Lesson Plan 2: Missiles Away, and Torpedoes Too
How Long Until I Hit The Target?

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Instructional Goal

Algebra teachers looking for an application activity to use formulas and manipulate variables in a formula, can guide their students through a look at the U.S. Navy's submarine fleet. The students will learn about the missiles and torpedoes being carried on U.S. Submarines and will learn how quickly the missile or torpedo will reach the target.

Common Core State Mathematics Standards:

- HSA.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
- HAS.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*
- HSF.1F.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases

In this lesson students will manipulate the distance formula as a function of rate and a function of time. Students will discuss how the rate is the relationship of the change in distance divided by the change in time. Students will discuss the speed and range considerations of the different missiles and torpedoes. Teachers are free to expand or shorten the lesson as needed.

Background Knowledge

Students should understand that the distance traveled (D) is calculated by multiplying your rate of speed (R) by the time traveled (T). The mathematical equation is D = RT.

Navy Background:

See www.ussnautilus.org for the Submarine Force Museum and Historic Ship Nautilus, plus
http://www.navy.mil/navydata/fact_display.asp?cid=2200&tid=200&ct=2 for the Harpoon missile and
http://www.navy.mil/navydata/fact_display.asp?cid=2200&tid=1300&ct=2 for the Tomahawk missile and
http://www.navy.mil/navydata/fact_display.asp?cid=2200&tid=1400&ct=2 for the Trident II missile and
http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=950&ct=2 for the MK48 torpedo.

Lesson Activities

1. View http://www.youtube.com/watch?v=1aPvGGvnAGQ which shows the acceleration of a Trident missile up to its maximum speed and http://www.youtube.com/watch?v=beU3sExN1BAd which shows a MK 48 torpedo at the end of its run.

2. Recognize the relationship between distance traveled, the time it takes to travel the distance, and the speed the object is traveling; write three equations, representing each factor as a function of the other factors.

3. Research the following 4 Navy missiles: the SUBROC, the Tomahawk, the Harpoon, and the Trident II missile. Record information on each missile, including the maximum range, the maximum speed, and the purpose for the specific missile (is it used for underwater targets, land targets, surface targets or air targets).

4. Calculate the time it takes each of the 4 missiles: SUBROC, Tomahawk, Harpoon, and Trident II, to reach its maximum range.

5. Graph the distance travelled and the time it takes each missile. (Graph all on the same Cartesian plane). Compare and discuss the speed and range of the SUBROC, the Tomahawk, the Harpoon, and the Trident II.

6. For the torpedo used by the Navy today, the MK 48, which travels at 102km/h, calculate the run time to its maximum range of 38 km.

7. Discuss why the Navy might use each of the 5 different weapons.

8. View http://www.youtube.com/watch?v=d5nZ-SwngnE for a missile test that didn't go right.

Navy Missile Information Source in addition to Navy Fact File data above:

Go to the following links to find the maximum range and rate of speed for each of the missiles/torpedoes:
en.wikipedia.org/wiki/Mark_48_torpedo
en.wikipedia.org/wiki/UUM-44_SUBROC
en.wikipedia.org/wiki/Tomahawkhttps://en.wikipedia.org/wiki/Harpoon
en.wikipedia.org/wiki/Trident

Application Activities (Student Worksheet Provided Below)

1. In groups, students will recall and discuss the formula for distance, rate and time. They will then write an equation that measures rate as a function of distance and time, and an equation that measures time as a function of distance and rate.

1. D =
2. R =
3. T =

Discuss the rate of change for the equation R = D/T

(Extension: Discuss Slope. Slope is the change in y divided by the change in x. In this example, Speed is the change in the distance traveled as the time increases).

2. Calculate the time it takes each weapon traveling at maximum speed to reach its maximum distance.

SUBROC:
Tomahawk:
Harpoon:
Trident II:

3. Graph the distance that each missile travels as a function of time. (Graph all four missiles on the same graph on the worksheet) Be sure to label each axis and name your graph.

Student Worksheet: How Long Until I Hit The Target?

1. Turn and talk to your partner about the formula for distance, rate and time. Record the formula below. Then, write an equation that measures rate as a function of distance and time, and an equation that measures time as a function of distance and rate.

1. D =

2. R =

3. T =

With your partner discuss what the rate of change is. R = _____

What does the slope represent for a graph of distance D vs time T?

2. Calculate the time it takes each weapon traveling at maximum speed to reach its maximum distance.

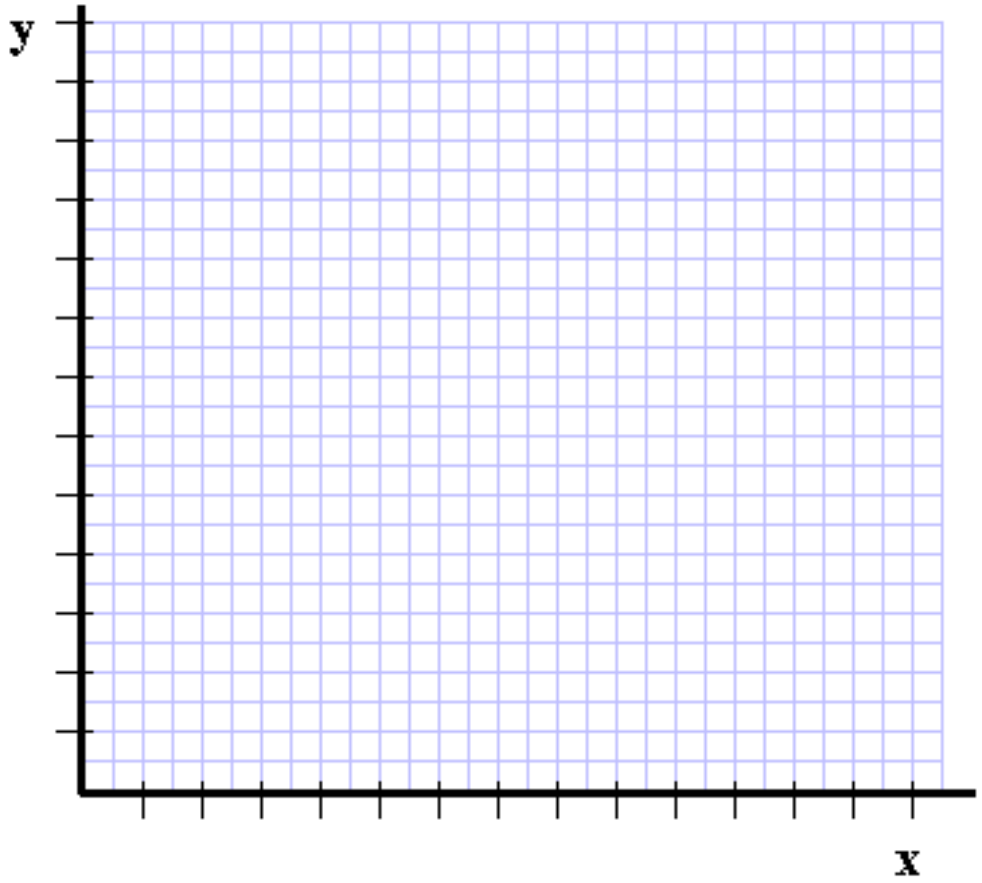
SUBROC:

Tomahawk:

Harpoon:

Trident II:

3. Graph the distance that each missile travels as a function of time. (Graph all four missiles on the same graph) Be sure to label each axis and name your graph. What does the slope represent?



4. (Extension) If you were making the decision of which weapons to load in a submarine, which weapons would you choose, and why?

(Be prepared to discuss your answers with the class).