Name ______________________________________ Date ___________ Class ____________

TEKS 2A.1.B

LESSON **9-6**

Technology Lab

Modeling Objects Rolling Down a Ramp

Plotting a ball or toy car rolling down a ramp of varying inclines creates a family of curves, which can be modeled by a series of quadratic equations. This activity investigates the values of the coefficients in the quadratic equation, $y = ax^2 + bx + c$.

MATERIALS

- TI-84
- CBR 2™ motion detector
- unit-to-CBR 2™ or I/O unit-to-unit cable
- EasyData application
- large (9 inch) playground ball
- long ramp (at least 2 meters or 6 feet—a lightweight board works well)
- protractor to measure angles
- books to prop up ramp

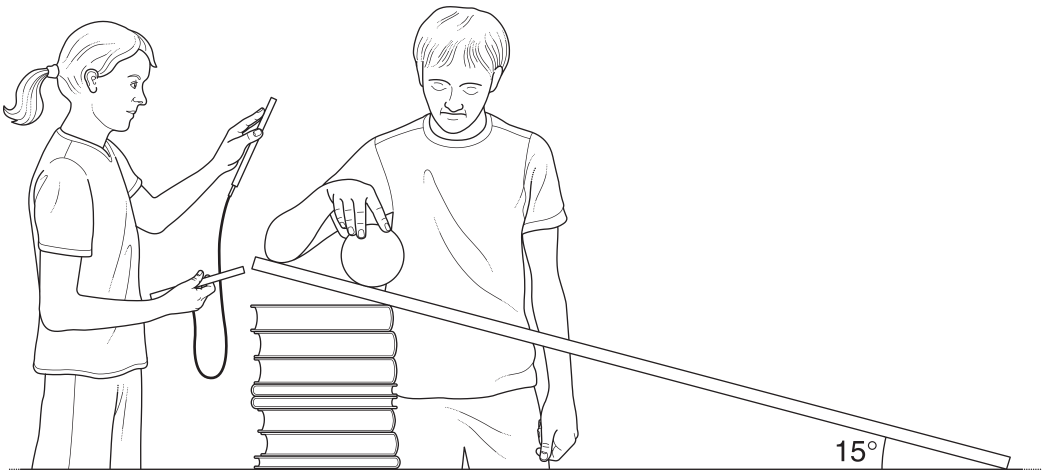
Activity 1

Follow these steps to measure the distance of a ball or toy car as it travels down a ramp.

1. Use a protractor to set the ramp at a 15° incline. Lay the CBR 2™ motion detector on the ramp and flip the sensor head so it is perpendicular to the ramp.

Mark a spot on the ramp 15 centimeters (about six inches) from the CBR 2™ motion detector. Have one student hold the ball at this mark, while a second student holds the calculator and CBR 2™ motion detector.

Hint: Aim the sensor directly at the ball and make sure that there is nothing in the *clear zone*.



2. Run the EasyData App.

3. To set up the calculator for data collection:

a. Select Setup (press WINDOW) to open the Setup menu.

b. Press 2 to select 2: Time Graph to open the Time Graph Settings screen.

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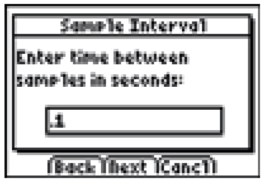
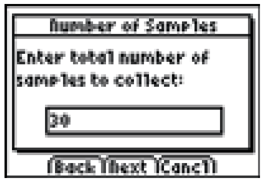
c. Select Edit (press ZOOM) to open the Sample Interval dialog window.

d. Enter 0.1 to set the time between samples in seconds.



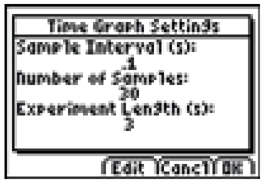
e. Select Next (press ZOOM) to advance to the Number of Samples dialog window.

f. Enter 30 to set the number of samples. Data collection will last for 3 seconds.



g. Select Next (press ZOOM) to display a summary of the new settings.

h. Select OK (press GRAPH) to return to the main screen.



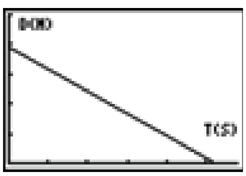
4. When the settings are correct, choose Start (press ZOOM) to begin sampling.

5. When the clicking begins, release the ball immediately (don't push) and step back.

6. When the clicking stops, the collected data is transferred to the calculator and a plot of distance vs. time is displayed.

