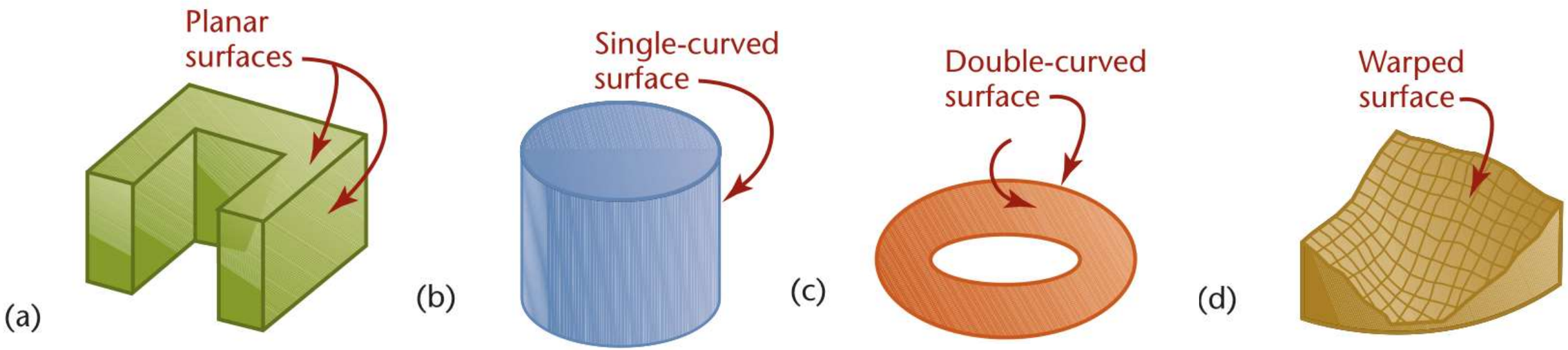
UNDERSTANDING SOLID OBJECTS

Three-dimensional figures are referred to as solids. Solids are bounded by the surfaces that contain them.

These surfaces can be one of the following four types:

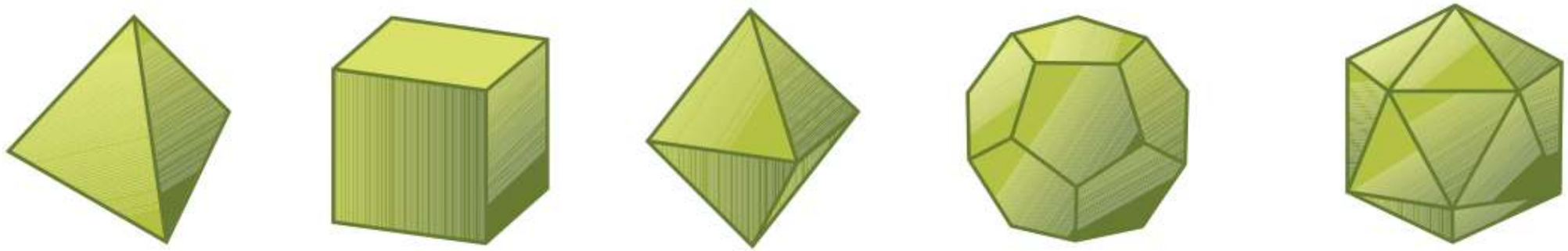


Types of Solids

- Solids that are bounded by plane surfaces are called **polyhedral.**
- These planar surfaces are also referred to as **faces** of the object.
- A **polygon** is a planar area that is enclosed by straight lines.

