TDL Math:

Warehouse Receiving & Storage Calculations

Industry: Transportation, Distribution, & Logistics (TDL)

Content Area: Mathematics

Core Topics: Using formulas, performing operations with decimals, solving multi-step word problems

Objective: Students will be able to use the tihi formula to calculate the number of cases on a pallet, solve multi-step warehouse storage problems, and compute and reconcile inventory data.

Materials included:
Instructor's notes
Scenario: Warehouse Receiving
Student worksheets
Handout
Quiz
Answer Keys

Industry Overview:
According to the U.S. Department of Labor, employment in the transportation and material movers industry is expected to grow approximately 8.6% between 2012 and 2022.* The transportation, distribution, and logistics (TDL) industry is comprised of a vast array of jobs, ranging from dock workers and delivery drivers to warehouse managers and logisticians. Mathematics and literacy skills are essential for students who plan to pursue a career in this field. TDL employees, including warehouse and distribution workers, must have the ability to use formulas and perform accurate mathematical calculations in their daily work.

* Source: http://www.bls.gov/emp/ep_table_101.htm Employment Projections program, U.S. Department of Labor, U.S. Bureau of Labor Statistics

Instructor's notes:

- The purpose of this module is to help students develop and apply math skills in a TDL workplace setting. The learning activities were designed to be incorporated throughout multiple instructional periods as math concepts are taught in a TDL context.

- After completing the module, students should be able to:
  - Use the tihi formula to calculate the number of cases on a pallet
  - Solve multi-step warehouse storage problems
  - Perform multi-step warehouse inventory calculations

- **Setting the stage:** Provide students with background information about the typical responsibilities of warehouse and distribution center employees. You may want to have students use the occupational outlook handbook, O*NET and/or other relevant websites to research the job responsibilities, educational/training requirements, salary, etc. for TDL positions that interest them. In addition, you could have students view videos depicting some typical warehouse and distribution center operations. (See links below)

  Bureau of Labor Statistics – Occupational Outlook Handbook:
  http://www.bls.gov/ooh/

  Occupational Information Network (O*NET)
  http://www.onetonline.org/link/summary/43-5071.00
  http://www.onetonline.org/link/summary/11-3071.02

  Virtual Warehouse tours:
  https://www.youtube.com/watch?v=QTrzEZJEX0c
  https://www.youtube.com/watch?v=b_893POZT44

- **For Activity 1:** Give students a copy of **Handout 1** to illustrate various pallet stacking patterns. Explain how to use the tihi formula to calculate the number of cases/boxes on a pallet. Work the scenario example with the class. Have students work the practice problems and complete the delivery log independently. Provide additional practice as needed. Have students complete **Worksheet 1**.

- **For Activity 2:** Explain the steps to calculate warehouse storage needed for deliveries. Work the scenario example with the class. Have students complete the practice problem independently. Provide additional practice as needed. Have students complete **Worksheet 2**.

- **For Activity 3:** Explain the steps to calculate inventory and complete an inventory log. Work the scenario example with the class. Have students complete the practice problem and inventory log independently. Provide additional practice as needed. Have students complete **Worksheet 3**.

- **Assessment: Quiz – Warehouse receiving, storage, & inventory calculations**

Workplace Scenario:

You are a supervisor at *BSP* Warehouse and Distribution, Inc. Your warehouse provides storage and distribution services for several vendors throughout the Midwest. One of your primary responsibilities is to train and supervise the shipping and receiving clerks who work at your warehouse. This week you are training Juan, a new employee, on receiving, storage, and inventory procedures.

Activity 1: Checking in deliveries using tihi

One of the responsibilities of a receiving clerk is to verify all deliveries received at the warehouse. Clerks are required to make a physical count of the cases coming into the warehouse and enter this information into the warehouse computer database. You explain to Juan that most of the products received in the warehouse are shipped on pallets. Cartons are packed on pallets in a variety of configurations, depending on the weight, size, and shape of the cases to be stacked. **Handout 1** shows some examples of pallet stacking patterns. One method to count the cases on a pallet is to use the **tihi** formula. The **'ti'** refers to the number of cases in one tier or layer of the pallet. The **'hi'** refers to the height, that is, the number of layers on the pallet. Multiplying the ti (the number of cases on the top layer) by the hi (the number of layers) gives you the total number of cases contained on the pallet. You have Juan practice using the tihi method for some incoming pallet shipments in the receiving area:

Example: Item #101 The tihi for this pallet is 10:4 10 x 4 = 40 cases on the pallet.

