Describing Motion Graphically

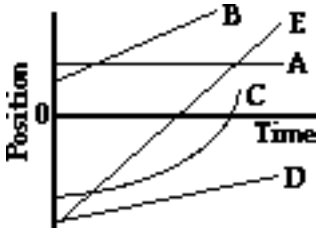
Study **Lessons 3 and 4** of the **1-D Kinematics** chapter at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/1DKin/1KinTOC.html

MOP Connection: Kinematic Graphing: sublevels 1-11 (emphasis on sublevels 9-11)

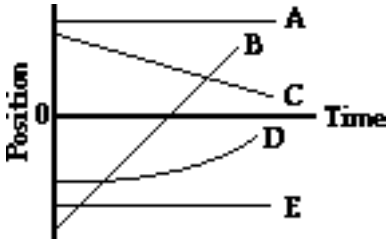
1. The slope of the line on a position vs. time graph reveals information about an object's velocity. The magnitude (numerical value) of the slope is equal to the object's speed and the direction of the slope (upward/+ or downward/-) is the same as the direction of the velocity vector. Apply this understanding to answer the following questions.

   a. A horizontal line means _____.
   b. A straight diagonal line means _____.
   c. A curved line means _____.
   d. A gradually sloped line means _____.
   e. A steeply sloped line means _____.



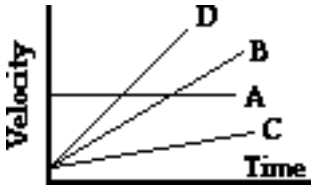
2. The motion of several objects is depicted on the position vs. time graph. Answer the following questions. Each question may have less than one, one, or more than one answer.

   _____ a. Which object(s) is(are) at rest?
   _____ b. Which object(s) is(are) accelerating?
   _____ c. Which object(s) is(are) not moving?
   _____ d. Which object(s) change(s) its direction?
   _____ e. Which object is traveling fastest?
   _____ f. Which moving object is traveling slowest?
   _____ g. Which object(s) is(are) moving in the same direction as object B?



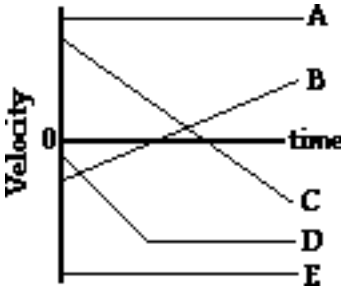
3. The slope of the line on a velocity vs. time graph reveals information about an object's acceleration. Furthermore, the area under the line is equal to the object's displacement. Apply this understanding to answer the following questions.

   a. A horizontal line means _____.
   b. A straight diagonal line means _____.
   c. A gradually sloped line means _____.
   d. A steeply sloped line means _____.



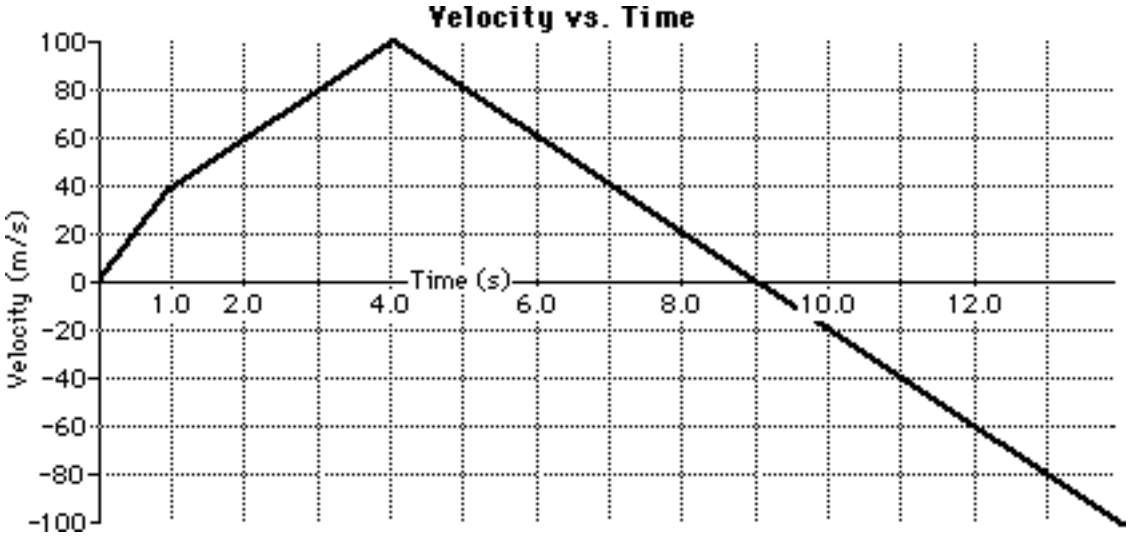
4. The motion of several objects is depicted by a velocity vs. time graph. Answer the following questions. Each question may have less than one, one, or more than one answer.