Regular Polyhedra

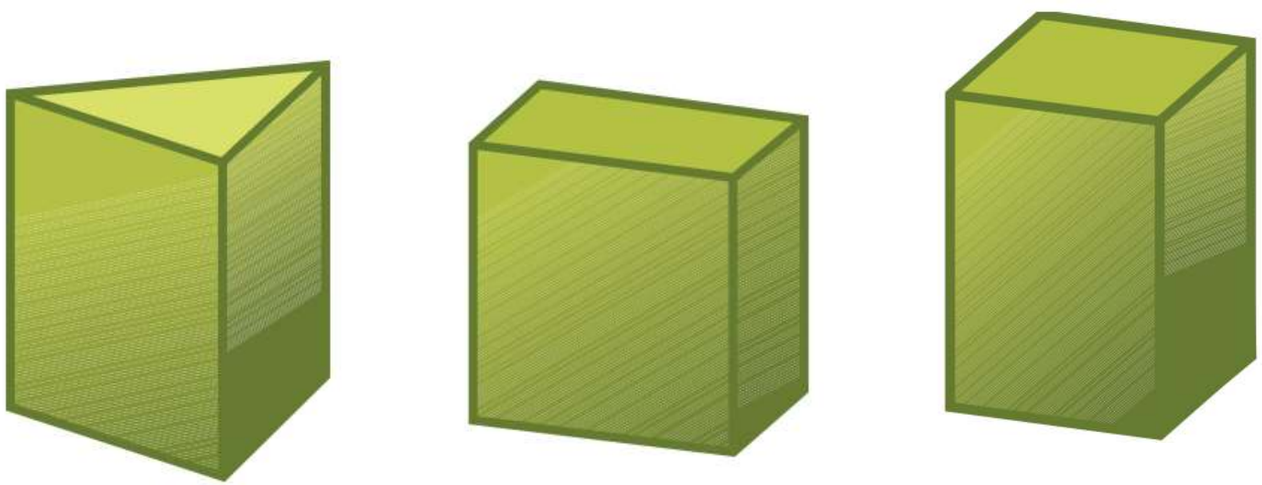
- If the faces of a solid are equal regular polygons, it is called a **regular polyhedron**.
- There are **five regular polyhedra**:



Tetrahedron (4 triangles) | Hexahedron (cube) | Octahedron (8 triangles) | Dodecahedron (12 pentagons) | Icosahedron (20 triangles)

Types of Solids

- A **prism** has two bases, which are parallel equal polygons, and three or more additional faces, which are parallelograms
- A **triangular prism** has triangular bases,
- A **rectangular prism** has rectangular bases, and so on.



Types of Solids

- A **right prism** has faces and lateral (side) edges that are perpendicular to the bases;
- an **oblique prism** has faces and lateral edges that are angled to the bases.
- If one end is cut off to form an end that is not parallel to the bases, the prism is said to be **truncated**

Right rectangular

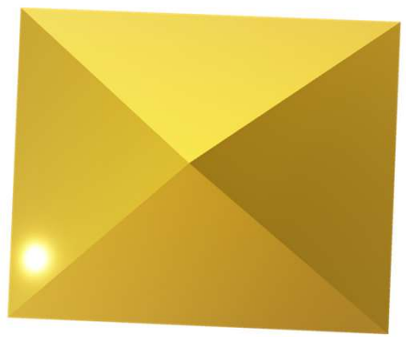
Oblique rectangular

Right pentagonal

Oblique hexagonal

Types of Solids

- A **pyramid** has a polygon for a base and triangular lateral faces that intersect at a common point called the **vertex .** T
- he line from the center of the base to the vertex is called the **axis**.
- If the axis is perpendicular to the base, the pyramid is called a **right pyramid**; otherwise, it is an **oblique pyramid**.
- **A triangular pyramid** has a triangular base, a **square pyramid** has a square base, and so on.
- If a portion near the vertex has been cut off, the pyramid is **truncated**, or it is referred to as a **frustum**.



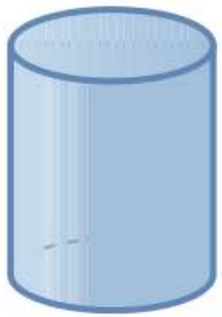
Right square (truncated)

Oblique pentagonal

Types of Solids

Cylinders

- A **cylinder** has a single-curved exterior surface.
- You can think of a cylinder as being formed by taking a straight line and moving it in a circular path to enclose a volume.



