Outline of Basics of Geometrical Drawing (Rev 3- Prefinal)

(Pre-requisite: Students are advised to revise geometrical construction as a part of geometry in their course and practice use of set-squares. Considering difficulties in demonstration in IOMS, with our infrastructure, following videos are recommended in order of preference)

1. **https://www.youtube.com/watch?v=vBiwAgSfy7c : Essential**
2. **https://www.youtube.com/watch?v=zRg_7TXtTxw&t=11s : Desirable**
3. **https://www.youtube.com/results?search_query=use+of+set+square+for+ITI : Useful**

Preamble: We have been thinking since beginning of this initiative to explain and expose basic concepts of drawing to students attending **Interactive Online Mentoring Sessions (IOMS**), the flagship of our humble initiative **Gyan Vigyan Sarita (GVS)**. This initiative is aimed at to groom competence to compete among unprivileged students. It is an effort with the sense of **Personal Social Responsibility (PSR)** to Democratize Education. GVS is a ***non-organizational, non-remunerative, non-commercial and non-political*** initiative.

During our involvement over 9 years in the mentoring initiative, we have realized that students are getting drifted away from basic concepts of subject matter, for multiple reasons. One typical example is not to use Set-Square, an integral part of Geometry Box, an essential constituent of expensive School Kit, provided/prescribed by schools. Without going into reasons we are trying to concentrate in IOMS as to what remedial actions can be taken to check these tendencies.

Geometry and drawing is an inclusive attribute in pursuit of learning and education specially in mathematics and science stream. Competence in drawing helps a student to grow conceptually.

In this stream, the ability of a student to visualize problems, translate the same to a representative figure, and analyze the problem with the subject matter helps them in gaining competence. These basic/foundation concepts of drawing will play an important role in their forward journey. Else, iteratively revisiting the concepts, during forward journey, will consume their time disproportionate.

As students proceed in higher classes with unclear concepts they are the worst sufferer because at that stage neither teacher has time to explain these basic concepts nor it is feasible for students to cope up with the deficiency.

Despite our passion, the necessity of the concepts of geometrical drawing and present state of exposure to basic geometrical constructions is driving us to frame an abridged exposure to students attending IOMS.

We accept that this should have been started by us much earlier. Nevertheless, one is never late to make a proper beginning. Accordingly, during special sessions, organized under IOMS, to cover Basic Concepts of Geometrical Drawing, students are required to participate with drawing copy, geometry box, a set of pencils duly sharpened. They are required to submit their practice sheets for checking and guidance in respect of corrections of errors, if any. Thus students are led to witness effect of practicing right concepts properly.

We believe that teachers and students would find this document useful, and may like to carry it forward in their domain to make students better learners, in turn an asset of society, nation and humanity.

Acknowledgement: *This document is result of collective efforts of Shri Shivadheen Dixit, Harmohan Singh Chopra and Shri Sharad Saxena, who are successful engineers and great artists by passion. Moreover, they are associated with this initiative with a sense of* ***Personal Social Responsibility (PSR)****.*

Basics Concepts of Plain Geometry & Geometrical Figures

A geometric figure is any combination of points, lines or planes.

Points: In geometry, a point is a location represented by a dot. A point does not have any length, width or size, It only has a position

Lines: When two distinct points are connected they form a line.

Planes: A two dimensional (2D) plane is a perfectly a flat surface which extends in all directions and is known as a plane surface. A plane extends infinitely in two dimensions with no thickness.

Simple Geometrical Figures

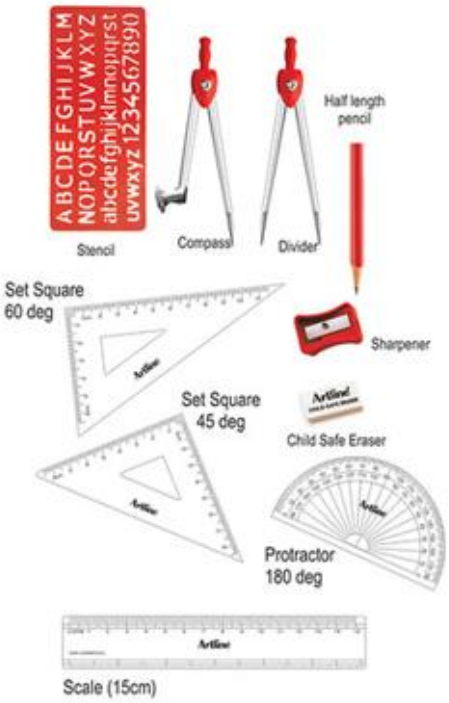
1. Point
2. Line with the concept of scale and angle
3. Triangle
4. Quadrilateral
5. Circle
6. Polygon

Higher Geometrical figures

1. Ellipse
2. Parabola
3. Hyperbola
4. Cycloid
5. Many more

Professional Geometrical Figures

1. Projection of Point, Line, Plane, Objects
2. Mirror Image
3. Isometric View
4. Perspective View
5. Shading, Shadowing, Hatching
6. Doodle Drawing



Instruments available in the simple Geometry Box, which is generally a part of school bag, can be used to draw most of the above Geometrical Figures.

Fig. 1: Instruments in a Geometry Box a part of School Bag->

Once students gain proficiency in geometrical drawing, they can use freehand or scaled drawing to represent any object while describing a problem or its solution. Such drawings are known as **Analytic Drawing,** and are integral part of problem and its solution.

Analytic Drawing is a traditional style of pencil-and-paper drawing to construct 2D projections of 3D shapes using the rules of perspectives. This allows us to precisely infer 3d meaning of an object in the form of 2D drawings.

- A **Two-Dimensional** shape can be defined as a flat figure or a shape that has two dimensions viz. length and width
- A **Three-Dimensional** shape can be defined as a solid figure or an object or a shape that has three dimensions viz. length, width and height (or thickness or depth). These are isometric drawings used in figures related to mathematics and physics.
- **Rules of Perspective**- A technique applied in drawing and painting to give a flat surface or imagery a sense of depth or height. It finds application in architectural work and is being simply introduced for completeness of this document, without getting into details. Inspired students may try to reach experts in the field for guidance. Rules of perspective are as under –
  - **Rule # 1:** Object that are closer appear bigger.
  - **Rule # 2:** Parallel lines appear to intersect at some point defined as Vanishing Point (VP)
  - **Rule # 3:** ***One Point Perspective*** – All parallel lines seep to meet at *One Vanishing Point* Fig. 44 and 45.
  - **Rule # 4:** ***Two Point Perspective*** – Horizontal lines left to the observer seem to meet at a VP on the left of the observer. Likewise, horizontal lines on the right of the observer on the VP at the right . Thus there are *Two Vanishing Points*, Fig. 46 &47.
  - **Rule # 5:** ***Three Point Perspective*** – There are separate *3 Vanishing Points*, one for vertical lines and two for horizontal lines as enumerated at Rule 4. Fig. 48 & 49.
  - **Rule # 6**: ***Zero Point Perspective*** - It is used to give illusion of depth when there are no parallel lines and therefore there is no vanishing point. One of the principle used in it is that in closer object more details are shown as compared to farther objects.

Some Exercises for Practice from different sources are drawn for ready reference and are shown in the following pages. (may please zoom figures for better clarity, wherever needed)

Fig 2 to 7 are for revision of Geometrical Constructions as a part of Geometry upto class 9th

