T-Chart Writing Tips and Rules

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pennsylvania
DEPARTMENT OF EDUCATION

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T-CHART WRITING TIPS AND RULES

Many educators have been looking for the connection between career and technical education (CTE) and mathematics education. Math T-Charts were originally created by CTE instructors and Math instructors across the state through the efforts of the statewide CTE Integration Council and requirements from the Pennsylvania Department of Education.

T-Charts illustrate real-life math applications in a CTE program and compare and contrast them with Pennsylvania core math standards. Each T-Chart provides:

- A detailed example from each side of the "T" (CTE program and Pennsylvania core standard).
- Written explanation of the math and program-related information.
- Nine practice problems and answers – three CTE program-related problems, three generic problems and three Pennsylvania core standard-type problems.

If you are working with a Math instructor to complete a T-Chart, the Math instructor will provide assistance needed to develop the math language which is shown on the right side of the T-Chart. The Math instructor can assist the CTE instructor in completing pages 2-4 of the T-Chart.

If you are working alone to complete a T-Chart, use a seeded T-Chart to create a program specific T-Chart. The seeded T-Charts already contain the math procedure for teaching the core standard on the right side. You, the CTE instructor, will develop the left side of the T-Chart which is program specific. You should complete the T-Chart with a CTE lesson in mind. Include discussion and tips for peers on page 2 of the T-Chart. Instructors should review a completed T-Chart prior to creating their own. Complete and seeded T-Charts can be found at PDE Seeded Math T-Charts.

1. **Renaming the Seeded T-Chart File**
    a. Download or transfer the Seeded T-Chart to your work storage area (desktop/flash drive)
    b. The original seeded T-Chart filename will be similar to:
       Seeded T-Chart Program C.C.2.3.HS.A.12 Volume
    c. Using the **SAVE AS** command, rename the file by **DELETING** the word "Seeded" and **REPLACE** the word "Program" with your actual Program name and CIP Code number. For example, **T-Chart Welding 48.0508 C.C.2.3.HS.A.12 Volume - Welded Tank**
    d. Click **SAVE** to create a new file.

2. **File Storage Size**
   File size is important. Excessively large files will be difficult for everyone to use. The average size of files must not exceed 200 Kilobytes, and most of your files should be 100 Kilobytes or less (which means in a few rare instances a larger file may be justified). Oversized file size is typically caused by excessive or inefficient graphic applications. Be sure to minimize photos and drawings. Use JPEG graphics versus Bitmap. Be aware of the physical size of a graphic (square inches). Use compression to reduce file size.

3. **File Printout Format and Size**
   The T-Chart *MUST* remain a four page document and each page must be maintained in formatting and component layout. See the sample T-Chart on page nine. This may be challenging, but the content and graphics must be edited to fit the space available. If necessary, supplementary material may be attached after page four. Appendices should follow American Psychological Association rules regarding a header (Appendix A, B, C, etc.) and the appended item should be cited somewhere in the body of your T-Chart.

4. **Observe All Copyright Rules**
   All graphics must be original work that may be legally used by PDE. No copyrighted graphics or visual materials produced by others (non-PDE entities) may be used. Microsoft Office clipart is the exception. Digital photos and photo retouching are a good option; however, file size must not exceed an average of 200 Kilobytes.

5. **Be Careful with the Tab Button**
   The T-Charts are a series of tables that have been inserted into a Microsoft Word document. If you hit the tab button at the end of a table, it will force a new row which must then be deleted.

6. **Review a Sample Seeded T-Chart**
   Before beginning a T-Chart for your program area, review the sample T-Charts on page five and page nine. To become more familiar with the T-Chart format, CTE instructors are encouraged to view completed T-Charts for their program area. T-Charts can be found at PDE Math T-Charts.

DIRECTIONS FOR CTE INSTRUCTOR

For each box of the T-Chart on pages one and two, you will enter the information specific to your program area. Use a seeded T-Chart while completing your program T-Chart as a reference.

