MiSP Force and Gravity Worksheet #3, L3

Name _____ Date _____

FORCE AND ACCELERATION

Introduction

Today you will view a video of a typical skydive. The skydiver had a skydiving altimeter mounted in a special box with a video camera, so you can see the skydiver's altitude during the skydive on the screen. You will collect and record time and altitude data directly from the video. The altimeter records several aberrant values at the beginning of the jump due to the abrupt change from the still air in the cabin of the airplane to the ~100 mph airstream. At about 14 seconds, the altimeter stabilizes and you can record more accurate data.

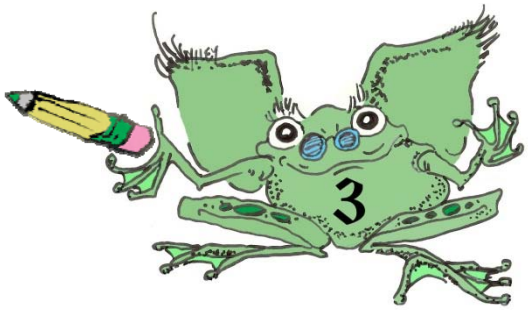
Procedure:

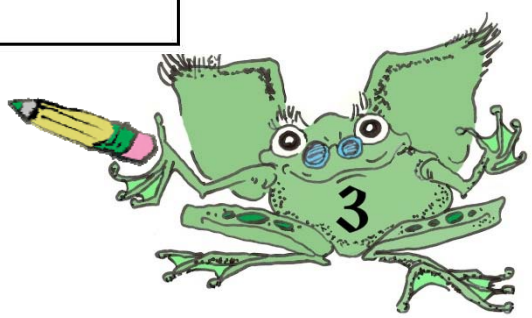
- Practice reading the altimeter, using the worksheet your teacher provides.
- View the video in its entirety to become familiar with the sequence.
- View the video a second time, and record in data table 1 the altitude at which the skydiver leaves the plane and the time when she lands.

Data Table 1	Time (min.: sec.)	Altitude (feet)
Exit from the airplane	0:00	
Landing		0

Graph your data:

1. Plot these two data points on the graph provided.
    a. Make altitude the dependent variable and time the independent variable.
    b. Use six divisions on the *x*-axis for each minute so the seconds can be plotted easily.
2. Draw a line connecting the points on your graph.

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3. Calculate the following values.

a. Find the difference between the exit altitude and the landing altitude (include units).

_____

_____

b. Find the difference between the exit time and the landing time (include units).

_____

_____

c. Divide the difference in altitude by the difference in time (include units).

_____

_____

d. What is the term used for change in location (difference in altitude) divided by the change in time?

_____

e. Did the skydiver appear to fall at the same velocity during the entire skydive?

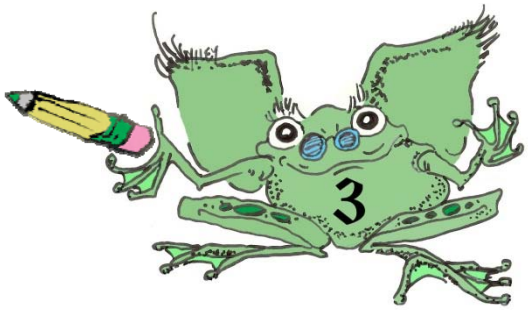
_____

f. What is inaccurate about your graph and calculations?

_____

_____

g. If the skydiver fell faster, would the line representing her average velocity be above or below the line on your graph? _____



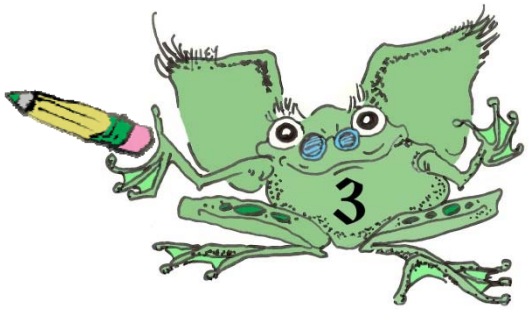
h. If the skydiver fell slower, would the line representing her average speed be above or below the line on your graph? _____

i. View the video for a third time. This time record the time and altitude
   1. when she exits the plane
   2. at 14 seconds into the skydive
   3. when she opens her parachute
   4. when she lands

Data Table 2	Time (min.: sec.)	Altitude (feet)
Exit from the airplane	0:00	
14 seconds into the skydive	0:14	
Opening of parachute		
Landing		0

j. Add the new data points to your graph and draw three new lines:

1. Draw a line between the point representing the exit from the airplane and the point representing 14 seconds into free fall.
2. Draw a line between the point representing 14 seconds into free fall and the point where the parachute opens. The first two lines together represent the free fall portion of the skydive.
3. Draw a line between the point where the parachute opens and the point where the skydiver lands. This is the canopy portion of the skydive.