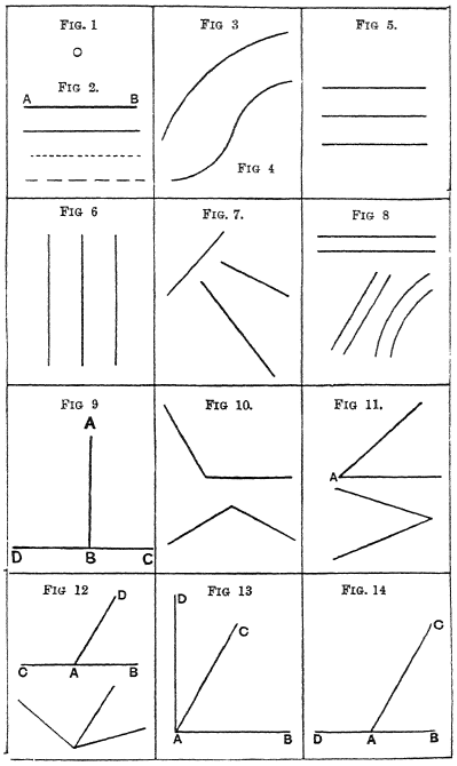


Fig. 2: Lines and angles

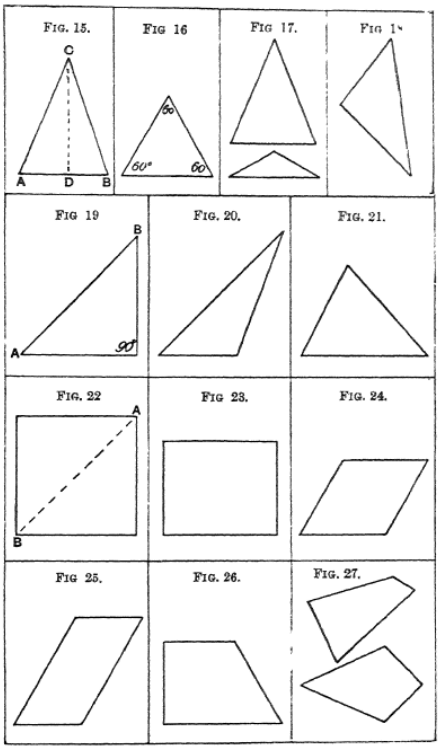


Fig. 3: Triangles and Quadrilaterals

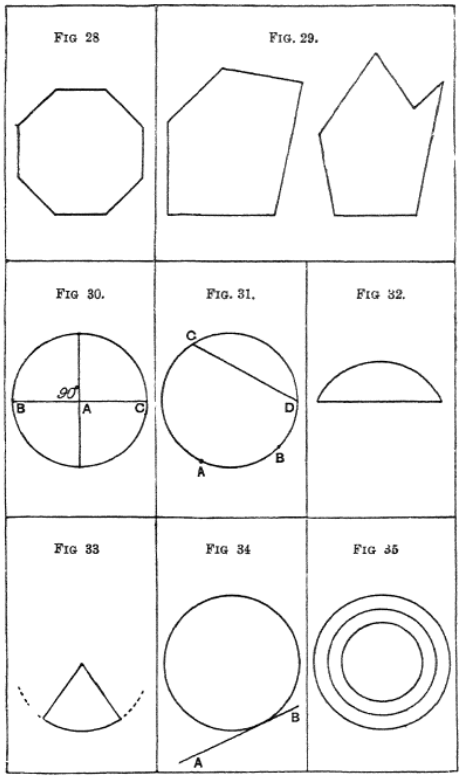


Fig. 4: Polygons and Circles

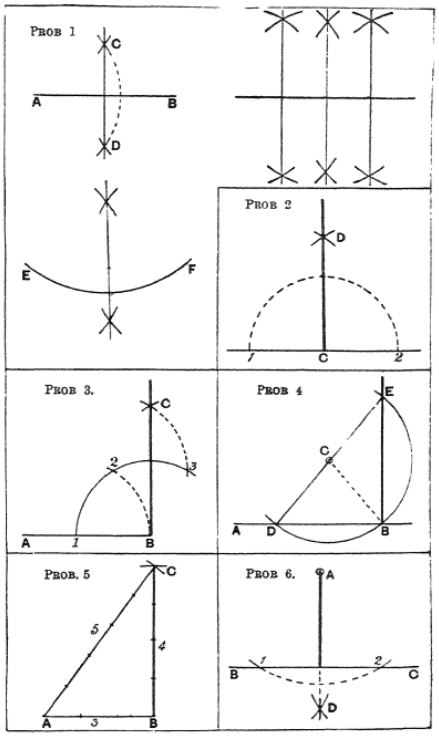
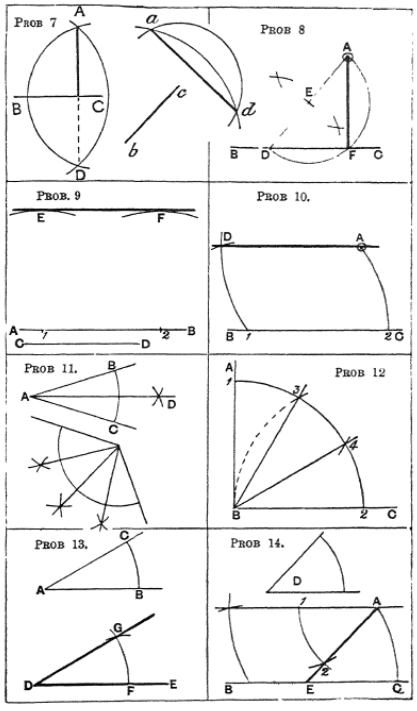


Fig. 5: Geometrical Constructions



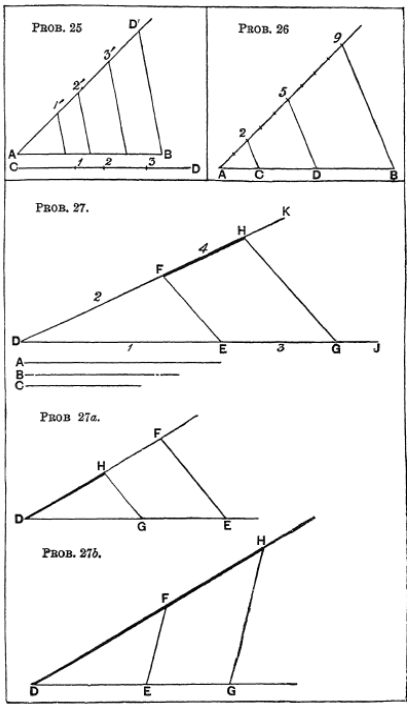
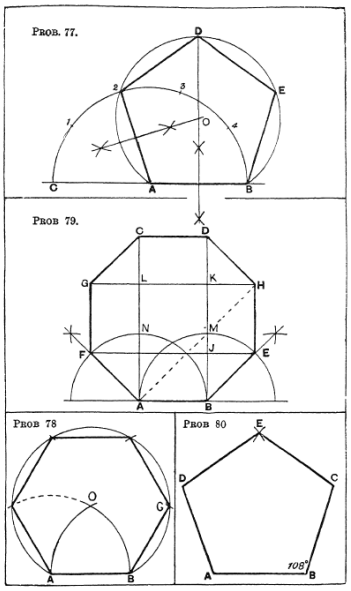
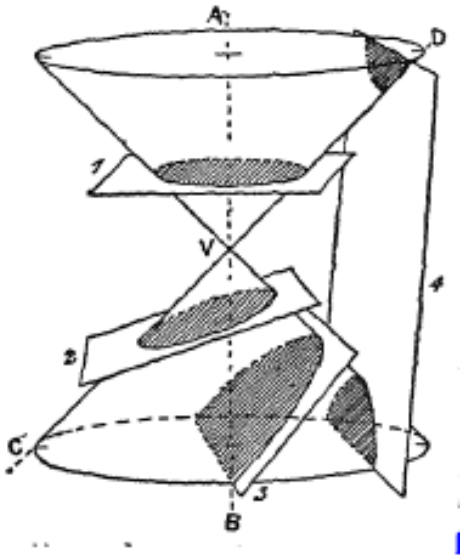


Fig. 6: Similar Triangles





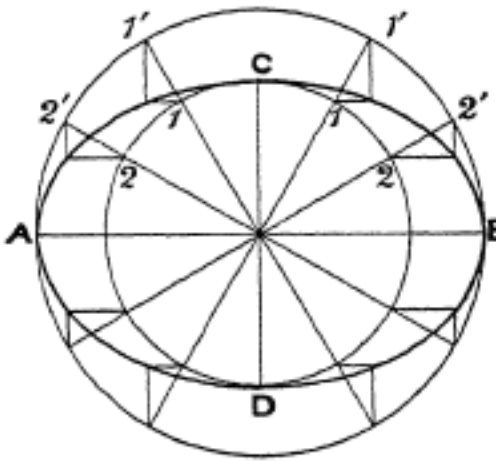


Fig. 7: Construction of Polygons **Fig. 8: Visualize Conic Sections** **Fig. 9: Construction of Ellipse**

