Apophis Math

Objectives

- Students will recall math facts to solve problems
- Students will use a coordinate graph to plot points and interpret information from the graph
- Students will use measurement to solve problems
- Students will use probability and ratios to solve problems
- Students will round large numbers to various place values
- Students will convert metric measurements to metric equivalents
- Students will convert standard measurements to standard equivalents
- Students will use multiplication to solve problems
- Students will use long division to solve problems
- Students will convert units of time into other equivalents

Suggested Grade Level

4^{th}-8^{th}

Subject Area

Math

Timeline

One to two class periods

Standards

Number and Operations

- Understand the place-value structure of the base-ten number system and be able to represent and compare whole numbers and decimals
- Develop understanding of fractions as parts of unit wholes, as parts of a collection, as locations on number lines, and as divisions of whole numbers
- Develop fluency in adding, subtracting, multiplying, and dividing whole numbers
- Develop and use strategies to estimate the results of whole-number computations and to judge the reasonableness of such results
- Develop and use strategies to estimate computations involving fractions and decimals in situations relevant to students' experience
- Select appropriate methods and tools for computing with whole numbers from among mental computation, estimation, calculators, and paper and pencil according to the context and nature of the computation and use the selected method or tools
- Work flexibly with fractions, decimals, and percents to solve problems
- Understand and use ratios and proportions to represent quantitative relationships

- Develop an understanding of large numbers and recognize and appropriately use exponential, scientific, and calculator notation
- Understand the meaning and effects of arithmetic operations with fractions, decimals, and integers
- Select appropriate methods and tools for computing with fractions and decimals from among mental computation, estimation, calculators or computers, and paper and pencil, depending on the situation, and apply the selected methods
- Develop and use strategies to estimate the results of rational-number computations and judge the reasonableness of the results

Algebra

- Describe, extend, and make generalizations about geometric and numeric patterns
- Represent and analyze patterns and functions, using words, tables, and graphs
- Model problem situations with objects and use representations such as graphs, tables, and equations to draw conclusions
- Model and solve contextualized problems using various representations, such as graphs, tables, and equations
- Use graphs to analyze the nature of changes in quantities in linear relationships

Geometry

- Make and use coordinate systems to specify locations and to describe paths
- Use coordinate geometry to represent and examine the properties of geometric shapes
- Use two-dimensional representations of three-dimensional objects to visualize and solve problems such as those involving surface area and volume
- Recognize and apply geometric ideas and relationships in areas outside the mathematics classroom, such as art, science, and everyday life

Measurement

- Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute
- Carry out simple unit conversions, such as from centimeters to meters, within a system of measurement
- Understand that measurements are approximations and how differences in units affect precision
- Select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles
- Understand both metric and customary systems of measurement
- Understand relationships among units and convert from one unit to another within the same system

- Understand, select, and use units of appropriate size and type to measure angles, perimeter, area, surface area, and volume
- Select and apply techniques and tools to accurately find length, area, volume, and angle measures to appropriate levels of precision
- Solve simple problems involving rates and derived measurements for such attributes as velocity and density

Data Analysis and Probability

- Describe events as likely or unlikely and discuss the degree of likelihood using such words as *certain, equally likely,* and *impossible*
- Understand that the measure of the likelihood of an event can be represented by a number from 0 to 1

Problem Solving

- Build new mathematical knowledge through problem solving
- Solve problems that arise in mathematics and in other contexts
- Apply and adapt a variety of appropriate strategies to solve problems
- Monitor and reflect on the process of mathematical problem solving

Reasoning and Proof

- Recognize reasoning and proof as fundamental aspects of mathematics
- Make and investigate mathematical conjectures
- Develop and evaluate mathematical arguments and proofs
- Select and use various types of reasoning and methods of proof

Communication

- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- Analyze and evaluate the mathematical thinking and strategies of others
- Use the language of mathematics to express mathematical ideas precisely

Connections

- Recognize and use connections among mathematical ideas
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
- Recognize and apply mathematics in contexts outside of mathematics

Representation

- Create and use representations to organize, record, and communicate mathematical ideas
- Select, apply, and translate among mathematical representations to solve problems
- Use representations to model and interpret physical, social, and mathematical phenomena

Background

Students will use information gathered from scientific observations of Apophis to solve math problems. Students must have an understanding of long division and coordinate graphing to complete the activities. Students must also have an understanding of converting units in the metric system, and converting units in the standard system of measurement.

