# Machine Tool Technology (48.0501) T-Chart



Calculate drill depth	Construct and compare linear, quadratic, and exponential models to solve problems			
<b>Program Task:</b> Perform drilling on the drill press/ vertical milling machine.	PA Core Standard: CC.2.2.HS.C.5			
	<b>Description:</b> Construct and compare linear, quadratic, and exponential models to solve problems.			
<b>Program Associated Vocabulary:</b> PROPORTIONATE	Math Associated Vocabulary: INVERSE, RECIPROCAL, PROPORTION, CROSS MULTIPLICATION, RATIO, CONSTANT			
<b>Program Formulas and Procedures:</b> When performing drilling operations it is important to know the length of the tip of a drill so that holes will be drilled to the proper depth.	Formulas and Procedures: Direct Variation: $y = kx$ y is directly proportional to x with constant k not equal to zero.			
The length of a 118° drill point is proportionate to its diameter and can be shown by the following formula. As the	<b>Inverse Variation:</b> $y = k/x$ y is directly proportional to x with constant k not equal to zero.			
diameter of the drill increases, the length of the point will increase. $L = 2 \times D$	<b>Example: Inverse Variation</b> y = k/x			
$L = .3 \times D$ Where L = length of the drill point, D = Diameter of the drill, and .3 is the constant	y = 20/x $k = 20$			
<b>Example:</b> If a group of <sup>1</sup> / <sub>4</sub> " and 5/16" diameters, two holes are both to be drilled to a full diameter depth of .5", what would be the total drill depth required for the two hole sizes?	x12410 $y$ 201052 As the x value increases the y value decreases. Notice if you solve the equation for k you get k = xy. For each value of x and y above $xy = k$ . k is 20. Example: Direct Variation $y = kx$ $y = 2x$			
Depth for $\frac{1}{4}$ drill: L = .3 x. 25 = .075" Add .075" to the .5" to get a full depth of .575" for the $\frac{1}{4}$ " drill.				
<b>Depth for the 5/16" drill:</b> L = .3 x .3125 = .09375" ≈ .094	y = 3x $k = 3$			
Add .094" to the .5" to get a full depth of .594" for the 5/16" drill.	x         1         2         4         10           y         3         6         8         30			
	As the x value increases, the y value increases			

As the x value increases, the y value increases. Notice if you solve the equation for k you get k = y/x. For each value of x and y above y/x = k. k is 3.

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### Instructor's Script – Comparing and Contrasting

The Machine Tool Technology example gives an example of direct variation. In this example as one variable increases, the other variable increases as well. This shows the importance of knowing how important it is to determine how one variable changes another variable. Keystone Exams and other standardized tests may contain a number of questions regarding different circumstances where one variable changes as another does. It may be direct or inverse variation. It may be exponential growth or decay.

It may be similar figures with the change in perimeter, area or volume. When you have similar figures, if the height is doubled the perimeter will also be doubled since the scale factor and the ratio of the perimeters is the same. The area of the figure would be multiplied by 4 since the ratio is  $1^2:2^2$ . The volume would be multiplied by 8 since the ratio is  $1^3:2^3$ .

#### **Common Mistakes Made By Students**

Students often make the mistake of not knowing the correct formula to use. One of the best ways to figure out what the change in one variable would be if there is a change in another is to make a table of values to find the pattern. Also, some data may not have a pattern.

### **CTE Instructor's Extended Discussion**

Using basic formulas that show relationships between two factors can be used in many areas in machining.

One case similar to drill point depth is countersinking depths. Increasing the cutting depth of a countersinking tool increases the diameter of the chamfer or countersink on a part. The factor depends on the angle of the tool.

When calculating RPM for machining operations, as tool diameter increases, RPM will decrease and vice versa. If a different cutting speed is applied to the same size tool for different materials, a lower cutting speed will result in a proportionately lower RPM and vice versa.

## Additional Example:

You are given two similar cylinders with a scale factor of 1:3.

- a. If the height of the smaller is tripled how does this change the height of the other?
- b. If the height of the smaller is tripled how does this change the surface area of the other?
- c. If the height of the smaller is tripled how does this change the volume of the other?

#### Solution

- a. All of the linear measurements of the two cylinders will be in the same ratio. So if the height of the smaller is tripled then the height of the other will be tripled also.
- b. All of the area measurements of the cylinders will be in the ratio of  $1^2:3^2$ . So if the height of the smaller is tripled, then the surface area of the other is going to be multiplied by 9.
- c. The volume of the cylinders will be in the ratio  $1^3:3^3$ . So if the height of the smaller is tripled, then the volume of the other is going to be multiplied by 27.