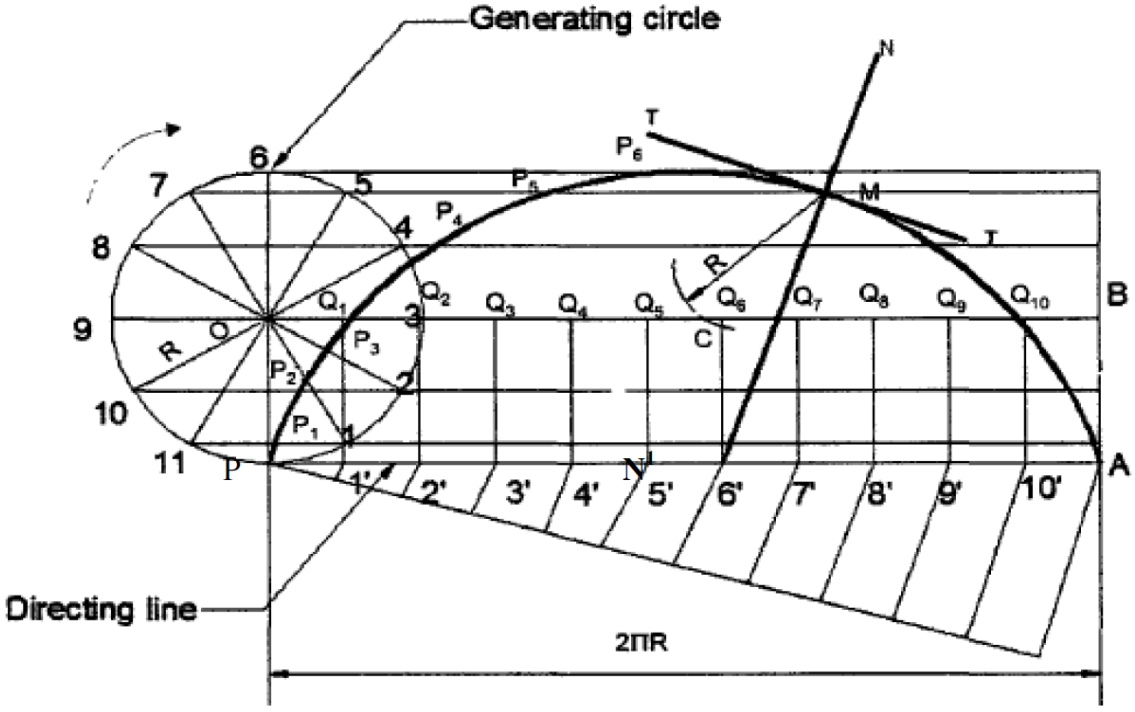
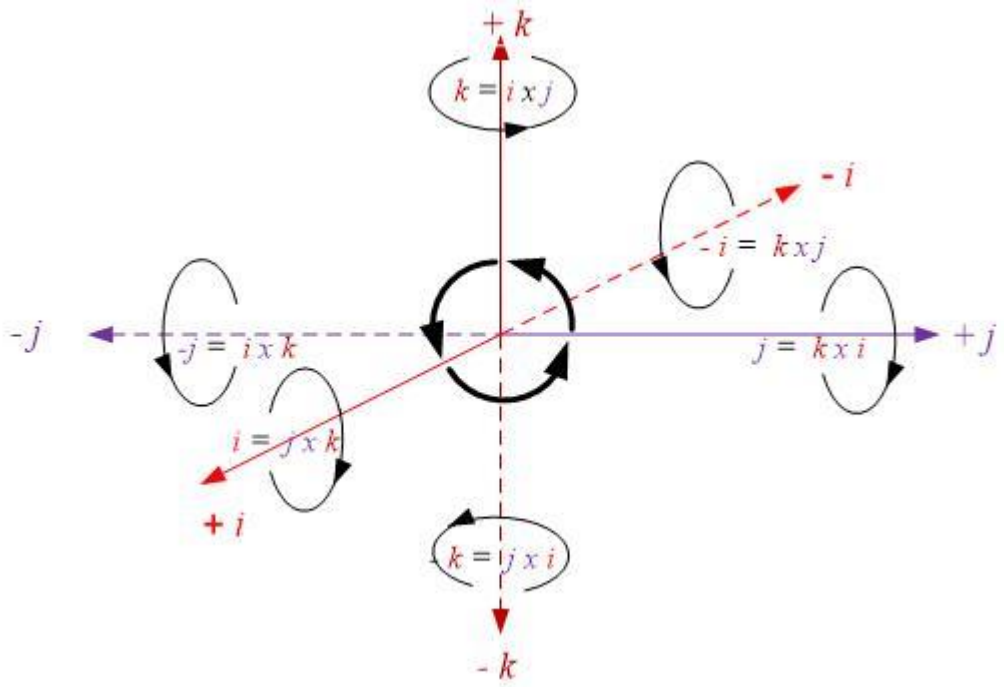


Fig. 10: Construction of Ellipse

(Drawings in Fig. 8-10 are part of Geometrical Constructions in professional course)

Fig 11: 3D-Space, $\hat{\imath}, \hat{\jmath}, \hat{k}$ Unit vectors and its correlation with sign convention of angles (Anticlockwise- Positive)

(It is inclusive in concepts of Vector Algebra)



Projections of point, lines, planes and cuboid

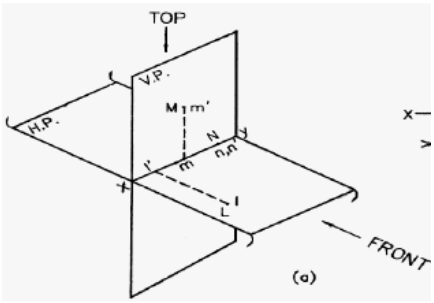
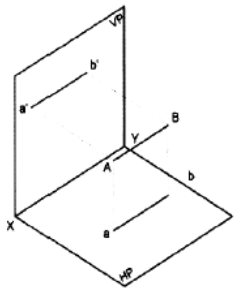


Fig 12: Projection of Point



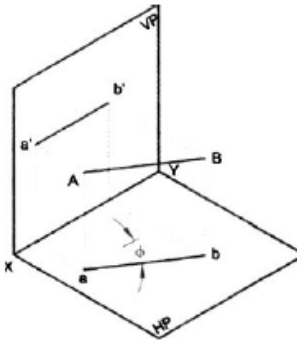
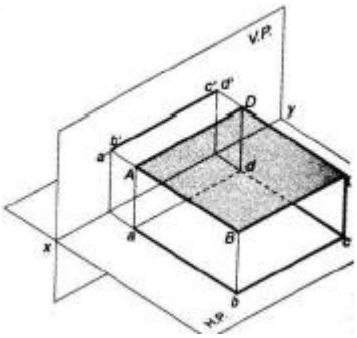


Fig 13: Projection of Lines



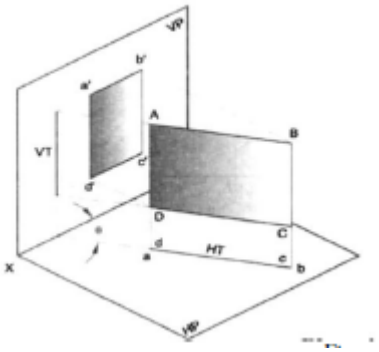


Fig 14: Projection of Planes

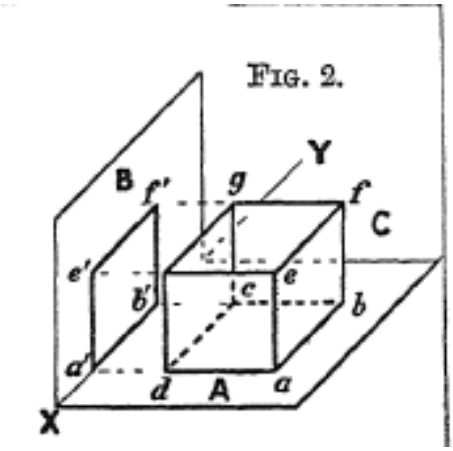
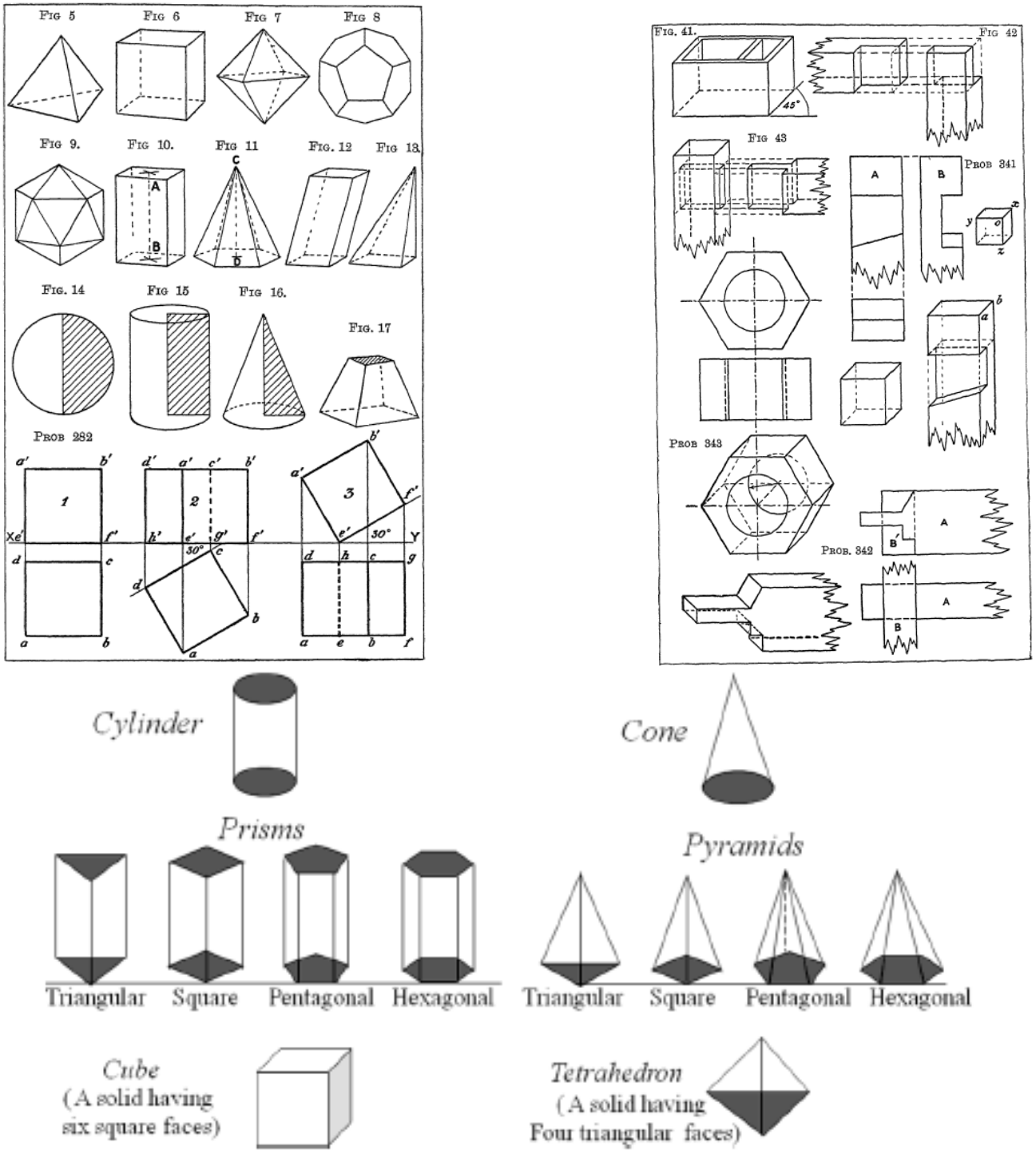