Materials

Apophis math worksheet, pencil; math lab: centimeter graph paper, two pins or tacks per group or student, string, centimeter ruler, different colored pencils

Lesson

1. Review the following concepts with students prior to doing the activity: long division, coordinate graphing, conversion of metric units of measurement, conversion of standard units of measurement, and conversion of time units.
2. Explain to the students that they are now working for LINEAR-the Lincoln Near Earth Asteroid Research Center. It is a joint operation between the Air Force, NASA and MIT's Lincoln Laboratory. They have been charged with gathering information on Apophis to help track the NEA (Near Earth Asteroid).
3. Have students complete the worksheet.
4. Make sure students double-check all of their answers for accuracy. (The fate of the world is in their hands, they can not afford to make a mistake.)

Extensions

Students will participate in a math lab. The objective is to simulate the orbits of Earth and Apophis. This will be a very simple lab and very little calculation will be needed on the part of the students. If the teacher wishes to make this a more difficult lab, then he/she can make the students calculate the various ellipses to get the orbits of Earth and Apophis.

1. Have students create a graph on paper or use centimeter graph paper. Make sure the graph is at least 30 cm long.
2. Place a tack or pin at the center of the graph. This will be focus #1 of the ellipse.
3. Cut a piece of string at least 20 cm long and tie it together to make a loop. Make sure that when the loop is stretched out it reaches 10 cm from focus #1.
4. Loop one end of the string around the pin at the center of the graph. Place your pencil on the inside of the loop. Stretch the string out. It should reach to 10 cm; if not, retie the string.
5. Trace a circle around focus #1. The circle should reach to 10 cm all the way around the graph. This circle represents Earth's orbit. Keep in mind that Earth's true orbit is not a circle, but an ellipse. It is nearly a circle, but is still an ellipse. This needs to be discussed with the students. For the purposes of this demonstration a circular orbit is used for simplicity.

6. Now we will create Apophis' orbit. Remove the string from the first part. Place another pin 4 cm from focus #1 along the major axis.
7. Cut another piece of string at least 23.5 cm long. Tie this string into a loop so that it stretches approximately 11.5 cm from focus #1 along the major axis.
8. Using a different color for Apophis' orbit, place your pencil or pen inside the looped string.
9. Stretch the string to its maximum point. Continue tracing the ellipse by stretching the string as far as it will go.
10. Have students circle the two points at which the two orbits intersect.

Evaluation/Assessment

Use the worksheet for a math grade.

Resources

National Math Standards: http://standards.nctm.org/document/index.htm

NASA: http://www.nasa.gov

LINEAR (Lincoln Near Earth Asteroid Research Center): http://www.ll.mit.edu/LINEAR/

Wikipedia: http://www.wikipedia.org

Apophis Math Worksheet

Name _____

Date _____

Answer the following questions.

1. Apophis was discovered on June 19, 2004. How long ago was that in:

   Years _____

   Months _____

   Weeks _____

   Days _____

2. Apophis will make a close-approach to Earth on April 13, 2029. How long is that from now in:

   Years _____

   Months _____

   Weeks _____

   Days _____

3. Apophis may strike the Earth (not very likely) on April 13, 2036. How long is that from now in:

   Years _____

   Months _____

   Weeks _____

   Days _____

4. The probability that Apophis will hit the Earth is 1 in 43,000. Write that probability as a :

   Fraction: _____

   Percent (round to the nearest tenth): _____

   Ratio: _____

5. Apophis will pass within 22,200 miles of the Earth. Convert that number to:

   Yards _____

   Feet _____

   Inches _____

6. The mass of Apophis is 110,231,131,092.4 lbs. Write this number in expanded form, word form, and short word form.

   Expanded form:
   _____
   _____
   _____

   Word form:
   _____
   _____
   _____
   _____

   Short word form:
   _____
   _____
   _____
   _____

7. Round the mass of Apophis to the following places:

   Billions: _____

   Ten millions: _____

   Hundred thousands: _____

   Hundreds: _____

8. The mass of Apophis is 510,000,000,000 kg. Write that number in scientific notation.

   _____

9. Convert that number into grams.

_____

10. The mass of Apophis is 110,231,131,092.4 lbs. If a school bus weighs 32,000 lbs, how many school buses would it take to equal the mass of Apophis?

