

Describing Motion with Position-Time Graphs

Read from Lesson 3 of the 1-D Kinematics chapter at The Physics Classroom:

- <http://www.physicsclassroom.com/Class/1DKin/U1L3a.html>
- <http://www.physicsclassroom.com/Class/1DKin/U1L3b.html>
- <http://www.physicsclassroom.com/Class/1DKin/U1L3c.html>

MOP Connection: Kinematic Graphing: sublevels 1-4 (and some of sublevels 9-11)

Motion can be described using words, diagrams, numerical information, equations, and graphs. Describing motion with graphs involves representing how a quantity such as the object's position can change with respect to the time. The key to using position-time graphs is knowing that the slope of a position-time graph reveals information about the object's velocity. By *detecting* the slope, one can infer about an object's velocity. "As the slope goes, so goes the velocity."

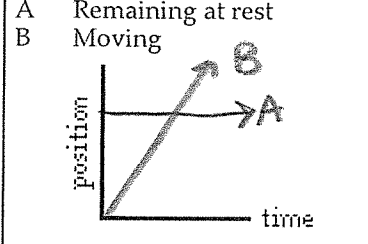
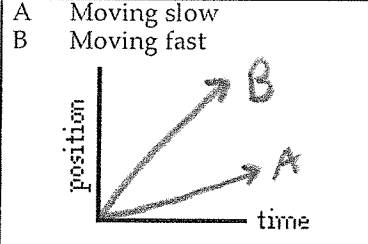
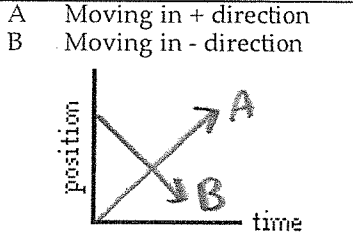
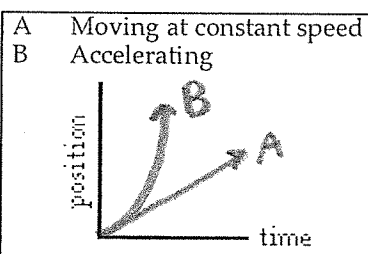
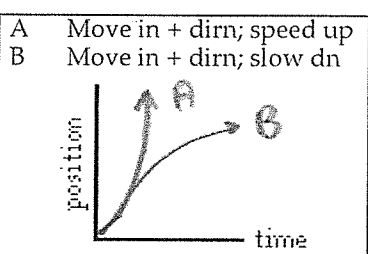
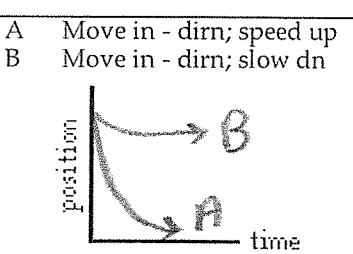
Review:

1. Categorize the following motions as being either examples of + or - acceleration.

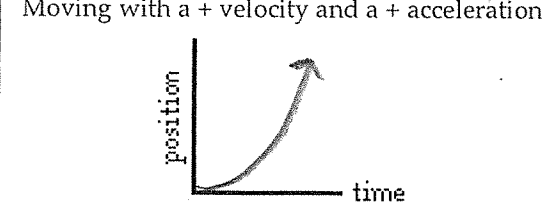
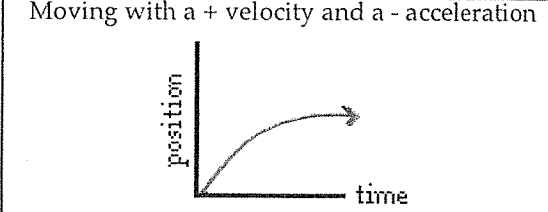
a. Moving in the + direction and speeding up (getting faster)	+
b. Moving in the + direction and slowing down (getting slower)	-
c. Moving in the - direction and speeding up (getting faster)	-
d. Moving in the - direction and slowing down (getting slower)	+

Interpreting Position-Graphs

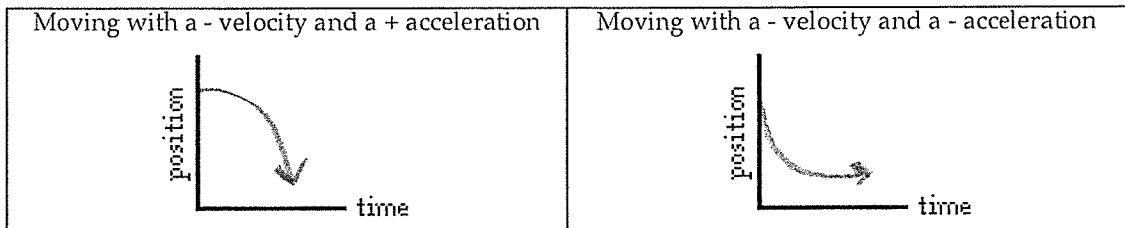
2. On the graphs below, draw two lines/curves to represent the given verbal descriptions; label the lines/curves as A or B.