Fig 15: Projection of Solid

Students are advised to practice Fig 12 to 15 using Set square

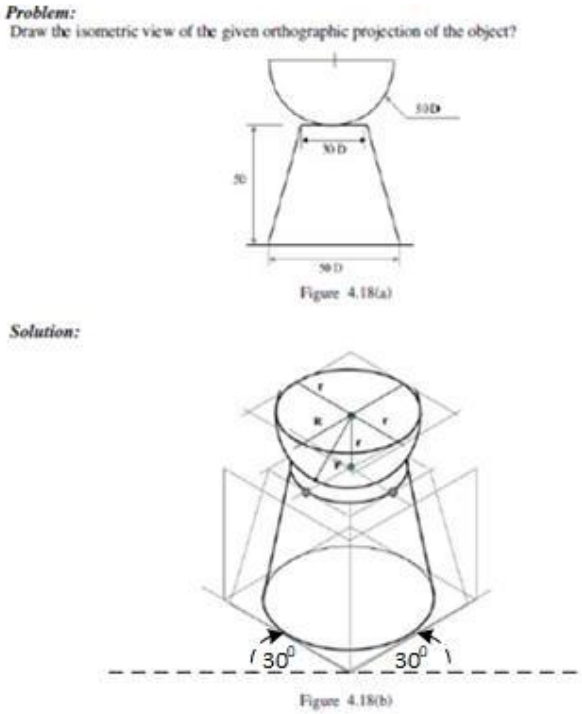
Fig. 16: Representation of 3D objects in 3D space



Students are advised practice diagrams included in Fig. 16 as free-hand drawing. It will help in building neuro-muscular coordination

Fig: 17: Exercise On Isometric Drawing based on Front Elevation of a Symmetrical Object

(Inspired students may like to practice it)



Some Typical Figure from Physics

(Only for visualization of drawings and how the concepts of drawing are used therein)

Students would find drawing similar to these in their text books and reference books, at different stages. Yet these are to help students inspired in these special sessions to visualize and attempt to draw different physical process they observe in their day-to-day life. It is just for your ready reference and use as and when you need them.

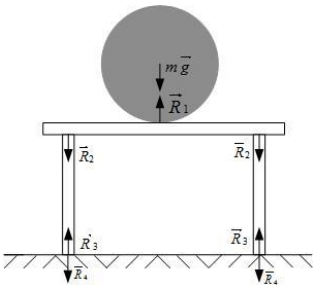


Fig 18: Third Law Of Motion

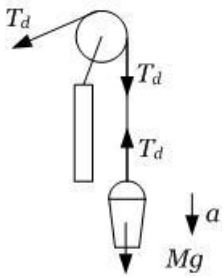


Fig 19: Pulley Action

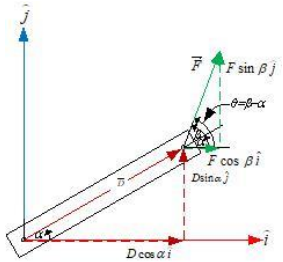


Fig. 20: Principle of Dot-Product of Vectors

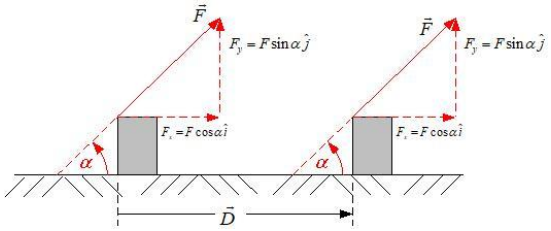


Fig. 21: Principle of Cross-Product of Vectors

Fig 22: Deformation in solids

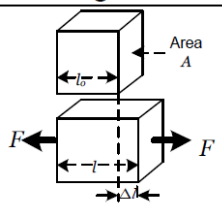
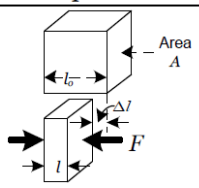
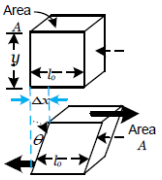
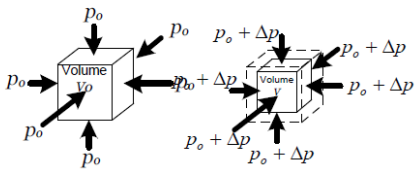
Linear *Deformation*		Surface Deformation	Bulk Deformation
Tensile Stress	Compressive Stress	Shear Force	Compressive Force
Elongation	Compression	Slippage	Compression
			