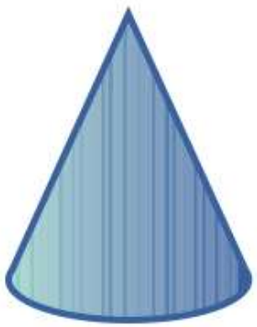
Right circular

Oblique circular

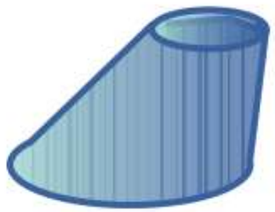
Types of Solids

Cones

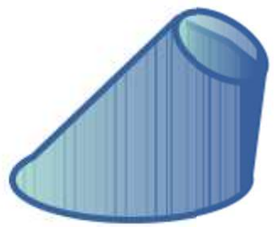
- A **cone** has a single-curved exterior surface .
- You can think of it as being formed by moving one end of a straight line around a circle while keeping the other end fixed at a point, the vertex of the cone.



Right circular



Oblique circular (frustum)



Oblique circular (truncated)

Types of Solids

Spheres

- A **sphere** has a double-curved exterior surface.
- You can think of it as being formed by revolving a circle about one of its diameters, somewhat like spinning a coin.
- The **poles** of the sphere are the points at the top and bottom of the sphere that would not move while it was spinning.
- The **axis** of the sphere is the term for the line between its poles.

Types of Solids

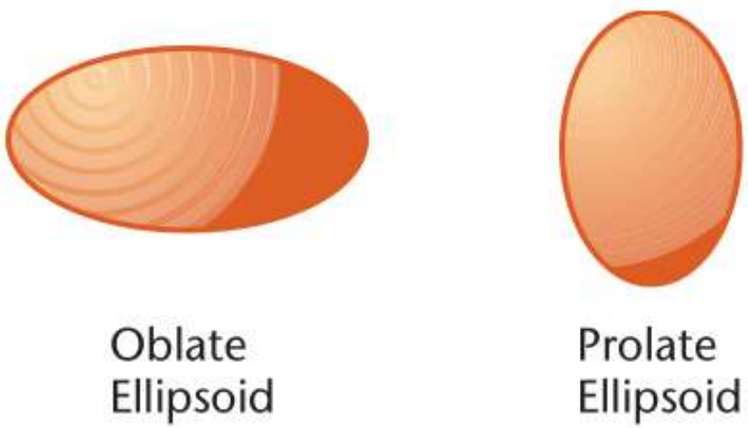
Tori

- A **torus** is shaped like a doughnut.
- Its boundary surface is double curved.
- You can think of it as being formed by revolving a circle (or other curve) around an axis that is positioned away from (outside) the curve.

