R T S I
Q u i z S o l u t i o n s

Following are the solutions for the Shop Math Quiz found in the September issue of Tooling & Production magazine's Shop Talk with Steve Rose.

		ANSWER
1.	What is the decimal equivalent of 27/40?	0.675
	27 ÷ 40 = 0.675	
2.	A 1/4-20 external thread is required on a 1.5" length. How many threads will be formed on this length?	30 threads
	There are 20 threads per inch on this thread so: 20 x 1.5 = 30	
3.	You get a new box of 10 inserts. If you use 4/5 of them, how many are left?	2 inserts
	4/5 x 10 = 8 inserts used 10 - 8 = 2 inserts left	
4.	A boring bar has a 7:1 length-to-diameter ratio. If the diameter is 1.250", what is the length?	8.75" long
	For each inch of diameter, the length is 7 inches so: 1.250 x 7 = 8.75	
5.	If a triangle has 2 angles of 30 each, what is the size of the 3rd angle?	120º
	A triangle has 180 degrees total so: 180 - (2 x 30) = 120	
6.	A right triangle has one side length of 3.25" and another side length of 4.55", what is the length of the hypotenuse?	5.5915"
	Using Pythagorean Theorem ($A^2 + B^2 = C^2$): A = 3.25", B = 4.55" find C	
	$3.25^2 + 4.55^2 = C^2$ C = 5.5915	

ANSWER

7. Find the length of the diagonal (line JK) of this cube which has an edge length of 4.5 cm. — 7.79 cm

Use Pythagorean Theorem and solve the problem in 2 steps.
First form a triangle on the bottom face and find the length of the diagonal on the bottom face. The two sides will be 4.5 cm each.

$4.5^2 + 4.5^2 = C^2$ C = 6.3640 -this is the length of the diagonal of the bottom face

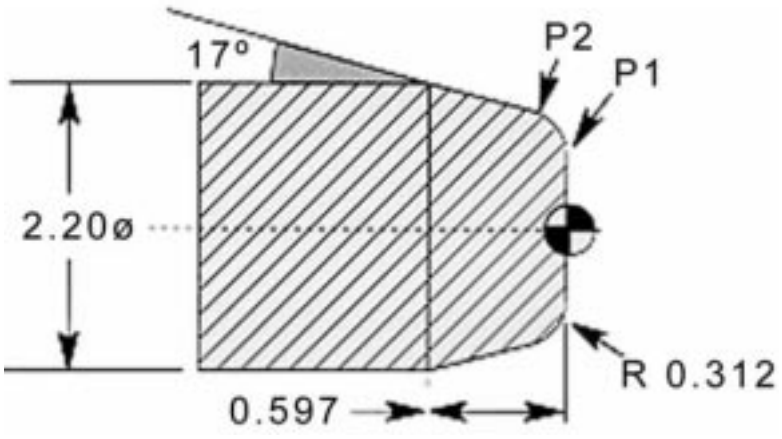
Create another triangle using the line JK, the back right edge of the cube and the bottom face diagonal. Again, use Pythagorean Theorem to calculate the length of line JK.
A = 4.5 cm (the right back edge)
B = 6.3640 cm (the bottom face diagonal)
C = line JK $4.5^2 + 6.3640^2 = C^2$ C = 7.79 cm

8. One machinist has worked at the XYZ Co. 3 times as long as a newcomer. An old-timer has worked there 5 times as long as the newcomer. The three employees have a total of 63 years at the XYZ Co. How long has each worked at the company? — machinist = 21 yrs, old timer = 35 yrs, new comer = 7 yrs

Solve this problem by setting up an equation and solve for the unknown. There appears to be 3 unknowns, but they are all factors of 1 unknown, the number of years for the newcomer. So use X for the number of years in which the newcomer has worked. The machinist has worked 3 times as long, 3X. And the old-timer is 5X. The total is 63 years, so create an equation and solve for X.

$X + 3X + 5X = 63$
$9X = 63$
$X = 7$ So X = 7,
3X = 21
5X = 35

9. Calculate the points P1 and P2 on the following part.
P1 is the start point of the 0.312 radius. P2 is the end point of the 0.312 radius.



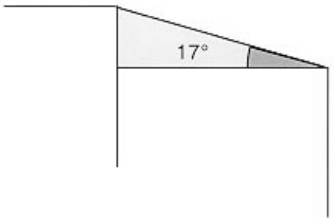
ANSWER

9. There are four dimensions to find, P1 in Z and X. And P2 in Z and X axes.

P1 Z0.00
P1 X1.3733
P2 Z-0.2208
P2 X1.9700

Do the easy one first. P1 in Z = 0.00

step #1 Extend the lines to create an intersection point, as shown.