Fig 23: Effect of Centripetal Force in Sky-wheel

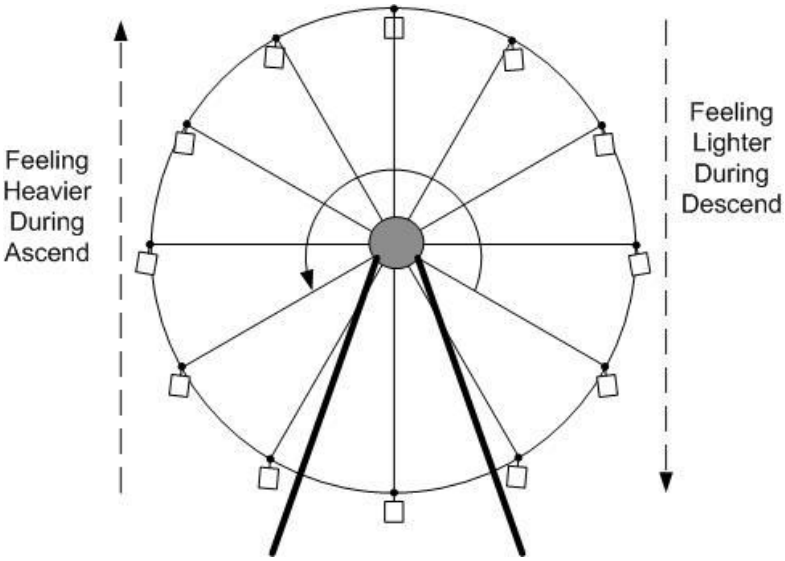


Fig 24: Spring Action

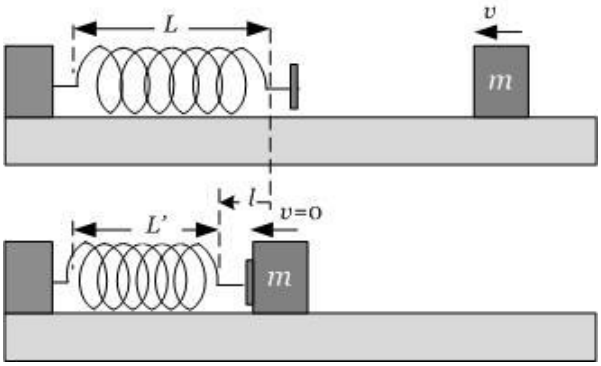


Fig 25: Demonstration of Different Phenomenon of Physics with Beam Balance

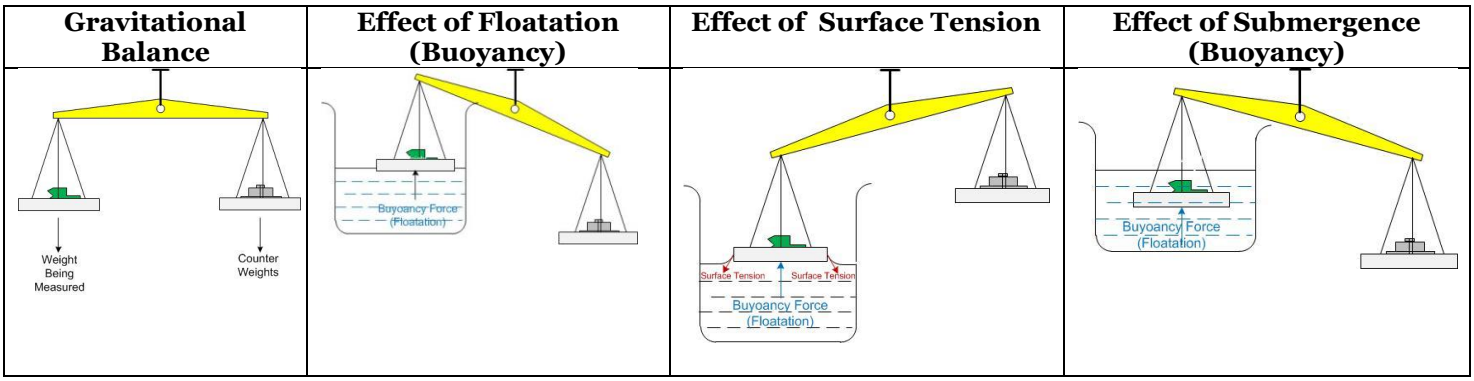


Fig 26: Effect of Circular Motion on Plane into Liner Motion

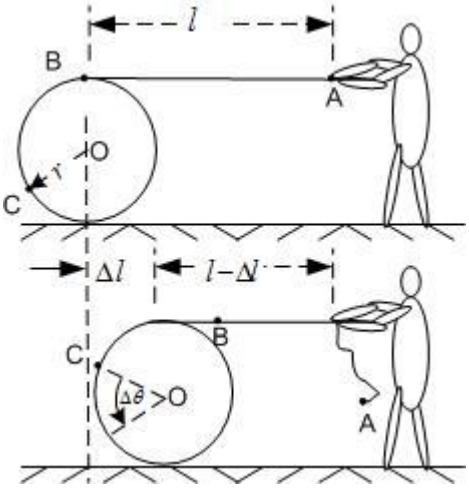


Fig 27: Visualizing Buoyancy Effect

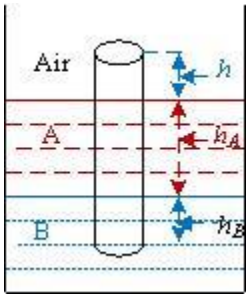


Fig28: Hydrostatic Effect of Revolution

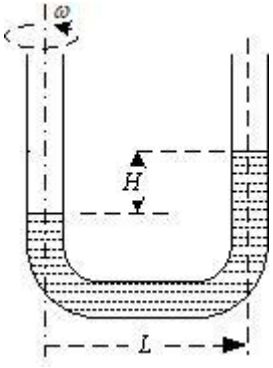


Fig 28: Reflection at Plane Surface

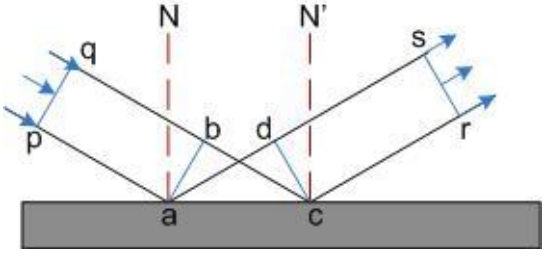


Fig 29: Reflection t Spherical Surface

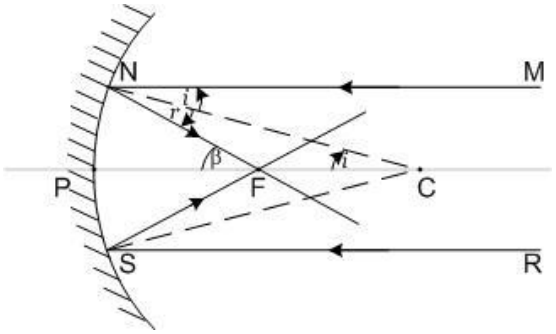


Fig 30: Image Formation by Lens

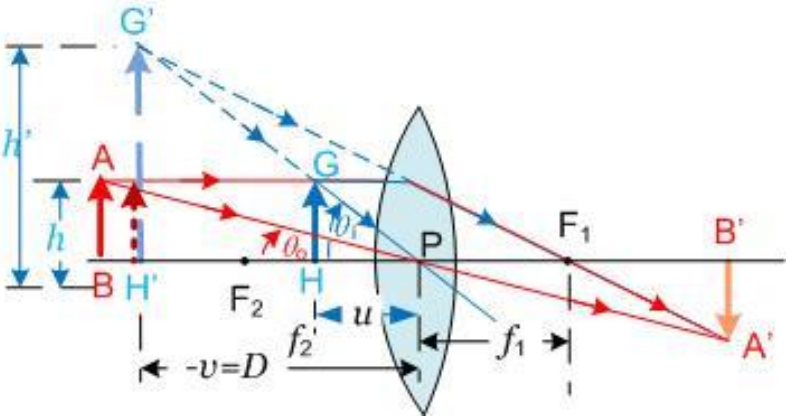


Fig 31: Magnetic Field Due to a Bar Magnet

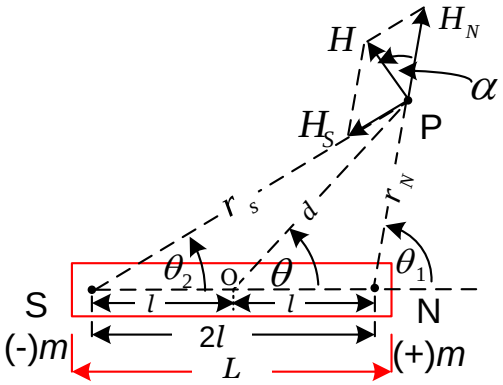


Fig 32: Electromagnetic Induction

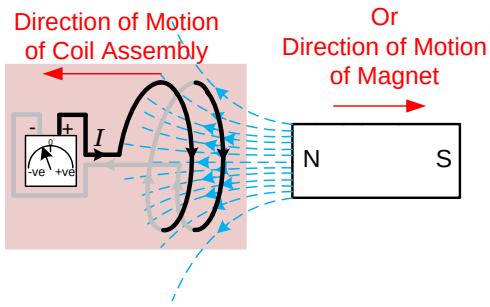


Fig 33: Mutual Electromagnetic Induction

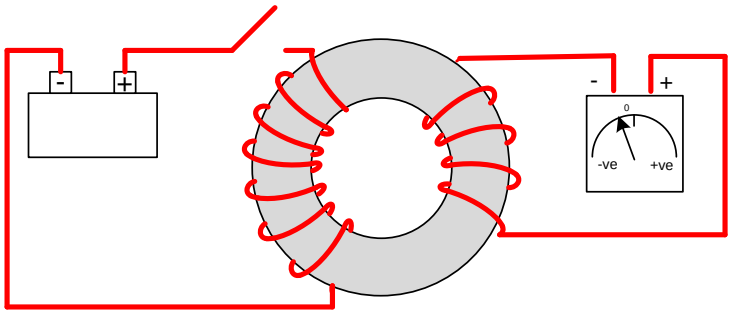


Fig 34: Ampere's Right Hand Thumb Rule