Answer: _____

11. The average school bus is approximately 39.25 ft long. How many school buses would it take to equal the length of Apophis if Apophis is 1,350 ft. long? (round your answer to the nearest tenth)

Answer: _____

12. Apophis is approximately 400 m long. Convert that number into:

    km _____

    hm _____

    dam _____

    m 400

    dm _____

    cm _____

    mm _____

13. Apophis takes 323 days to orbit the sun. How much time is that in:

    Months _____

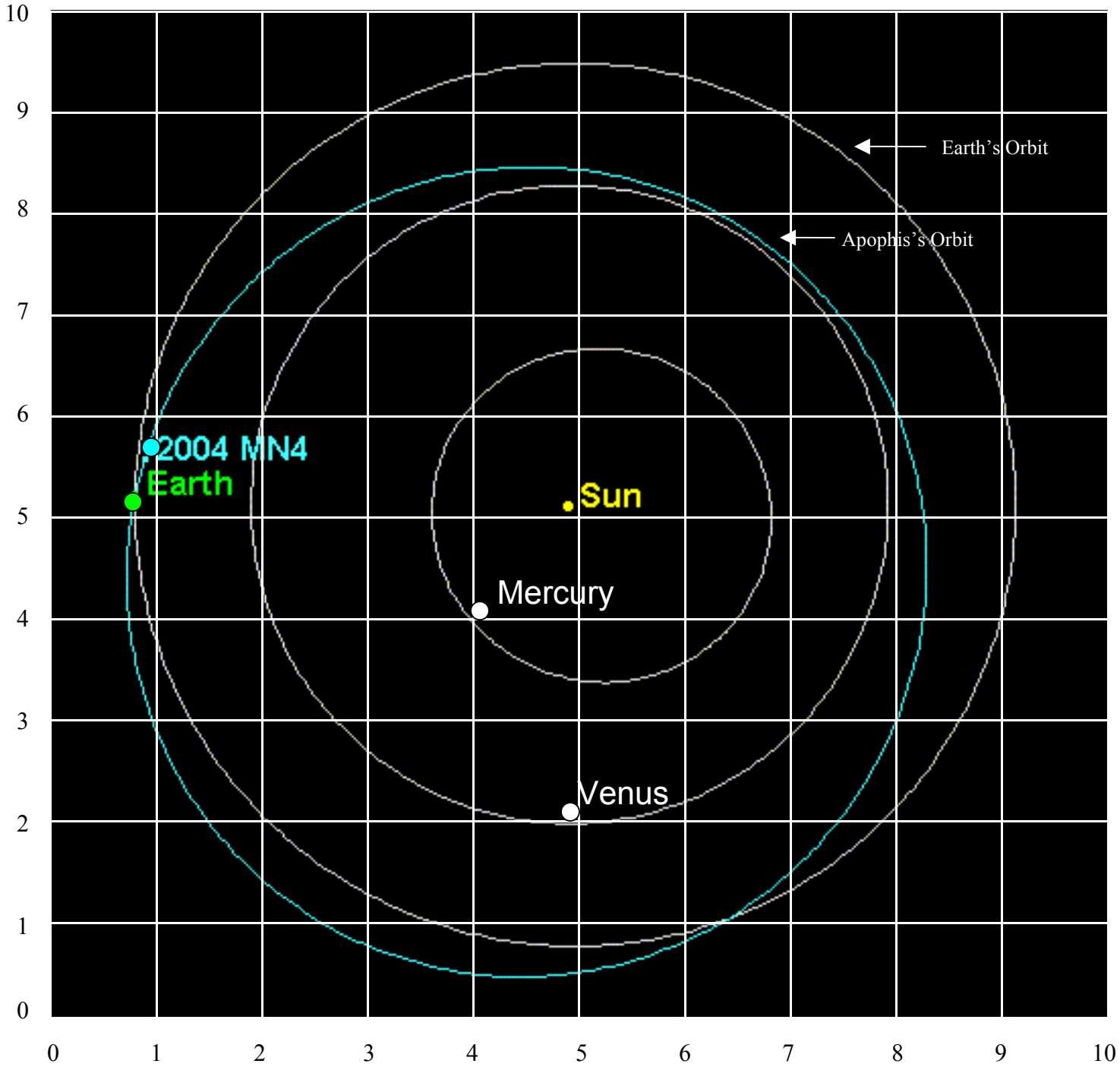
    Hours _____

    Minutes _____

    Seconds _____

14. If Apophis is traveling at 30.73 km/s (kilometers per second), how many km/h is that?

15. If Apophis is traveling at 19.1 m/s (miles per second), how many mph is that?



Use the coordinate graph to answer the following questions.

16. The Sun is approximately at what coordinate? (,)

17. The Earth is approximately at what coordinate? (,)

18. Asteroid 2004 MN4 (Apophis) is approximately at what coordinate?

    (,)

19. Besides the coordinate (1, 5), where else does the path of Apophis and Earth intersect?

    (,)

20. Mercury is at approximately what coordinate? (,)

21. Venus is at approximately what coordinate? (,)

22. Does the orbit of Apophis intersect with the orbit of Venus? _____

23. List at least five coordinate points along Apophis' orbit.

    (,)
    (,)
    (,)
    (,)
    (,)

