Practical Tips
Freehand lines

- To sketch long lines, mark the ends of the line with a light 6H pencil.
- Draw long sweeps between, keeping your eye on the mark you are moving your pencil toward.
- Make several strokes, improving the accuracy of your line.
- Finally darken in the distinct line with an HB lead.

- If your line looks like this you may be gripping your pencil too tightly or trying too hard to imitate mechanical lines.

- Slight wiggles are okay as long as the line continues on a straight path.

- Occasional gaps are fine and make it easier to draw straight.

One of the most important factors in making good sketches is line quality. For many people, the biggest problem with line quality is not making object lines thick and dark enough. Make object lines black and relatively thick.

Practice with permanent markers

- Engineers are often required to maintain permanent records during the design process in a design notebook. This can help when applying for patents and in showing the steps the design went through. These records are required to be in ink. Practice sketching with felt-tip markers so that you can draw neat permanent sketches such as will be required in your design notebook.

- Disposable engineering markers are available in various widths and may be used freehand or with templates to make neat permanent sketches.
LINE WEIGHTS

- Make dimension, extension, and centerlines thin, sharp, and black.
- Make hidden lines medium and black.
- Make visible and cutting plane lines thick and black.
- Make construction lines thick and light.

HORIZONTAL LINES

- Hold your pencil naturally, about 1 inch back from the point, and approximately at right angles to the line to be drawn.
- Draw horizontal lines from left to right with a free and easy wrist-and-arm movement.

DRAWING VERTICAL LINES

- Draw vertical lines downward with finger and wrist movements.

TWO METHODS FOR BLOCKING IN HORIZONTAL AND VERTICAL LINES

Method A
Hold your pencil firmly, sliding a rigid finger along the edge of the paper to maintain a uniform border.

Method B
Mark the distance on a piece of paper and use it like a ruler. Hold your pencil as shown and make distance marks by tilting the pencil down to paper. Slide your hand to the next location.

TWO METHODS FOR FINDING MIDPOINTS

Method A
Gauge the half-distance with your pencil. Try the distance on the left and then right, adjusting until it matches on both sides.

Method B
Mark the endpoints of the line on a strip of paper. Fold the paper to bring the endpoints together. Use the crease as the midpoint.
Step by Step 3.3
Three methods for sketching arcs

Method A
1. Locate the center of the arc and lightly
   block in perpendicular lines. Mark off
   the radius distance along the lines.
2. Draw a 45-degree line through the
   center-point and mark off the radius
   distance along it.
3. Lightly sketch in the arc as shown.
   Darken the final arc.

Method B
1. Locate the center of the arc and lightly
   block in perpendicular lines. Mark off
   the radius distance along the lines.
2. Mark the radius distance on a strip of
   paper and use it as a trammel.
3. Lightly sketch in the arc as shown.
   Darken the final arc.

Method C
Use these steps to draw arcs sketched to
points of tangency.
1. Locate the center of the arc and
   sketch in the lines to which the arc is
tangent.
2. Draw perpendiculars from the center
to the tangent lines.
3. Draw in the arc tangent to the lines
   ending at the perpendicular lines.
4. Darken in the arc and then darken the
   lines from the points of tangency.

Practical Tips
Freehand circles

This method of drawing freehand circles is particularly quick and easy.

Using your hand like a compass, you can create circles and arcs with surprising accuracy after a few minutes of practice.

1. Place the tip of your little finger or the knuckle
   joint of your little finger at the center.
2. "Feed" the pencil out to the radius you want as
   you would do with a compass.
3. Hold this position rigidly and revolve the paper
   with your free hand.
THREE METHODS FOR SKETCHING CIRCLES

Method A

1. Sketch lightly the enclosing square and mark the midpoint of each side.
2. Draw light arcs connecting the midpoints.
3. Darken in the final circle.

Method B

1. Sketch the two centerlines.
2. Add light 45-degree radial lines. Sketch light arcs across the lines at an estimated radius distance from the center.
3. Darken the final circle.

Method C

1. Mark the estimated radius on the edge of a card or scrap of paper and set off from the center as many points as desired.
2. Sketch the final circle through these points.
**Step by Step 3.2**

Three ways to sketch an ellipse

**Method A**
1. Hold the pencil naturally, resting your weight on your upper forearm, and move the pencil rapidly above the paper in the elliptical path you want.
2. Lower the pencil to draw several light overlapping ellipses.
3. Darken the final ellipse.

**Method B**
1. Sketch lightly the enclosing rectangle.
2. Mark the midpoints of the sides and sketch light tangent arcs, as shown.
3. Complete the ellipse lightly and darken in the final ellipse.

**Method C**
1. To sketch an ellipse on given axes, lightly sketch in the major and minor axes of the ellipse.
2. Mark the distance along the axes and lightly block in the ellipse.
3. Darken the final ellipse.

**Practical Tip**

**Using a trammel**

The trammel method is a good way to sketch accurate ellipses.

To make a trammel, mark one-half the desired length of the minor axis on the edge of a card or strip of paper (A-B). Using the same starting point, mark one-half the length of the major axis (A-C). The measurements will overlap.

Next, line up the last two trammel points (B and C) on the axes and mark a small dot at the location of the first point (A). Move the trammel to different positions keeping B and C on the axes and mark points at A to define the ellipse.

Sketch the final ellipse through the points, as shown.