EXPLORATIONS ™

Activity 4

Objectives

- Use the CellSheet™ App to predict future trends based on average daily use
- Use a linear regression model to predict future trends

What Is A Kanban?

Introduction

Have you ever gone to buy a new CD or DVD only to find that the store has sold out? In your frustration, you wonder how the store manager could have let the item be sold out. You might think that the store manager did not keep very good track of the inventory. What you might not realize is that retailers and manufacturers try to keep their inventory to a minimum to save money. To do so, they need a system to track their inventory so they can project when they need to order more of a particular product.

Kanban is a method that the manufacturing industry uses to track inventory. It consists of data collection, analysis, and projection to determine when to place orders for more components or parts.

In this activity, you will determine when you will need to order more components so that inventory is kept to a minimum without dropping below a fixed level. You want to be sure that components are never out of stock and manufacturing is never halted.

Problem

E-Z Electrik Company manufactures several hundred electrical devices each week. Each device requires four bolts, part #01-0202. These parts are purchased by E-Z Electrik in batches of 3,000. Once an order has been placed, delivery takes five days. Orders are made so that the inventory never goes below 200, the reserve quantity.

The following table shows the inventory of part #01-0202 at the *beginning of each day* for the past seven working days.

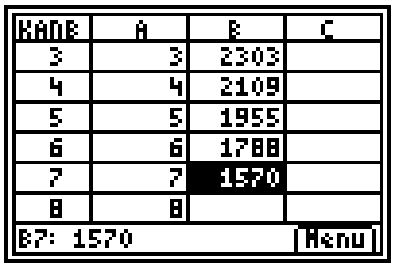
Day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Inventory	2,782	2,525	2,303	2,109	1,955	1,788	1,570

Based on the daily inventory of part #01-0202 for the past seven days, when should the next order be made?

Exploration

1. Start a new spreadsheet in the CellSheet™ App, and name it **KANBAN**.
2. Enter the numbers **1** through **15** in column A. (You may do this by typing each number in the cells, or by entering **1** in cell A1, then using the formula **=A1+1** in cell A2 and copying that formula down through cell A15.)
3. Enter the inventory for the first seven days in column B.

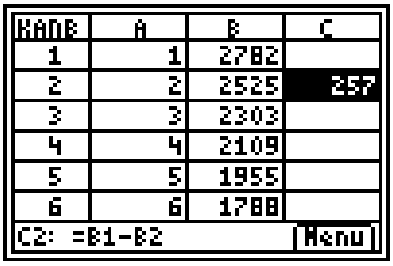
   In order to predict the number of parts that are going to be used each day, you need to determine the quantity that has been used on each of the days for which you have data.



KANB	A	B	C
3	3	2303	
4	4	2109	
5	5	1955	
6	6	1788	
7	7	1570	
8	8		

B7: 1570 Menu

4. To determine the quantity of part #01-0202 being used on day 1, subtract the quantity on hand at the beginning of day 2 from the quantity on hand at the beginning of day 1. In cell C2, enter the formula **=B1–B2**.

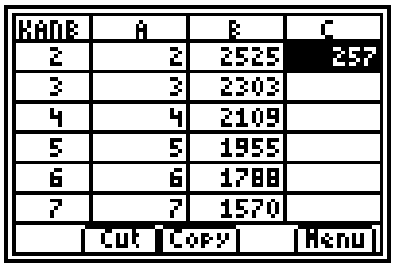


KANB	A	B	C
1	1	2782	
2	2	2525	257
3	3	2303	
4	4	2109	
5	5	1955	
6	6	1788	

C2: =B1-B2 Menu

5. Copy the formula from cell C2 down through cell C7 to calculate the quantity used each day.

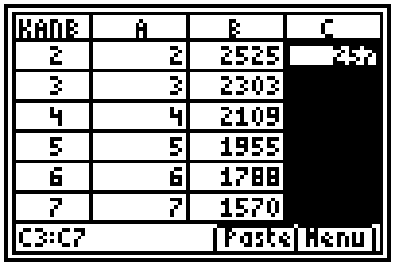
   a. Place the cursor on cell C2. Press [Y=], and then select **Copy** by pressing [ZOOM].



KANB	A	B	C
2	2	2525	257
3	3	2303	
4	4	2109	
5	5	1955	
6	6	1788	
7	7	1570	

Cut Copy Menu

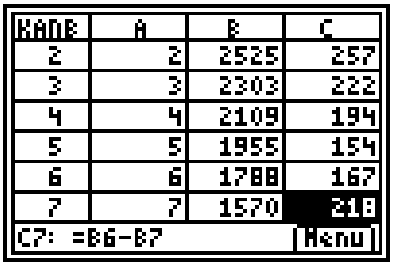
   b. Move to cell C3, and then press [Y=] to identify the range. Use the down cursor key ([▼]) to highlight the cells to C7.



