MiSP Force and Gravity Worksheet #2, L3

Name _____ Date _____

FORCE AND ACCELERATION

Introduction

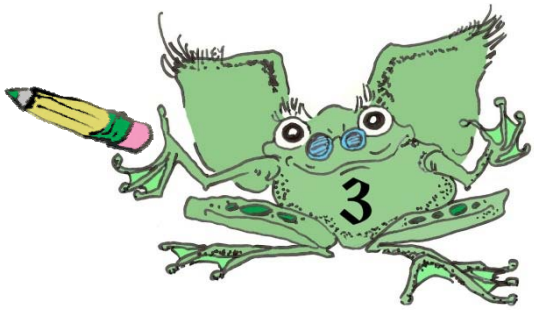
When you push a toy car once, it will roll for a while and then stop. Why does it stop?

_____

When an object falls toward Earth due to the force of gravity, it will accelerate because gravity is a constant force unlike the single push on a toy car. As the object falls, it also encounters a resistance in the form of air. This will slow down the fall. What happens to the air resistance as the object accelerates due to gravity? How does this affect the velocity of the falling object? You will discover answers to these questions in today's activity.

Your teacher will show a video of BASE jumping from the New River Gorge Bridge in West Virginia. BASE jumping is the activity or sport of jumping from a high structure; *BASE* is an acronym for *b*uilding, *a*ntenna, *s*pan, and *e*arth. The video sequence ends with the narrator's noting that in order to know how long they can wait before opening their parachute during a BASE jump, jumpers must know how high above the ground they are before they jump and how fast they are moving during the jump. The table below is one of the tools BASE jumpers use to gauge the amount of time they can delay before throwing out the pilot chute to open their parachutes.

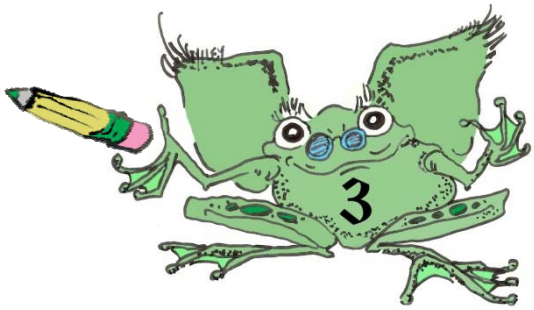
The bridge in the video is 876 feet above the surface of the river. For this activity, instead of predicting what will happen during a jump from the bridge, we are going to predict what would happen if a BASE jumper jumped from Burj Khalifa (2717 ft. tall) in Dubai, United Arab Emirates. First fill in the altitude and velocity columns in the table on the next page. To find the altitude, subtract the distance fallen at each point in time from the starting altitude (2717 ft). To find the velocity, first calculate the distance between each set of consecutive seconds (e.g., subtract distance at 2 seconds from distance at 1 second = 46 ft) and divide by 1 second (= 46 ft/sec). The first two entries were done for you. After you have finished the calculations, graph this altitude at each second of the free fall.

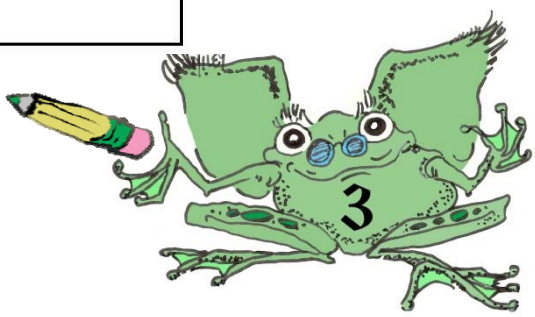


Free Fall Table				
Time (sec)	**Distance Fallen (ft)**	**Altitude (2717 ft. — distance fallen)**	**Velocity between consecutive seconds**	**Acceleration**
0	0	2717		
1	16	*2701*	*16*	
2	62	*2655*	*46*	
3	138			
4	242			
5	366			
6	504			
7	652			
8	808			
9	971			
10	1138			
11	1309			
12	1484			
13	1659			
14	1835			
15	2011			
16	2187			
17	2363			
18	2539			
19	2715			
20	2891			

Graphing your data:

1. Label the *x*- and *y*-axes.
2. Which is the
   a. manipulated/independent variable? _____
   b. dependent/responding variable? _____
3. Decide on an appropriate interval for both the *x*- and *y*-axes.
4. Plot the data.
5. Draw a line connecting the individual points on your graph.
6. Create a title for your graph.