24. The diameter of the Earth at the equator is 12,756.274 km. How many meters is that?

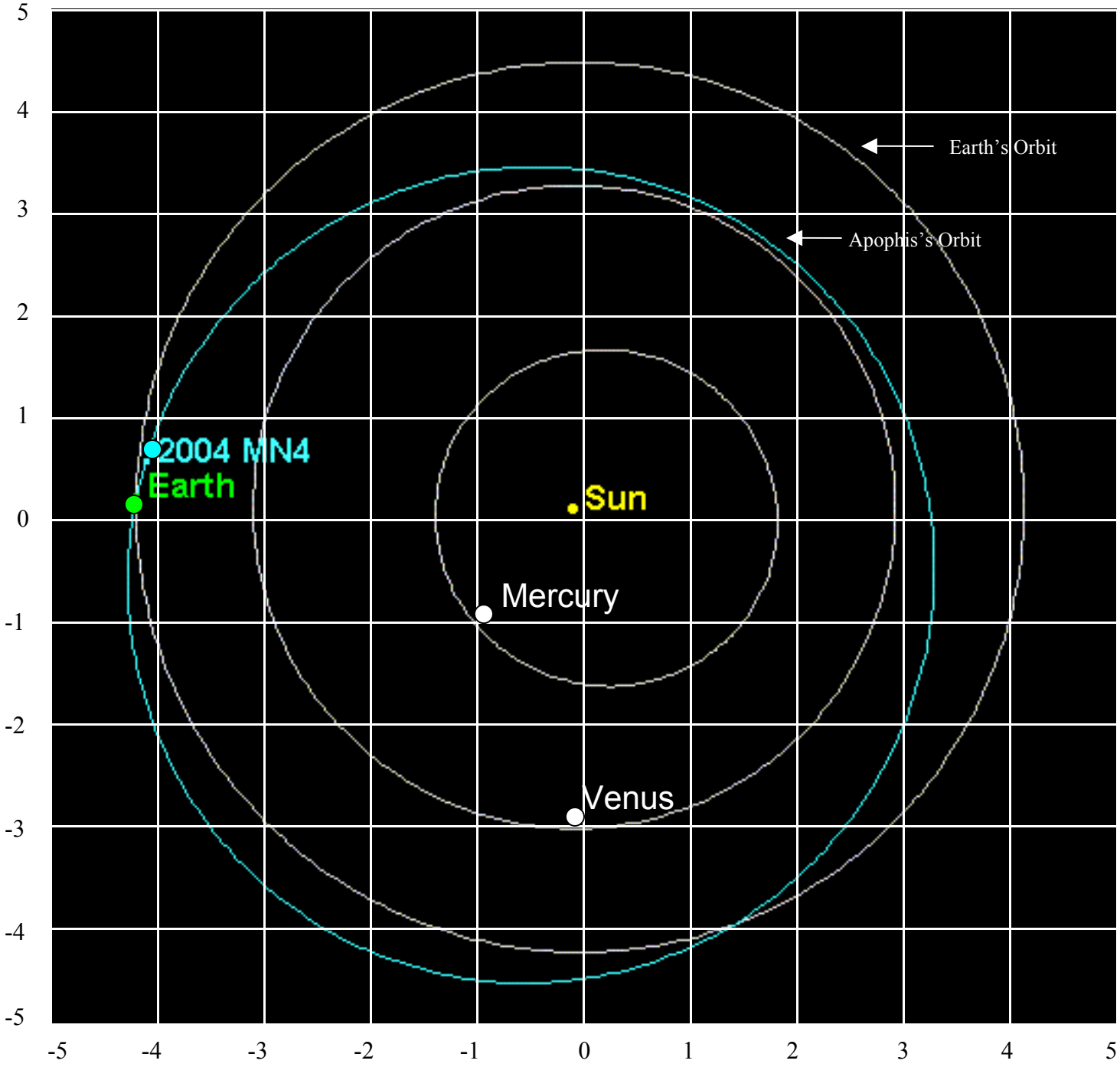
    _____

25. If you were to make a model of the Earth and the Earth was the size of a soccer field (100 m), how big would the model of Apophis be? (You will need to set up a proportion.)

    _____

Answers

1. Answers vary
2. Answers vary
3. Answers vary
4. 1/43,000
   2.3%
   43,000:1
5. 39,072,000 yds
   117,216,000 ft
   1,406,592,000 in
6. 100,000,000,000 + 10,000,000,000 + 200,000,000 + 30,000,000 + 1,000,000 + 100,000 + 30,000 + 1,000 + 90 + 2 + .4
   One hundred ten billion, two hundred thirty one million, one hundred thirty one thousand, ninety two *and* four tenths
   110 billion, 231 million, 131 thousand, 92 *and* 4 tenths
7. 110,000,000,000
   110,230,000,000
   110,231,100,000
   110,231,131,100
8. 5×10^{10} kg
9. 510,000,000,000,000 g
10. 3,444,732 buses
11. 34.4 school buses
12. .4 km
    4 hm
    40 dam
    400 m
    4,000 dm
    40,000 cm
    400,000 mm
13. 7,752 hours
    465,120 minutes
    27,907,200 seconds
14. 110,628 km/h
15. 68,760 mph
16. (5, 5)
17. (1, 5)
18. (1, 6)
19. (6, 1)
20. (4, 4)
21. (5, 2)
22. No
23. Answers vary. Some include: (8, 3); (8, 6); (3, 8); (1, 3); (3, 1)
