APPENDICES

Appendix 1 List of Experts for Validation of Tools

- Dr. Mandira Sikdar, Dean – Student Affairs, Navrachana University.
- Dr. Pallavi Ghalsasi, Associate Professor, Navrachana University.
- Ms. Marry Chacko, Head Of Department-Science NISV, International Examiner for Physics, IBDP.
- Mr. Apurva Christian, Head Of Department-Electrical Department, Butler Polytechnic, Vadodara.
- Mr. Krunal Patel, Head Of Department- Mechanical Department, Butler Polytechnic, Vadodara.
- Mrs. Seema Rathod, Head Of Department- Civil Department, Butler Polytechnic, Vadodara.
- Ms. Sharon Patel, English Faculty, General Department, Butler Polytechnic, Vadodara.

Appendix 2 A Post-tests

Post-test 1:Teacher made Achievement Test: Unit Test I: SI System and Measurement

Name **20 Marks**
Date **45 min**
Branch

Section A

Q1) Answer the following questions (Any 5) **(10 Marks)**

1) Define a Unit. Write its characteristics.
2) Write the uses of a Vernier Calliper.
3) Define Meter in SI Unit.
4) Define pitch of a micro meter screw guage.
5) Differentiate between Fundamental and Derived Quantities.
6) Define Least Count of the Micro meter Screw Guage and write its formula.

Section B

Q2) Draw a neat and labeled diagram of Vernier Calliper and explain its construction. **(7 Marks)**

OR

Draw a neat and labeled diagram of Micrometer Screw Guage and explain its construction.

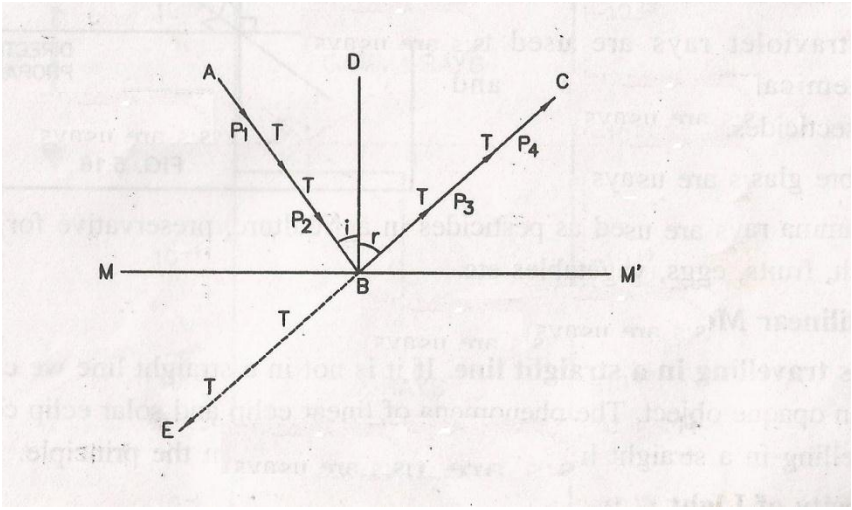
Q3) Differentiate between Accuracy and Precision **(3 Marks)**

Post test 2:Teacher made Achievement Test: Unit Test II: Light

Name **20 Marks**
Date **45 min**
Branch

Section A

Q1) Identify the following in the figure given below: (3Marks)



a) Incident ray
b) Reflected ray
c) Normal
d) Medium
e) Reflected Angle
f) Incident Angle

Q2) Define Refraction of light. State its Laws and its applications. **(4 Marks)**

OR

Q2) Define and write the applications of Diffraction of light with suitable diagram.

Q3) Explain resonance with its applications and suitable diagram **(7 Marks)**

Q4) Explain Interference of light with suitable diagram. Explain its types and write its applications. **(6 Marks)**

Post test 3:Teacher made Achievement Test: Unit Test III: Waves

Name **20 Marks**
Date **45 min**
Branch

Section A

Q1) Answer the following questions (Any 5) **(10 Marks)**

1) Define a wave and write its types.

2) What are mechanical waves. Explain with suitable examples.

3) What is the relation between wave velocity, period and wavelength.

4) Define wavelength and write its unit.

5) Define Frequency of a wave and write its unit.

6) Explain with example amplitude of a wave.

Section B

Q2) Differentiate between Longitudinal and Transverse Waves with suitable diagram and write its applications. **(4 Marks)**

Q3) Explain Supervision of waves with examples. **(6 Marks)**

Post test 4: Comprehensive Achievement Test: Unit Test I, II and III:

Name **30 Marks**
Date **75 min**
Branch

Section A

Q1) Answer the following Questions: (Any 5): (10 Marks)

1) Define Accuracy and Precision.
2) Define in SI Unit: Meter, Ampere.
3) Explain reflection of light with diagram
4) Explain dispersion of light.
5) Define amplitude and periodic time of a wave.
6) Write properties of light.

Section B

Q2) Derive the relation between wavelength, velocity and frequency of a wave. **(4 Marks)**

OR

Q2) Explain Resonance with suitable examples.

Q3) Explain construction and Least Count of Micrometer Screw Gauge with appropriate labeled diagram and explain errors in it. **(7 Marks)**

Q4) Explain the phenomenon of resonance and write its applications. **(5 Marks)**

Q5) Explain Superposition of Waves and write its applications. **(4 Marks)**

Post test 5: Delayed comprehensive post-test

Name **30 Marks**

Date **75 min**

Branch

Section A

Q1) Answer the following Questions: (Any 5): (10 Marks)

1) Define Fundamental Quantities and give any two examples.
2) Define in SI Unit: Kelvin, Meter.
3) Explain refraction of light with diagram
4) Explain diffraction of light.
5) Define wavelength and frequency of a wave.
6) Define pitch of a micrometer screw gauge..

Section B

Q2) Define Interference of light and explain its types with its applications. **(4 Marks)**

OR

Q2) Explain Superposition with suitable examples.

Q3) Explain construction and Least Count of Vernier Calliper with appropriate labeled diagram and explain errors in it. **(7 Marks)**

Q4) Explain polarization of light with its types. **(5 Marks)**

Q5) Differentiate with suitable examples and diagram Longitudinal and Transverse Waves. **(4 Marks)**

Appendix 3B Scoring Key for Post-tests

Post-test 1: Unit I: SI System and Measurement

Section A

Q1) Answer the following questions. (any 5) (10 Marks)

Ans 1) A unit is a value, quantity or magnitude in terms of which other values, quantities or magnitudes are expressed. Generally a unit is independent of physical and environmental conditions and is fixed by definition.

A unit should be such that: (i) It must be possible to define it unambiguous, (ii) It should be easy to reproduce and (iii) It must be invariable with time and place. It should be possible to multiply or divide each one of the standard.

Ans 2) Uses of Vernier Calliper: Vernier Calliper is a measuring device of least count 0.01 cm.

- It is used to measure the thickness of metallic sheets
- outer diameter of the spheres
- depth of the graduated cylinder.

Ans 3) Meter: It is defined in terms of the standard wavelength of light and is equal to 1650763.73 wavelengths in vacumm of radiation corresponding to transition between the energy levels 2p10 and 5d5 of krypton 86 atom.

Ans 4) Pitch: Distance between two consecutive threads of a screw is called pitch of a micro meter screw guage.