   _____ a. Which object(s) is(are) at rest?
   _____ b. Which object(s) is(are) accelerating?
   _____ c. Which object(s) is(are) not moving?
   _____ d. Which object(s) change(s) its direction?
   _____ e. Which accelerating object has the smallest acceleration?
   _____ f. Which object has the greatest acceleration?
   _____ g. Which object(s) is(are) moving in the same direction as object E?



Interpreting Velocity-Time Graphs

The motion of a two-stage rocket is portrayed by the following velocity-time graph.



Several students analyze the graph and make the following statements. Indicate whether the statements are correct or incorrect. Justify your answers by referring to specific features about the graph.

Student Statement	**Correct? Yes or No**
1. After 4 seconds, the rocket is moving in the negative direction (i.e., down). Justification: _____	_____
2. The rocket is traveling with a greater speed during the time interval from 0 to 1 second than the time interval from 1 to 4 seconds. Justification: _____	_____
3. The rocket changes its direction after the fourth second. Justification: _____	_____
4. During the time interval from 4 to 9 seconds, the rocket is moving in the positive direction (up) and slowing down. Justification: _____	_____
5. At nine seconds, the rocket has returned to its initial starting position. Justification: _____	_____

Motion Problems

Read from **Lesson 6** of the **1-D Kinematics** chapter at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/1DKin/U1L6a.html
http://www.physicsclassroom.com/Class/1DKin/U1L6b.html
http://www.physicsclassroom.com/Class/1DKin/U1L6c.html
http://www.physicsclassroom.com/Class/1DKin/U1L6d.html

MOP Connection: None

Show your work on the following problems.

1. An airplane accelerates down a run-way at 3.20 m/s^2 for 32.8 s until is finally lifts off the ground. Determine the distance traveled before take-off.

2. A race car accelerates uniformly from 18.5 m/s to 46.1 m/s in 2.47 seconds. Determine the acceleration of the car and the distance traveled.

3. A feather is dropped on the moon from a height of 1.40 meters. The acceleration of gravity on the moon is 1.67 m/s^2. Determine the time for the feather to fall to the surface of the moon.

4. A bullet leaves a rifle with a muzzle velocity of 521 m/s. While accelerating through the barrel of the rifle, the bullet moves a distance of 0.840 m. Determine the acceleration of the bullet (assume a uniform acceleration).

5. An engineer is designing a runway for an airport. Several planes will use the runway and the engineer must design it so that it is long enough for the largest planes to become airborne before the runway ends. If the largest plane accelerates at 3.30 m/s^2 and has a takeoff speed of 88.0 m/s, then what is the minimum allowed length for the runway?

6. A student drives 4.8-km trip to school and averages a speed of 22.6 m/s. On the return trip home, the student travels with an average speed of 16.8 m/s over the same distance. What is the average speed (in m/s) of the student for the two-way trip? (Be careful.)

7. Rennata Gas is driving through town at 25.0 m/s and begins to accelerate at a constant rate of -1.0 m/s^2. Eventually Rennata comes to a complete stop. Represent Rennata's accelerated motion by sketching a velocity-time graph. Use kinematic equations to calculate the distance which Rennata travels while decelerating. Then use the velocity-time graph to determine this distance. **PSYW**

8. Otto Emissions is driving his car at 25.0 m/s. Otto accelerates at 2.0 m/s^2 for 5 seconds. Otto then maintains a constant velocity for 10 more seconds. Determine the distance Otto traveled during the entire 15 seconds. (Consider using a velocity-time graph.)

9. Chuck Wagon travels with a constant velocity of 0.5 mile/minute for 10 minutes. Chuck then decelerates at -.25 $mile/min^2$ for 2 minutes. Determine the total distance traveled by Chuck Wagon during the 12 minutes of motion. (Consider using a velocity-time graph.)

Free Fall

Read **Sections a**, **b** and **d** from **Lesson 5** of the **1-D Kinematics** chapter at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/1DKin/U1L5a.html