KANB	A	B	C
2	2	2525	257
3	3	2303	
4	4	2109	
5	5	1955	
6	6	1788	
7	7	1570	

C3:C7 Paste Menu

   c. Paste the formula into the highlighted cells by pressing [TRACE].



KANB	A	B	C
2	2	2525	257
3	3	2303	222
4	4	2109	194
5	5	1955	154
6	6	1788	167
7	7	1570	218

C7: =B6-B7 Menu

Column C shows the quantity of part #01-0202 used each day. Find the average number of parts used each day to come up with a prediction for future use.

6. Enter a formula in cell D7 to find the average. Two formulas are possible:

_____

_____

The average number of parts used for the first seven days is _____. This is a good predictor for the quantity of parts that will be used for each of the remaining days.

7. In cell C8, enter the formula **=$D$7**. Remember that the dollar signs keep the cell reference the same even as the formula is copied into other cells in column C.

KANB	B	C	D
3	2303	222	
4	2109	194	
5	1955	154	
6	1788	167	
7	1570	218	202
8		202	

C8: =$D$7 [Menu]

8. Copy the contents of cell C8 down through cell C15. You are using 202 as the predicted quantity of part #01-0202 used each day.

KANB	B	C	D
10		202	
11		202	
12		202	
13		202	
14		202	
15		202	

C15: =$D$7 [Menu]

9. To find the projected inventory at the beginning of day 8, subtract the predicted quantity used from the total quantity available.

a. Write the formula for this operation:

_____. Enter it in cell B8.

KANB	B	C	D
7	1570	218	202
8	1368	202	
9		202	
10		202	
11		202	
12		202	

B8: =B7-C8 [Menu]

b. Copy the formula in cell B8 down through cell B15.

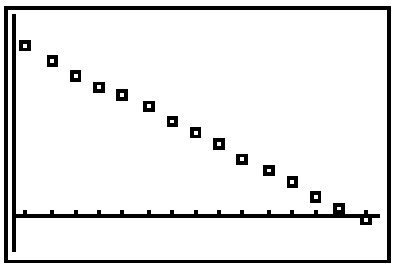
KANB	B	C	D
10	964	202	
11	762	202	
12	560	202	
13	358	202	
14	156	202	
15	-46	202	

B15: =B14-C15 [Menu]

As you can see, at the beginning of day 14, the inventory is *below* the reserve quantity of 200 components. The order needs to be received by end of day 12 so that the number of parts does not drop below 200. If the order takes five days to be received, then the order needs to be made on day 7.

The same data can be displayed graphically.

10. Select **Menu > Charts > Scatter** to display the graph. Set the **XRange** to **A1:A15** and the **YRange** to **B1:B15**.



Another method for tracking inventory is using the linear regression model. First you want to find the linear equation for your data.

11. Highlight cell A1 through B7 using ZOOM and Y=.

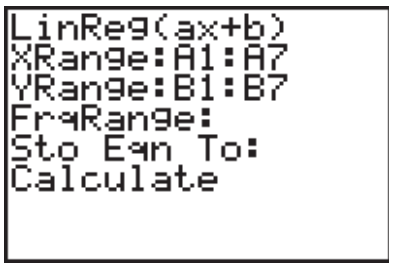
RANK	A	B	C
2	2	2525	257
3	3	2303	222
4	4	2109	194
5	5	1955	154
6	6	1788	167
7	7	1570	218

A1:B7 | Paste | Menu

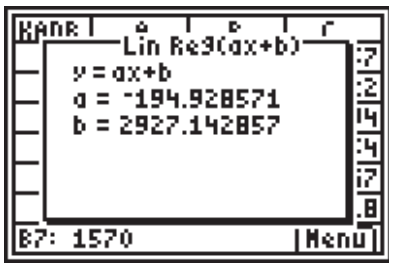
12. Select **Menu > Options > Statistics** > **LinReg(ax+b)**.

It is important to recognize that the slope of the linear model represents the number of units used each day—a rate. Slope in mathematics is defined as the change in *y* over the change in *x*, $\Delta y/\Delta x$. In this case, the variables represent the change in the inventory over the change in time (days).

13. By selecting the range over which the linear regression will be calculated, the **XRange** and **YRange** appear automatically. Press ENTER five times to cycle through this screen.



14. The linear equation is approximately $y = -195x + 2{,}927$.



The linear equation gave a slope of ⁻195, instead of ⁻202, the average found with the average use method. In the linear regression calculation, seven pairs of numbers were used rather than the six used to find the average quantity.

15. In order to determine when the reserve quantity will be reached, solve the linear equation.

$$200 = {}^{-}195x + 2927$$

$$195x = 2727$$

$$x = 13.98$$

The inventory will reach 200 toward the end of the day 13. Thus, the order needs to be made to arrive on day 12 so the reserve quantity is never reached. Make the order on day 7.