Ans 5) Fundamental Quantities: The quantities which do not need any other quantitites to describe themselves are called fundamental quantities. Eg. Meter, kilo gramDerived Quantities: Quantities which depend on fundamental quantities for their description are called derived quantities. Eg. Area, Volume

Ans 6) Least Count of a micrometer screw guage = $=\frac{PitchDistance}{No.of Divisionsoncircularscale}$

$=\frac{1\ mm}{100}$ $=\frac{0.1}{100}$= 0.01 cm

Section B

Ans 2)Construction: Vernier Calliper is a mechanical device which combines a main scale and a Vernier scale invented by Paul Vernier.

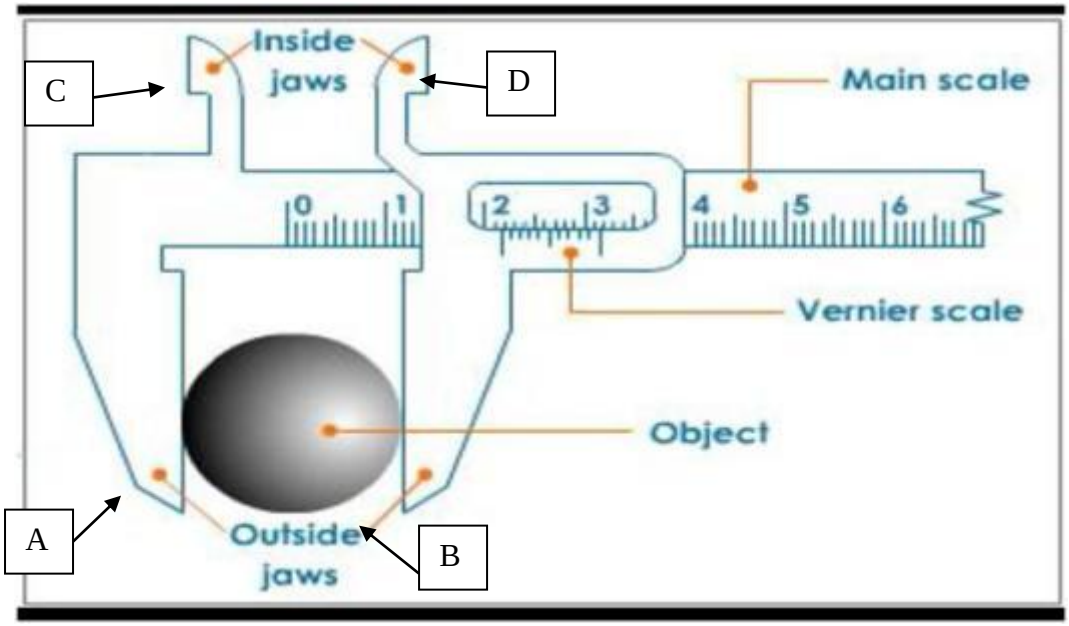


Figure 4.1: Vernier and its parts

Principle of Vernier:

(n-1) MSD = n divisions on VSD

MSD - Main Scale Division

VSD - Vernier Scale Division

Hence,

Least count of Vernier Calliper = Smallest division on main scale / Total number of divisions on Vernier scale.

LC = s/n = 0.1/10 = 0.01 cm

Vernier Calliper consists of a rectangular steel frame with a linear scale along its arm which is called main scale and a sliding attachment with a suitable scale Vernier scale.

A button p with a spring action helps in fixing the Vernier at any desired position on the main scale.

J1 and **J2** are called external jaws

J1 is fixed and **J2** is movable jaw.

J3 and **J4** are called internal jaws.

J3 is fixed jaw and **J4** is a movable jaw.

S1 is the long thin metal strip fixed to the Vernier scale.

If jaws ***b*** and ***c*** are in contact with ***d*** and ***a*** respectively and if zero of main scale coincides with zero of Vernier scale, the Vernier does not have any error i.e. zero error.

Ans 2) **Micrometer Screw Guage**

Figure :Micrometer

Construction of Micrometer screw guage

There are two main parts of the MS gauge.

1. Semicircular steel plate (frame) whose both ends are in the form of a hollow cylinder.

A hollow tube N is attached to the right side of the hollow cylinder a straight line XY, called a base line is drawn.

A scale in mm is marked on this line. It is called Main Scale.

Screw S1, who's left end B is flat and its right end is fixed with the hollow tube. The circular edge of the hollow tube is divided into 50 or 100 equal parts. This is called circular scale.

L.C. of micrometer screw $= \frac{Pitch Distance}{No. of Divisions on circular scale}$

$= \frac{1\ mm}{100}$ $= \frac{0.1}{100}$ =0.001 cm

Zero Error: When there is no gap between (A and B) anvil and screw end, the zero of circular scale should coincide with the base line XY. If this is not the case the micrometer possesses error.

Ans 3) Accuracy: It is defined as closeness of a measurement of the accepted value for a specific physical quantity. It is expressed in terms of error.

Precision: The agreement between the numerical values of two or more measurements made in the same way and expressed in terms of deviation.

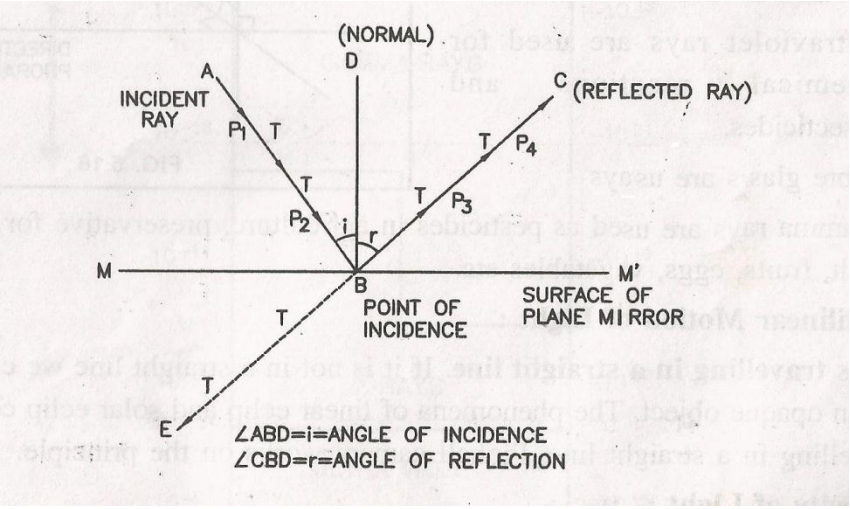
Precision depends on resolution and limit of the observation taken by the instrument.

It depends on least count of the instrument.

Example: Micrometer screw guage is more precise as compared to Vernier Calliper as the least count of micrometer screw guage is 0.001 cm and of Vernier Calliper it is 0,01 cm.

Scoring Key: Post-test 2:Unit II: LIGHT

Ans1)



Ans 2) Refraction: When a ray of light is travelling from one medium to another medium, it changes its direction of travelling at the contact surface of the two medium. This phenomenon is called refraction.

Laws of Refraction:

1) Incident ray, normal and refracted ray are in the same plane.

2) Incident ray and refracted ray are in different media.

3) Ratio of sine of angle of incidence to the sine of angle of refraction is constant for the given two media.

Applications: Diamond, in cars in remote sensors, mirage, Rainbow, blue colour of sky, Lasers.

OR

Ans 2) Dispersion of light: When a ray of light is passing through the prism it spilts up into its constituent colors. This is dispersion of light.

ABC is a prism. White beam of light incidents on PQ surface. It moves at QR. When it comes out of prism it comes as RS and split into seven colours called spectrum.

Ans 3) Resonance: When a body is subjected to a periodic force whose frequency coincides with natural frequency of the body, the body begins to vibrate with very large amplitude. This phenomenon is called resonance. The resonance takes place when the frequency of the forced oscillations, is equal to the frequency of the free oscillations. i.e. natural frequency of the body.

