Machine Tool Technology (48.0501) T-Chart

Calculate machining time	=	Construct and compare linear, quadratic, and exponential models to solve problems

Program Task: Job planning, bench work, and layout.

Program Associated Vocabulary:
RATE

Program Formulas and Procedures:
In industry, it is important to know how long operations will take to complete. This is important for quoting and meeting delivery schedules.

Example 1:
If you can produce parts at the rate of 30 per 8 hour day, how long will it take to fill a 230 piece order?

Let N=Number of parts in the order
Let R=Number of parts produced per day
Let D=Number of days needed

$$N = R \text{ x } D$$
$$230 = 30 \text{ x } D$$
$$\frac{230}{30} = D$$
$$D = 7.6 \text{ Days}$$

Example 2:
If this customer wants 16,200 parts this year, how many days of production are needed to meet the demand? Can you fill this order at your current level of production? If not, how can you meet the requirement?

$$N = R \text{ x } D$$
$$16,200 = 30 \text{ x } D$$
$$\frac{16,200}{30} = D$$
$$D = 540 \text{ Days}$$

You cannot meet this by only running 8 hours daily. If you hired a second employee to work 8 hours daily, it would take 270 days (540 ÷ 2) to fill the full order.

If you and your employee work 5 day weeks, how many weeks will it take to finish the order? Could you then meet the deadline?

$$\text{Weeks} = 270 \div 5 = 54 \text{ five-day weeks}$$

You still cannot meet the order. Two more full weeks of 16 hour days are needed. So you both need to work another 10 days (probably Saturdays) to fill the order.

PA Common Core Standard: CC.2.2.HS.C.5

Description: Construct and compare linear, quadratic, and exponential models to solve problems.

Math Associated Vocabulary:
RATE, CONSTANT, VARIABLE, EXPONENTIAL GROWTH, EXPONENTIAL DECAY, LINEAR

Formulas and Procedures:
Formulas for constant or linear rates of change: y = kx (where k is used to represent the constant of variation)
Examples of situations that could be modelled by a direct variation equation:

- The amount of time spent running at a steady pace and the number of miles ran
- The number of lawns you mow and the amount of money you make
- The amount of gas you buy (in gallons) and the amount of money you pay

Example: If x varies directly as y, and y = 12 when x = 3, then find y when x = 20.

Step 1: Write the correct equation. Direct variation problems are solved using the equation y = kx.	$y = kx$
Step 2: Use the information given in the problem to find the value of k. In this case, you need to find k when x = 9 and y = 6.	$12 = k(3)$ $k = \frac{12}{3} = 4$
Step 3: Rewrite the equation from step 1 substituting in the value of k found in step 2.	$y = 4x$
Step 4: Use the equation found in step 3 and the remaining information given in the problem to answer the question asked. In this case, you need to find y when x = 20.	$y = 4(20)$ $y = 80$

Instructor's Script – Comparing and Contrasting

In the machine tool industry calculating rates of change or the rate you will be able to complete a job is important. You have deadlines to meet, because the people who are purchasing your products also have deadlines to meet.

Common Mistakes Made By Students

Many CTE situations will provide a constant of variation but a common mistake is substituting x and y incorrectly when needing to find a constant.

CTE Instructor's Extended Discussion

Rates and time are things that students do not usually think about very much. They usually only consider what they are supposed to be *doing right now, and do not think about the bigger picture.* It is important to show examples like the one on page one so they start to see that bigger picture.

Even if they are only an employee and not the person quoting work or scheduling time to meet commitments, students need to know that they have to meet short and long term goals to keep their companies in business and keep their own jobs.

This concept can also be used to determine material usage like how much material is needed to produce a certain number of parts of a certain size. Another use is to calculate depths of cuts or the number of cuts required to perform a machining operation. It is also possible to encounter an inverse constant rate of variation. The formula for inverse variation is $y = \frac{k}{x}$ where is k is a constant.

Example:

Two months ago, the company purchased 100 pounds of aluminum. After two months there is 85 pounds left. At this rate how many pounds will be left after 5 months?

