Machine Tool Technology (48.0501) T - Chart

Construct circles, arcs, and tangent arcs and lines	=	Identify/use properties of radius, diameter, tangent

Program Task: Perform layout operations.

Program Associated Vocabulary:
ARC, DIAMETER, FILLET, RADII, RADIUS, TANGENT, DIVIDER

Program Formulas and Procedures:
When performing a layout, the machinist must frequently construct circles and partial circles (arcs). Understanding the relationship between radius and diameter is critical so that layout is performed accurately.

Diameter = 2 x Radius

Radius = ½ Diameter

Example:
A blueprint calls for a 20 mm diameter hole. What would the divider setting be to lay out this hole?

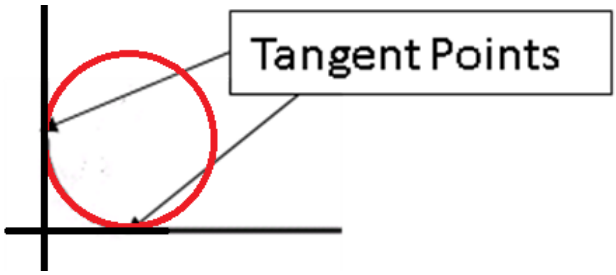
Since a hole's (circle's) radius is ½ its diameter, the 20 mm must be divided by two.

$20 \div 2 = 10$

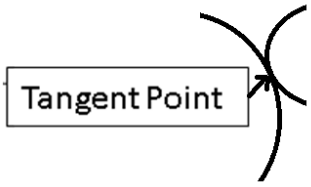
The divider must be set to 10 mm to construct the circle.

The concept of tangent is also vital to the machinist because layout often requires arcs to be connected to other arcs or to lines at tangent points.

Example:
The sketch below shows two lines that are tangent to an arc and their tangent points.



Example:
The sketch below shows two arcs that are tangent to each other and the tangent point.



PA Core Standard: CC.2.3.HS.A.8

Description: Identify and/or use the properties of a radius, diameter and/or tangent of a circle. (Given numbers should be whole.)

Math Associated Vocabulary:
RADIUS, DIAMETER, TANGENT, CIRCLE, CONGRUENT, PERPENDICULAR, POINT OF TANGENCY, EXTERNAL, INTERNAL, CIRCUMFERENCE, AREA, VOLUME

Formulas and Procedures:
Area of a Circle: $A = \pi r^2$

Circumference of a Circle: $C = 2\pi r$

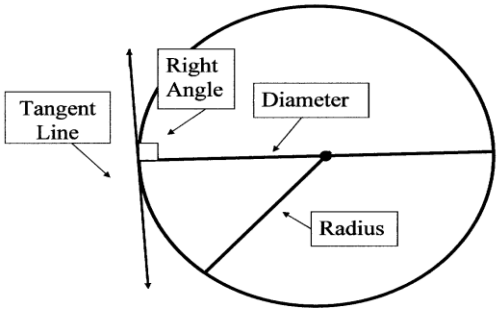
Cylinder: $SA = 2\pi r^2 + 2\pi rh$ $V = \pi r^2 h$

Sphere: $SA = 4 \pi r^2$ $V = (4/3) \times \pi \times r^3$

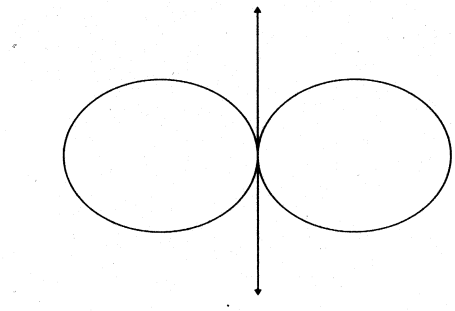
Cone: $SA = \pi r^2 + \pi r\sqrt{r^2 + h^2}$ $V = 1/3\pi r^2 h$

Theorem: Tangent segments to a circle from the same external point are congruent.