Types of Solids

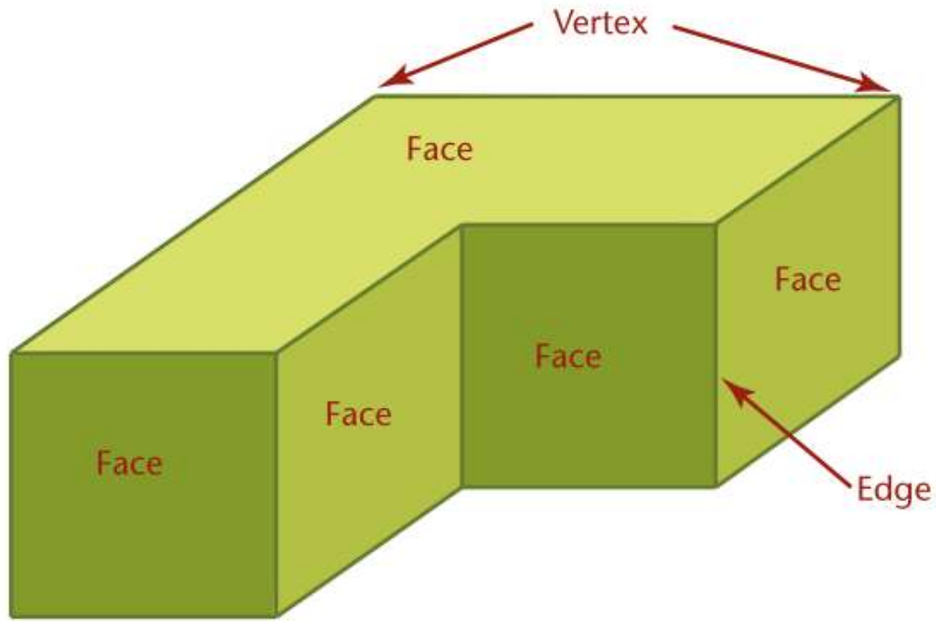
Ellipsoids

- An **oblate or prolate ellipsoid** is shaped like an egg.
- You can think of it as being formed by revolving an ellipse about its minor or major axis, respectively.



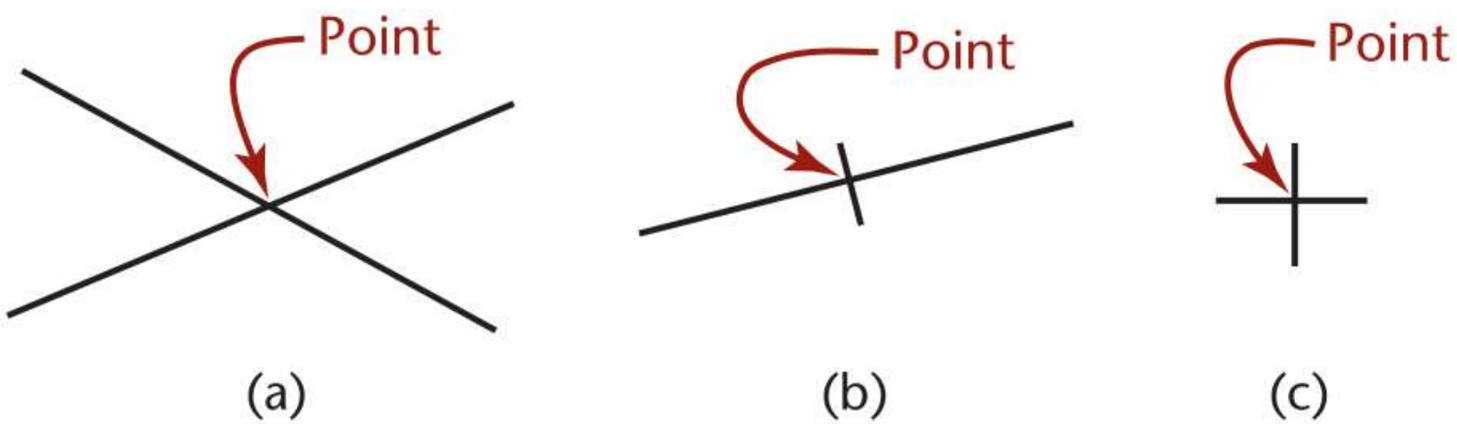
Edges and Vertices

- An **edge** of a solid is formed where two surfaces intersect.
- Edges are represented in drawings by visible or hidden lines
- A **vertex** (plural, vertices) of a solid is formed where three or more surfaces intersect.
- The end of an edge is a vertex.
- These vertices or “points” are very useful in defining the locations of the solid object feature that you will sketch