T-Chart, Page 1 CTE Components (using seeded T-Chart) - Left Side
1. Identify CTE program and CIP code in the header
2. In the gray title box, identify the POS math descriptor
3. In the Program POS Task box, identify the POS task
4. Identify CTE program associated vocabulary
5. Enter CTE program formulas and procedures
6. Identify date originated in the footer (Originated June xxxx) – all other information will remain the same

T-Chart, Page 2 Components
1. **Instructor's Script – Comparing and Contrasting** The math instructor comments here and ties both sides of page one together
2. **Common Mistakes Made By Students** Either or both instructors identify common student mistakes here
3. **CTE Instructor's Extended Discussion** The CTE instructor expands on the importance of the math concept as it relates to completion of the CTE task, or identifies other examples where this math concept may be used in the CTE program

T-Chart, Page 3 and 4 Components
1. Insert three program relevant problems in the Career and Technical Math Concepts box.
2. On page 4, copy and paste the three problems and provide an answer key in right hand column

DIRECTIONS FOR MATH INSTRUCTOR

T-Chart, Page 1 CTE Components (using seeded T-Chart) - Right Side
1. The math instructor reviews but does not change page one of seeded T-Chart (except footer)
2. Identify date originated in the footer (Originated June xxxx) – all other information will remain the same
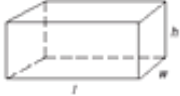
T-Chart, Page 2 Components
1. **Instructor's Script – Comparing and Contrasting**   The math instructor comments here and ties both sides of page one together
2. **Common Mistakes Made By Students**   Either or both instructors identify common student mistakes here
3. **CTE Instructor's Extended Discussion**   The CTE instructor comments/elaborates here

T-Chart, Page 3 and 4 Components
1. Math instructor makes no changes to pages three and four of seeded T-Charts

SAMPLE SEEDED T-CHART

Insert CTE Program Name here (insert CIP code here) T-Chart — **pennsylvania** DEPARTMENT OF EDUCATION

TYPE POS MATH DESCRIPTOR HERE =	EXPLAIN VOLUME FORMULAS AND USE THEM TO SOLVE PROBLEMS
Program POS Task: Enter POS task here.	**PA Core Standard:** CC.2.3.HS.A.12 **Description:** Explain volume formulas and use them to solve problems.
Program Associated Vocabulary ENTER PROGRAM VOCABULARY HERE.	**Math Associated Vocabulary** AREA, VOLUME, LENGTH, WIDTH, HEIGHT, RECTANGULAR, ROUND, CYLINDRICAL, BASE, RADIUS, RECTANGULAR PRISM
CTE Program Formulas and Procedures Display program example of math concept by entering text, graphic, and formulas in this column.	**Formulas and Procedures for Volume:** **Cylinder:** $V = \pi r^2 h$ **Cone:** $V = {}^1\!/_3 \pi r^2 h$ **Rectangular Prism:** $V = lwh$ **Sphere:** $V = {}^4\!/_3 \pi r^3$ **Pyramid:** $V = {}^1\!/_3$ (area of the base)h r = radius $\quad$ h = height $\quad$ w = width b = base $\quad$ l = length or slant height **Example:** How many cubic inches of air can a beach ball hold if it has a diameter of 14 inches? Round to the nearest whole number. **Steps to finding volume** 1. Identify the solid. (sphere) 2. Write the formula for calculating the volume of that solid using the formula sheet. $\quad V = {}^4\!/_3 \pi r^3$ 3. Identify the properties of the solid used in the formula. $\quad$ d = 2r or r = ½d $\quad$ r = ½ x 14 = 7 4. Substitute the actual properties of the solid into the formula. $\quad V = {}^4\!/_3 \pi r^3$ 5. Perform the necessary mathematical operations to obtain your answer. $\quad V = {}^4\!/_3 \pi r^3 = {}^4\!/_3 (3.14)(7^3) \approx 1,436$ 6. Write the appropriate unit after your answer. $\quad$ 1,436 in^3

Instructor's Script – Comparing and Contrasting
Math or program area instructor should fill in this area by comparing academic math problems to lab area problems. The instructor should describe ways that career and technical program math is similar or different from the academic math that occurs in the common core or on Keystone related exams.

