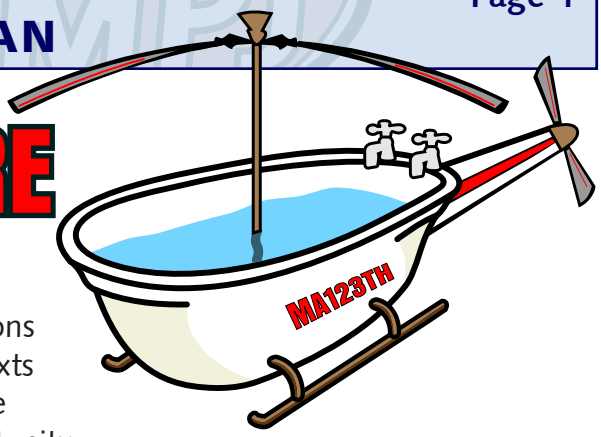
LESSON PLAN

TUBICOPTERS & MORE



OBJECTIVE

The goal of this lesson is two-fold:1) Students draw conclusions from graphs within contexts and 2) Students use these contexts to discern the meaning of slope and intercepts. To meet these objectives it is very important that the teacher use the opportunity inherent in the lesson to have students write and discuss their thoughts. This lesson is heavy on oral & written responses rather than numerical.

Concepts
Interpreting graphs, particularly in regards to the meaning of slopes and intercepts.

Time: 2 hours.

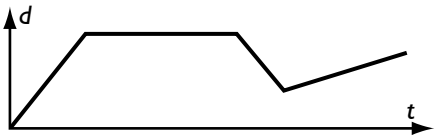
Materials
Student Handouts
Computer with Internet

Preparation
Free online app from AbsorbLearning.com http://bit.ly/10yYiTO

HELICOPTER (day 1)

This first segment of the lesson is based on the "Plotting a Distance-Time Graph" app from AbsorbLearning.com (http://bit.ly/10yYiTO). In general, the app has a helicopter moving left to right while graphing the relationship of its horizontal distance (0-16 m) to time (0-10 sec). Since the graph is not plotting altitude, the students are challenged to reconcile the shape of the graph to the flight path of the helicopter. It is exactly that cognitive conflict that makes this activity so valuable.

1) Click the helicopter to start the time, but don't move it. Since there is no change in horizontal distance as time expires, the graph is a horizontal line at d = 0.
2) Click the helicopter and lift it straight up. As time expires, the horizontal distance still does not change, therefore the graph is identical to that of #1.
3) Click the helicopter and move it at a moderate pace to the right. The line now plots diagonally because distance increases as time increases.
4) This time, ask the students BEFORE you start the app, "What will the graph look like if the helicopter goes backwards?" The helicopter will have to go forward first, but the graph does not "go backwards." The graph has a downward (negative) slope when the helicopter goes backwards, because the distance from the starting point decreases as time increases. The app plots points up and down, but never plots backwards (to the left), because that would imply that the helicopter was moving back in time.
5) Again, prompt the students before you start the app, "What is it about the flight of the helicopter that affects the steepness of the graph?" Show flights of various rates, even changing the rate within the same flight, to show how faster rates produce steeper lines.
6) Now that students understand that the faster the helicopter goes, the steeper the line is graphed, ask the class, "How do I get it to graph a vertical line?" Move the helicopter as fast as possible in an attempt to get a vertical line. The idea is that a vertical line implies "being in all places at the same time," which of course is impossible. This gives us another reason for an undefined slope, besides the inability to divide by zero in the traditional slope formula.
7) Have students commit to their own sketch before the reveal on this one. Point out that the halfway point is found on the distance axis, not the time axis.