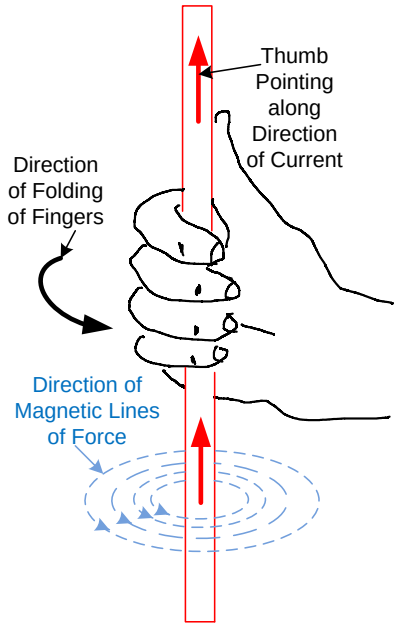


Fig 35: Application of Biot-Savart's Law

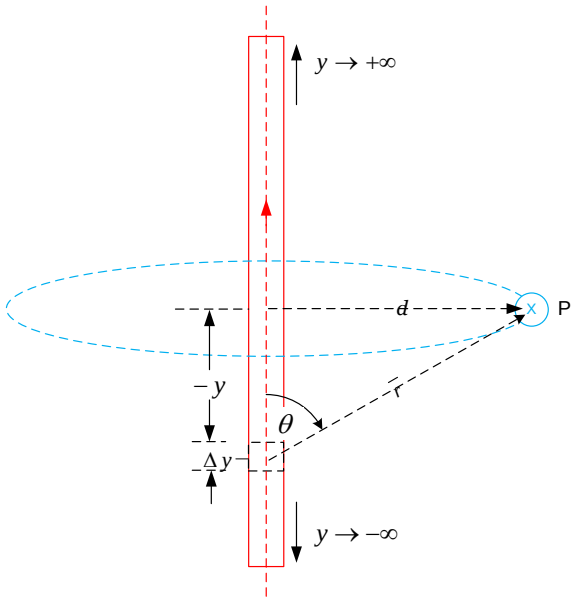


Fig 36: Torque on Magnetic Dipole in Magnetic Field

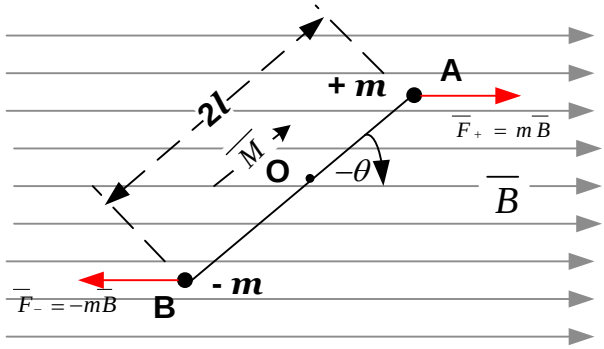


Fig 37: Force On a Current Carrying Conductor Placed in Magnetic Field

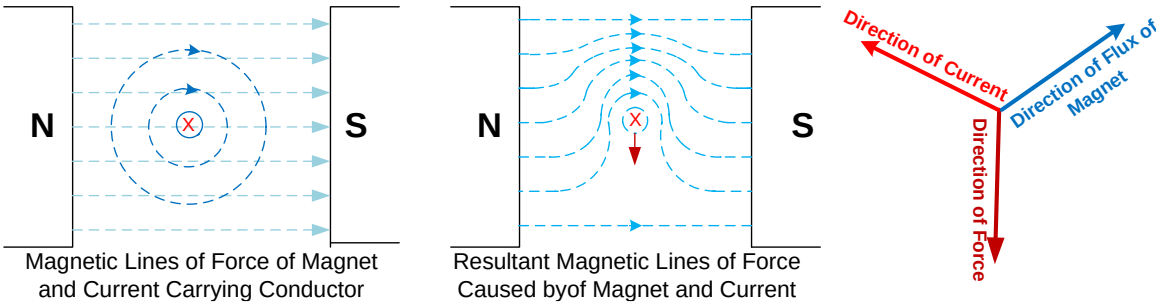


Fig 38: Magnetic Field due to Current in Solenoid

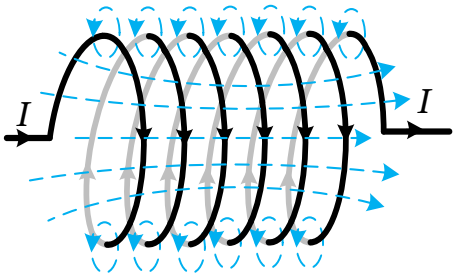


Fig 39: Phase of AC Current w.r.t. Position of Coil in an Alternator

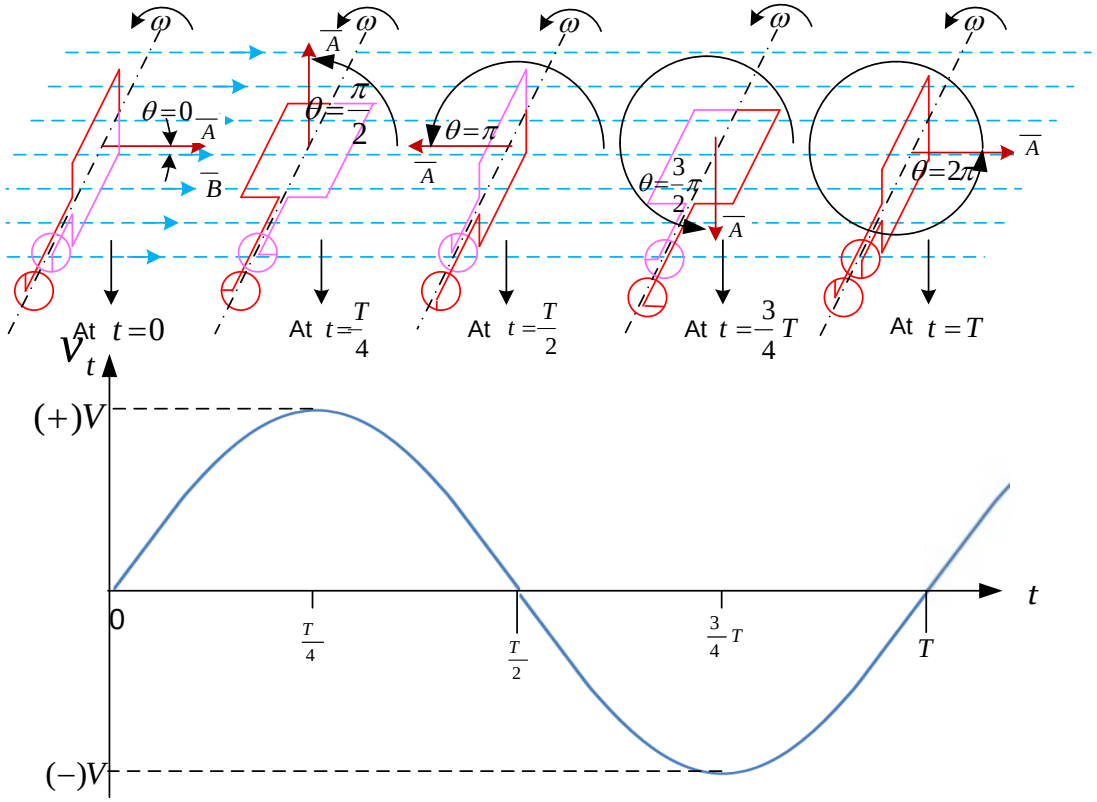
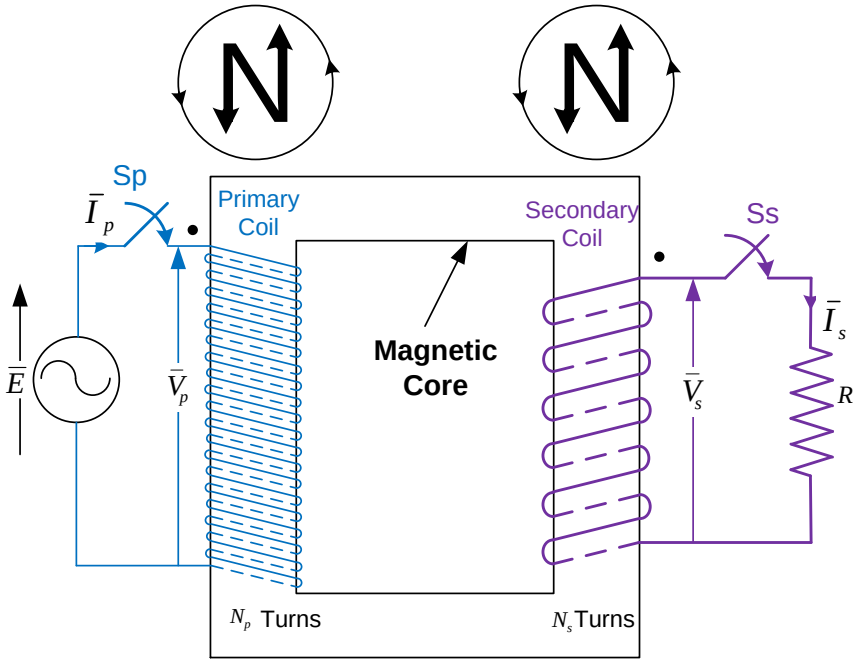


Fig 40: Principle of Transformer



Some Object Drawings for visualization and practice with shadow effect in diffused light

<Fig41

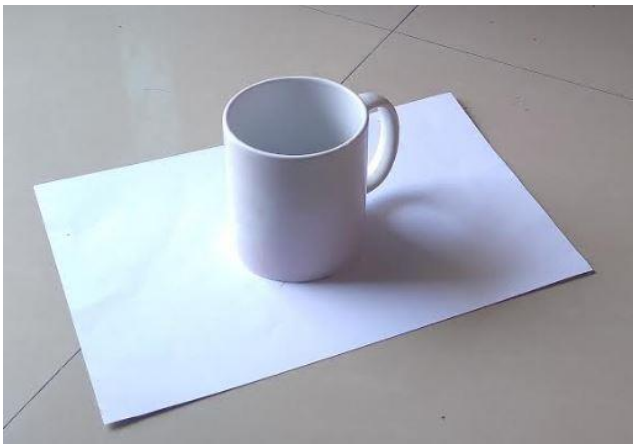


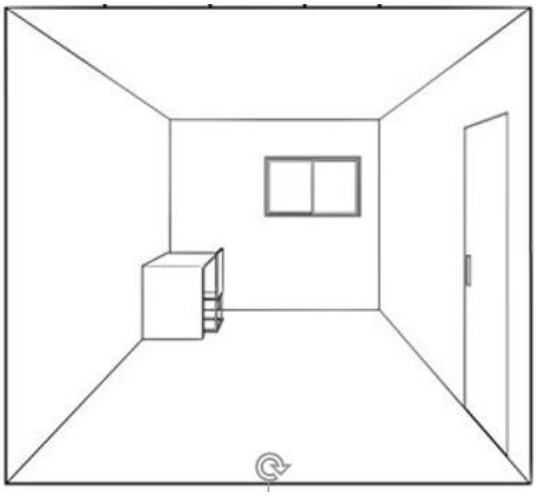
Fig 42>

Fig 43>

Perspective Photo and Drawing (Useful in architectural work or artistic creations)

Only for visualization. Students inspired to pursue career in the field of architecture or high end drawing are advised to practice it.