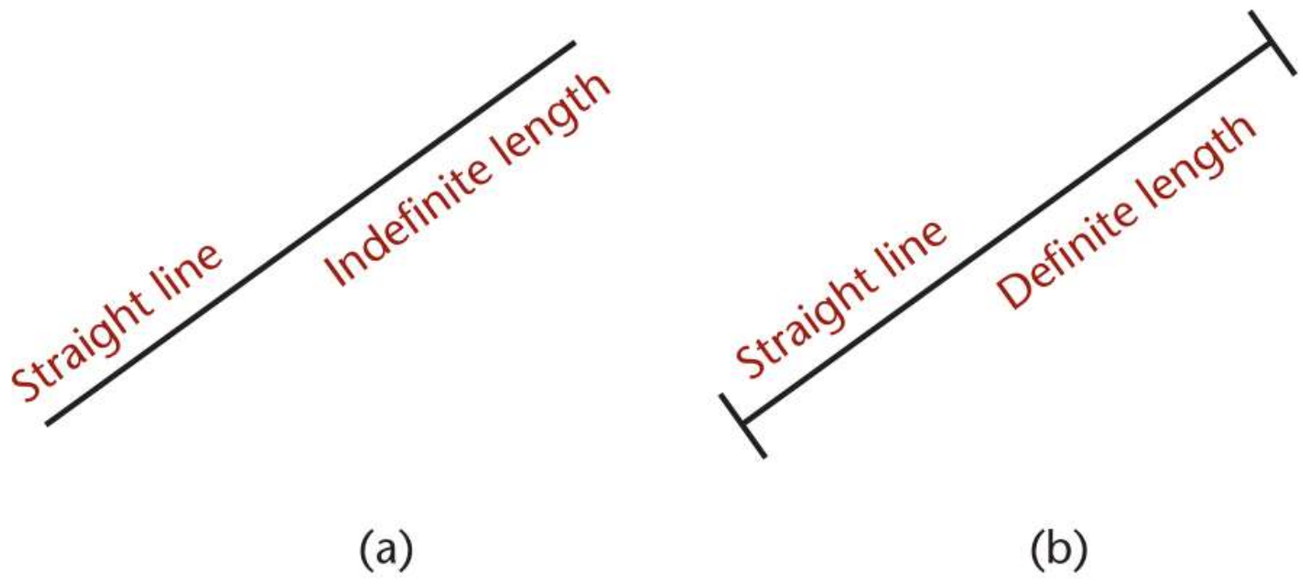
Points and Lines

- A **point** is used to represent a location in space but has no width, height, or depth
- A point in a drawing is represented by the **intersection of two lines** by a **short crossbar** on a line or by a **small cross**
- Do not represent points by simple dots on the paper. This makes the drawing look “blobby” and is not as accurate.



Points and Lines

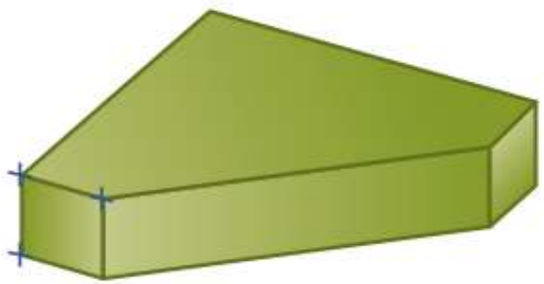
- A **line** is used in drawings to represent the edge of a solid object.
- A straight line is the shortest distance between two points and is commonly referred to simply as a “line.”
- **If the line is indefinite in extent**, in a drawing the length is a matter of convenience, and the endpoints are not marked
- **If the endpoints of the line are significant**, they are marked by small drawn crossbars



Planes

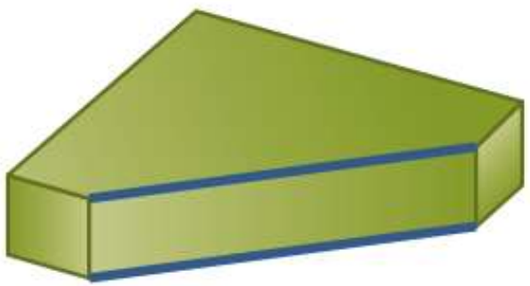
Planes are defined by any of the following

