Unit Summary

Lesson 1: Linear Equations

Time: 2-3 class periods (50 minutes each)

Grade-Level Expectations Addressed:

(A1B10) Generalize patterns using explicitly or recursively defined functions.
(A1C10) Compare and contrast various forms of representations of patterns.
(G4B10) Draw or use visual models to represent and solve problems.

Essential Question to Guide the Unit and Focus Teaching and Learning:

1. How can slope and y-intercept be determined from data, graphs, and equations?
2. How is slope and y-intercept interpreted for physical world problems?
3. How can various representations of a linear model be used to make predictions about real-life situations?

Specific Classroom Arrangement/Preparations:

Classroom Arrangements: These lessons will work best when students are assigned to cooperative learning groups.
Cooperative learning groups are made up of four students grouped heterogeneously by ability—high, medium high, medium low, and low.
Each group will have students numbered 1 to 4. Those numbers will give each student a specific role within the group during activities.
Prior Knowledge: Students should be proficient in use of the slope-intercept (y=mx+b) form of a linear equation. They should be able to identify the slope and y-intercept, and be able to graph equations of this form.

Lesson Materials:

- Graphing calculators need to be available to each student during class time (TI-83 calculators were used to develop this lesson, but other calculator brands could be used as well.)
- Handouts of lesson problems
- Graph paper

Technology/Manipulatives/Resources:

Students will use graphing calculators to explore properties of linear equations that can be found in the y=tables and graphs.

Step-by-Step Process:

LEARNING ACTIVITIES	QUESTIONS FOR STUDENTS	TEACHER SUPPORT
Warm-up Activity	Use your graphing calculator to	a. Students should

	produce graphs and side-by-side tables for each of the following equations using a scale of 1 unit starting at x=0. a. $y=2x$ b. $y=x^2$ c. $y=2^x$ For each equation, describe the graph and the pattern shown in the table. Which graph appears to be linear? How can the table be used to support your answer? Write an equation that you believe to be linear and use your graphing calculator to test your belief.	recognize this as a straight line graph and know the table will show a constant rate of change. When x=0, the value of y=0 and the values of y continue to increase by 2 for every 1 change in x. b. Students should notice that this graph looks like half of a "U" and that the table shows a rate of change that is not constant. Students may notice that while y begins at zero like the last equation, the y values increase by 1,3,5,7,9, etc. (NOT a constant difference for the change in y while the change in x is the constant difference, 1) c. Students should notice that this graph looks similar to the last graph—NOT linear, but curved. They should notice the y values are increasing much more quickly than in the previous two

		graphs. Some students may notice that the y-values are powers of 2. The graph of part (a) is linear because it produces a straight line and the rate of change shown in the table is constant. **In later lessons, students will learn the graph of $y=x^2$ is quadratic, and the graph of $y=2^x$ is exponential. It is not necessary to teach those concepts at this point. Generally, students should recognize (a) as linear and (b and c) as NOT linear—based on the rates of change observed. The equation students choose should be of the form y=mx+b. They can compare with a group member as the teacher walks around to monitor progress.
OBJECTIVE 1: What comes next? Notes: Remember that y=mx+b is the slope-intercept form of a linear equation, where m=slope and b=y-intercept. x and y refer to	Translate the following equations into NOW-NEXT form. 1. $y = 5x + 7$ **NEXT=NOW+5, start at 7** 2. $y = -3x + 5$	Students should be able to make these translations rather quickly. Write these problems on the overhead or board and ask

