Material Handling/Logistics (52.0203) T-Chart

| Calculate driver productivity | = | Use units as a way to understand and solve problems |

Program Task: Calculate driver productivity of forklift drivers.

Program Associated Vocabulary:
PRODUCTIVITY, PALLETS PER HOUR, DOWNTIME, RATE

Program Formulas and Procedures:
Companies keep statistics on the productivity of their forklift drivers. Driver productivity is usually described in terms of pallets per hour. It may seem like 14 and 15 pallets per hour are pretty close numbers, but they have significant implications over time for larger businesses.

Example:
Let's look at a 12-hour shift in a warehouse that operates 50 forklifts. What is the difference between an average driver productivity of 14 pallets per hour and 15 pallets per hour?

14 pallets per hour:

$$\frac{50 \text{ lifts}}{1} \text{ x } \frac{12 \text{ hrs.}}{1 \text{ shift}} \text{ x } \frac{14 \text{ plts.}}{1 \text{ hr.}} = 8{,}400 \text{ pallets per shift}$$

15 pallets per hour:

$$\frac{50 \text{ lifts}}{1} \text{ x } \frac{12 \text{ hrs.}}{1 \text{ shift}} \text{ x } \frac{15 \text{ plts.}}{1 \text{ hr.}} = 9{,}000 \text{ pallets per shift}$$

For this warehouse, an average of 15 pallets per hour means 600 more pallets loaded per day. If we assume the warehouse operates 365 days per year, then the warehouse would load 219,000 more pallets per year.

PA Core Standard: CC.2.1.HS.F.4

Description: Use units as a way to understand problems and to guide the solution of multi-step problems.

Math Associated Vocabulary:
RATE, DECIMAL, RATIO, DIMENSIONAL/UNIT ANALYSIS

Formulas and Procedures:
Dimensional or Unit Analysis can be used to solve problems using operations because by analyzing the units, one can determine whether or not the equation was set up correctly.

Basic Steps:
1. Determine the unit given and the unit needed (answer).
2. Write the number with the unit you are given as a fraction over one on the left hand side and write an equal sign followed by the unit you need on the far right hand side.
3. Multiply by the rates you are given or conversion factors (write as fractions), making sure that the unit that was given in numerator is also on the bottom (denominator) of the given rate or conversion factor.
4. Remember, units cancel out just like numbers do! Continue to multiply by rates or conversion factors until the unit needed is the only unit that does not cancel.
5. Perform the indicated operations.

Example: A snail can crawl 13 feet in 2.5 hours. How far can it crawl in 240 minutes?

1. unit given = 240 minutes, unit needed = feet

2. $\dfrac{240 \text{ min.}}{1} = \text{feet}$

3. $\dfrac{240 \text{ min.}}{1} \text{ x } \dfrac{1 \text{ hr.}}{60 \text{ min.}} \text{ x } \dfrac{13 \text{ ft.}}{2.5 \text{ hrs.}} = \text{feet}$

4. $\dfrac{240 \cancel{\text{ min.}}}{1} \text{ x } \dfrac{1 \cancel{\text{ hr.}}}{60 \cancel{\text{ min.}}} \text{ x } \dfrac{13 \text{ ft.}}{2.5 \cancel{\text{ hrs.}}} = \text{feet}$

5. $\dfrac{240(1)(13)\text{ft.}}{(1)(60)(2.5)} = 20.8\text{ft.}$

Instructor's Script - Comparing and Contrasting

The eligible content item appears to be similar to CC2.1.HS.F.3 but there is a slight difference. Although this eligible content item can include proportional relationships, because the ratio itself is often a "rate", this eligible content item includes any operation using a rate or multiple rates and is often more complex.

Common Mistakes Made By Students

Use of incorrect conversion factors or omission of essential conversion factor

For instance, in the problem shown below, a conversion factor (60 minutes = 1 hour) was omitted from the solution.

What is 60 miles per hour in feet per second?

$$\frac{60\,\text{miles}}{1\,\text{hour}} \times \frac{5280\,\text{feet}}{1\,\text{mile}} \times \frac{1\,\text{minute}}{60\,\text{seconds}}$$

Incorrectly setting up the problem

For instance, in the problem shown below, the problem has been set up incorrectly. Instead of starting with the 60 miles per hour, the solution begins with the conversion factor.

What is 60 miles per hour in feet per second?

$$\frac{1\,\text{mile}}{5280\,\text{feet}} \times \frac{1\,\text{hour}}{60\,\text{miles}} \times \frac{60\,\text{minutes}}{1\,\text{hour}} \times \frac{60\,\text{seconds}}{1\,\text{minute}} = \frac{1}{88}\,\text{feet}$$

CTE Instructor's Extended Discussion

Companies keep statistics on the productivity of their forklift drivers. Driver productivity is usually described in terms of pallets per hour. It is very important that students understand that a lack of motivation affects productivity which could affect their job plus the life of the business itself.
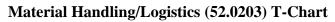
The example on the Material Handling/Logistics side of the T-Chart creates interesting opportunities to explore this concept. For instance, let's assume that it costs the company $1,000/hour to operate these 50 forklifts. With this in mind, how much would it cost the company to load 100,000 pallets if the average driver productivity rate was 15 pallets/hour? 14 pallets/hour?