- **Three points not lying in a straight line**
- **Two parallel lines**
- **Two intersecting lines**
- **A point and a line**



(a) Three points not in a line

(c) Two intersecting lines



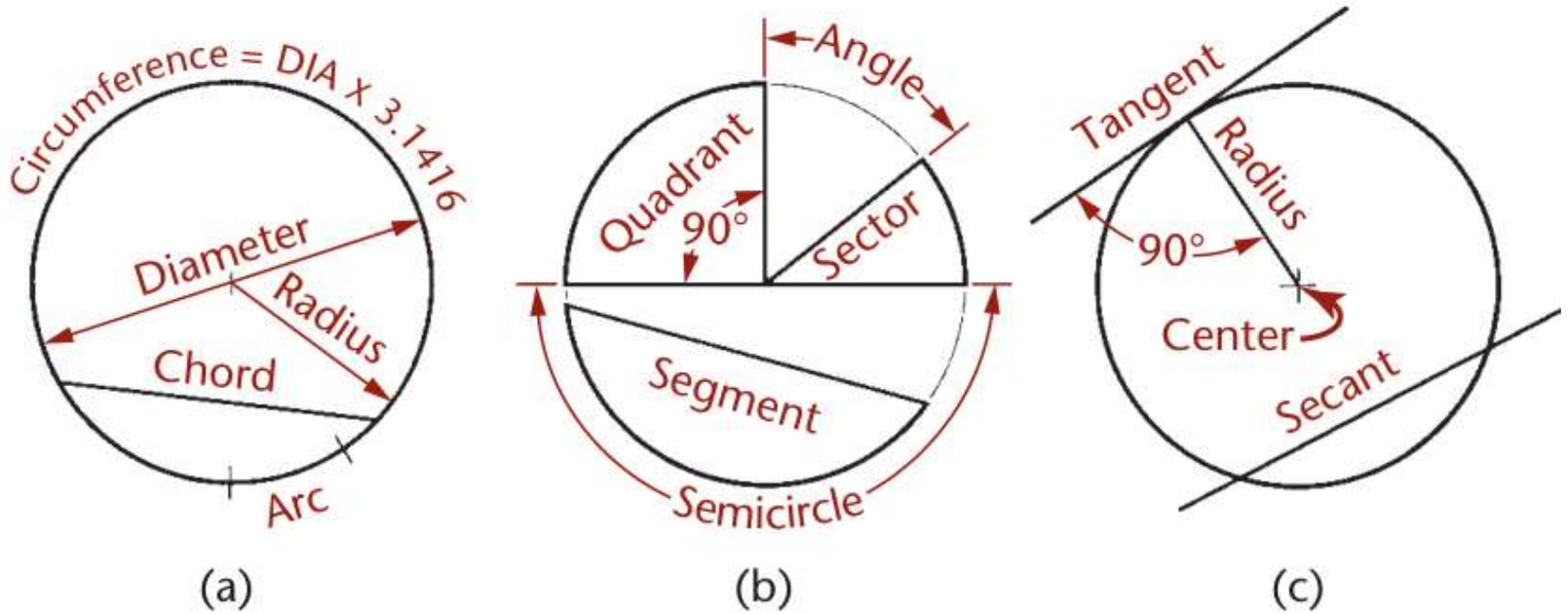
(b) Two parallel lines

(d) A point and a line

CIRCLES

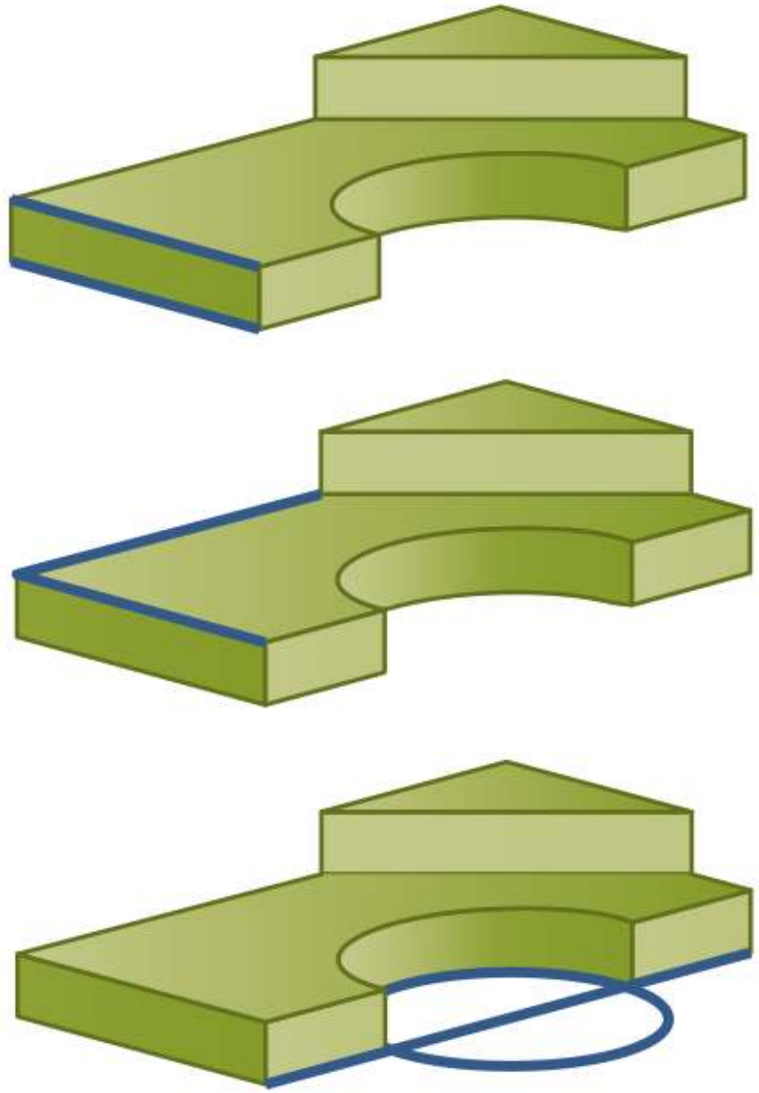
A **circle** is a set of points that are equidistant from a center point.

- The distance from the center to one of the points is the **radius.**
- The distance across the center to any two points on opposite sides is the **diameter**.
- The **circumference** of a circle contains 360° of arc.



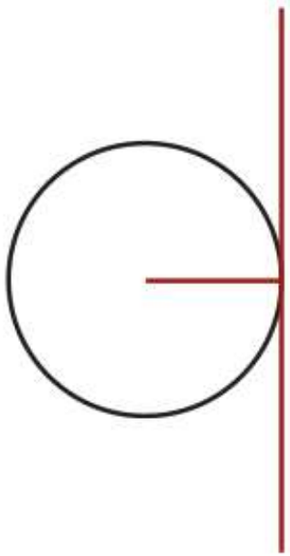
GEOMETRIC RELATIONSHIPS

- Two lines or planes are **parallel** when they are an equal distance apart at every point. **Parallel entities never intersect**, even if extended to infinity.
- Two lines or planes are **perpendicular** when they intersect at right angles.
- Two entities **intersect** if they have at least one point in common. Two straight lines intersect at only a single point.
- A circle and a straight line intersect at two points,



GEOMETRIC RELATIONSHIPS

- Two entities are **tangent** if they touch each other but do not intersect, even if extended to infinity,
- A **line that is tangent to a circle** will have only one point in common with the circle



A radial line from the point where a line is tangent to a circle will always be perpendicular to that line.