Theorem: If a line is tangent to a circle, it is perpendicular to the radius drawn to the point of tangency.



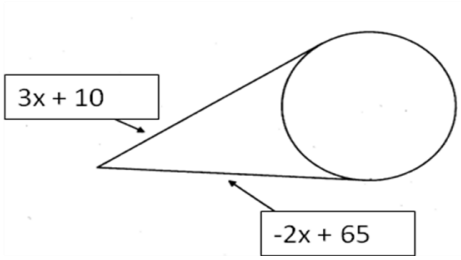
The picture below shows tangent circles with a common interior tangent line.



Instructor's Script – Comparing and Contrasting
If you look at the examples on the first page of this T-Chart you can see that the tangent arcs are very similar to the picture of tangent circles. This leads us into another concept of arcs and arc length.

Common Mistakes Made By Students
Students do not know the math concepts or how to apply them.

Example: Find the value of x
$3x + 10 = -2x + 65$ Set up the equation.
$3x = -2x + 55$ Subtract 10 from each side of the equation.
$5x = 55$ Add 2x to each side of the equation.
$x = 11$ Divide by 5.



CTE Instructor's Extended Discussion
There are other situations that involve diameter/radius and tangent relationships.

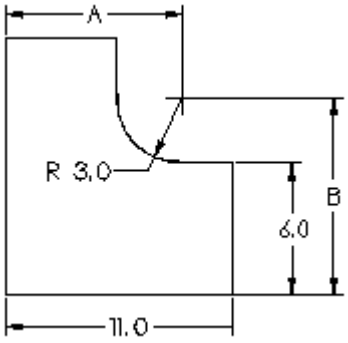
One situation involves machining an insider corner radius, or fillet. If a fillet is specified on a blueprint, the machinist must choose the correct diameter tool to produce that radius since cutting tools are defined by diameter, not radius.

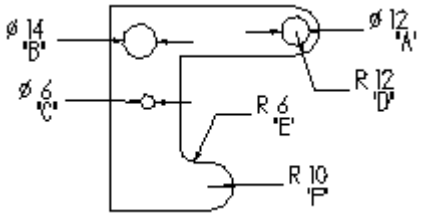
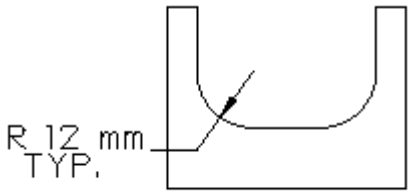
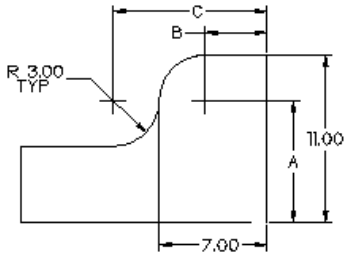
Example: What diameter endmill must be used to create a 10 mm fillet radius? Since diameter = 2 x radius, the correct endmill diameter would be found by multiplying 10 by 2, so a 20 mm diameter endmill would be needed.

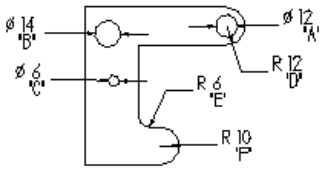
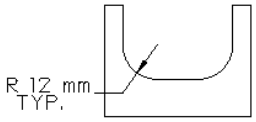
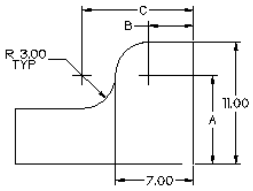
Another instance is when two linear distances and a corner radius is specified. The machinist needs to subtract the size of the radius from the linear dimensional locations to determine the location of the center point of the radius. The corner radius will then be positioned correctly and tangent to each line.

Example: The 6" and the 11" dimensions are given, but "A" and "B" need to be determined to locate the center point of the radius for layout.