It is used to strengthening some selected frequencies in musical instruments such as sitar. In medical science in NMR i.e. Nuclear Magnetic Resonance., Spin Magnetic Resonance SMR. The resonance is avoided in various parts of machine, loud speakers, microphones.

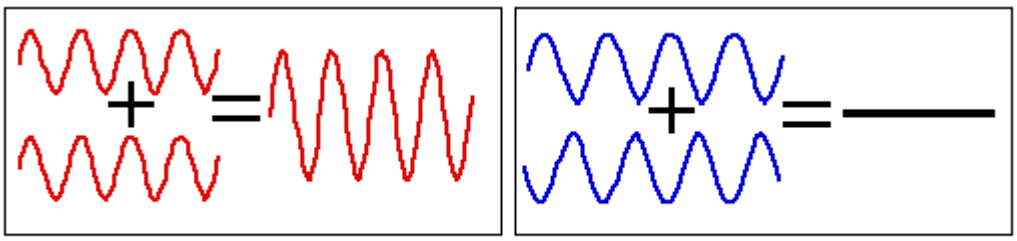
Ans 4) Interference of light: The phenomenon of interference is produced when two waves of monochromatic light is incident on a point.

As a result, amplitude is produced which is different from the original amplitude.

There are two types of interference:

1) Constructive interference

2) Destructive interference.



Scoring Key: post-test: 3: SOUND

Section A

Ans 1) Wave is a disturbance propogating in a medium in which medium particles are in simple harmonic motion.

There are two types of waves: Longituinal Waves and Transverse Waves.

Ans 2) Mechanical Waves: The waves which need elastic medium to propagate are called mechanical waves. The medium particles take part in propagation of wave. E.g. waves in a string, Sound waves in air, Sound waves in glass or water.

Ans 3) Speed of a wave= Wavelength/ Period

Ans 4) Wavelength: The distance between two consecutive particles in the same phase is called wavelength. Its unit is Angstrom. 1 A0 = 10-10 meter

Ans 5) Frequency of a wave: It is the number of vibrations performed by the particle in one second. Unit of frequency is hertz.

Ans 6) Amplitude of wave: The maximum displacement of the particle from the mean position is called amplitude.

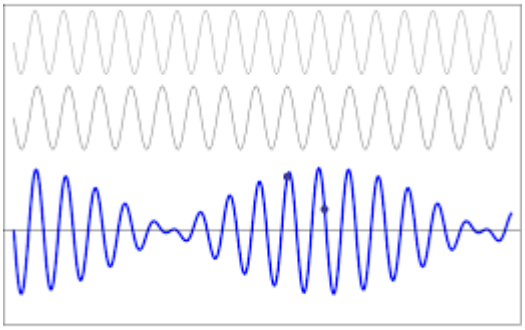
Section B

Ans 2) Transverse waves: The particles of the medium vibrate in the direction perpendicular to the direction of propogation of wave. The waves travel in the forms of crest and troughs. They requires elasticity of shape for its maintenance. The waves are possible in solid media only. The medium undergoes deformation of shape. There is no change in the density and pressure of the medium. These waves can be polarized. E.g. light waves, water waves, when a stone is dropped in water, waves in rope.

Longitudinal waves: The particles of the medium vibrate in the direction parallel to the direction of propagation of wave. The waves travel in the forms of compression and rarefactions. They requires elasticity of volume for its maintenance. The waves are possible in liquids and gases. The medium undergoes deformation of volume.

There is a change in the density and pressure of the medium. These waves cannot be polarized. E.g. sound waves.

Ans 3) Superposition of waves: When a particle of medium comes under the influence of two or more waves simultaneously, its net displacement is the vector sum of displacement that would occur under the influence of the individual waves.



Scoring Key 4: Post-test 4: Comprehensive test Unit I,II and III

Section A

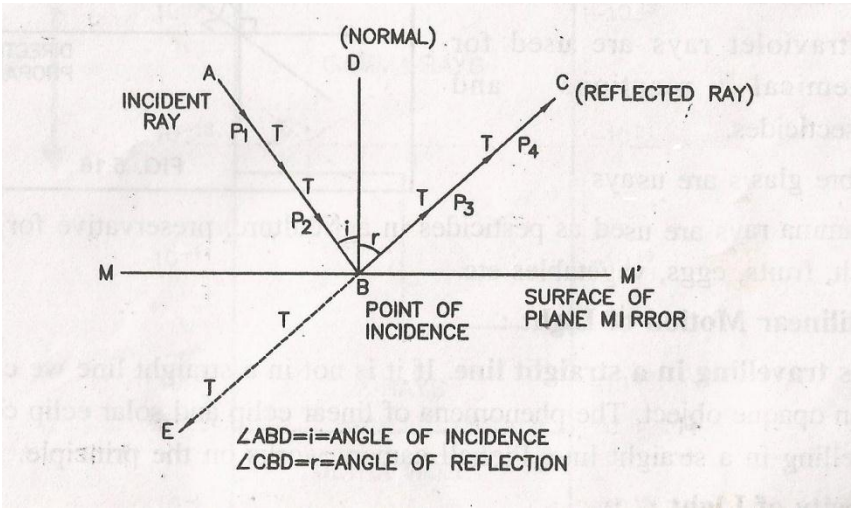
Ans 1) Accuracy: It is defined as closeness of a measurement of the accepted value for a specific physical quantity. It is expressed in terms of error.

Precision: The agreement between the numerical values of two or more measurements made in the same way and expressed in terms of deviation.

Ans 2) Meter: It is defined in terms of the standard wavelength of light and is equal to 1650763.73 wavelengths in vacumm of radiation corresponding to transition between the energy levels 2p10 and 5d5 of krypton 86 atom.

Ampere: it is defined as the current which when flowing through two parallel conductors of infinitely long and negligible cross section area placed in vacuum one meter apart, conductor experiences a force of 2.0 X 10-7 newton per meter.

Ans 4) Reflection of light: Whenever light travels in a transparent medium and meets the surface of another polished opaque medium, the light is reflected back in the same medium. This phenomenon of light is known as reflection.



Ans 4)Dispersion of light: When a ray of light is passing through the prism it spilts up into its constituent colors. This is dispersion of light.

Ans 5) Amplitude: The maximum displacement of the particle from the mean position is called amplitude.

Periodic time: Time taken for one comlete oscillation is called periodic time. T=1/f, where f=frequency.

Ans 6) Properties of light: Light always travels in a straight line.

The velocity of light waves is 3X108 meter/second.

Light shows reflection, refraction, dispersion, polarization, diffraction.

Section B

Ans 2) Relation between velocity, wavelength and frequency:

The wave advances through a distance equal to wavelength in a periodic time of oscillation. Thye distance through which the wave advances in one second is called wave velocity.

Wave velocity= Distance travelled/ time

$V= \lambda/T$

$V= \lambda(1/T) = \lambda.n$, where $n=1/T$ is the frequency of the wave. Thus $v= \lambda.n$

Ans 2) Resonance: When a body is subjected to a periodic force whose frequency coincides with natural frequency of the body, the body begins to vibrate with very large amplitude. This phenomenon is called resonance. The resonance takes place when the frequency of the forced oscillations, is equal to the frequency of the free oscillations. i.e. natural frequency of the body.