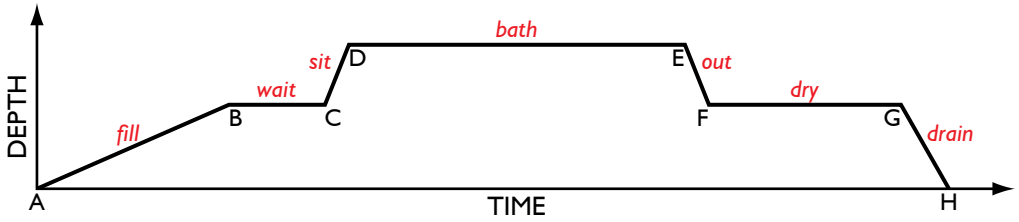


TUBICOPTERS (continued)

BATH TUB (day 2)

For this second segment of the lesson, it is suggested to have students write all their responses to the bath tub questions before having them discuss their answers with each other. This will help drive home the overall concept of slope emphasized by the bath tub context.

8)



9) $\overline{AB}$ represents when the depth of the water is increasing (positive) while $\overline{GH}$ represents when the depth of the water is decreasing (negative).

10) When you step into a tub, the water rises faster than when the water is flowing form the faucet.

11) It drains faster than it fills. You can tell because the slope is greater (absolute value of, technically), than AB.

12) Because the water depth is greater when a person is sitting in the tub than when they are not.

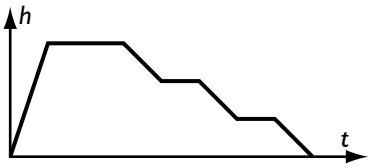
FLAGPOLE *(Contributed by Larry McGehe, Consultant, Daytona Beach, FL)*

This third segment of the lesson asks the students to read values on the axes and to produce their own sketch, forcing the students to compare-n-contrast the two graphs in context.

13) The flag is repeatedly being yanked up the pole, with a pause as the person pulling on the rope exchanges hands. The final long horizontal line is the flag reaching its final height.

14) The students should be encouraged to read the y-axis for this value, and shown how the height of 5 meters is maintained for several seconds.

15) Student versions should look something like the diagram on the right.



LEMONADE STAND

This fourth segment of the lesson focuses on the meaning of both x- and y- intercepts. It would be helpful to emphasize that each one has at least one coordinate value of zero.

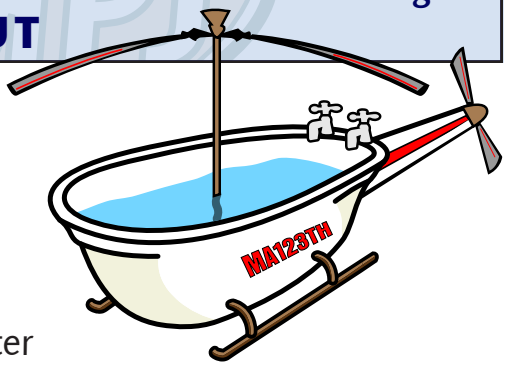
16) There are negative values because of the initial cost to open the stand. At time zero, you start in the red.

17) It represents the number of sales required to break even. At this point, your profit is zero, you have neither made nor lost money on the lemonade stand.

PRACTICE/ASSESSMENT

The answers to this section are: 18) B 19) D 20) C 21) A

TUBICOPTERS & MORE

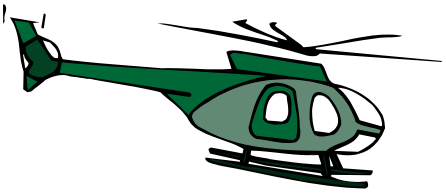


HELICOPTER

1) Why does the graph plot horizontally when the helicopter stays stationary?

2) Why does the graph plot horizontally when the helicopter goes up?

3) Why does the graph plot oblique lines (diagonally) when the helicopter goes forward?



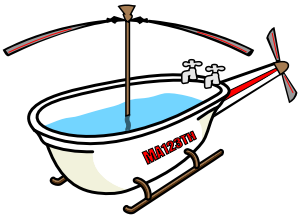
4) Why does the graph plot downward when the helicopter goes backwards? Is there a way to get the graph to "plot backwards?"

5) What determines the steepness of the graph?

6) If a horizontal line implies being in the same place at all times, what would a vertical line imply?