Try This

1. Which of these plots do you think best matches the *Distance-Time* plot of a ball rolling down a ramp?

I


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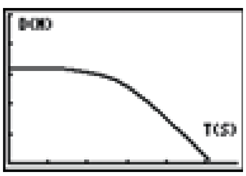

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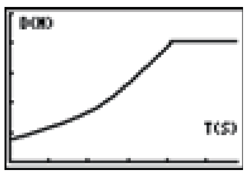

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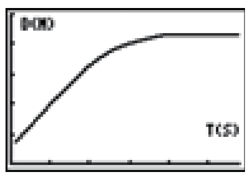

2. What physical property is represented along the *x*-axis? ______________________

What are the units? ______________________

What physical property is represented along the *y*-axis? ______________________

What are the units? ______________________

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3. Sketch what the plot really looks like. Label the axis. Label the plot at the points when the ball was released and when it reached the end of the ramp.

4. What type of function does this plot, between the two points you identified, represent?

____

5. Discuss your change in understanding between the graph you chose in question 1 and the curve you sketched in question 3.

____

____

Activity 2

Examine what happens for differing inclines.

1. Predict what will happen if the incline increases. Create a sketch of the predicted plot.

2. Adjust the incline to 30°. Repeat Steps 2 through 6 from Activity 1. Sketch this plot next to the drawing in Exercise 1, label it 30°.

3. Repeat Steps 2 through 6 from Activity 1 for inclines of 45° and 60° and sketch these plots next to the drawings in Exercise 1.

4. Sketch and label the plots for 0° and 90°.

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Try This

Adjust the time values so that $x = 0$ for the initial height (the time at which the ball was released. You can do this manually by subtracting the x value for the first point from all the points on your plot, or you can enter L1(1)→A:L1→L1.

6. Calculate the values for a, b, and c for the family of curves in the form $y = ax^2 + bx + c$ at 0°, 15°, 30°, 45°, 60°, 90°.

____

____

____

7. What are the minimum and maximum values for a? Why?

____

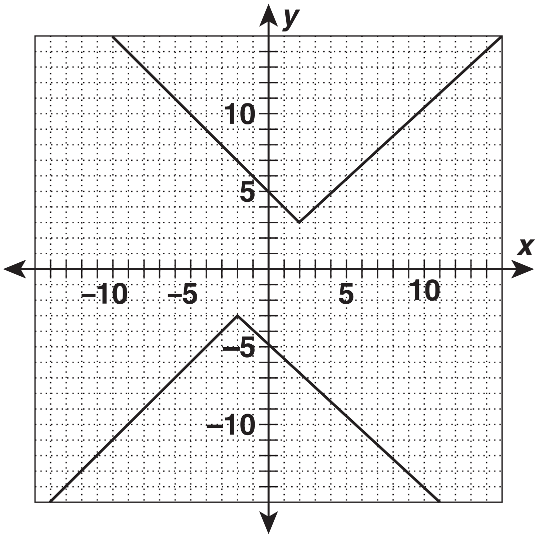
____

____

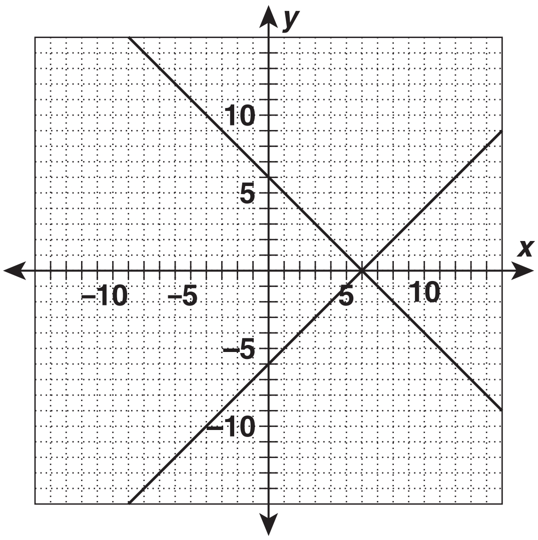
8. Write an expression describing the mathematical relationship between a and the angle of inclination.

____

3.



4.