<p>A Remaining at rest B Moving</p> 	<p>A Moving slow B Moving fast</p> 	<p>A Moving in + direction B Moving in - direction</p> 
<p>A Moving at constant speed B Accelerating</p> 	<p>A Move in + dirn; speed up B Move in + dirn; slow dn</p> 	<p>A Move in - dirn; speed up B Move in - dirn; slow dn</p> 

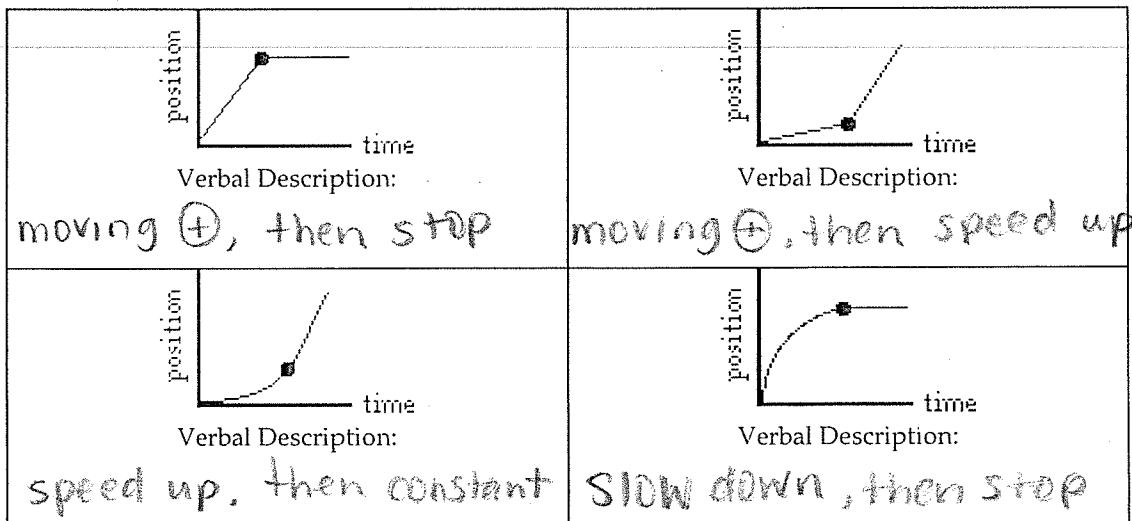
3. For each type of accelerated motion, construct the appropriate shape of a position-time graph.

<p>Moving with a + velocity and a + acceleration</p> 	<p>Moving with a + velocity and a - acceleration</p> 
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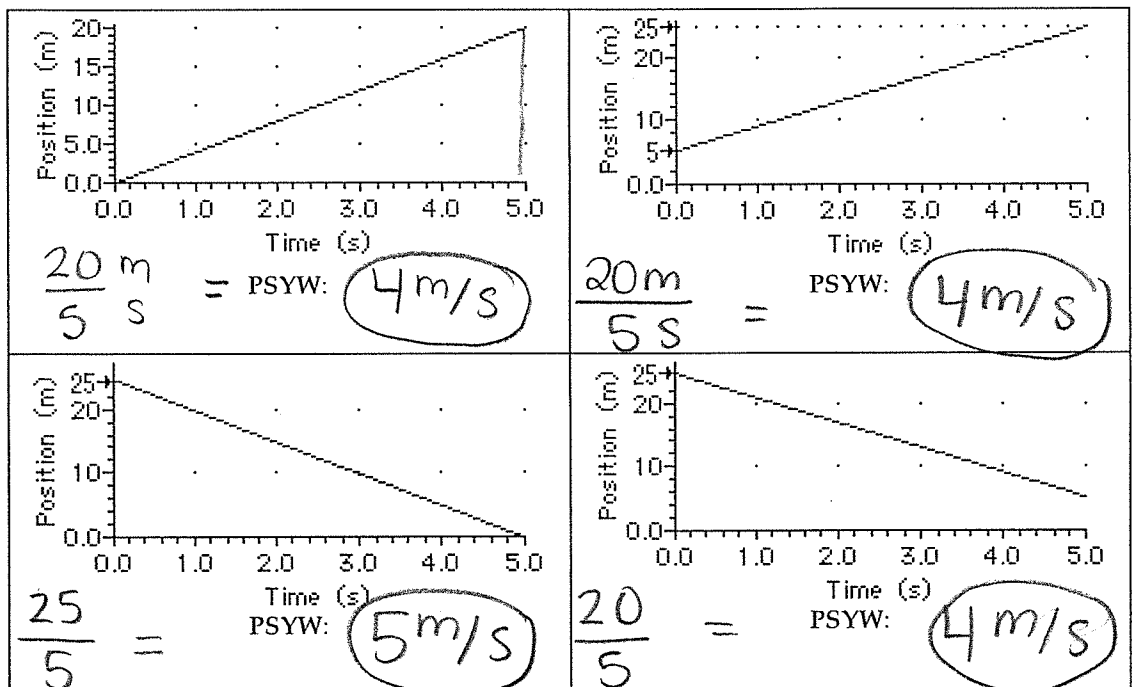
Motion in One Dimension