Material Handling/Logistics (52.0203) T-Chart

Problems	Occupational (Contextual) Math Concepts	Solutions
1. Calculate the number of pallets a warehouse operating 100 forklifts can load in 12 hours if the driver productivity is 18.3 pallets per hour.		
2. Calculate the number of pallets a warehouse operating 100 forklifts can load in 12 hours if the driver productivity is 15.9 pallets per hour.		
3. Calculate the number of pallets a warehouse operating 45 forklifts can load in 12 hours if the driver productivity is 13.6 pallets per hour.		

Problems	Related, Generic Math Concepts	Solutions
4. One milliliter of ink can print 50 pages of text. If you have 10 gallons, how many pages can you print? (1 gallon = 3.79 L)		
5. Sandy is traveling at 97 km. on 102 minutes. What is her speed in miles per hour if 1 mile = 1.6 km.?		
6. A worker unloads 9 crates every 36 minutes and is paid $2 per crate. How much money does he make in an 8 hour shift?		

Problems	PA Core Math Look	Solutions
7. Kathy and John are helping to create party favors for the school dance. Kathy can create 30 in one hour and John can create 40 in two hours. At that rate, how long will it take to create 500 party favors?		
8. Two trucks are plowing snow and moving in opposite directions. The first truck can plow snow at 23 mph and the other can plow at 17 mph. How long will it take them to plow 200 miles of road?		
9. A car gets 35 miles per gallon of gas. If the cost of gas is $3.97 per gallon, how much will it cost to make a 485 mile trip?		

	Problems	Occupational (Contextual) Math Concepts	Solutions
1.	Calculate the number of pallets a warehouse operating 100 forklifts can load in 12 hours if the driver productivity is 18.3 pallets per hour.	$\dfrac{100\,\text{lifts}}{1} \times \dfrac{12\,\text{hrs.}}{1\,\text{shift}} \times \dfrac{18.3\,\text{plts.}}{1\,\text{hr.}}$	$= 21{,}960$ pallets per shift
2.	Calculate the number of pallets a warehouse operating 100 forklifts can load in 12 hours if the driver productivity is 15.9 pallets per hour.	$\dfrac{100\,\text{lifts}}{1} \times \dfrac{12\,\text{hrs.}}{1\,\text{shift}} \times \dfrac{15.9\,\text{plts.}}{1\,\text{hr.}}$	$= 19{,}080$ pallets per shift
3.	Calculate the number of pallets a warehouse operating 45 forklifts can load in 12 hours if the driver productivity is 13.6 pallets per hour.	$\dfrac{45\,\text{lifts}}{1} \times \dfrac{12\,\text{hrs.}}{1\,\text{shift}} \times \dfrac{13.6\,\text{plts.}}{1\,\text{hr.}}$	$= 7{,}344$ pallets per shift

	Problems	Related, Generic Math Concepts	Solutions
4.	One milliliter of ink can print 50 pages of text. If you have 10 gallons, how many pages can you print? (1 gallon = 3.79 L)	$\dfrac{10\,\text{gallons}}{1} \times \dfrac{3.79\,\text{liters}}{1\,\text{gallon}} \times \dfrac{1000\,\text{ml.}}{1\,\text{liter}} \times \dfrac{50\,\text{pages}}{1\,\text{ml.}} =$ $1{,}895{,}000$ pages	
5.	Sandy is traveling at 97 km. on 102 minutes. What is her speed in miles per hour if 1 mile = 1.6 km.?	$\dfrac{97\,\text{km.}}{102\,\text{min.}} \times \dfrac{1\,\text{mile}}{1.6\,\text{km.}} \times \dfrac{60\,\text{min.}}{1\,\text{hr.}} = 35$ miles per hour	
6.	A worker unloads 9 crates every 36 minutes and is paid $2 per crate. How much money does he make in an 8 hour shift?	$\dfrac{8\,\text{hrs.}}{1} \times \dfrac{60\,\text{min.}}{1\,\text{hr.}} \times \dfrac{9\,\text{crates}}{36\,\text{min.}} \times \dfrac{\$2}{1\,\text{crate}} = \$240$	

	Problems	PA Core Math Look	Solutions
7.	Kathy and John are helping to create party favors for the school dance. Kathy can create 30 in one hour and John can create 40 in two hours. At that rate, how long will it take to create 500 party favors?	$\dfrac{40\,\text{pf}}{2\,\text{hr.}} = \dfrac{20\,\text{pf}}{1\,\text{hr.}}$ total rate $= \dfrac{20\,\text{pf}}{1\,\text{hr.}} + \dfrac{30\,\text{pf}}{1\,\text{hr.}} = \dfrac{50\,\text{pf}}{1\,\text{hr.}}$ $\dfrac{500\,\text{pf}}{1} \times \dfrac{1\,\text{hr.}}{50\,\text{pf}} = 10\,\text{hrs.}$	
8.	Two trucks are plowing snow and moving in opposite directions. The first truck can plow snow at 23 mph and the other can plow at 17 mph. How long will it take them to plow 200 miles of road?	Rate 1 + rate 2 = 23 mph + 17 mph = 40 mph $\dfrac{200\,\text{miles}}{1} \times \dfrac{1\,\text{hour}}{40\,\text{miles}} = 5\,\text{hours}$	
9.	A car gets 35 miles per gallon of gas. If the cost of gas is $3.97 per gallon, how much will it cost to make a 485 mile trip?	$\dfrac{485\,\text{miles}}{1} \times \dfrac{1\,\text{gallon}}{35\,\text{miles}} \times \dfrac{\$3.97}{1\,\text{gallon}} = \$55.01$	