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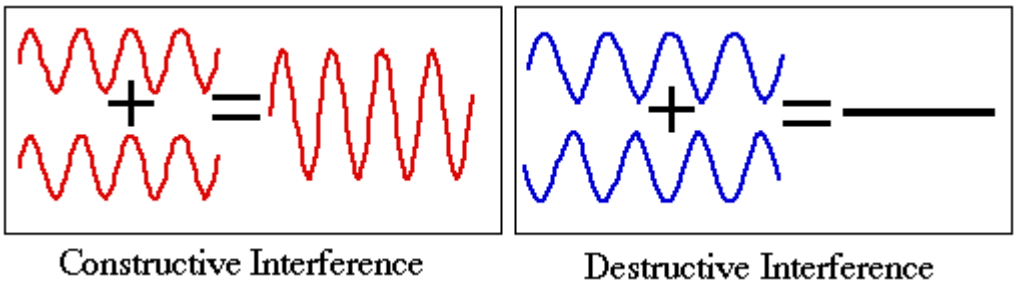


OR

Ans 2) **Construction:** Vernier Calliper is a mechanical device which combines a main scale and a Vernier scale invented by Paul Vernier.

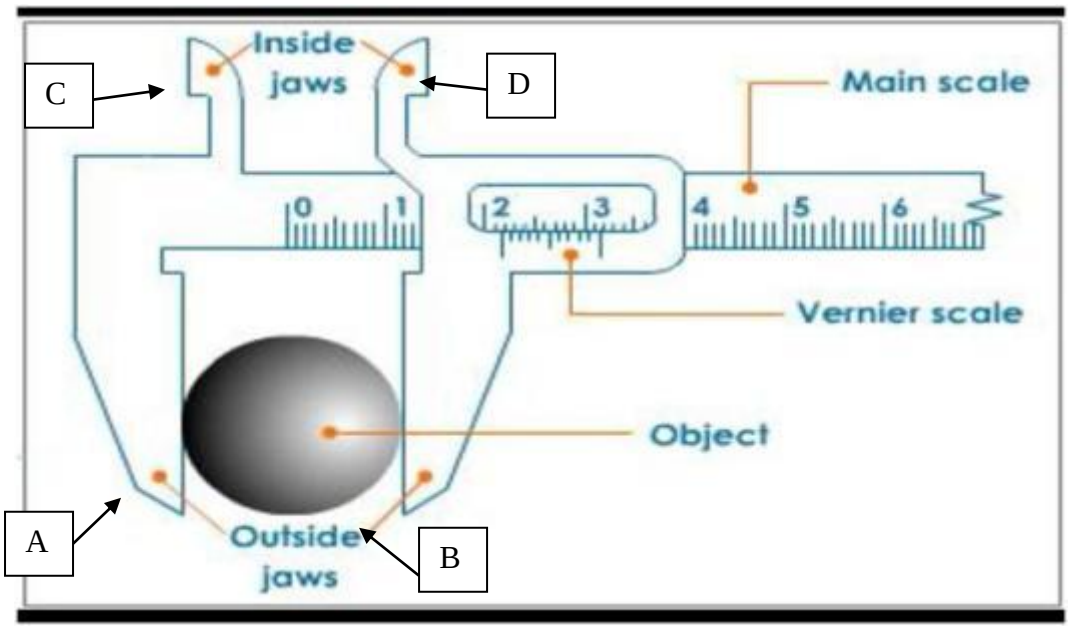


Figure 4.1: Vernier and its parts

Principle of Vernier:

(n-1) MSD = n divisions on VSD

MSD - Main Scale Division

VSD - Vernier Scale Division

Hence,

Least count of Vernier Calliper = Smallest division on main scale / Total number of divisions on Vernier scale.

LC = s/n = 0.1/10 = 0.01 cm

Vernier Calliper consists of a rectangular steel frame with a linear scale along its arm which is called main scale and a sliding attachment with a suitable scale Vernier scale.

A button p with a spring action helps in fixing the Vernier at any desired position on the main scale.

J1 and **J2** are called external jaws

J1 is fixed and **J2** is movable jaw.

J3 and **J4** are called internal jaws.

J3 is fixed jaw and **J4** is a movable jaw.

S1 is the long thin metal strip fixed to the Vernier scale.

If jaws ***b*** and ***c*** are in contact with ***d*** and ***a*** respectively and if zero of main scale coincides with zero of Vernier scale, the Vernier does not have any error i.e. zero error.

Figure 4.4 Micrometer

There are two main parts of the MS gauge.

1. Semicircular steel plate (frame) whose both ends are in the form of a hollow cylinder.

A hollow tube N is attached to the right side of the hollow cylinder a straight line XY, called a base line is drawn.

A scale in mm is marked on this line. It is called Main Scale.

Screw S1, who's left end B is flat and its right end is fixed with the hollow tube. The circular edge of the hollow tube is divided into 50 or 100 equal parts. This is called circular scale.

L.C. of micrometer screw $= \frac{Pitch Distance}{No. of Divisions on circular scale}$

$= \frac{1\ mm}{100}$ $= \frac{0.1}{100}$ =0.001 cm

Zero Error: When there is no gap between (A and B) anvil and screw end, the zero of circular scale should coincide with the base line XY. If this is not the case the micrometer possesses error.

Positive Error:

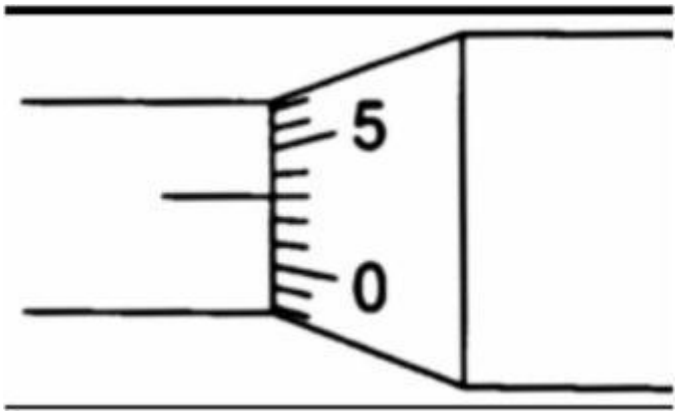


Figure 4.5 Positive Error in Micrometer

The zero is positive error of the circular scale stands below the base line XY.

Positive error = No. of division making XY X L.C.

= 5 X 0.1 mm = 0.05 mm

Correction = 0.05 mm

Negative Error:

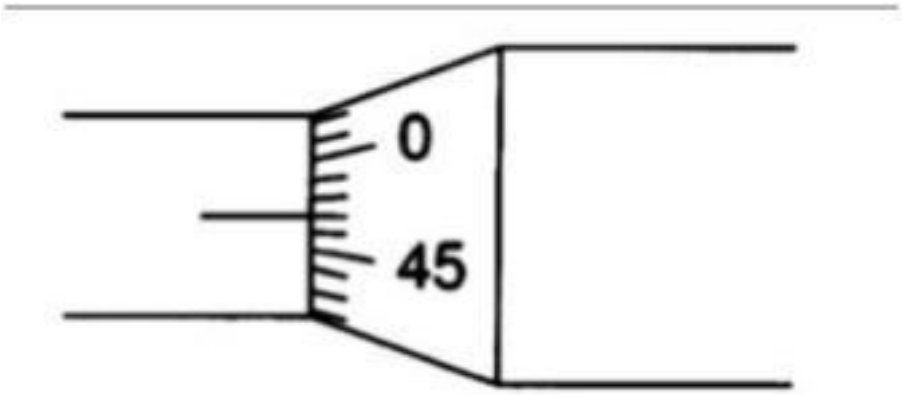


Figure 4.6 Negative Error in Micrometer

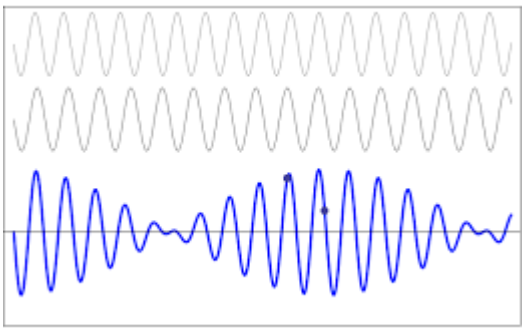
If the zero of the circular scale stands above the base line, the error is negative.