Practice: Use the tihi formula to calculate the number of cases for the following pallets.

Item #102 tihi 2:5 Total cases =_____ Item #103 tihi 4:6 Total cases = _____

The delivery ticket for item #104 indicates that there should be 50 cases on the pallet. Your tihi count is 8:6. Is the delivery ticket correct? _____ 8 x 6 = _____

You explain to Juan that he will complete a delivery log for the pallet deliveries he checks into the warehouse. First, he will need to enter the item number, description, and number of cases from the delivery ticket into the log. Next, he will enter the tihi and the total number of cases computed with the tihi formula. If correct, place a check mark in the last box. If the tihi count does not match the delivery ticket count, indicate the + or – difference in the last box. A copy of the delivery log is then sent to the ordering department to resolve any differences with the supplier. Complete the partial delivery log with your tihi counts from the examples you just worked.

Date: 1/15/15		**Delivery Check in Log**		**Counted by:** Juan G.	
Item #	**Description**	**Del. Ticket Quantity (cs)**	**Ti Hi**	**Ti Hi Quantity (cs)**	**√ or +/-**
101	Fan belts	40	10 x 4	40	√
102	Meters	10	2 x 5		
103	Gauges	24	4 x 6		
104	Bearings	50	8 x 6		

Worksheet 1: Checking in deliveries with tihi **Name** _____

Juan checked in the following deliveries this afternoon. Use the tihi formula to calculate the number of cases contained on each pallet and complete the delivery log with all the required information.

1.	Item #005	8” steel bolts	tihi 16:4
2.	Item #006	10” steel bolts	tihi 12:4
3.	Item #112	12” hoses	tihi 4:7
4.	Item #106	6” hoses	tihi 6:8
5.	Item #025	Sensors	tihi 8:12
6.	Item #152	Gaskets	tihi 8:7
7.	Item #004	6” clamps	tihi 18:4
8.	Item #214	Rubber seals	tihi 12:7
9.	Item #035	Switches	tihi 18:5
10.	Item #202	Valves	tihi 8:4

Date: 1/16/15 **Delivery Check in Log** **Checked by:** Juan G

Received from: Our Company, Inc.

Item #	Description	Del. Ticket Quantity (cs)	Ti x Hi	Ti Hi Quantity (cs)	√ or +/-
005	8” steel bolts	64	16 x 4	64	√
006	10” steel bolts	48			
112	12” hose	28			
106	6” hose	48			
025	Sensors	96			
152	Gaskets	60			
004	6” clamps	72			
214	Rubber seals	84			
035	Switches	90			
202	Valves	32			
	Totals				

Activity 2: Warehouse storage calculations

Once products are received and checked in, the pallets are labeled with a location sticker indicating the section of the warehouse where the products will be stored. For example, H22-5 means the product will be stored in section H, isle 22, rack #5. This system makes it more efficient for workers to store and locate products for shipping.

You explain to Juan that he will need to calculate the amount of storage space required for incoming shipments. He must also check the computer to determine in what section of the warehouse the products will be stored and if there is sufficient storage space available in that section.

Example:

1a. You are expecting a shipment of 400 cases of item #201; there are 40 cases on each pallet. The pallets are to be stored in section D12 of the warehouse. If 4 pallets fit on a storage rack in this section, how many racks will you need for the 400 cases?

Step 1: Calculate the number of pallets you will be receiving. If there are 400 cases and each pallet has 40 cases, you can divide 400 by 40 to find the total number of pallets. 400 ÷ 40 = 10 pallets.