Both methods gave the same answer: the order needs to be made on day 7 to ensure delivery by day 12.

Student Worksheet

Name _____

Date _____

Navigating the CellSheet™ Application

1. You can graph data in CellSheet by pressing _____ to select the **Menu**. From the **Menu** options, select _____.

2. Once you select the type of chart, you enter the **XRange** and **YRange** as follows: **A1** _____ **A5**.

Solving the Problem

3. Complete the table.

Day	Beginning Inventory	Number of Parts Used the Previous Day	Average Quantity Used Each Day
1	2,782		
2	2,525		
3	2,303		
4	2,109		
5	1,955		
6	1,788		
7	1,570		

Analyzing the Data

4. The data show that the inventory of part #01-0202 will decrease at an average rate of _____ units per day. Because the inventory is projected to reach the reserve quantity sometime on day _____, the order should be made on day _____, allowing five days for delivery.

5. A linear regression model uses the equation _____. The slope of the line is represented by _____ and is _____ when it is used to represent depleting inventory. The *y*-intercept is represented by _____.

Extending the Activity

1. A traffic engineer collected data for the number of cars that pass by a fixed point on a busy highway. He collected the data for several days showing the number of cars each day. Based on those data, the engineer found that a linear model fit the data. If *d* represents days, with zero as today, and *N* represents the number of cars, then the model is $N = 34.5d + 43468$.

   Explain what units are appropriate for the numbers 34.5 and 43468.

2. Use the following information to determine when an order needs to be made for part #01-0324. Solve the problem using both average rate of use and the linear regression equation as predictors.

Orders of part #01-0324 are made in batches of 4,500. It takes four days to receive an order after the order has been placed. Orders are made so that the inventory never gets below 400, the reserve quantity.

The following table shows the inventory for the past 7 working days.

Day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Inventory	4,202	3,901	3,579	3,238	2,901	2,591	2,273

Teacher Notes

Activity 4

What Is A Kanban?

Objectives

- Use the CellSheet™ App to predict future trends bsed on average daily use
- Use a linear regression model in the CellSheet App to predict future trends

Materials

- TI-84 Plus/TI-83 Plus

Time

- 60 minutes

Preparation

The concept that things are used and have to be replenished should not be new to students. Some of them may work in retail and have helped stock shelves or do inventory. Others may be familiar with debit lunch cards, phone cards, or other rechargeable cash cards. Other possible examples include filling a car with gas before it runs out of gas or saving part of their weekly allowance for a desired purchase.

Elicit Questions

You and your family are planning to drive from St. Paul, Minnesota to Dallas, Texas, a distance of 992 miles. Your family car averages 24 miles per gallon on the highway and the tank holds 18 gallons. Your father always stops for more gas as soon as the gas warning light goes on, when the gas tank has reached the reserve quantity of two gallons. If your father sets the cruise control to 65 mph, after how many hours of driving will he stop to fill up the gas tank? How many times will it be necessary to stop and get gas?

Management

Encourage students to discuss with one another their calculations and findings as they work through the Exploration. The linear regression model may pose some difficulty for students less comfortable with algebraic concepts.

Answers to Exploration Questions

6. **=(C2+C3+C4+C5+C6+C7)/6; =sum(C2:C7)/6**; 202.

9. **a.** **=B7–C8**

Answers to the Student Worksheet

Navigating the CellSheet™ Application

1. GRAPH or ALPHA [F5], **Charts**
2. **:**

Solving the Problem

3.

Day	Beginning Inventory	Number of Parts Used the Previous Day	Average Quantity Used Each Day
1	2,782		
2	2,525	*257*	
3	2,303	*222*	
4	2,109	*194*	
5	1,955	*154*	
6	1,788	*167*	
7	1,570	*218*	*202*

Analyzing the Data

4. 202; 13; 7
5. $y = ax + b$; a; negative; b

Extending the Activity

1. 34.5 is a rate representing the $\frac{\text{number of cars}}{\text{number of days}}$; 43468 is the number of cars.
2. According to average rate of use model, the average daily rate of use is about 322 parts. At that rate, the inventory will reach the reserve quantity of 400 by the end of day 12. If it takes four days for the order to be received, then the order needs to be placed on day 7 so that the order is received on day 11, and the reserve quantity is never reached.

   With the linear regression model, the linear equation is approximately $y = {}^{-}325x + 4539$. (Round to 325 to err on the side of safety.)

   In order to determine when the reserve quantity will be reached, solve the linear equation. The inventory will reach 400 toward the end of day 12. Thus, the order needs to be made on day 7 so that it is received on day 11.

$$400 = {}^{-}325x + 4539$$

$$325x = 4139$$

$$x = 12.7$$