Negative error = No. of division matching XY X L.C.

= 47 X 0.01 mm = 0.047 mm

Correction = 0.047 mm

Ans 5) Superposition of waves: When a particle of medium comes under the influence of two or more waves simultaneously, its net displacement is the vector sum of displacement that would occur under the influence of the individual waves.



Scoring Key 5: Post-test: 5: Delayed comprehensive post-test

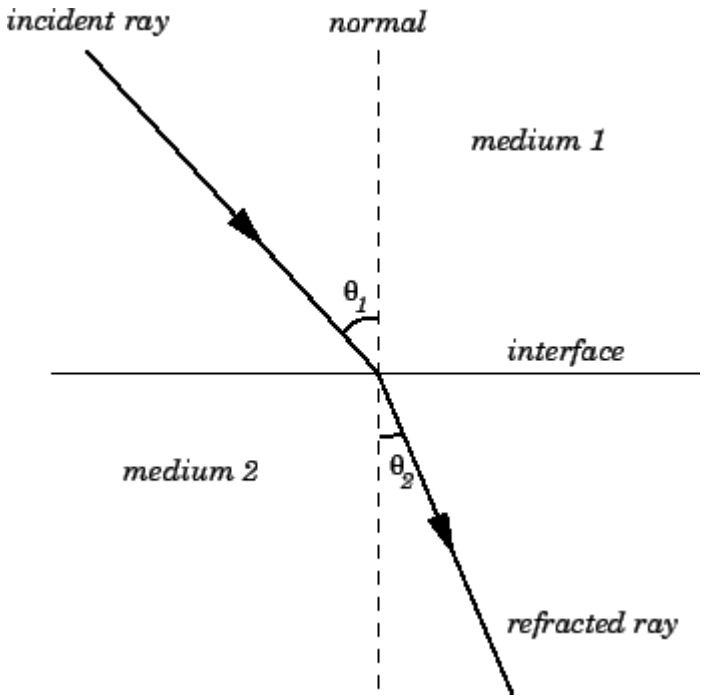
Section A

Ans 1) Fundamental quantities are the quantities which do not require any other quantities for their description. E.g. meter, kilogram, Kelvin

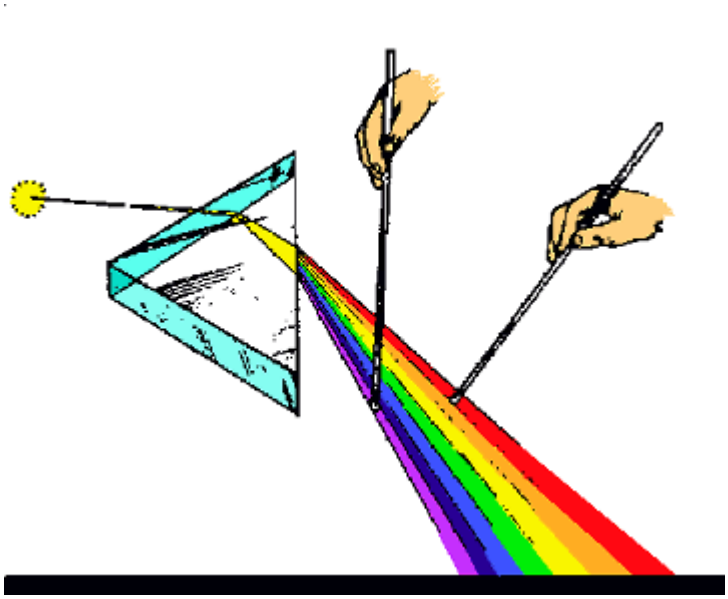
Ans 2) Kelvin: On thermodynamic scale 1/273.16th part of temperature of triple point of water is defined to be 10 K.

Meter: It is defined in terms of the standard wavelength of light and is equal to 1650763.73 wavelengths in vacumm of radiation corresponding to transition between the energy levels 2p10 and 5d5 of krypton 86 atom.

Ans 3) Refraction: When a ray of light is travelling from one medium to another medium, it changes its direction of travelling at the contact surface of the two medium. This phenomenon is called refraction.



Ans4) Dispersion of Light: When a ray of light is passing through the prism it spilts up into its constituent colors. This is dispersion of light.



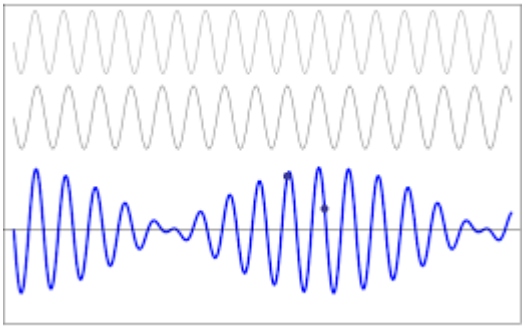
Ans 5) Wavelength: The distance between two consecutive particles in the same phase is called wavelength. Its unit is Angstrom. 1 A0 = 10-10 meter

Frequency of a wave: It is the number of vibrations performed by the particle in one second. Unit of frequency is hertz.

Ans 6) Pitch of a micrometer screw guage is defined as distance between two consecutive threads of a screw. It is 0.01 cm for a micro meter screw guage.

Section B

Ans 2) Superposition of waves: When a particle of medium comes under the influence of two or more waves simultaneously, its net displacement is the vector sum of displacement that would occur under the influence of the individual waves.



Ans 3) Transverse waves: The particles of the medium vibrate in the direction perpendicular to the direction of propogation of wave. The waves travel in the forms of crest and troughs. They requires elasticity of shape for its maintenance. The waves are possible in solid media only. The medium undergoes deformation of shape. There is no change in the density and pressure of the medium. These waves can be polarized. E.g. light waves, water waves, when a stone is dropped in water, waves in rope.

Longitudinal waves: The particles of the medium vibrate in the direction parallel to the direction of propagation of wave. The waves travel in the forms of compression and rarefactions. They requires elasticity of volume for its maintenance. The waves are possible in liquids and gases. The medium undergoes deformation of volume. There is a change in the density and pressure of the medium. These waves cannot be polarized. E.g. sound waves.

Appendix 4

Instructional Design: Section B

HAND OUT FOR STUDENTS

Unit I : SI System and measurement

Hand Out: Instructional Design 1

The **centimeter–gram–second system** (abbreviated **CGS** or **cgs**) is a variant of the *metric system* of *physical units* based on *centimeter* as the unit of *length*, *gram* as a unit of *mass*, and *second* as a unit of *time*. All CGS *mechanical units* are unambiguously derived from these three base units, but there are several different ways of extending the CGS system to cover *electromagnetism*.

The CGS system has been largely supplanted by the *MKS system*, based on *meter*, *kilogram*, and *second*. MKS was in turn extended and replaced by the *International System of Units* (SI). The latter adopts the three base units of MKS, plus the *ampere*, *mole*, *candela* and *Kelvin*. In many fields of science and engineering, SI is the only system of units in use. However, there remain certain subfields where CGS is prevalent.