Fig 44: 1-Point Perspective



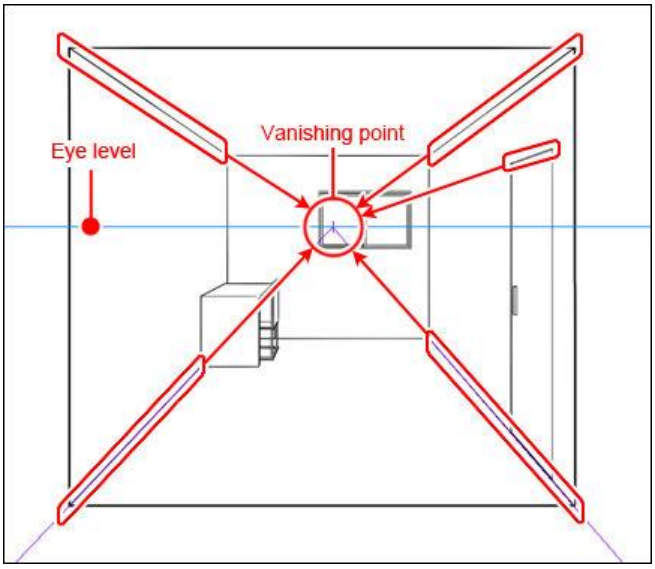


Fig 45: 1-Point Perspective (A Simplified Version)

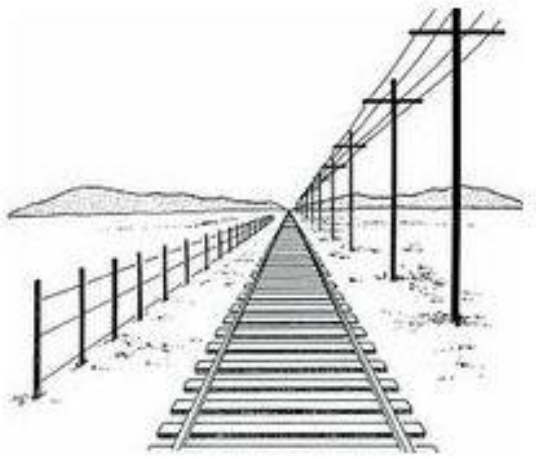


Fig 46: 2-Point Perspective

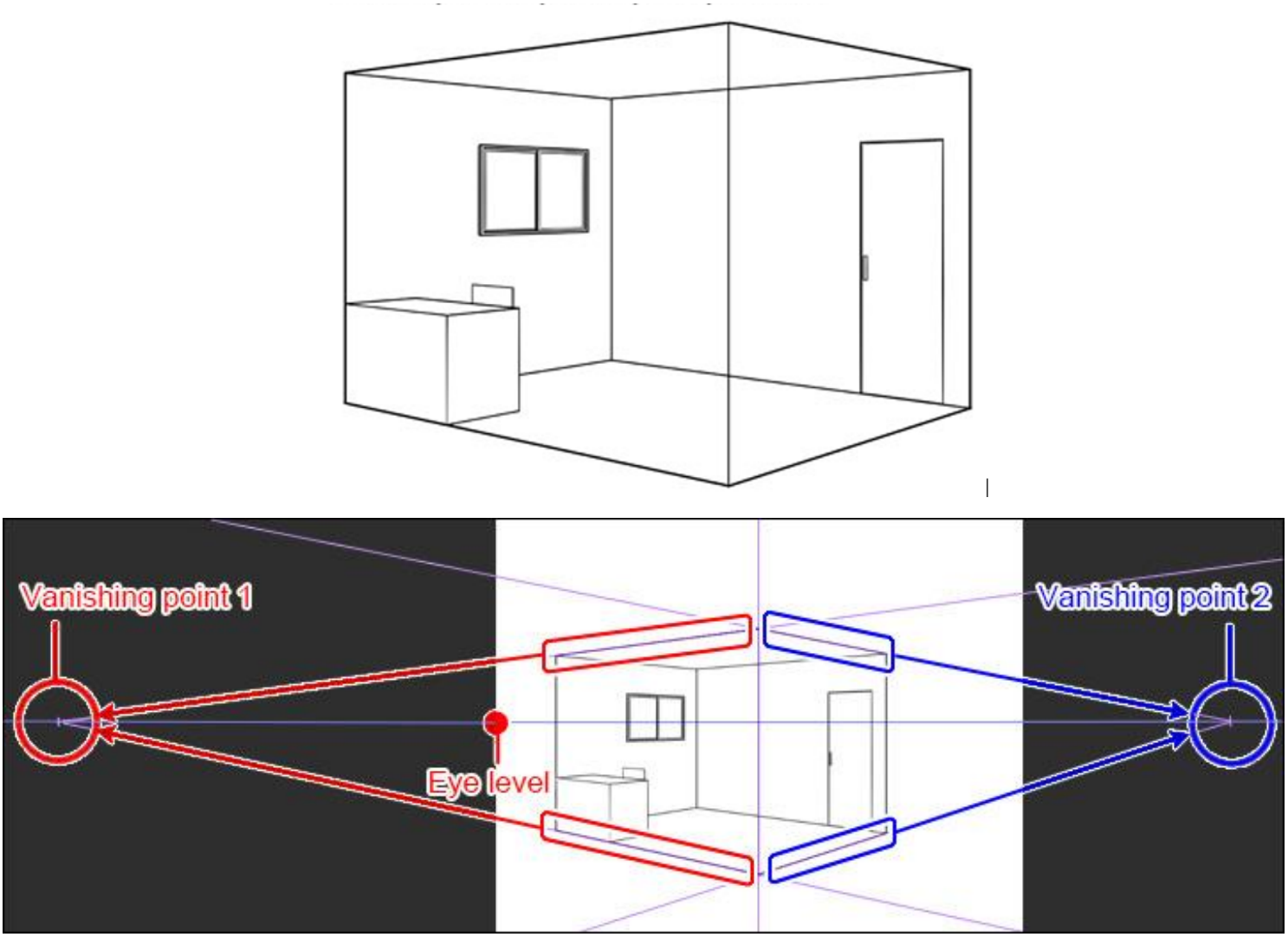


Fig 47: 2-Point Perspective (A Simplified Version)

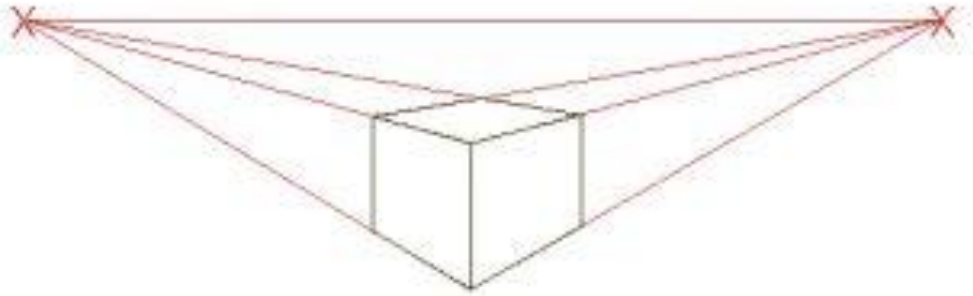
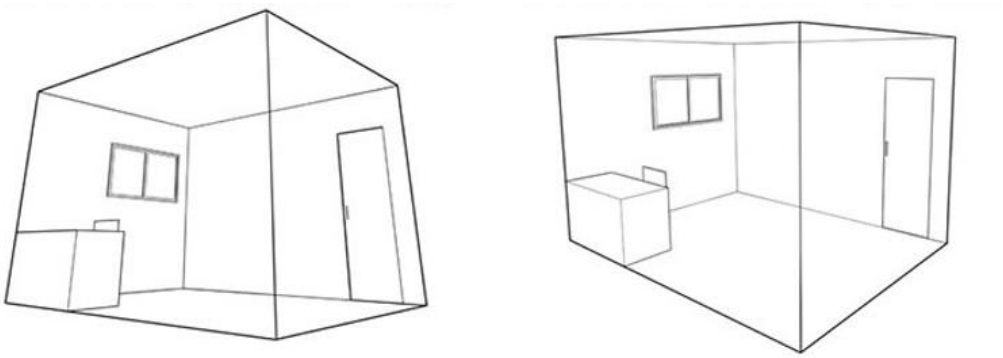