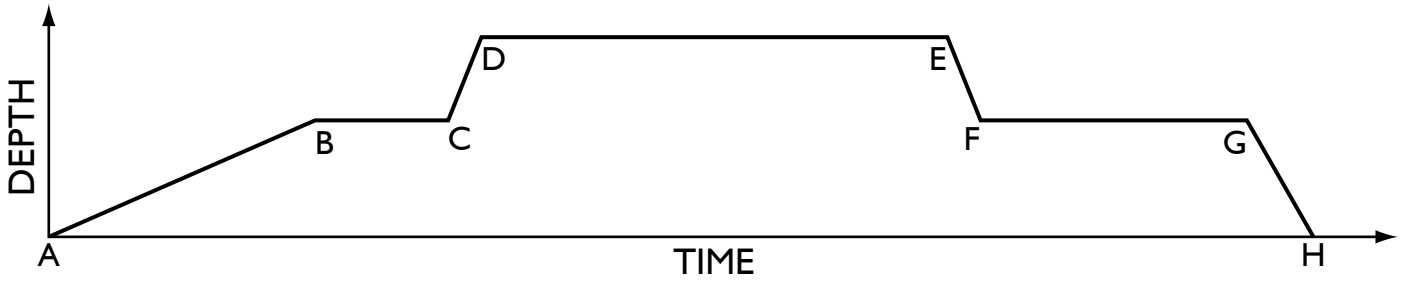
7) Sketch a graph of the time and distance for a helicopter that goes fast to the halfway point, hovers for awhile, then goes backwards fast until it is just shy of the starting point, then goes forward again slowly.

TUBICOPTERS (continued)



BATH TUB

The graph below represents the water level of a bath tub over time. It shows the tub filling, the water turned off, someone sitting in the tub, bathing, then getting out, drying off and finally the tub draining.

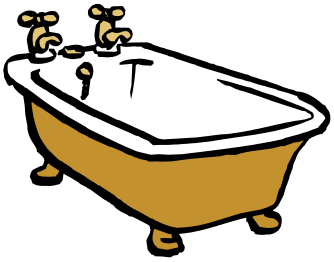


8) Mark the graph for each of these: fill, wait, sit, bath, out, dry, drain.

9) Why is the slope of $\overline{AB}$ positive while the slope of $\overline{GH}$ is negative?

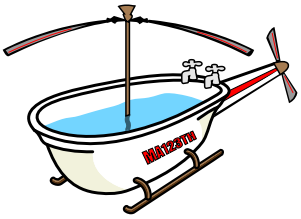
10) Why is the slope of $\overline{CD}$ greater than that of $\overline{AB}$?

11) Does the tub drain slower or faster than it fills? How can you tell?



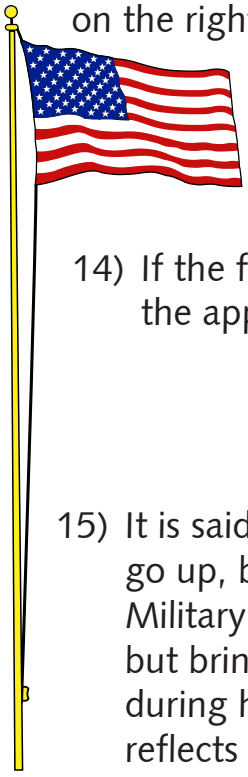
12) Why is $\overline{DE}$ higher than $\overline{BC}$? Why is $\overline{DE}$ longer than $\overline{FG}$?

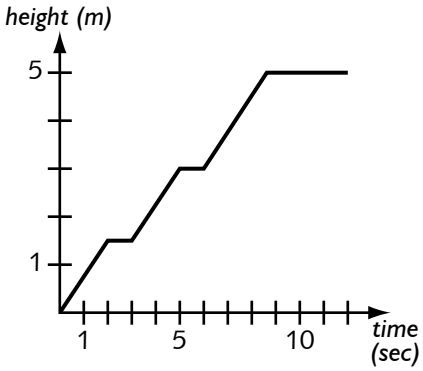
TUBICOPTERS (continued)