In measurements of purely mechanical systems (involving units of *length*, *mass*, *force*, *energy*, *pressure*, and so on), the differences between CGS and SI are straightforward and rather trivial; the *unit-conversion factors* are all *powers* of 10 arising from the relations 100 cm = 1 m and 1000 g = 1 kg. For example, the CGS-derived unit of force is the *dyne*, equal to 1 g·cm/s2, while the SI-derived unit of force is the *Newton*, 1 kg·m/s2. Thus it is straightforward to show that 1 dyne = 10−5 Newton's.

Definition of Unit: A unit is a value, quantity or magnitude in terms of which other values, quantities or magnitudes are expressed. Generally a unit is independent of physical and environmental conditions and is fixed by definition.

A unit should be such that: (i) It must be possible to define it unambiguous, (ii) It should be easy to reproduce and (iii) It must be invariable with time and place. It should be possible to multiply or divide each one of the standard.

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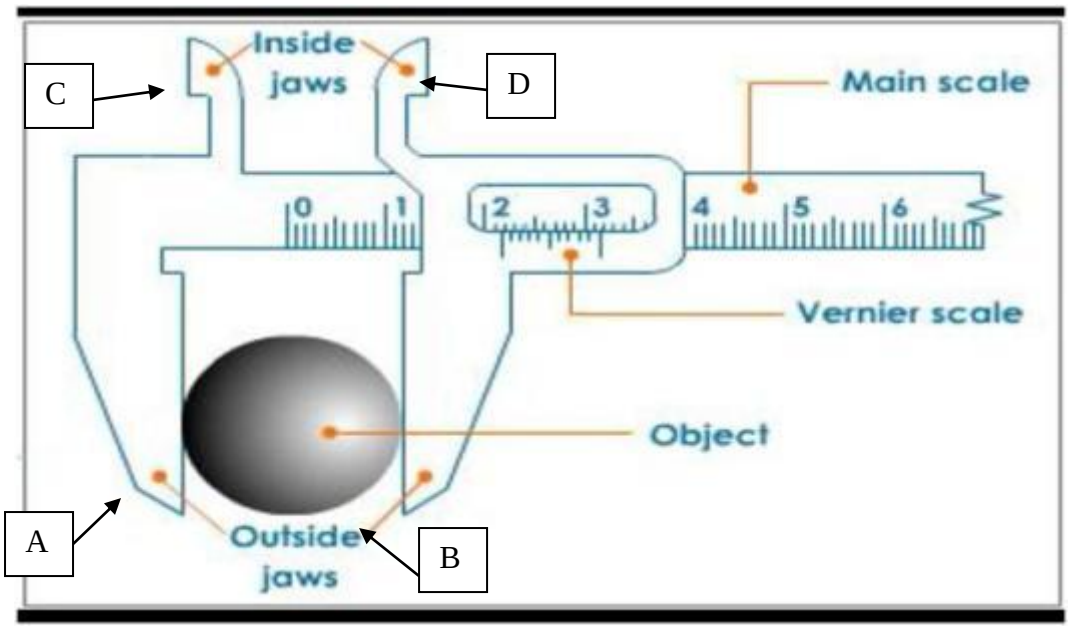

Vernier Calliper and its parts

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Vernier Calliper consists of a rectangular steel frame with a linear scale along its arm which is called main scale and a sliding attachment with a suitable scale Vernier scale.

A button p with a spring action helps in fixing the Vernier at any desired position on the main scale.

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J1 is fixed and **J2** is movable jaw.

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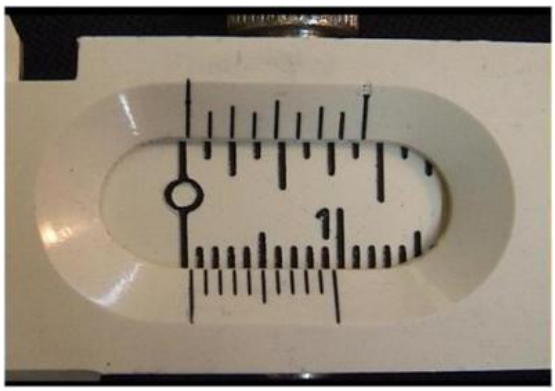
S1 is the long thin metal strip fixed to the Vernier scale.

If jaws ***b*** and ***c*** are in contact with ***d*** and ***a*** respectively and if zero of main scale coincides with zero of Vernier scale, the Vernier does not have any error i.e. zero error.

Positive error (Negative correction):



Vernier Scale and Main Scale

Bring the two jaws ***b*** and ***d*** on contact with each other.

If the zero of the Vernier scale stands to the right of the zero mark of the main scale the error is said to be the positive error.

Now note the division mark of the Vernier scale which is on line with division mark of the main scale.

Suppose it is third division mark. Then,

Positive error =3 X least count =3 X 0.01 =0.03 cm

Correction negative = -0.03 cm

Negative error (Positive Correction)

Vernier Scale Zero Error

If the zero of the Vernier scale stands to the left of the zero mark of the main scale the error is said to be the Negative error.

Positive error = 5 X least count = 5 X 0.01 = 0.05 cm

Correction Positive = 0.05 cm

Students groups will be paired into two each and mutual sharing of constructed knowledge among each other will be done.

Least count of Vernier Calliper = $\frac{smallestdivisiononmainscale}{TotalNo.of\,Divisionson\,vernier\,scale}$

$= \frac{0.1}{10}$ cm

= 0.01 cm

Uses of Vernier Calliper: Thus, Vernier Calliper is a measuring device of least count 0.01 cm.

It is used to measure the thickness of metallic sheets, outer diameter of the spheres and depth of the graduated cylinder. It may have zero error means no error, positive error wherein the correction will be negative and negative error wherein the correction will be positive.

Hand Out: Instructional Design III : Micrometer Screw Guage

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Figure :Micrometer

There are two main parts of the MS gauge.

1. Semicircular steel plate (frame) whose both ends are in the form of a hollow cylinder.

A hollow tube N is attached to the right side of the hollow cylinder a straight line XY, called a base line is drawn.

A scale in mm is marked on this line. It is called Main Scale.

Screw S1, who's left end B is flat and its right end is fixed with the hollow tube. The circular edge of the hollow tube is divided into 50 or 100 equal parts. This is called circular scale.

L.C. of micrometer screw $= \frac{Pitch Distance}{No. of Divisions on circular scale}$

$= \frac{1\ mm}{100}$ $= \frac{0.1}{100}$ =0.001 cm

Zero Error: When there is no gap between (A and B) anvil and screw end, the zero of circular scale should coincide with the base line XY. If this is not the case the micrometer possesses error.

Positive Error:

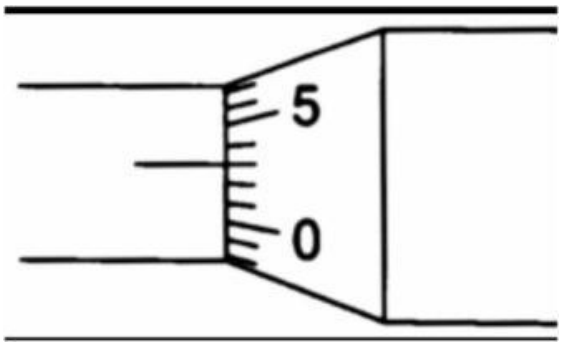


Figure: Positive Error in Micrometer

The zero is positive error of the circular scale stands below the base line XY.

Positive error = No. of division making XY X L.C.