Step 2: Calculate the number of racks you will need for the 10 pallets. If each rack holds 4 pallets, you can divide 10 by 4 to determine the total number of racks needed. 10 ÷ 4 = **2.5 racks needed**.

1b. After checking the computer, you find there are 6 open racks in section D12. How many open racks will remain after the 400 cases are stored? 6 – 2.5 = **3.5 racks left**.

Practice:

1a. You will be receiving a shipment of 192 cases of item #202; there are 64 cases on each pallet. The pallets are to be stored in section D15 of the warehouse. If 2 pallets fit on a storage rack, how many racks will you need for the 192 cases?

Step 1: Calculate the number of pallets you will be receiving.

Step 2: Calculate the number of storage racks you will need.

1b. If there are 3.5 racks available in section D15, how many open racks will remain after storing the 192 cases?

Worksheet 2: Warehouse storage calculations **Name** _____

Perform the storage calculations for each of the following deliveries.

1. **a.** You will be receiving a shipment of 168 cases of item #203; there are 28 cases on each pallet. The pallets are to be stored in section D1 of the warehouse. If 4 pallets fit on a storage rack, how many racks will you need for the 168 cases?

   b. If there are 4 racks available in section D1, how many open racks will remain after storing the 168 cases?

2. **a.** You will be receiving a shipment of 240 cases of item #204; there are 48 cases on each pallet. The pallets are to be stored in section D2 of the warehouse. If 2 pallets fit on a storage rack, how many racks will you need for the 240 cases?

   b. If there are 6 racks available in section D2, how many open racks will remain after storing the 240 cases?

3. **a.** You will be receiving a shipment of 768 cases of item #205; there are 96 cases on each pallet. The pallets are to be stored in section D3 of the warehouse. If 4 pallets fit on a storage rack, how many racks will you need for the 768 cases?

   b. If there are 5 racks available in section D3, how many open racks will remain after storing the 768 cases?

4. **a.** You will be receiving a shipment of 504 cases of item #207; there are 72 cases on each pallet. The pallets are to be stored in section D4 of the warehouse. If 4 pallets fit on a storage rack, how many racks will you need for the cases?

   b. If there are 4 racks available in section D4, how many open racks will remain after storing the 504 cases?

5. **a.** You will be receiving a shipment of 384 cases of item #210; there are 32 cases on each pallet. The pallets are to be stored in section D5 of the warehouse. If 2 pallets fit on a storage rack, how many racks will you need for the cases?

   b. If there are 8.5 racks available in section D5, how many open racks will remain after storing the cases?

Activity 3: Counting Inventory

You tell Juan that another responsibility he has as a clerk is to take inventory of the products on hand. Every week, products from different storage sections of the warehouse are physically counted and reconciled with the inventory listed in the company's computer database. This week, you will be counting the inventory in section D of the warehouse.

Example:
Your first task is to count item #201. You find one rack containing 2 full pallets and another rack with 25 cases of this item. Each pallet has a tihi of 10:4. According to the carton label, each case holds 12 units. How many units of item #201 are in the inventory?

Step 1: Calculate the number of cases on one pallet. 10 x 4 = 40 cases

Step 2: Since there are two full pallets, multiply the result in step one by 2. 40 x 2 = 80 cases

Step 3: Calculate the total number of cases. 80 + 25 = 105 cases

Step 4: Calculate the total number of units. If each case contains 12 units, you can find the total number of units by multiplying 105 x 12 = **1260 units on hand**

According to the warehouse computer inventory, there should be 1260 units on hand; therefore, the physical count matches the inventory.

Practice: Calculate the inventory for item #202 and complete the partial inventory log as indicated. Place a √ in the "Inventory Verified" column if the count matches the warehouse inventory shown. If the count differs from the warehouse inventory, indicate the + or – amount in the last column of the inventory log.

Item #202: There is one rack with 2 full pallets and one rack with 1 full pallet and 8 cases. Each pallet has a tihi of 16:4 and each case contains 4 units. How many total units are in the inventory?