Common Mistakes Made By Students
Using Incorrect Formula: Correctly identifying the type of object you are dealing with and use the appropriate formula (2 formulas may be needed for complex objects)
Using Consistent Units: If the problem asks for the answer in square feet instead of square inches, be sure to either convert your given measurements into feet first (inches ÷ 12 = feet).
                              OR
convert your square inch answer into square feet (sq. inches ÷ 144 = sq. feet).

CTE Instructor's Extended Discussion
The CTE instructor may add comments here describing the importance of this math skill in relationship to the program task, or note common problems which students have when making the computations.

Problems	Career and Technical Math Concepts		Solutions
1. Program relevant problem	Allow work space here		
2. Program relevant problem	Allow work space here		
3. Program relevant problem	Allow work space here		
Problems	**Related, Generic Math Concepts**		**Solutions**
4. One soup can has a d=3" and h=4", another soup can has a d=4 and a h=3. Which can holds more soup?			
5. A size 7 regulation basketball has a d=9.39". What is the volume of the basketball?			
6. How much water would you need to fill a rectangular fish tank with a height of 16.5 inches, a length of 32 inches, and a width of 8.5 inches?			
Problems	**PA Core Math Look**		**Solutions**
7. Find the volume of a cylinder if d=12.5' and h=28.45'.			
8. Find the volume of a sphere if d=27.75".			
9. Find the volume of a 4-sided pyramid with a square base b=10, and h=25.			

Problems	Career and Technical Math Concepts	Solutions
1. Program relevant problem		Provide answer here
2. Program relevant problem		Provide answer here
3. Program relevant problem		Provide answer here

Problems	Related, Generic Math Concepts	Solutions
4. One soup can has a diameter = 3" and height = 4", another soup can has a diameter = 4" and a height = 3". Which can holds more soup?	$V = \pi r^2 h$ Can 1: $r = \frac{1}{2}(3)$ $V = \pi(1.5)^2 4$ $V \approx 8.26\,in.^3$	Can 2: $r = \frac{1}{2}(4)$ $V = \pi(2)^2 3$ $V \approx 37.68\,in.^3$
5. A size 7 regulation basketball has a d=9.39". What is the volume of the basketball?	$Radius\,(r) = \dfrac{9.39}{2} = 4.695$ $V = \frac{4}{3} \times \pi \times r^3$ $V = 1.333 \times \pi \times 4.695^3$ $V \approx 1.333 \times \pi \times 103.5$ $V \approx 433.21\,in^3$	
6. How much water would you need to fill a rectangular fish tank with a height of 16.5 inches, a length of 32 inches, and a width of 8.5 inches?	$V = lwh$ V=(32)(8.5)(16.5)= 4,488 in³	

Problems	PA Core Math Look	Solutions
7. Find the volume of a cylinder d=12.5' h=28.45'.	$V = \pi r^2 h$ $r = \frac{1}{2}(12.5) = 6.25$ $V = \pi \times 6.25^2 \times 28.75$ $V \approx 3,526.367 ft^3$	
8. Find the volume of a sphere d=27.75".	$V = \frac{4}{3} \times \pi \times r^3$ ⟶ $V = 1.333 \times \pi \times 13.875^3$ $V \approx 11,183.23\,in^3$	
9. Find the volume of 4-sided pyramid with a square base b=10(base side), height =25.	$V = \frac{1}{3}(area\ of\ base)\,h$ Area of base = 10 x 10 = 100 $V = \frac{1}{3}(100)(25) \approx 833.33\ unit^3$	

SAMPLE COMPLETED T-CHART

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| Estimate concrete volume | = | Explain volume formulas and use them to solve problems |

Program Task: Estimate cubic yards of concrete for a foundation wall.

PA Core Standard: CC.2.3.HS.A.12

Description: Explain volume formulas and use them to solve problems.