the ordered pair (x,y) that satisfies the equation. Another term for slope is the rate of change. The rate of change describes the change in y compared to the change in x. The formula to find slope or rate of change given two points is $m = \frac{y_2 - y_1}{x_2 - x_1}$. You may remember this as rise over run. The linear y= equation is said to be written in *explicit* form. Another way to write equations is in recursive form, NOW-NEXT. NOW-NEXT equations convert the beginning NOW value into the NEXT value that occurs due to the rate of change. In a linear relationship, the starting value, NOW, is the y-intercept; and rate of change is the slope. In general, the recursive form is written as $NEXT = NOW + m$, *starting at b*. Where m is the rate of change or slope and b is the y-intercept. For example the equation $y = 3x + 4$ can be written as *NEXT=NOW+3, starting at 4.*	**NEXT=NOW - 3, start at 5** 3. $y = -2x - 6$ **NEXT=NOW – 2, start at -6** 4. $y = x - 9$ **NEXT=NOW+1, start at -9** 5. $y = 10x$ **NEXT=NOW+10, start at 0** 6. $y = 3$ **NEXT=NOW+0, start at 3** Translate the following equations from NOW-NEXT form into y= form. 1. NEXT=NOW – 5, start at 12 $\boldsymbol{y} = -5\boldsymbol{x} + 12$ 2. NEXT=NOW+ 20, start at -4 $\boldsymbol{y} = 20\boldsymbol{x} - 4$ 3. NEXT=NOW-0.5, start at 0 $\boldsymbol{y} = -0.5\boldsymbol{x}$ 4. NEXT=NOW, start at 100. $\boldsymbol{y} = 100$ 5. NEXT=NOW+1.2, start at 3.5 $\boldsymbol{y} = 1.2\boldsymbol{x} + 3.5$ 6. NEXT=NOW-20, start at -15 $\boldsymbol{y} = -20\boldsymbol{x} - 15$	students to copy them onto their paper. Person #1 will keep their paper out for the group to use. Person #1 will do problem #1 and write the answer on the paper as they justify it to the other group members. The paper will then be passed to person #2 for problem 2, and so on until the problems are complete. This should take about 10 minutes. Then discuss the answers as a class and allow all students to record the correct answers on their own papers. **Teacher Note:** Be sure that students are placing the slopes and y-intercepts correctly.

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<td>OBJECTIVE 2:
Activity 1:
The slope(rate of change) and y-intercept (starting value) can be identified from tables, graphs, and equations. This time students will be given four tables in which to identify the rates of change, y-intercepts, and write equations in both y=mx+b form and NOW-NEXT form.</td>
<td>Using each table 1)identify the rate of change and the y – intercept 2)write a y= equation and
<table><tr><th>Number of Rides</th><th>Total Cost at the Park</th></tr><tr><td>0</td><td>30</td></tr><tr><td>1</td><td>30</td></tr><tr><td>2</td><td>30</td></tr><tr><td>3</td><td>30</td></tr><tr><td>4</td><td>30</td></tr><tr><td>5</td><td>30</td></tr><tr><td></td><td></td></tr></table>
3)write a NOW-NEXT equation</td>
<td>Teacher should monitor the groups/students providing feedback and assistance.</td>
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See Lesson I Appendix for Linear Graph Sheet 1 and Linear Graph Sheet 2 Activity 2:		**The teacher should observe students and answer questions as they work.**

Number of Rides	Total Cost at the Park
0	20
2	22
4	24
6	**26**
8	28
10	30
10	29
15	31
20	33
25	35

Number of Rides	Total Cost at the Park
0	10
3	16
6	22
9	28
12	34

Why might the park have different pricing plans available?

It gives choice to people who want to spend all day compared to people who are only going for one hour. It also allows people to pay less if they just want to get into the park and not ride many times.

What type of person might be

Cooperative Learning Activity -Group students in pairs -Distribute Linear Graph Sheet 1 and Sheet 2 to each pair, -Student one completes graph sheet 1 and student two completes graph sheet two (individually) -Students compare their graphs and worksheet results with their partner. -Students share findings with the class. **See Lesson I Appendix for Cell Phone Costs worksheet** Activity 3: Hand out the Cell Phone Costs lesson sheet to students. Have them read the lesson carefully. Ask the Cell Phone Costs Questions for Students to review prior learning objectives.	interested in each plan? **Answers may vary.** How would the graphs of these tables compare? **All of the graphs are increasing. The greater the price per ride, the steeper the line. The first table represents a constant function so it is a horizontal line.** Cell Phone Cost Questions For Students 1. What is the title of the graph? 2. How many of you use a cell phone? 3. Do you pay for your own cell phone? 4. How many hours do you use your cell phone each month? 5. How do cell phone companies charge their customers? 6. On the graph, what does the y-axis represent? 7. What does the x-axis represent?	**Students can graph data and find line of best fit with a graphing utility.** **Get information from local telephone companies regarding prices in your area.** **Instructional Strategies used: Highly Effective Questioning and Cooperative Learning.**