= 5 X 0.1 mm = 0.05 mm

Correction = 0.05 mm

Negative Error:

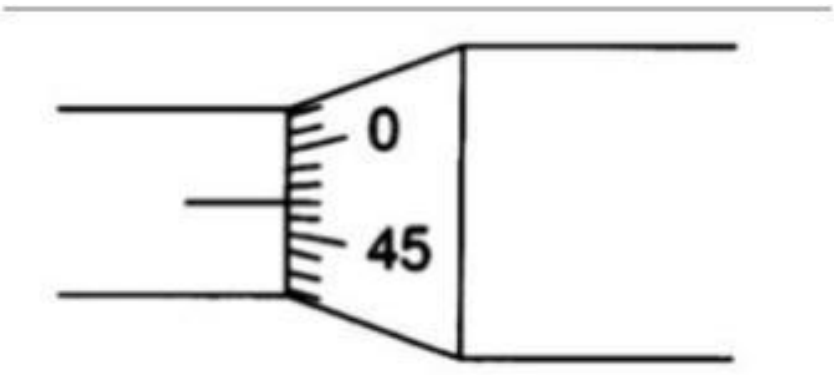


Figure: Negative Error in Micrometer

If the zero of the circular scale stands above the base line, the error is negative.

Negative error = No. of division matching XY X L.C.

= 47 X 0.01 mm = 0.047 mm

Correction = 0.047 mm

Uses of Micro meter Screw Guage

Uses: It is used to measure thousandth part of the cm of 106th part of a meter and hence it is known as Micrometer.

Micrometer screw guage is used to measure very small dimensions.

It has negative error and positive error.

It can be used to measure diameter of steel balls, diameter of a thin wire.

Instructional Design 4: Accuracy and Precision

The difference in the observation of all the times is due to accuracy.

Accuracy

It is defined as closeness of a measurement of the accepted value for a specific physical quantity.

- For data to be as good as possible, they have to be accurate and precise.

Precision

The agreement between the numerical values of two or more measurement made in a similar way and expressed in terms of deviation.

It relates to resolution of device.

Examples:

Like given in digital watches time given is 11:01':12" i.e. 11 hours 1 minute and 12 seconds.

While in Mobile Phones or Wrist watches time shown is 11:01 am i.e. time is expressed only in terms of hours and minute.

- Thus accuracy is the closeness of a measurement of the accepted value for a specific physical quantity.

- It is expressed in terms of error.

- And precision is the agreement between the numerical values of two or more measurements made in the same way and expressed in terms of deviation.

Unit 2: Waves

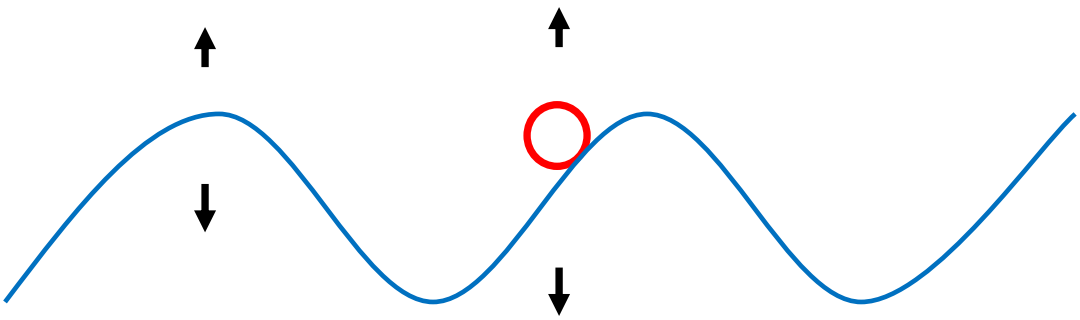
Waves Parameters

A wave that is transverse wave is created.

With a transverse wave, if the particle (your hand) moves up and down, the wave will move to the left *AND OR* right of the particle.

The word perpendicular means that if one thing is up and down, the other thing is left and right. "A transparent wave is a wave where the particle moves perpendicular to the medium."

The medium in this case is the rope.



Wave: Crest and Trough

[The beach ball is just like the particle. It vibrates up and down as the waves moves left and right. The ball is moving perpendicular to the wave.]

- A tape represents a particle in the wave.
- Notice that it too was going up and down.
- It was not moving along the wave.

Unit 3: LIGHT

Properties of Light: Reflection and Refraction

Reflection: Whenever light travels in a transparent medium and meets the surface of another polished opaque medium, the light is reflected back in the same medium. This phenomenon of light is known as reflection.

Laws of reflection: Objects can be seen by the light they emit, or, more often, by the light they reflect. Reflected light obeys the law of reflection:

1) The incident ray, normal and reflected ray, all lie in one plane.
2) The angle of incidence (i) is equal to angle of reflection (r). i.e. i = r
3) Incident ray and reflected ray are opposite to normal.
4) A normal incident ray of light retraces its path during reflection.

Figure: Laws of Reflection

Refraction: When we talk about the speed of light, we're usually talking about the speed of light in a vacuum, which is 3.00 x 108 m/s. When light travels through something else, such as glass, diamond, or plastic, it travels at a different speed.

The speed of light in a given material is related to a quantity called the index of refraction, n, which is defined as the ratio of the speed of light in vacuum to the speed of light in the medium:

Index of refraction : n = c / v

When light travels from one medium to another, the speed changes, as does the wavelength. The index of refraction can also be stated in terms of wavelength:

Appendix 5: Semi-structured Interview for students

Students' view on learning following constructivist instructional designs

Sr. No.	Questions	Frequency response in percentage
1	How was the teaching-learning in physics different for the units of SI Measurement, Waves and Light?	
2	How was it different from the teaching other units?	
3	Do you use some skills you acquired during that classes in your present studies?	
4	Do you ask questions to your present faculties at present with respect to the clarity of the concepts?	
5	Do you use your understanding of new knowledge in application of real life examples?	
6	What were the activities you liked most during teaching-learning of the three units?	
7	What new things you tried based on the activities implemented during those sessions?	
8	Were you able to connect the content taught with your prior knowledge with the new learning?	
9	Did you have the chance to work independently?	
10	Did you gain conceptual clarity?	

Appendix 6: Photographs of implementing constructivist sessions.

Appendix 7: Scores of student's posttest

Scores of Post Test - 1

Sr.	Experimental Group	Control Group
1	12	11
2	14	9
3	17	9
4	15	12
5	16	8
6	15	12
7	16	13
8	19	11
9	12	13
10	14	14
11	16	12
12	15	7
13	15	13
14	19	15
15	19	13
16	17	15
17	14	12
18	17	5
19	19	7
20	17	14
21	12	13
22	14	8
23	15	10
24	16	11
25	11	13
26	14	11
27	13	9
28	17	7
29	16	8
30	14	12
Mean	15.33	10.90

Scores of Post Test – 2

Sr	Experimental Group	Control Group
1	15	9
2	16	8
3	14	9
4	13	13
5	15	7
6	16	11
7	17	10
8	14	9
9	17	12
10	18	13
11	14	11
12	15	7
13	16	8
14	14	9
15	12	12
16	15	11
17	16	10
18	18	7
19	15	9
20	14	13
21	12	14
22	11	15
23	10	10
24	14	11
25	11	7
26	14	11
27	13	9
28	17	8
29	16	9
30	15	10
Mean	14.57	10.07

Scores of Post Test – 3

Sr	Experimental Group	Control Group
1	17	10
2	18	12
3	15	12
4	16	11
5	14	15
6	15	11
7	17	12
8	14	13
9	17	12
10	16	10
11	16	11
12	11	8
13	15	9
14	13	11
15	11	18
16	17	11
17	19	10
18	18	14
19	13	9
20	14	13
21	9	7
22	11	13
23	14	10
24	15	15
25	11	12
26	14	11
27	17	7
28	18	13
29	17	12
30	13	9
Mean	14.83	11.37

