LESSON 4-4

Success for English Language Learners

Determinants and Cramer's Rule

Steps for Success

Step I Start the lesson by providing students with the following support.

- Discuss the words *diagonal* and *vertical* with students. A diagonal is angle to angle, whereas vertical denotes directly overhead or in an upward and downward plane.
- Discuss the meanings of the vocabulary words *determinant, coefficient matrix,* and *Cramer's Rule* with students. Explain that Cramer's Rule is named after its originator, Gabriel Cramer, a Swiss mathematician who lived from 1704–1752.

Step II Help students understand how to find determinants of 2×2 and 3×3 matrices by following these procedures.

- Point out that finding the determinant of a 2×2 matrix involves fewer steps than finding the determinant of a 3×3 matrix. Finding the determinant of a 2×2 matrix involves subtracting the products of the diagonals. Follow these steps to find the determinant of a 3×3 matrix.
  1. Multiply each "down" diagonal and add the sums.
  2. Multiply each "up" diagonal and add the sums.
  3. Calculate the difference of the sums.
- Have students work in small groups of mixed proficiency levels to solve examples of finding determinants of both 2×2 and 3×3 matrices. Students with a strong grasp of the concept can guide less proficient students in finding the determinants.

Step III Ask English Language Learners to complete the worksheet for this lesson.

- Point out that Example 1A in the student textbook is supported by Problem 1. Point out that the process is different for finding the determinants of 2×2 and 3×3 matrices.

Making Connections

- Discuss the implication of linear models, such as the application of Cramer's Rule, in the natural and social sciences where nonlinear models are approximated by such.

Name ______________________________________ Date ___________ Class ____________

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Problem 1

Find the determinant of the matrix.

$$\begin{bmatrix} 6 & 5 \\ 8 & 3 \end{bmatrix}$$

$$\begin{vmatrix} 6 & 5 \\ 8 & 3 \end{vmatrix}$$

First cross multiply.

$$= 6(3) - 8(5)$$

The determinant is the difference of the products of the diagonals.

$$= 18 - 40 = -22$$

−22 is the determinant.

The determinant is −22.

Think and Discuss

1. Why is it important not to confuse the $|A|$ notation with absolute value notation?

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2. Why is the determinant a useful measure?

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Lesson 4-4

1. If A is a matrix it denotes determinant, if A is a number it denotes absolute value.
2. Using Cramer's Rule, the determinant can be used to solve systems of equations.

Lesson 4-5

1. If it is not square, then $AA^{-1} \neq A^{-1}A$.
2. There is no multiplicative inverse of the matrix.
3. It can be used to solve $A \cdot X = B$, where A is a coefficient matrix, X is a variable matrix, and B is a constant matrix.

Lesson 4-6

1. Because they are not coefficients of variables.
2. Answers may vary.

CHAPTER 5

Lesson 5-1

1. The graph moves right/left.
2. The graph moves up/down.
3. The y-coordinates of all points on the graph would change sign.

Lesson 5-2

1. Because $f(4) = 6$.
2. It opens up when $a > 0$.

Lesson 5-3

1. If a point on the graph is reflected across the axis of symmetry, the image is also on the graph.
2. Because a quadratic function can go up, then down; a linear function only goes up or down.

Lesson 5-4

1. Because the square root introduces the plus/minus sign.
2. Because you are changing the equation into a square plus a constant term.

Lesson 5-5

1. It is the square root of -1. It is used to work with negative square roots.
2. You could substitute the answer in the original equation.

Lesson 5-6

1. Because the square root is positive.
2. c would be 0 and the roots would be 0 and -10.

Lesson 5-7

1. The point $(0, 0)$ involves the least amount of calculation.
2. It is dotted because in the problem it is a less than sign, not a less than or equal to sign.

Lesson 5-8

1. The difference between the x-values is constant.
2. Between 4 and 6 the graph is at 9, goes down, and comes back up to 9. The vertex must be between 4 and 6.
3. It opens up because all the y-values are at least 9.

Lesson 5-9

1. Quadrant II, because it corresponds to the point $(-9, 1)$.
2. The additive inverses of 10 and $-4i$.