See Lesson I Appendix for Graphing Handout 1 OBJECTIVE 3: Students will collect data from a real life situation that they believe will result in a linear relationship. Students will bring data to next class period. Students must bring in 8 data points Divide the class into pairs of students and provide them with two copies of the Graphing Handout 1 worksheet. Each pair of students will plot his or her set of data	8. What increments are used on the y-axis? 9. What is the cost for using the cell phone 2 hours? 4 hours? 10. If you are charged $40, how many hours did you use your cell phone? $30.00? 11. Does the line representing Cell Phone Cost have a positive or negative slope? 12. What is the slope of the line? 13. How do you know?(explain) 14. Which answer is correct for Question #2? 15. Why is answer A incorrect? B? D? 16. What is the y-intercept of the line? 17. How do you know?(explain) 18. Which is the correct answer for #1? 19. Why is answer A incorrect, C? D? 20. What is the slope-intercept equation for the line on the graph? 21. How do you know?(explain) 22. Which is the correct answer to Questions #3? 23. Why is answer A incorrect? C? D? 24. What is the correct answer to Question #4? 25. How do you know?(explain) 26. Why is answer A incorrect? B? D? 27. What would happen to the line if the slope was	As students are working check the following: Is the data linear? Are students correctly plotting the data points? Are students correctly interpreting the meaning of rate of change in the context of real-life data? Are students correctly interpreting the meaning of the y-intercept of a line in the context of real-life data? **Teacher Note!!!!!** **Create a few sets of real-life data to assign to students who did not complete their homework.**

on the handout. Students should graph 8 data points. After plotting the data they should draw their line of best fit, and answer the questions on the handout. The students should display their graphs in the room. Students should move from graph to graph at this time and view the work of their classmates. Students should answer the following questions (in written form) for at least 3 of their classmates work: What similarities did you notice among the graphs? What differences did you observe? What caused these differences? Was the information presented on the graph represented appropriately? What rate of change does the slope of the line represent? What is the meaning of the y-intercept in the context of the data you presented?	negative? **Make a table of values t-chart to organize the answers to the following questions:** What similarities did you notice among the graphs? What differences did you observe? What caused these differences? What changes needed to be made to any of the graphs? What rate of change does the slope of the line represent? What is the meaning of the y-intercept in the context of the data you presented?	**Teacher Note:** **See Lesson I Appendix for Graphing Handout 2 if you wish to make an additional assignment to students.**
All worksheets for Objective 4 are in the **Lesson I Appendix for Graphing activities** OBJECTIVE 4: Students should be divided into teams of two	**Based on the data table is the slope of the line positive or negative?** **What is the y-intercept of the**	

to work and should be given a copy of the handout Year v. Price Handout. After completing the questions on the handout, students should be given the opportunity to discuss their findings as a class. Each student should be given a copy of the handout, Years Since 1974 v. Price Handout. After completing the questions, students should be given the opportunity to discuss their findings as a class. Students will complete the Mean Income: Year v. Mean Yearly Income Handout and Years Since 1974 v. Mean Yearly Income Handout for the next class period. Have students complete the Comparing and Contrasting Worksheet.	**line and what does it mean?** **Is the slope of the line positive or negative?** **What is the y-intercept of the line and what does it mean?**	**TEACHER REFLECTION AND SUGGESTION NOTES AFTER THE LESSON:** Give the students traditional linear problems in y=mx+b form and ask students to translate them into NOW-NEXT equations. Ask students to extend a traditional linear work problem to a more in-depth situation that requires predictions that can be supported by tables and graphs. Have students compete with a partner to see who can graph linear equations the fastest. One partner uses the graphing calculator while the other partner does everything by hand. Both students have to sketch their graphs on paper. Give students traditional problems in y=mx+b form and ask students to translate them into NOW-NEXT equations.