Inventory Log				
Date:	1/19/15			
Name:	Juan G.			
Location:	D			
Item number	**Quantity listed on Inventory (units)**	**Actual Inventory Count (units)**	**Inventory Verified**	**+/-**
201	1260	1260	√	
202	804			

Worksheet 3: Counting Inventory **Name** _____

Calculate the inventory for the following products and complete the inventory log.

1. Item #203 1 full pallet and 22 cases; pallet tihi 4:7; 6 units per case
2. Item #204 3 full pallets and 5 cases; pallet tihi 6:8; 12 units per case
3. Item #205 2 full pallets and 20 cases; pallet tihi 8:12; 4 units per case
4. Item #206 3 full pallets and 4 cases; pallet tihi 8:7; 6 units per case
5. Item #207 1 full pallet and 14 cases; pallet tihi 18:4; 12 units per case
6. Item #208 2 full pallets and 6 cases; pallet tihi 12:7; 10 units per case
7. Item #209 4 full pallets and 10 cases; pallet tihi 18:5; 2 units per case
8. Item #210 3 full pallets and 28 cases; pallet tihi 8:4; 12 units per case
9. Item #211 2 full pallets and 30 cases; pallet tihi 12:4; 6 units per case
10. Item #212 6 full pallets and 12 cases; pallet tihi 10:4; 8 units per case

Inventory Log				
Date:	1/19/15			
Name:	Juan G.			
Location:	F12			
Item number	**Quantity listed on Inventory (units)**	**Actual Inventory Count (units)**	**Inventory Verified √**	+/-
201	1260	1260	√	
202	804	800		-4
203	300			
204	1788			
205	850			
206	1030			
207	1032			
208	1740			
209	740			
210	1488			
211	756			
212	2016			

Quiz: Warehouse receiving, storage, & inventory calculations **Name: _____**

Warehouse receiving: Use the tihi formula to calculate the number of cases contained on each pallet.

1.	Item #301	Sensors	tihi 12:7
2.	Item #402	Gauges	tihi 8:5
3.	Item #503	12" hoses	tihi 4:6
4.	Item #604	Switches	tihi 8:6
5.	Item #705	Valves	tihi 10:5

Warehouse storage: Complete the following storage calculations.

6a. You will be receiving a shipment of 280 cases of item #306; there are 56 cases on each pallet. The pallets are to be stored in section F5 of the warehouse. If 2 pallets fit on a storage rack, how many racks will you need for the cases?

6b. If there are 6 racks available in section F5, how many open racks will remain after storing the cases?

7a. You will be receiving a shipment of 576 cases of item #307; there are 48 cases on each pallet. The pallets are to be stored in section F6 of the warehouse. If 4 pallets fit on a storage rack, how many racks will you need for the cases?

7b. If there are 4.75 racks available in section F6, how many open racks will remain after storing the cases?

Warehouse Inventory: Calculate the inventory for the following products and complete the inventory log.

8. Item #203 8 full pallets and 23 cases; pallet tihi 4:7; 12units per case
9. Item #204 5 full pallets and 31cases; pallet tihi 6:8; 6 units per case
10. Item #205 3 full pallets and 14cases; pallet tihi 8:12; 4 units per case

Inventory Log				
Date:	1/19/15			
Name:	Juan G.			
Location:	F8			
Item number	**Quantity listed on Inventory (units)**	**Actual Inventory Count (units)**	**Inventory Verified √**	+/-
203	2964			
204	1625			
205	1208			

Practice Problems **Answer Key**

Activity 1

Practice: 2 x 5 = 10 cases

4 x 6 = 24 cases

No; 8 x 6 = 48 cases

Activity 2

Practice 1a: 192 ÷ 64 = 3 pallets

3 ÷ 2 = 1.5 racks needed

Practice 1b: 3.5 – 1.5 = 2 racks remaining

Activity 3

Practice:

Number of cases on one pallet: 16 x 4 = 64 cases/pallet

Number of full pallets is 3, so 64 x 3 = 192 cases

Total number of cases: 192 + 8 = 200 cases

Total number of units: 200 x 4 = 800 units

Inventory verified: - 4

Worksheet 1: Checking in deliveries with tihi — Answer Key

Juan checked in the following deliveries this afternoon. Use the tihi formula to calculate the number of cases contained on each pallet and complete the delivery log with all the required information.