Problems Career and Technical Ma									Solutions	
1.	A cour VMC. .002", depth t D = D	Itersink i If every what adj to make to iameter	is creatin v.001" or justment the diam Change,	g a $\emptyset.22$ f depth in should b eter .210 d = dept	$25 \times 90^{\circ}$ ncreases be made t "? D = 2 h change	chamfer the diam to the pro d, where	on a neter by ogrammed			
2.	A print thick p drilled L = Le	t specifie late. Wl ? The po ength of	es a $\emptyset 5/8$ hat is the oint leng drill tip,	3'' hole to minimu th is .3 ti D = Drij	b be drill m total d mes the ll diamet	ed throu lepth tha diameter er	gh a <sup>3</sup> /4" t must be :.			
3.	Your c both al alumin steel is the alu stainles P = Fa	ompany uminum um part turned a minum p ss steel p ctor of cl	produce and stai is turned at 600 RI part, what part? $S =$ hange from	s the san nless ste l at 2600 PM. If th t should PA, whe pm A to	the cylind el. The ( RPM where ID is the RPM the RPM erre $A = F$ S	lrical par OD of th hile the s pored at I be for l RPM for	t from e stainless 1600 on poring the aluminum,			
	<b>T</b> 1	6 11 .	Pr	oblems		Rel	ated, Gener	ic Math Concepts	Solutions	
4.	For the represe	e followi ent direct	ng proble t variatio	ems dete n, indire	rmine if ct variati	the valu ion or ne	es ither.			
		Х	2	3	4	8				
		у	18	12	9	4.5				
5.							1			
		Х	2	3	4	5				
		У	14	21	28	30				
6.	j.									
		X	3	9	10	12	-			
		у	9	27	30	36				
			Pro	blems			PA Core	Math Look	Solutions	
7.	You ar If the h change	e given the given the given the height of the height be an arrive the height of the height be he	two simi the smal ght of the	lar cones ller is mu other?	s with a s altiplied	scale fact by 4, how	for of 1:4. w does this			
8.	If the h change	neight of the surf	the smal face area	ller is mu of the ot	iltiplied her?	by 4, ho	w does this			
9.	9. If the height of the smaller is multiplied by 4, how does this change the volume of the other?									



			Probl	ems	Ca	reer and	Technical Math Concepts Solutions
1.	A countersir VMC. If ev by .002", wh programmed D = 2d, whe	hk is crea ery .001' hat adjust l depth to re D = D	ating a $\varnothing$ of depti tment sho to make the the make the theory of the t	.225 x 9 h increas ould be 1 he diame Change,	$0^{\circ}$ chamfe ses the dia made to the eter .210 <sup>20</sup> d = depth	er on a ameter he ? h change	.225210 = .015 The diameter needs to <i>decrease by</i> .015 $D = 2 \ge d \rightarrow .015 = 2 \ge d$ $\frac{.015}{2} = d \rightarrow d = .0075$ Decrease the programmed depth by .0075"
2.	A print spec <sup>3</sup> / <sub>4</sub> " thick pla must be drill diameter. L	ifies a Ø te. Wha led? The = Length	5/8" hole t is the m point le n of drill	e to be d iinimum ngth is tip, D =	rilled thro total dep 3 times th Drill diar	ough a th that ne neter	L = .3D L = .3 x .625 = .1875 Add .1875 to .75 for a total depth of .9375".
3.	Your compa- both aluming aluminum pa- stainless stee at 1600 on the for boring the RPM for alu	ny produ um and s art is turn el is turn he alumin ne stainle uminum,	aces the s stainless s ned at 26 ed at 600 num part ess steel p P = Factor	ame cyl steel. Th 00 RPM RPM. , what sl part? S = or of cha	indrical p ne OD of while the If the ID hould the PA, whe ange from	e the e is bored RPM be re A= A to S	$S = P \ge A$ $S = P \ge A$ $600 = P \ge 2600$ $S = P \ge 1600$ $\frac{600}{2600} = P$ $S = .23 \ge 1600$ $P \approx .23$ $S = 368 \text{ RPM}$
			Problem	IS	R	elated, G	eneric Math Concepts Solutions
4.	For the follo represent dir	wing pro rect varia	blems dention, ind	etermine irect var 4 9	e if the value of	lues neither.	This is an example of inverse variation. As the x value increases, the y value decreases. Solving the equation $y = k/x$ for k gives $k = xy$ . For each pair of values k is equal to 36. (2 x 18, 3 x 12, 4 x 9, 8 x 4.5) The equation would be $y = 36/x$ . $k = 36$
5.	x y	2 14	3 21	4 28	5 30		This is an example of neither. As the x value increases the y value increases, but the relationship is not consistent. $2/14 = 7$ , $3/21 = 7$ , $4/28 = 7$ , $5/30$ is not equal to 7. There is no value for k.
6.	x y	3 9	9 27	10 30	12 36		This is an example of direct variation. As the x value increases, the y value increases. Solving the equation $y = kx$ for k gives $k = y/x$ . For each pair of values k is equal to 3. (9/3, 27/9, 30/10, 12/36) The equation would be $y = 3x$ .
		P	roblems			PA C	Core Math Look Solutions
7.	You are give 1:4. If the he does this cha	en two si eight of t ange the	milar con he smalle height of	nes with er is mul the othe	a scale fa tiplied by er?	actor of 74, how	All of the linear measurements of the two cones will be in the same ratio. So if the height of the smaller is multiplied by 4 then the height of the other will be multiplied by 4 also.
8.	If the height does this cha	of the sr ange the	naller is surface a	multiplie rea of th	ed by 4, h ne other?	IOW	All of the area measurements of the cones will be in the ratio of $1^2:4^2$ . So if the height of the smaller is tripled, then the surface area of the other is going to be multiplied by 16.
9.	If the height does this cha	of the sr ange the	naller is volume o	multiplie of the otl	ed by 4, h her?	low	The volume of the cones will be in the ratio $1^3:4^3$ . So if the height of the smaller is tripled, then the volume of the other is going to be multiplied by 64.