Analysis:

1. Calculate the unit rate of change (slope) for each of the three new lines you drew on your graph.

	Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Altitude (ft) Δy	Δ Time (seconds) Δx	**Unit Rate of Change (slope)** $\Delta y/\Delta x$
Exit from airplane to 14 seconds				
14 seconds to opening of the parachute				
Opening of the parachute to landing				

2. What does the unit rate of change above represent? (What term is used to describe a change in location divided by a change in time?)

_____

3. Are the unit rates of change (slopes) positive (+) or negative (-)? _____ What does this mean?

_____

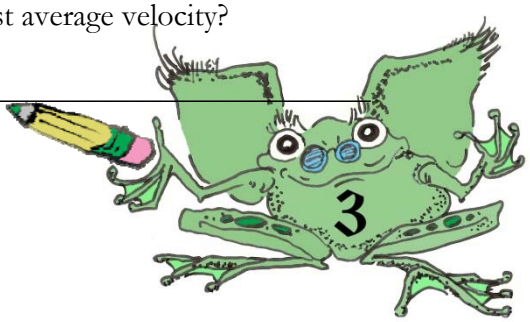
_____

4. Which of the lines on your graph (the line representing which part of the skydive) had the greatest slope?

_____

5. In which part of the skydive was the skydiver moving at the greatest average velocity?

_____



6. Which of the lines on your graph (representing which part of the skydive) had the smallest slope?

_____

7. In which part of the skydive was the skydiver moving at the slowest velocity?

_____

8. Although you could not calculate it, the velocity during the first 14 seconds of free fall was changing constantly. Why? (Recall what you learned from the BASE jump lesson in Worksheet #2.)

_____

_____

9. Do you think the velocity changed <u>during</u> the second part of the free fall (14 seconds to the time when the skydiver opens the parachute)? _____ Why or why not?

_____

_____

10. How could you determine this more accurately?

_____

_____

11. What happens to the velocity when the parachute opens?

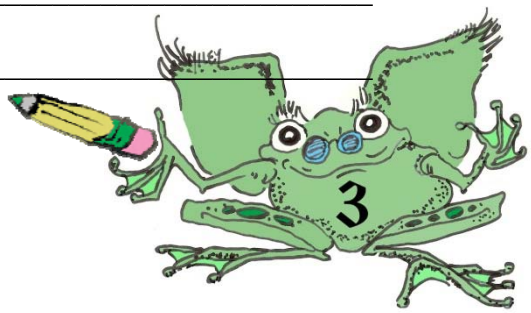
_____

_____

12. Why does this happen?

_____

_____



13. If the skydiver had opened her parachute 5 seconds later than she did, would her average velocity over the entire skydive have been greater or less than it was? Explain your answer.

_____

_____

_____

14. For any linear relationship, an equation can be written for that line. The general equation for a line is $y = mx + b$

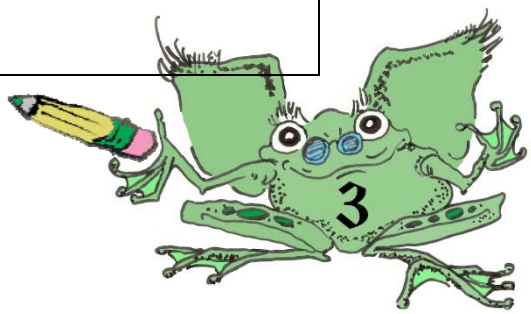
- The m in the equation stands for the unit rate of change (slope).
- The b in the equation stands for the y-intercept. This is where the line passes through the y-axis.

You can treat each segment of your graph as a separate line and determine the equation for that line by extrapolating back to find a y-intercept.

Determine the y-intercept for each line segment on your graph.

Y-Intercept for line between exit from the plane and 14 sec. into the skydive
m = Ordered pair (x, y) = (___ , ___) b =

Y-Intercept for line between 14 sec. and opening of the parachute
m = Ordered pair (x, y) = (___ , ___) $y = mx + b$ Solve for b:

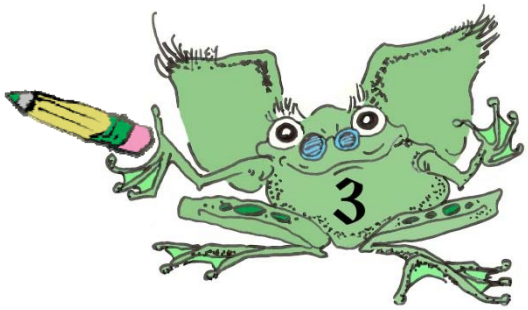


Y-Intercept for line between opening of the parachute and landing
m = Ordered pair (x, y) = (___ , ___) $y = mx + b$ Solve for b:

15. Fill in the table below.

Data Table 3	m	b	Equation for line
Line between exit from the plane and 12 sec. into the skydive			
Line between 12 sec. and opening of the parachute			
Line between opening of the parachute and landing			

16. How long after jumping from the plane would the skydiver have landed if she had continued to fall at the same velocity as during the first segment of the skydive? Show your calculations.



17. How long would the entire skydive take if the skydiver fell at terminal velocity for the entire dive? Show your calculations.

18. If the skydiver had opened her parachute 5 seconds later than she did, would her average velocity over the entire skydive have been greater or less than it was? Explain your answer.