1. Item #005 8” steel bolts tihi 16:4
2. Item #006 10” steel bolts tihi 12:4
3. Item #112 12” hoses tihi 4:7
4. Item #106 6” hoses tihi 6:8
5. Item #025 Sensors tihi 8:12
6. Item #152 Gaskets tihi 8:7
7. Item #004 6” clamps tihi 18:4
8. Item #214 Rubber seals tihi 12:7
9. Item #035 Switches tihi 18:5
10. Item #202 Valves tihi 8:4

Date: 1/16/15 **Delivery Check in Log** **Checked by:** Juan G

Received from: Our Company, Inc.

Item #	Description	Del. Ticket Quantity (cs)	Ti x Hi	Ti Hi Quantity (cs)	√ or +/-
005	8” steel bolts	64	16 x 4	64	√
006	10” steel bolts	48	12 x 4	48	√
112	12” hose	28	4 x 7	28	√
106	6” hose	48	6 x 8	48	√
025	Sensors	96	8 x 12	96	√
152	Gaskets	60	8 x 7	56	-4
004	6” clamps	72	18 x 4	72	√
214	Rubber seals	84	12 x 7	84	√
035	Switches	90	18 x 5	90	√
202	Valves	32	8 x 4	32	√
	Totals	622		618	-4

Worksheet 2: Warehouse storage calculations — Answer Key

Perform the storage calculations for each of the following deliveries.

1. **a.** You will be receiving a shipment of 168 cases of item #203; there are 28 cases on each pallet. The pallets are to be stored in section D1 of the warehouse. If 4 pallets fit on a storage rack, how many racks will you need for the 168 cases? 168 ÷ 28 = 6 pallets; 6 ÷ 4 = 1.5 racks

   b. If there are 4 racks available in section D1, how many open racks will remain after storing the 168 cases? 4 – 1.5 = 2.5 racks left

2. **a.** You will be receiving a shipment of 240 cases of item #204; there are 48 cases on each pallet. The pallets are to be stored in section D2 of the warehouse. If 2 pallets fit on a storage rack, how many racks will you need for the 240 cases? 240 ÷ 48 = 5 pallets; 5 ÷ 2 = 2.5 racks

   b. If there are 6 racks available in section D2, how many open racks will remain after storing the 240 cases? 6 – 2.5 = 3.5 racks left

3. **a.** You will be receiving a shipment of 768 cases of item #205; there are 96 cases on each pallet. The pallets are to be stored in section D3 of the warehouse. If 4 pallets fit on a storage rack, how many racks will you need for the 768 cases? 768 ÷ 96 = 8 pallets; 8 ÷ 4 = 2 racks

   b. If there are 5 racks available in section D3, how many open racks will remain after storing the 768 cases? 5 – 2 = 3 racks left

4. **a.** You will be receiving a shipment of 504 cases of item #207; there are 72 cases on each pallet. The pallets are to be stored in section D4 of the warehouse. If 4 pallets fit on a storage rack, how many racks will you need for the cases? 504 ÷ 72 = 7 pallets; 7 ÷ 4 = 1.75 racks

   b. If there are 4 racks available in section D4, how many open racks will remain after storing the 504 cases? 4 – 1.75 = 2.25 racks left

5. **a.** You will be receiving a shipment of 384 cases of item #210; there are 32 cases on each pallet. The pallets are to be stored in section D5 of the warehouse. If 2 pallets fit on a storage rack, how many racks will you need for the cases? 384 ÷ 32 = 12 pallets; 12 ÷ 2 = 6 racks

   b. If there are 8.5 racks available in section D5, how many open racks will remain after storing the cases? 8.5 – 6 = 2.5 racks left

Worksheet 3: Counting Inventory **Answer Key**

Calculate the inventory for the following products and complete the inventory log.