Fig 48: 3-Point Perspective

Low Angle **High Angle**



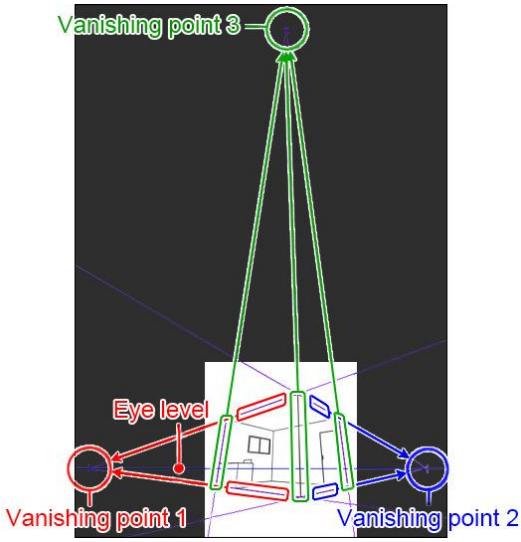


Fig 49: 3-Point Perspective (A Simplified Version)

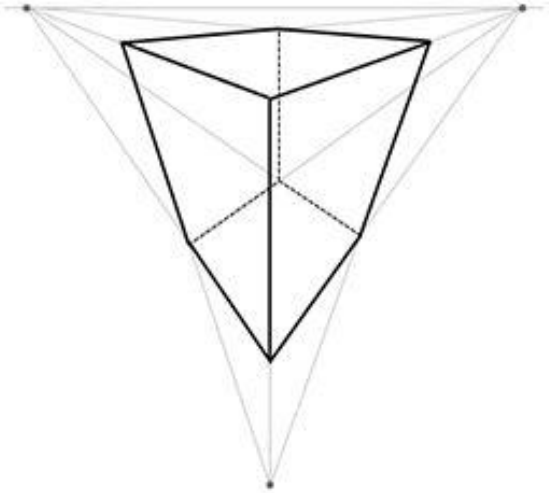
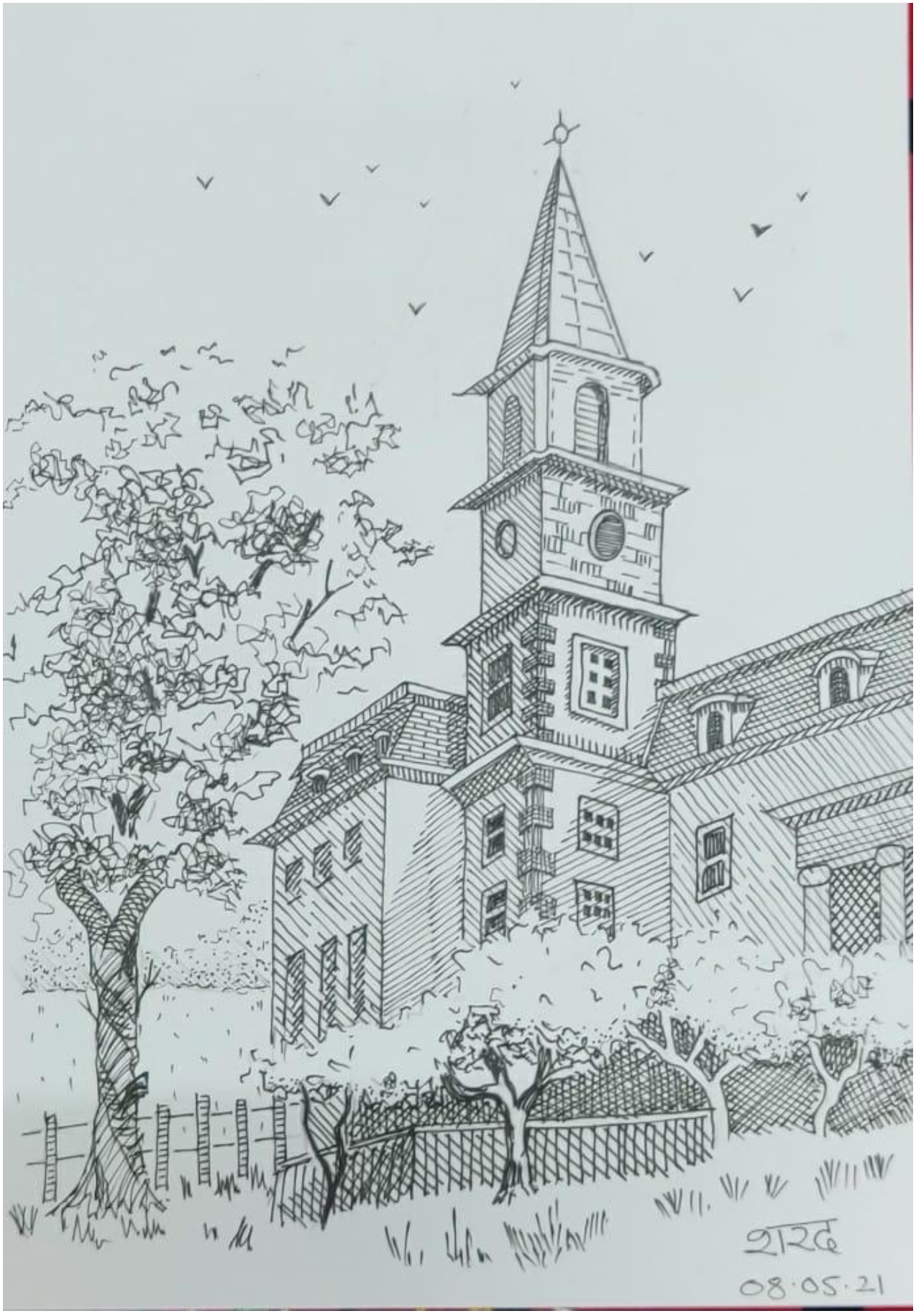


Fig 50: Shadow Effect Through Hatching in Drawing



Road Map: These concepts of drawing would be integrated into IOMS in the form short-term programme of Three sessions of Two hours each on weekends.

First Session covers basic geometrical constructions including representation of a rational number and an irrational numbers using geometry box.

Second Session covers projection of a point, line, surface and a cuboid.

Third Session covers application of geometrical drawing in various diagrams related to physics.

Students are advised to practice after each session for improvement concepts and freehand drawing.

Summary: *An effort is being made to apprise students in general about basic concepts of geometrical drawings, through special sessions under our IOMS initiative. Accordingly, an outline of concepts has been drawn with some figure from classic book of Morris on Geometrical Drawing and Engineering Graphics Practice Manual of Malla Reddy College of Engineering & Technology, Secunderabad. Figures on Physics are from Mentor's Manual, available as free web resource on Gyan Vigyan Sarita. Drawing from figure 2 to 15 if practices sincerely using geometry box, it helps to develop required neuro-muscular coordination necessary for synchronized movement of hand, pencil and eye, an essential requirement for making a good drawing. Once it is achieved students can practice rest of the drawing freehand and pursue on the path of perfection.*

These concepts are helpful to students in –

- *visualization of problem*
- *draw diagrams in mathematics and physics*
- *analyze problem leading to correct solution*

It will help students in a big way if they practice these drawings during fatigue relaxation or leisure. They will experience its benefits, progressively as they move forward in mathematics and science stream. At that stage neither teachers nor students will have either time and patience to deal with these useful concepts.

Implementation of this outline has been started on June 26th, 2021 with students of Rama Krishna Mission School, Sitanagram, A.P. who are attending ***Interactive Online Mentoring Sessions (IOMS)****, flagship of* ***Gyan Vigyan Sarita****. Our experience in mentoring these concepts would be utilized to progressively refine this document, with a hope that other teachers may like to use it for those students who have not received formal training in drawing. We would pursue mentoring every batch of students attending IOMS on this outline of Geometrical drawing.*

Brief profile of the contributors:

1. **Er**. **Shivadheen Dixit**, BE (Elect), 1972, Govt. Engineering College Jabalpur. He has grown in a family where engineering drawing was the basic profession. He had his schooling from Kalaniketan, Jabalpur, in Technical Stream. Artist by passion, engineer by qualification and profession, turned into a financial expert.

2. **Er. Harmohan Singh Chopra,** BE (Civil)-1972, Govt. Engineering College. Artist by passion and an engineer by qualification and profession**.** He is founder-cum Managing Director of an architectural and civil construction company. He has organized many exhibitions of his art work.

3. **Er. Sharad Saxena, BE(E&C**), 1983, Govt. Engineering College Jabalpur. Engineer by qualification and profession, turned into a IT expert, artist by passion. He is a passionate mentor of mathematics and science. He has devised many experiment to demonstrate various concepts of mathematics and science.

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