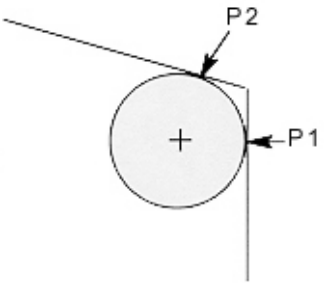


step #2 Use the triangle and trig to calculate the distance from the larger diameter to the smaller diameter. This give the X position of the new point.

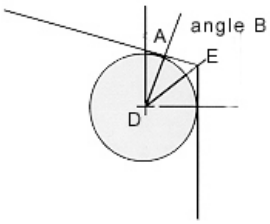
tan angle = opposite / adjacent

tan 17 = opp / 0.597

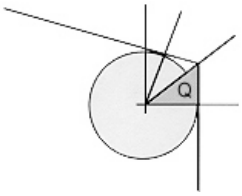
opp length = 0.1825 2.20 - (2 x 0.1825) = 1.835



step #3 Knowing the intersection point is at X 1.835, calculate the distance from the intersection point and P1. Find the center of the radius and draw lines as shown. Through geometry, it is known that angle A is 17, which means angle B is 73 degrees. This is bisected with line DE, making each angle 36.5.



step #4 Use triangle Q and trig to find the distance between the point of intersection and P1 (in X).

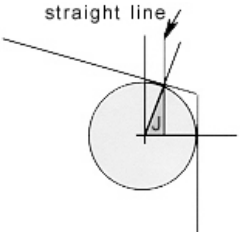


tan 36.5 = opp / 0.312

opp = 0.2309 1.835 - (2 x 0.2309) = 1.3733

So P1 Z = 0

X = 1.3733



step #5 Draw a line from the P2 point to the horizontal line, creating triangle J. Use triangle J and trig to find the Z and X positions for P2. From geometry, we know that this triangle has a 17 angle and a hypotenuse of 0.312. Calculate the adjacent side length.

cos 17 = adj / 0.312

adj = 0.2984 Add this to P1 X to find P2X 1.3733 + (2 x 0.2984) = 1.9700

Use the same triangle to find the opposite side length.

sin 17 = opp / 0.312

opp = 0.0912 Subtract this from the arc center position to find P2 Z distance. 0.312 - 0.0912 = 0.2208

P2X = 1.9700 P2Z = -0.2208

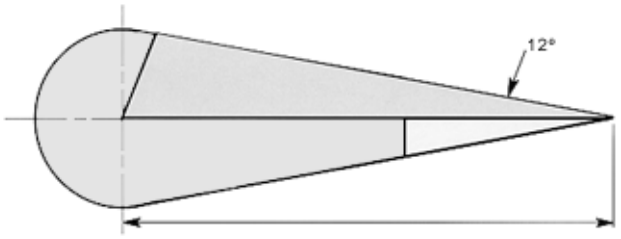
ANSWER

A = 8.7201

10. To find the length of the unknown A:

step #1 Extend the sides to make a point as shown.

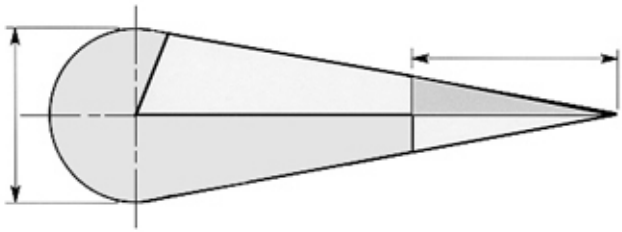
step #2 Through geometry, we know the point has an included angle of 12 degrees. From the arc center, draw a line to the tangent point of the side. Because it is tangent, the line and side of the part form a 90 degree corner.



Use the triangle that is formed to calculate the length of the hypotenuse.

sin 12 = 2.25 / hyp
hyp = 10.82

step #3 Now we know the length of the center line from the arc center to the point. The length of the cone must be subtracted.



Form a triangle in the cone and use trig to calculate the side length.

tan 12 = 0.925 / adj
adj = 4.3518

Step #4 Subtract the side length from the length calculated in step #2. Then add the radius to calculate length A.

10.82 - 4.35 = 6.47 + 2.25 = 8.72

11. This problem is solved with the following steps.

step #1 The distance for A is found by simply subtracting the difference between the full diameter with the ball and the part diameter. Then divide by two.

(6.011 - 5.675) /2 = 0.168

step #2 Determine the angle per side on the worm thread.