Program Associated Vocabulary
DIMENSION, ESTIMATE, CUBIC FEET, CUBIC VOLUME, CUBIC YARDS

Math Associated Vocabulary
AREA, VOLUME, LENGTH, WIDTH, HEIGHT, RECTANGULAR, ROUND, CYLINDRICAL, BASE, RADIUS, RECTANGULAR PRISM

Program Formulas and Procedures
Concrete is estimated and ordered in cubic yards. 1 cubic yard contains 27 cubic feet. A house foundation wall is related to a rectangular prism. A foundation wall has a length, width and height. When determining how much volume of cement is needed it is important to have the length, width and height in decimal feet.
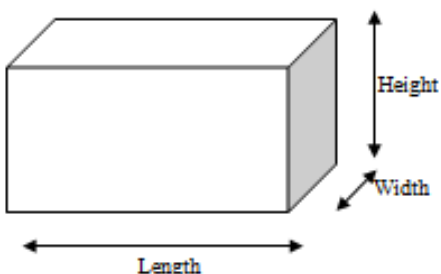
Formulas and Procedures for Volume:

Cylinder:
$V = \pi r^2 h$

Cone:
$V = {}^1/_3 \pi r^2 h$

Rectangular Prism:
$V = lwh$

Sphere:
$V = {}^4/_3 \pi r^3$

Pyramid:
$V = {}^1/_3$ (area of the base)h
r = radius h = height w = width
b = base l = length or slant height

To determine the volume needed in cubic yards the following formula is used:

Cubic yards = $\dfrac{L' \times W' \times H'}{27}$

A foundation wall measures 27' 5" long, 8" wide and 9' high
The length needs to be converted to decimal feet
$5" \div 12 = .417'$

The width needs to be converted to decimal feet

$8" \div 12 = .667'$

Cubic yards = $\dfrac{27.417' \times .667' \times 9'}{27}$ = $\dfrac{164.58'}{27}$

$\approx 6.10 \text{ yrd.}^3$

Example: How many cubic inches of air can a beach ball hold if it has a diameter of 14 inches?

Steps to finding volume
1. Identify the solid (sphere)
2. Write the formula for calculating the volume of that solid using the formula sheet
   $V = {}^4/_3 \pi r^3$
3. Identify the properties of the solid used in the formula
   $d = 2r$ or $r = \frac{1}{2}d$
   $r = \frac{1}{2} \times 14 = 7$
4. Substitute the actual properties of the solid into the formula
   $V = {}^4/_3 \pi r^3$
   Perform the necessary mathematical operations to obtain your answer
   $V = {}^4/_3 \pi r^3 = {}^4/_3 (3.14)(7^3) = 1436$
5. Write the appropriate unit after your answer.
   1436 in^3

Instructor's Script—Comparing and Contrasting
The carpentry example on page one shows how volumes must be calculated for rectangular prisms to pour foundation walls. Carpenters also work with cylinders when they pour footers for posts as presented in problem number 2 on page three. The mathematical formulas for volume indicate a certain type of orientation that may not match the application in question. For example, h will designate height of a cylinder, but if the cylinder is horizontal, h will be the same as the length!

Common Mistakes Made By Students
Using Incorrect Formula: Correctly identify the type of object you are dealing with and use the appropriate formula (2 formulas may be needed for complex objects).

Using Consistent Units: If the problem asks for the answer in square feet instead of square inches, be sure to either convert your given measurements into feet first (inches ÷ 12 = feet).
OR
Convert your square inch answer into square feet (sq. inches ÷ 144 = sq. feet).

CTE Instructor's Extended Discussion
The first formula to determine cubic yards is $\frac{L' \times W'' \times H'}{27}$ it is important that all numbers are in decimal feet.

Another formula for determining cubic yards of concrete is Length' x Width' x Thickness" x .0031=. Notice that the thickness is in inches. It is good practice to solve for cubic yards using both formulas and compare the information.