Scores of Teacher made Achievement Comprehensive Post-Test for Unit I, II and III

Sr.	Group A (Experimental)	Group B (Control)
1	24	20
2	25	22
3	22	25
4	24	18
5	23	21
6	27	18
7	19	16
8	23	21
9	26	23
10	27	14
11	22	16
12	23	18
13	28	21
14	26	22
15	29	15
16	22	16
17	21	14
26	16	18
19	21	21
20	26	22
21	22	25
22	26	18
23	24	21
24	27	23
25	21	20
26	22	17
27	24	18
28	25	19
29	26	21
30	24	20
Mean	23.83	19.43

Scores of Delayed response post-test for unit I, II and III

Sr.	Group A (Experimental)	Group B (Control)
1	21	21
2	22	20
3	23	21
4	22	18
5	23	20
6	27	21
7	19	20
8	22	20
9	15	21
10	19	17
11	24	22
12	23	18
13	18	19
14	26	18
15	29	18
16	17	20
17	18	17
26	24	18
19	24	22
20	26	17
21	29	19
22	23	18
23	26	21
24	23	22
25	20	21
26	21	18
27	24	18
28	22	20
29	24	22
30	20	21
Mean	22	20

Appendix 8: Draft Version of one instructional design

Lesson Plan – 1 SI-International Systems of Units

Objectives:

The student will be able to plan and conduct investigations in which

a) Length, mass, volume, density, temperature, weight, and force are accurately measured and reported using metric units (SI-International Systems of Units);
b) Conversions are made among metric units, applying appropriate prefixes.

Engage:

(Students will be divided into small groups each of 3 students.

Among them; one will be the recorder, other will be speaker & third will be observer.

Likewise ten groups will be made of class-strength 30 students, each of 3 students.)

Each group of students will be provided with:-

Block of different sizes, thickness & length, with metric ruler, beam balance, & weights, graduated cylinder, thermometer, erasers, sharpeners, etc.

(Students will be given activity sheet as follows to measure record their observations.)

Activity Sheet I

Sr. No.	Material	Area/Size/Temp.	Unit
1	Wooden blocks	5 cm^2	cm^2
2	Metallic blocks	7 cm^2	cm^2
3	Thermometer	100°C	°C
4	Chalks	7 cm	cm
5	Pencils	10 cm	cm
6	Eraser	2 cm	cm

7	Piece of cloth	1.5 meter	M
8	Watch	Time	Seconds
9	Sharpener	4 cm	Cm
10	Graduated Cylinder	500 ml	Ml
11	Ruler	15cm	Cm

Explore:

(Direct involvement of students in groups)

Students will measure all the materials provided and record their observations as per activity sheet.

Then each speaker from a group will write their observation on blackboard.

Then discussion on measurement regarding system of units will be done.

HAND OUTS

The **centimetre–gram–second system** (abbreviated **CGS** or **cgs**) is a variant of the metric system of physical units based on centimeter as the unit of length, gram as a unit of mass, and second as a unit of time. All CGS mechanical units are unambiguously derived from these three base units, but there are several different ways of extending the CGS system to cover electromagnetism.

The CGS system has been largely supplanted by the MKS system, based on meter, kilogram, and second. MKS was in turn extended and replaced by the International System of Units (SI). The latter adopts the three base units of MKS, plus the ampere, mole, candela and kelvin. In many fields of science and engineering, SI is the only system of units in use. However, there remain certain subfields where CGS is prevalent.

In measurements of purely mechanical systems (involving units of length, mass, force, energy, pressure, and so on), the differences between CGS and SI are straightforward and rather trivial; the unit-conversion factors are all powers of

10 arising from the relations 100 cm = 1 m and 1000 g = 1 kg. For example, the CGS-derived unit of force is the dyne, equal to 1 g·cm/s2, while the SI-derived unit of force is the newton, 1 kg·m/s2. Thus it is straightforward to show that 1 dyne = 10−5 newtons.

Definition of Unit

A unit should be such that

- It must be possible to define it unambiguous
- It should be easy to reproduce
- It must be invariable with time and place

It should be possible to multiply or divide each one of the standard.

Questions will be posed to students regarding the types of units like:

Q1. Do you know the system of units? Name them.

Ans. Metre, second , celcius

Q What is the length of the full chalk?

Ans Students will measure and answer: it is 8 cm or 3.2 inches or 0.08 metres.

Q Then what is the difference between centimeter-meter-kilometer or second-minute-hour, etc?

Ans. They are similar units in ascending order units.

Q. Do you know in what system of units do foot, pound, second come?

Ans.

Q. Can meter, Kilogram, second specify some system of unit?

Ans.

Discussion

Among ten groups of students pairing of two groups will be done in which students will explain each other what knowledge they have constructed to each other.

Then finally speaker of each paired group will consolidate the understanding of all six students of two groups.

Likewise five speakers will consolidate their constructed knowledge in front of whole class.

Teacher will acknowledge the necessary corrections.

Students will be given Activity Sheet II, wherein different units will be written and students will fill up the sheets.

ACTIVITY SHEET II

Sr. No.	Units	Formula	S I Unit
1	Length	L	Metre
2	Area	L X b	Metre2
3	Volume	L X b X h	Metre3
4	Time	T	second
5	Velocity	Displacement/time	Meter/second
6	Work	Force*distance	Newton Meter
7	Frequency	Vibration/second	Hertz
8	Mass	Mass	Kilogram
9	Current	I	Ampere
10	Surface Tension	Force/length	Newton / Meter

Students will fill up the sheets and discussion will be done in class on the difference between derived and basic units.

Giving students the opportunity to expand and solidify their understanding of the concept of different types of units.

HANDOUTS

There are two different types of units:

1 Fundamental/Basic Units:

The physical quantities which do not depend upon any other quantities of measurement are called Fundamental/ Basic Units.

e.g. units of length is meter, mass is kilogram, time is second, Electric current is Ampere, Temperature is Kelvin, Luminous Intensity is Candela.

2 Derived Units:

The physical quantities which depend upon the fundamental quantities for their measurement are called derived quantities.

e.g. Area, volume, density, speed, velocity and their units are m2, m3, Kg/m3, m/sec respectively.

ACTIVITY

Conversion of units

Description	**CGS**	**Unit**	**SI (MKS)**	**Unit**	**Factor**
Acceleration	galileo	Gal	metre per second squared	$m \cdot s^{-2}$	0.01
dynamic viscosity	poise	P	pascal second	$Pa \cdot s$	0.1
electric current	biot	Bi	ampere	A	10
energy (work)	erg		joule	J	10^{-7}
Force	dyne	dyn	newton	N	10^{-5}
heat energy	calorie	cal	joule	J	4.187
Pressure	barye	ba	pascal	Pa	0.1

Consolidation

Definition of Unit

A unit should be such that

- It must be possible to define it unambiguous
- It should be easy to reproduce
- It must be invariable with time and place

There are two different types of units:

- **1 Fundamental/Basic Units:**
- The physical quantities which do not depend upon any other quantities of measurement are called Fundamental/ Basic Units.
- e.g. units of length is meter, mass is kilogram, time is second, Electric current is Ampere, Temperature is Kelvin, Luminous Intensity is Candela.
- **2 Derived Units:**
- The physical quantities which depend upon the fundamental quantities for their measurement are called derived quantities.
- e.g. Area, volume, density, speed, velocity and their units are m2, m3, Kg/m3, m/sec respectively.

Evaluation

Students to measure the screen size of appliances like computer screens, TV, LED TV, Computer Monitor and Smart Phones.