Find the constant of variation $y = \frac{k}{x} \rightarrow 85 = \frac{k}{2} \rightarrow k = 170$

Write the formula $y = \frac{170}{x}$

Solve for the how many pounds will be left after 5 months

$$y = \frac{170}{5}$$

$y = 35$ pounds

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Problems	Career and Technical Math Concepts Solutions
1. Your CNC turning center can machine surgical implants at the rate of 12 per hour. How many hours do you need to run to meet your customer's order of 700 parts?	
2. On a milling operation you need to cut a 1.23" deep step in a block. If you take .075" per cut, how many passes will you need to take?	
3. If you take the 17 equal depth passes calculated from the job above, how deep will each pass actually be?	
Problems	**Related, Generic Math Concepts Solutions**
4. Jackie earned a total of $16 for 2 hours of walking dogs. Her neighbor wants her to walk their dogs 3 times this week. How much should she charge?	
5. How long would it take to lose 44 pounds if you lose at a constant rate of 1 ½ pounds per week?	
6. If fifty pounds of force stretches a spring five inches, how much will the spring be stretched by a force of 120 pounds? (Hooke's Law F=kd)	
Problems	**PA Core Math Look Solutions**
7. If y varies directly as x, and y = 8 when x = 2, find y when x = 1.	
8. If r varies directly as q, and r = 10 when q = 6, write an equation describing the variation.	
9. If y varies **inversely** as x , and the constant of variation is k = 5, what is y when x = 10?	

Problems	Career and Technical Math Concepts	Solutions
1. Your CNC turning center can machine surgical implants at the rate of 12 per hour. How many hours do you need to run to meet your customer's order of 700 parts?	N=Number of parts R=Number of parts/hour H=Hours needed	$N = R \times D$ $700 = 12 \times H$ $\frac{700}{12} = H$ $H = 58.3$ Hours
2. On a milling operation you need to cut a 1.23" deep step in a block. If you take .075" per cut, how many passes will you need to take?	N=Number of passes D=Depth of each pass T=Total depth of the step	$T = D \times N$ $1.23 = .075 \times N$ $\frac{1.23}{.075} = N$ $N = 16.4$, so 17 passes are needed.
3. If you take the 17 equal depth passes calculated from the job above, how deep will each pass actually be?	N=Number of passes D=Depth of each pass T=Total depth of the step	$T = D \times N$ $1.23 = D \times 17$ $\frac{1.23}{17} = D$ $D = .072353 \approx .072"$

Problems	Related, Generic Math Concepts	Solutions
4. Jackie earned a total of $16 for 2 hours of walking dogs. Her neighbor wants her to walk their dogs 3 times this week (2 hours each time). How much should she charge?	$y = kx \rightarrow 16 = k(2) \rightarrow k = 8$ $y = kx \rightarrow y = 8x$ $y = 8x \rightarrow y = 8 \times 6 = \$48$	
5. How long would it take to lose 44 pounds if you lose at a constant rate of 1 ½ pounds per week?	$y = mx$ $44 = 1\frac{1}{2}x$ $x = 29\frac{1}{3}$ It would take between 29 and 30 weeks to lose the weight at that rate.	
6. If fifty pounds of force stretches a spring five inches, how much will the spring be stretched by a force of 120 pounds? (Hooke's Law F=kd)	$F = kd \rightarrow 50 = k(5) \rightarrow k = 10$ $F = 10d \rightarrow 120 = 10d \rightarrow d = 12$ inches	

Problems	PA Core Math Look	Solutions
7. If y varies directly as x, and y = 8 when x = 2, find y when x = 1.	$y = kx \rightarrow 8 = k(2) \rightarrow k = 4$ $y = kx \rightarrow y = 4x$ $y = 4x \rightarrow y = 4 \times 1 \rightarrow y = 4$ when $x = 1, y = 4$	
8. If r varies directly as q, and r = 10 when q = 6, write an equation describing the variation.	$r = kq \rightarrow 10 = k(6) \rightarrow k = \frac{10}{6} = \frac{5}{3}$ $y = kx \rightarrow y = \frac{5}{3}x$	
9. If y varies inversely as x , and the constant of variation is k = 5, what is y when x = 10?	$y = \frac{k}{x} \rightarrow y = \frac{5}{x} \rightarrow y = \frac{5}{10} \rightarrow y = \frac{1}{2}$ when $x = 10, y = \frac{1}{2}$	