Problems	Career and Technical Math Concepts	Solutions
1. A customer has asked you to construct an above ground, rain water holding tank with r = 12' and h = 25'. What will be the total volume of the water tank?		
2. You need to set 3 concrete piers to support an above ground deck. Each pier has the following dimensions: d=12" and h=60". Find the volume of one pier in in^3, ft^3 & yd^3?		
3. A carpenter is pouring a cement walkway in front of a customer's house; the walkway is 35' long, 4' wide and 5" thick. How many cubic yards of cement did the carpenter order? Round up to the closest 1/2 yard.		

Problems	Related, Generic Math Concepts	Solutions
4. One soup can has a diameter =3" and height=4", another soup can has a diameter=4 and a height=3. Which can holds more soup?		
5. A size 7 regulation basketball has a diameter= 9.39". What is the volume of the basketball?		
6. How much water would you need to fill a rectangular fish tank with a height of 16.5 inches, a length of 32 inches, and a width of 8.5 inches?		

Problems	PA Core Math Look	Solutions
7. Find the volume of a cylinder d=12.75' h=28.75'		
8. Find the volume of a sphere d=27.75"		
9. Find the volume of 4-sided pyramid with a square base b=10, h=25		

Problems	Career and Technical Math Concepts	Solutions
1. A customer has asked you to construct an above ground, rain water holding tank with r=12' and h=25'. What will be the total volume of the water tank?	$V = \pi 12^2 25$ $V = \pi \times (144) \times 25$ or $V = 3.14 \times (12^2) \times 25$ $V = 11310 ft^3$ (rounded from 11309.73355)	
2. You need to set 3 concrete piers to support an above ground deck. Each pier has the following dimensions: d=12 inches and h=60". Find the volume of one pier in in³, ft³ & yd³?	$V = \pi 6^2 60$ $V = \pi \times 36 \times 60$ $V = 6,785.84 in^3$ $V = 6785.84 \div 1728 =$ $V = 3.9 ft^3$ $V = 3.9 \div 27$ $V = .25 yd^3$ (Rounded from 0.14)	

3. A carpenter is pouring a cement walkway in front of a customer's house; the walkway is 35' long, 4' wide and 5" thick. How many cubic yards of cement did the carpenter order? Round up to the closest ½ yard.	Cubic yards= $\underline{L' \times W" \times H'}$
	                     27
	Cubic yards = $\underline{35 \times 4 \times .417}$ ≈ 2.16
	                     27
	Cubic yards ≈ 2.16 ⟶ 2.5 cubic yards	

Problems	Related, Generic Math Concepts	Solutions
4. One soup can has a diameter=3" and height=4", another soup can has a diameter=4 and a height=3. Which can holds more soup?	$V = \pi r^2 h$ Can 1: $V = \pi (1.5)^2 4$ Can 2: $V = \pi (2)^2 3$ $V \approx 28.27 in.^3$ $V \approx 37.70 in.^3$	
5. A size 7 regulation basketball has a diameter=9.39". What is the volume of the basketball?	$V = \frac{4}{3} \times \pi \times r^3$ ⟶ $V = 1.333 \times \pi \times 4.695^3$ $V = 1.333 \times \pi \times 103.5$ $V = 433.43 in^3$	
6. How much water would you need to fill a rectangular fish tank with a height of 16.5 inches, a length of 32 inches, and a width of 8.5 inches?	$V = lwh$ Volume $= (32)(8.5)(16.5) = 4,488 in^3$	

Problems	PA Core Math Look	Solutions
7. Find the volume of a cylinder d=12.5' h=28.75'	$V = \pi r^2 h$ $V = \pi \times 6.25^2 \times 28.75$ $V \approx 3,528.156 ft^3$	
8. Find the volume of a sphere d=27.75"	$V = \frac{4}{3} \times \pi \times r^3$ ⟶ $V = 1.333 \times \pi \times 13.875^3$ $V = 1.333 \times \pi \times 2,671.15$ $V \approx 11,186.09 in^3$	
9. Find the volume of 4-sided pyramid with a square base b=10, h=25	$V = \frac{1}{3}(area\ of\ base)h \rightarrow V = \frac{1}{3}(10)(10)(25) \approx 833.33$	