29 / 2 = 14.5

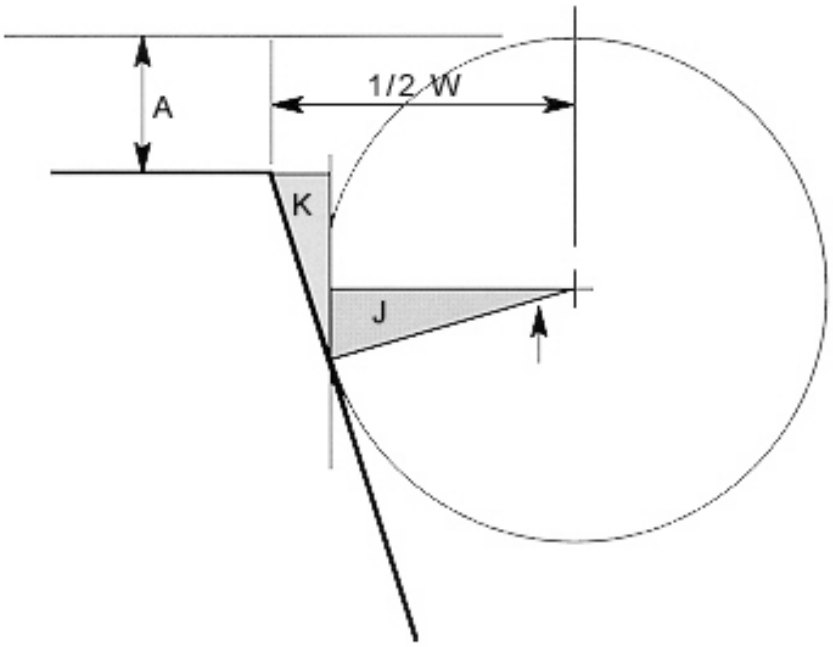
Step #3 Find the tangent point between the part and the gauge ball. Draw a right triangle with the hypotenuse between the tangent point and the center of the ball. This is triangle J. Through geometry we know that the small angle of this triangle is 14.5 degrees.

ANSWER
a = 0.168
W = 0.5586

Use trig to calculate the length from the center of the gauge ball and the vertical line from the tangent point. (The long side of triangle J)

cos 14.5 = adj / 0.250
adj = 0.2420

This is a part of the W dimension.



step #4 Now, find the distance from the top of the thread to the tangent point.

From the tangent point, draw another triangle as shown. This is triangle K. Again, through geometry, the small angle is 14.5 degrees. The only thing we know about this triangle is the angles. We need to find a length.

Using the first triangle (J), calculate the opposite side.

sin 14.5 = opp / 0.250 opp = 0.0623

Then determine the adjacent side of the triangle K.

(radius of gauge ball - dimension A) + short side of triangle J = length of adjacent side triangle K

(0.250 - 0.168) + 0.0625 = 0.1445

Now that you know the length of triangle K, use trig and calculate the opposite side length.

tan 14.5 = opp / 0.1445
opp = 0.0373

This short side plus the horizontal length of triangle J is one half of the length W.
0.0373 + 0.2420 = 0.2793
Double this amount for the value of W. W = 2 x 0.2793 = 0.5586

12.

ANSWER
X2.256
Z-2.3424

step #1 To find the X and Z position for the center of the radius, first calculate the size of the step between the two diameters.

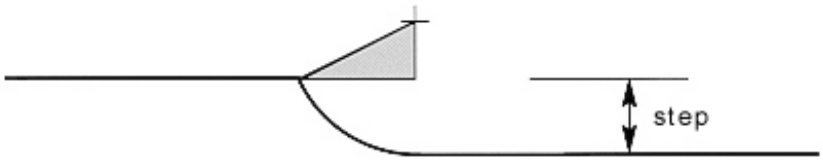
(1.350 - 1.132) / 2 = 0.109

Step #2 Draw a triangle from the arc center point and the tangent point to the larger diameter as shown. Because we know the step dimension from above, we can determine the length of the vertical side of this triangle.

arc radius - step dimension = vertical side of triangle

0.562 - 0.109 = 0.453

Step #3 Use Pythagorean theorem to find the length of the third side of the triangle.



A = 0.453
C = 0.562

$A^2 + B^2 = C^2$

C = 0.3326

Step #4 Subtract this amount from the Z length to the end of the arc.

2.6750 - 0.3326 = 2.3424

This is the Z dimension Z-2.3424

The X dimension is found by adding twice the radius value to the smaller diameter.

1.132 = (2 x .562) = 2.256

Z-2.3424
X2.256