24. 12,756,274 m
25. 2 mm



Use the coordinate graph to answer the following questions.

16. The Sun is approximately at what coordinate? (,)

17. The Earth is approximately at what coordinate? (,)

18. Asteroid 2004 MN4 (Apophis) is approximately at what coordinate?

    (,)

19. Besides the coordinate (1, 5), where else does the path of Apophis and Earth intersect?

    (,)

20. Mercury is at approximately what coordinate? (,)

21. Venus is at approximately what coordinate? (,)

22. Does the orbit of Apophis intersect with the orbit of Venus? _____

23. List at least five coordinate points along Apophis's orbit.

    (,)
    (,)
    (,)
    (,)
    (,)

24. The diameter of the Earth at the equator is 12,756.274 km. How many meters is that?

    _____

25. If you were to make a model of the Earth and the Earth was the size of a soccer field (100 m), how big would the model of Apophis be? (You will need to set up a proportion.)

    _____

Answers for Advanced Graph

16. (0, 0)
17. (-4, 0)
18. (-4, 1)
19. (1, -4) or (2, -4)
20. (-1, -1)
21. (0, -3)
22. No
23. Answers vary. Some include: (1, -4); (3, -2); (-4, -2); (-2, 3); (3, 1)
24. 12,756,274 m
25. 2 mm

Math Lab Example