1. Item #203 1 full pallet and 22 cases; pallet tihi 4:7; 6 units per case
2. Item #204 3 full pallets and 5 cases; pallet tihi 6:8; 12 units per case
3. Item #205 2 full pallets and 20 cases; pallet tihi 8:12; 4 units per case
4. Item #206 3 full pallets and 4 cases; pallet tihi 8:7; 6 units per case
5. Item #207 1 full pallet and 14 cases; pallet tihi 18:4; 12 units per case
6. Item #208 2 full pallets and 6 cases; pallet tihi 12:7; 10 units per case
7. Item #209 4 full pallets and 10 cases; pallet tihi 18:5; 2 units per case
8. Item #210 3 full pallets and 28 cases; pallet tihi 8:4; 12 units per case
9. Item #211 2 full pallets and 30 cases; pallet tihi 12:4; 6 units per case
10. Item #212 6 full pallets and 12 cases; pallet tihi 10:4; 8 units per case

Inventory Log				
Date:	1/19/15			
Name:	Juan G.			
Location:	F12			
Item number	**Quantity listed on Inventory (units)**	**Actual Inventory Count (units)**	**Inventory Verified √**	+/-
201	1260	1260	√	
202	804	800		-4
203	300	300	√	
204	1788	1788	√	
205	850	848		-2
206	1030	1032		+2
207	1032	1032	√	
208	1740	1740	√	
209	740	740	√	
210	1488	1490		+2
211	756	756	√	
212	2016	2016	√	

Quiz: Warehouse receiving, storage, & inventory calculations **Answer Key**

Receiving: Use the tihi formula to calculate the number of cases contained on each pallet.

1.	Item #301	Sensors	tihi 12:7	12 x 7 = 84 cases
2.	Item #402	Gauges	tihi 8:5	8 x 5 = 40 cases
3.	Item #503	12" hoses	tihi 4:6	4 x 6 = 24 cases
4.	Item #604	Switches	tihi 8:6	8 x 6 = 48 cases
5.	Item #705	Valves	tihi 10:5	10 x 5 = 50 cases

Storage: Complete the following storage calculations.

6a. You will be receiving a shipment of 280 cases of item #306; there are 56 cases on each pallet. The pallets are to be stored in section F5 of the warehouse. If 2 pallets fit on a storage rack, how many racks will you need for the cases? 280 ÷ 56 = 5 pallets; 5 ÷ 2 = 2.5 racks
6b. If there are 6 storage racks available in section F5, how many racks will remain after storing the cases? 6 – 2.5 = 3.5 rack left

7a. You will be receiving a shipment of 576 cases of item #307; there are 48 cases on each pallet. The pallets are to be stored in section F6 of the warehouse. If 4 pallets fit on a storage rack, how many racks will you need for the cases? 576 ÷ 48 = 12 pallets; 12 ÷ 4 = 3 racks
7b. If there are 4.75 racks available in section F6, how many open racks will remain after storing the cases? 4.75 – 3 = 1.75 racks left

Inventory: Calculate the inventory for the following products and complete the inventory log.

8. Item #203: 8 full pallets and 23 cases; pallet tihi 4:7; 12units/case 4 x 7 = 28; 28 x 8 = 224; 224 + 23 = 247 cases; 247 x 12 = 2964 units
9. Item #204: 5 full pallets and 31cases; pallet tihi 6:8; 6 units/case 6 x 8 = 48; 48 x 5 = 240; 240 + 31 = 271 cases; 271 x 6 = 1626 units
10. Item #205: 3 full pallets and 14cases; pallet tihi 8:12; 4 units/case 8 x 12 = 96; 96 x 3 = 288; 288 + 14 = 302 cases; 302 x 4 = 1208 units

Inventory Log				
Date:	1/19/15			
Name:	Juan G.			
Location:	F8			
Item number	**Quantity listed on Inventory (units)**	**Actual Inventory Count (units)**	**Inventory Verified √**	**+/-**
203	2964	2964	√	
204	1625	1626		+1
205	1208	1208	√	

Handout 1

Sample pallet stacking patterns