$A = 11 - 3 = 8$
$B = 6 + 3 = 9$



Problems	Career and Technical Concepts	Solutions
1. Determine divider settings for diameters A, B, & C and for radii D, E, & F. All dimensions are in mm.		
2. The sketch shows a part that will be machined on a conventional vertical mill. What diameter endmill will produce the correct fillet radius?		
3. A layout needs to be performed according to the blueprint shown. Determine distances A, B, and C to locate the center points of the radii. All dimensions are in inches.		
Problems	**Related, Generic Math Concepts**	**Solutions**
4. What must the radius of a cylinder whose height is 3 in. be if the cylinder is to hold 35 $in.^3$ of fluid?		
5. A family would like to build a fence in their backyard for a riding ring for their horse. How much fence should they buy if the ring covers ½ an acre of land? (1 acre = 4840 $yards^2$)		
6. A family has 75 ft. of fencing to fence in their circular garden. What is the approximate radius of the garden?		
Problems	**PA Core Math Look**	**Solutions**
7. Find the radius of a circle whose circumference is 20 ft.		
8. Find the radius of a circle whose area is 45 $in.^2$.		
9. Find the height of a cylinder whose volume is 300 $ft.^2$ and whose radius is 6 ft.		

Problems	Career and Technical Math Concepts	Solutions
1. Determine divider settings for diameters A, B, & C and for radii D, E, & F. All dimensions are in mm.		A = 12 ÷ 2 = 6 mm B = 14 ÷ 2 = 7 mm C = 6 ÷ 2 = 3 mm D = 12 mm E = 6 mm F = 10 mm
2. The sketch shows a part that will be machined on a conventional vertical mill. What diameter endmill will produce the correct fillet radius?		12 x 2 = 24 mm
3. A layout needs to be performed according to the blueprint shown. Determine distances A, B, and C to locate the center points of the radii. All dimensions are in inches.		A = 11 – 3 = 8” B = 7 – 3 = 4” C = 7 + 3 = 10”
Problems	**Related, Generic Math Concepts**	**Solutions**
4. What is the radius of a cylinder whose height is 3 in. and which holds 35 in.^{3} of fluid?		$v = \pi r^2 h \quad 35 = \pi r^2 3 \quad \frac{35}{3\pi} = r^2 \quad r = \sqrt{\frac{35}{3\pi}} \approx 1.93$ inches The radius of the cylinder must be about 1.93 inches.
5. A family would like to build a fence in their backyard for a riding ring for their horse. How much fence should they buy if the ring covers ½ an acre of land? (1 acre = 4840 yards^2)		½ acre = 2420 yds.^{2} $2420 = \pi r^2 \quad r = \sqrt{\frac{2420}{\pi}} \quad r \approx 27.75$ yds. $C = 2\pi r \quad C = 2\pi(27.75) \quad C = 174.36$ yds. They should buy about 175 yards of fencing.
6. A family has 75 ft. of fencing to fence in their circular garden. What is the approximate radius of the garden?		$C = 2\pi r \quad 75 = 2\pi r \quad r = \frac{75}{(2\pi)} \quad r \approx 11.94$ feet The radius is approximately 11.94 feet.
Problems	**PA Core Math Look**	**Solutions**
7. Find the radius of a circle whose circumference is 20 ft.		$C = 2\pi r \quad 20 = 2\pi r \quad r = \frac{20}{(2\pi)} \quad r \approx 3.18$ feet
8. Find the radius of a circle whose area is 45 in.^{2}.		$A = \pi r^2 \quad 45 = \pi r^2 \quad r = \sqrt{\frac{45}{\pi}} \quad r \approx 3.78$ inches
9. Find the height of a cylinder whose volume is 300 ft.^{2} and whose radius is 6 ft.		$V = \pi r^2 h \quad 300 = \pi 6^2 h \quad 300 = 36\pi h \quad \frac{300}{(36\pi)} = h$ $h \approx 2.65$ feet