MOP Connection: None

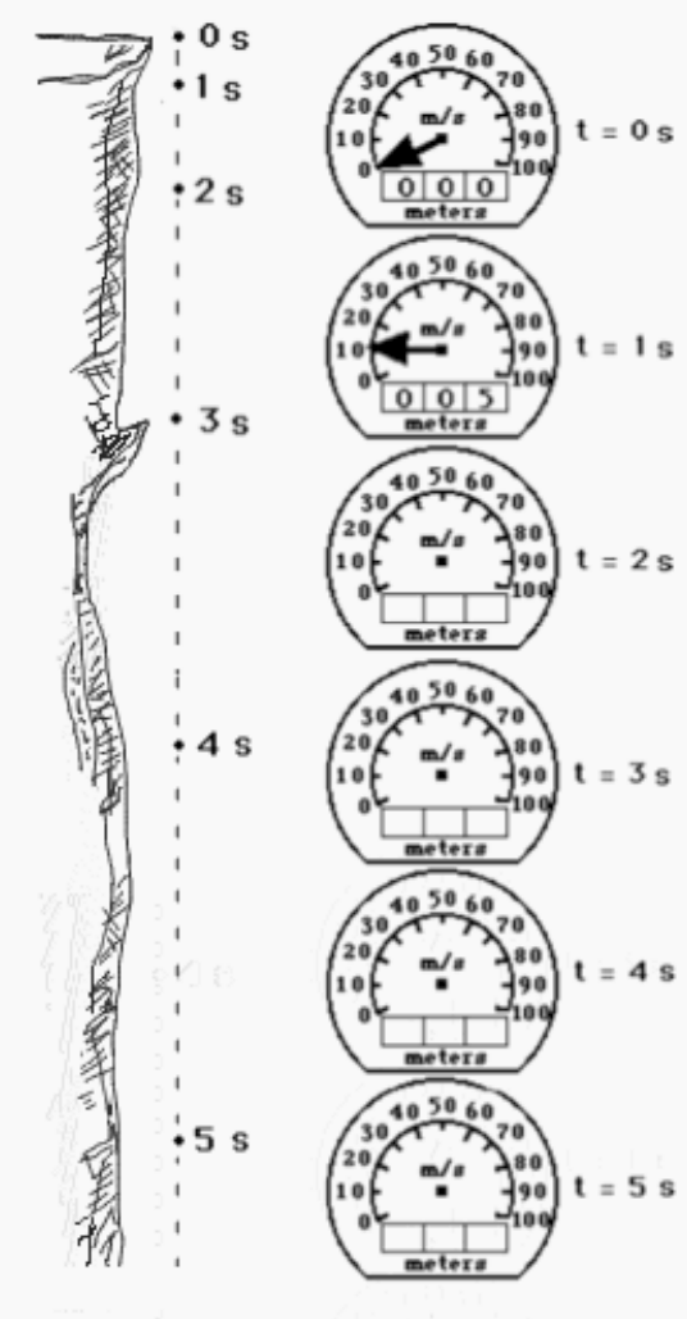
1. A rock is dropped from a rest position at the top of a cliff and free falls to the valley below. Assuming negligible air resistance, use kinematic equations to determine the distance fallen and the instantaneous speeds after each second. Indicate these values on the odometer (distance fallen) and the speedometer views shown to the right of the cliff. Round all odometer readings to the nearest whole number.

   Show a sample calculation below:

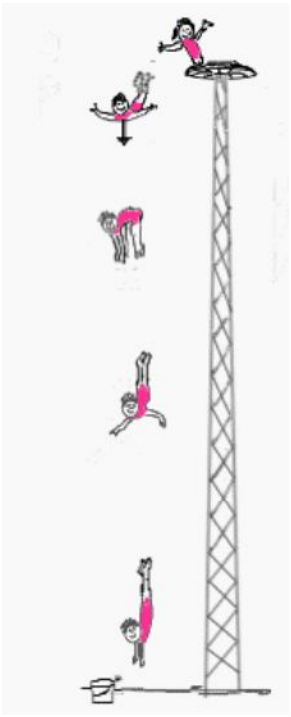
2. At which of the listed times is the acceleration the greatest? Explain your answer.

3. At which of the listed times is the speed the greatest? Explain your answer.

4. If the falling time of a free-falling object is doubled, the distance fallen increases by a factor of _____. Identify two times and use the distance fallen values to support your answer.



5. Miss E. deWater, the former platform diver of the Ringling Brothers' Circus, dives from a 19.6-meter high platform into a shallow bucket of water (see diagram at right).



a. State Miss E. deWater's acceleration as she is falling from the platform. _____ What assumption(s) must you make in order to state this value as the acceleration? Explain.

b. The velocity of Miss E. deWater after the first half second of fall is represented by an arrow. The size or length of the arrow is representative of the magnitude of her velocity. The direction of the arrow is representative of the direction of her velocity. For the remaining three positions shown in the diagram, construct an arrow of the approximate length to represent the velocity vector.

c. Use kinematic equations to fill in the table below.

Time (s)	Vel. (m/s)	Dist. Fallen (m)	Ht (m)
0	0	0	19.6
0.5			
1.0			
1.5			
2.0			

Show your work below for one of the rows of the table.

6. Michael Jordan was said to have a hang-time of 3.0 seconds (at least according to a popular NIKE commercial). Use kinematic equations to determine the height to which MJ could leap if he was wearing NIKE shoes and had a hang-time of 3.0 seconds.