FLAG

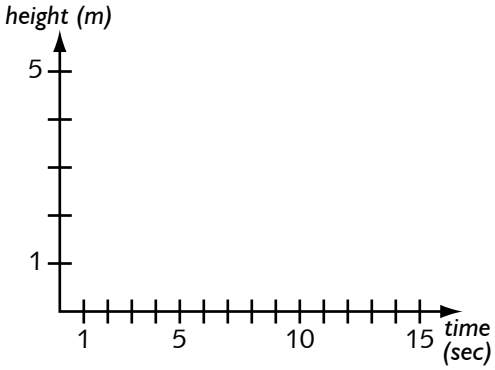
13) What was happening to the flag in the diagram on the right?





14) If the flag was raised to the top of the pole, what is the approximate height of the flagpole?

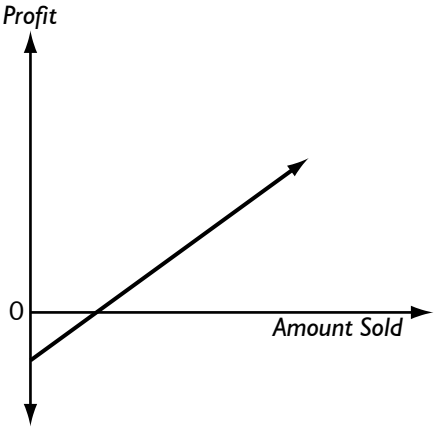
15) It is said that the American Flag is excited to go up, but sad to come down. Therefore, the Military raises the flag quickly with no pauses, but brings it down slowly, with small pauses during hand exchanges. Sketch a graph that reflects this method.



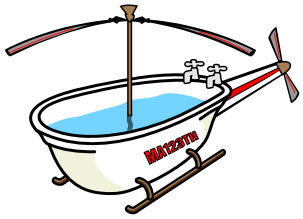
LEMONADE STAND

16) Why does the graph show profit values below zero?

17) What is the meaning of the point where the graph crosses the horizontal axis?

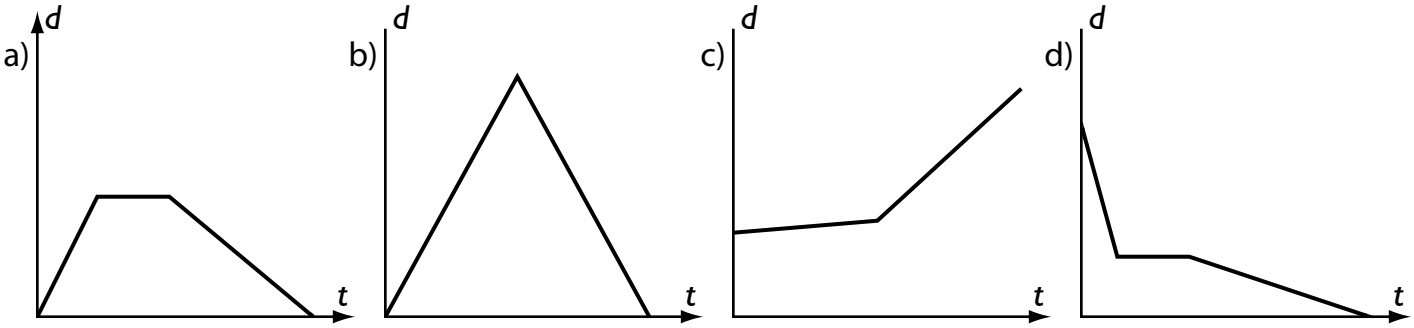


TUBICOPTERS (continued)



PRACTICE

Match each of the following scenarios with one of the graphs below.



18) Johnny runs up the street, but quickly turns and runs home at the same speed.

19) Jennifer is riding her bike home. She gets a flat tire. She can't fix it, so she walks the bike the rest of the way home.

20) Jamie is several blocks from home. She is walking to her friend's house which is even further from home. Halfway there, her friend picks her up in a car and she rides the rest of the way.

21) Jackson runs to his friend's house, hangs for a short while, and then walks home.