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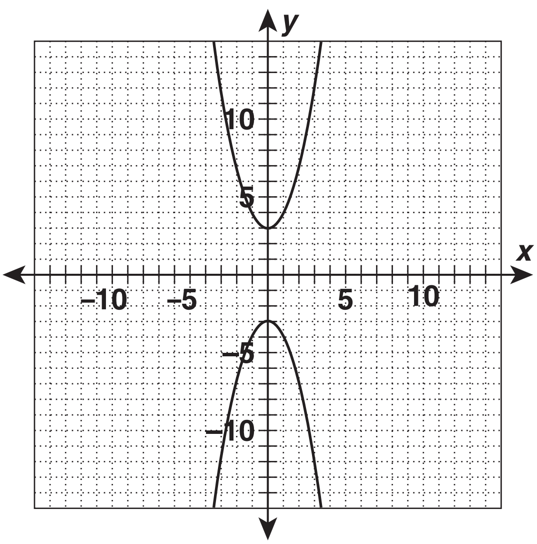
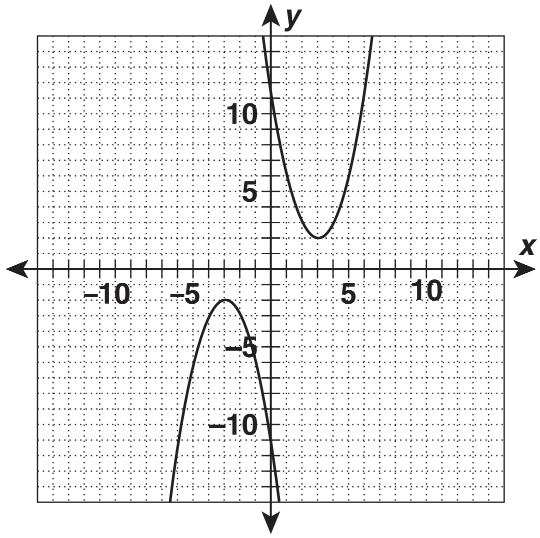


6.



LAB 9–6

Try This

1. Yes—it appears there is a pos. correllation in general
2. Yes—from the points I plotted—No
3. Approximately 2
4. It represents the rate of change in the atomic weight; for each increase of 1 in the atomic number, the atomic weight increases by 2.

TECH LAB 9-6

Try This

1. III
2. time; seconds; distance of object from CBR 2™ motion detector; feet or meters
3. Check students' drawings. (should be half of a parabola, concave up)
4. quadratic
5. Check students' answers.

Activity 2

1. Check students' drawings. (should be parabolic with increasing curvature)

2-3. Check students' drawings.

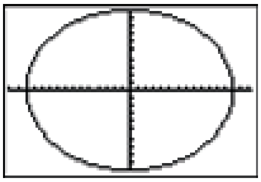
4. 0° is flat (ball can't roll); 90° is the same as a free-falling (dropping) ball

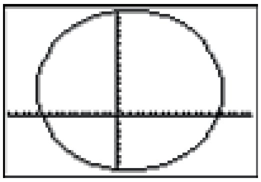
Try This

6. Since the ball is at rest when released, *b* should approach zero for each trial. *c* should approach the initial distance, 0.5 meters (1.5 feet). *a* increases as the angle of inclination increases.

TECH LAB 10-3

Activity 1

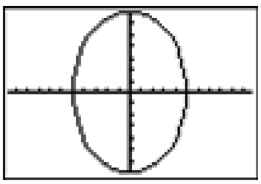
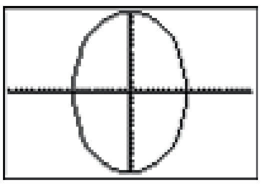
1. 

2. 

3. At the conics screen, you would press 2 instead of 1; *b* is 10 and *a* is 13.

Activity 2

1. $\frac{x^2}{100} + \frac{y^2}{196} = 1$

2.  

$\frac{(x)^2}{25} + \frac{(y)^2}{49} = 1$ $\quad$ $\frac{(x)^2}{100} + \frac{(y)^2}{196} = 1$

3. The graphs are the same shape, but the new graph is two-times as large.

TECH LAB 12-4

Try This

1. 30
2. 1.9375
3. 88,573

LAB 13-1

1. Tangent (opposite over adjacent)
2. To use right triangle trigonometry, you have to establish a right angle.
3. Holding the transit vertically (instead of horizontally) at a certain distance off the ground (e.g., five feet), with the zero line pointing at *B* (along *CB*) and parallel to the ground, measure the angle of elevation to the top of the tree by looking through the straw to the top of the tree. Then use the tangent function with the distance to the tree and the angle of elevation.

TECH LAB 13-6

1. 82.1
2. 96.8
3. 37.8
4. 7.8 hours

TECH LAB 14-3

1. $1 - \sin^2\theta$; They are the same.
2. They are the same.