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Analysis:

1. Pick two points along the line within the first 5 seconds and calculate the unit rate of change in altitude.

Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Altitude (feet) Δy	Δ Time (seconds) Δx	**Unit Rate of Change (slope)** $\Delta y/\Delta x$

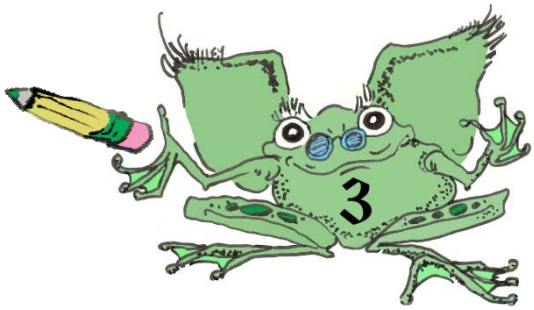
2. Pick two points along the line within the last 5 seconds and calculate the unit rate of change in altitude.

Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Altitude (feet) Δy	Δ Time (seconds) Δx	**Unit Rate of Change (slope)** $\Delta y/\Delta x$

3. You should notice that the change in altitude divided by the change in time changes.

$$\frac{\Delta \text{ altitude}}{\Delta \text{ time}} = \frac{\Delta y}{\Delta x} = \textbf{Unit rate of change (slope)}$$

4. What is the term used for this unit rate of change? _____



5. The general equation for a line is $y = mx + b$ where m represents the constant rate of change and b represents the value of y when $x = 0$ (also called the y-intercept). For the particular relationship we are working with here, why is it impossible to write a linear equation to represent the data?

_____

6. In general, what happened to the calculated velocities between each two seconds during free fall?

_____

_____

_____

7. Calculate the <u>change</u> in velocity during each consecutive second. Put this data in the table on page 2.

8. What is the term used for a change in velocity over time? _____

9. Calculate the acceleration during each consecutive second. Put this data in the table on page 2.

10. Describe what happens to the acceleration during the fall, and explain why this happens.

_____

_____

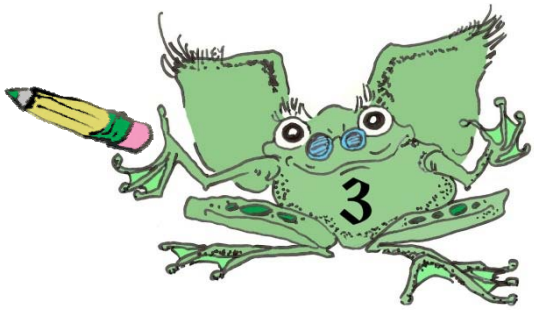
_____

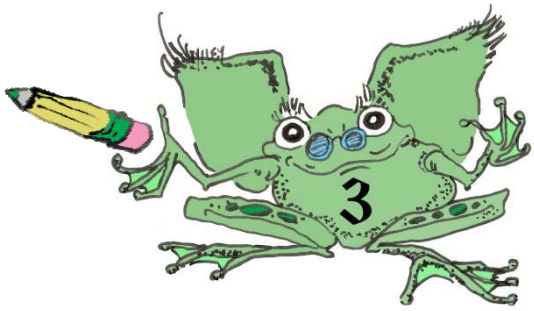
_____

11. The velocity at which acceleration becomes 0 is known as *terminal velocity*. You will see a skydiver falling at terminal velocity in the video we view tomorrow.

Question of the Day:

Why does a skydiver or BASE jumper need a parachute?

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