD HUSSAIN

20. *A pendulum is set in motion and 20 complete swings are timed. The time measured is 30 s.*

21. *What is the time for one complete swing of the pendulum?*

A. *0.67 s*

B. *0.75 s*

C. *1.5 s*

D. *3.0 s*

HAMAD HUSSIAN

HAMMAD HUSNAIN

UNITS AND SYMBOLS

RECOGNISE AND USE THE CONVENTIONS AND SYMBOLS CONTAINED IN 'SIGN, SYMBOLS AND SYSTEMATICS', ASSOCIATION OF SCIENCE EDUCATION, 2000.

QUANTITES, SYMBOL UNIT

HAFIZAD HUSSIAN

Quantity	Symbol	Unit
length	l	*km, m, cm, mm*
mass	m	*kg, g, mg*
time	t	*h, min, s, ms*
temperature	θ, T	°C
current	I	*A, mA*

QUANTITES, SYMBOL UNIT

Quantity	Symbol	Unit
volume	V	m^3, cm^3
density	ρ	g/cm^3, kg/m^3
speed	u, v	km/h, m/s, cm/s
work done	W, E	J, kWh
pressure	p, P	Pa, N/m^2
current	I	mA, A
resistance	R	Ω

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SOME PREFIXES OF SI UNITS

HAMMAD HUSSAIN

Prefix	Abbreviation	Power	Examples
micro	μ	10^{-6}	μm, μs
milli	*m*	10^{-3}	*mm, mg*
centi	*c*	10^{-2}	*cm*
kilo	*k*	10^{3}	*km, kg*
mega	*M*	10^{6}	*MW, MB*