4. Use your understanding of the meaning of slope and shape of position-time graphs to describe the motion depicted by each of the following graphs.



5. Use the position-time graphs below to determine the velocity. PSYW



Describing Motion with Velocity-Time Graphs

Read from Lesson 4 of the 1-D Kinematics chapter at The Physics Classroom:

- <http://www.physicsclassroom.com/Class/1DKin/U1L4a.html>
- <http://www.physicsclassroom.com/Class/1DKin/U1L4b.html>
- <http://www.physicsclassroom.com/Class/1DKin/U1L4c.html>
- <http://www.physicsclassroom.com/Class/1DKin/U1L4d.html>

MOP Connection: Kinematic Graphing: sublevels 5-8 (and some of sublevels 9-11)

Motion can be described using words, diagrams, numerical information, equations, and graphs. Describing motion with graphs involves representing how a quantity such as the object's velocity = changes with respect to the time. The key to using velocity-time graphs is knowing that the slope of a velocity-time graph represents the object's acceleration and the area represents the displacement.

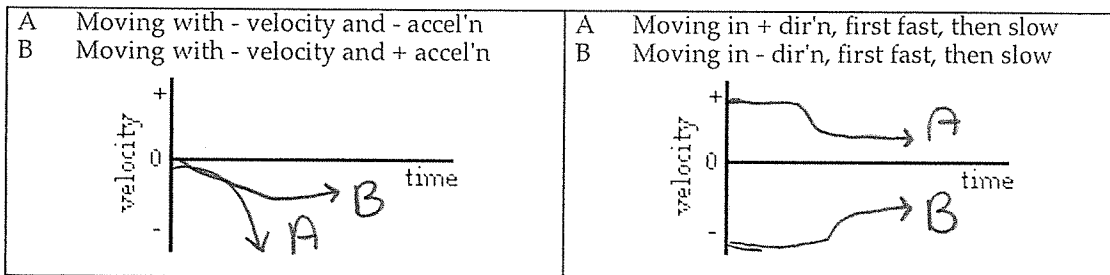
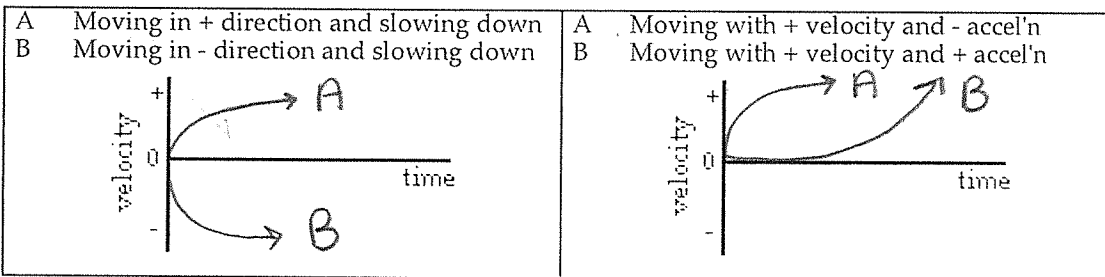
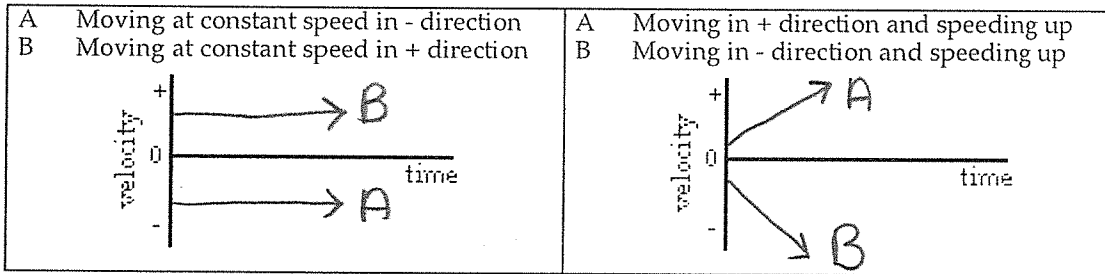
Review:

1. Categorize the following motions as being either examples of + or - acceleration.

a. Moving in the + direction and speeding up (getting faster)	+
b. Moving in the + direction and slowing down (getting slower)	-
c. Moving in the - direction and speeding up (getting faster)	-
d. Moving in the - direction and slowing down (getting slower)	+

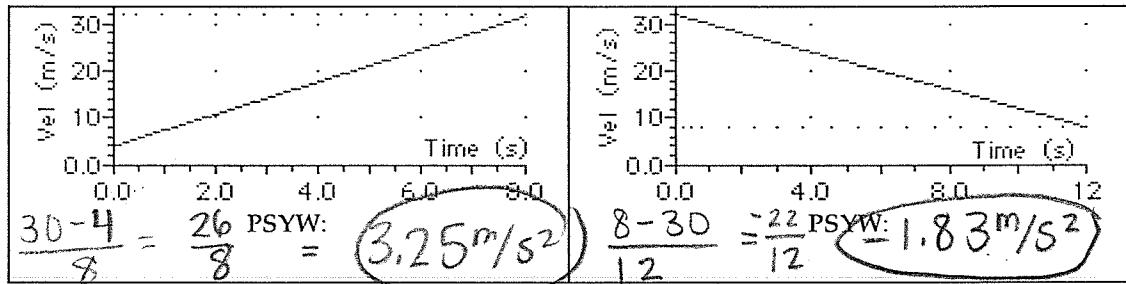
Interpreting Velocity-Graphs

2. On the graphs below, draw two lines/curves to represent the given verbal descriptions; label the lines/curves as A or B.



Motion in One Dimension

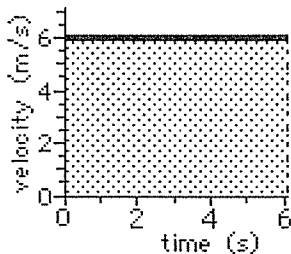
3. Use the velocity-time graphs below to determine the acceleration. PSYW



4. The area under the line of a velocity-time graph can be calculated using simple rectangle and triangle equations. The graphs below are examples:

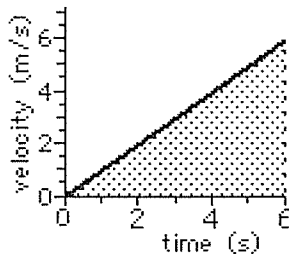
If the area under the line forms a ...

... rectangle, then use
area = base*height



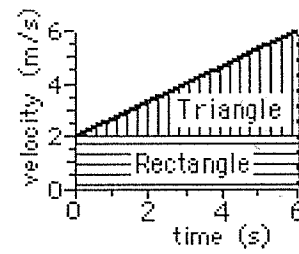
$A = (6 \text{ m/s}) * (6 \text{ s}) = 36 \text{ m}$

... triangle, then use
area = 0.5 * base*height



$A = 0.5 * (6 \text{ m/s}) * (6 \text{ s}) = 18 \text{ m}$

... trapezoid, then make it into
a rectangle + triangle
and add the two areas.

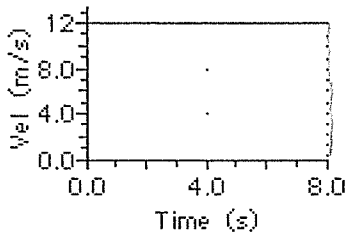


$A_{\text{total}} = A_{\text{rectangle}} + A_{\text{triangle}}$

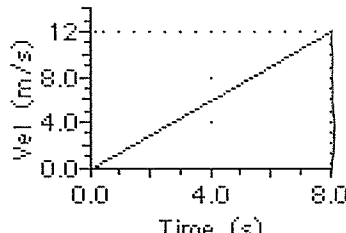
$A_{\text{total}} = (2 \text{ m/s}) * (6 \text{ s}) + 0.5 * (4 \text{ m/s}) * (6 \text{ s}) = 24 \text{ m}$

Find the displacement of the objects represented by the following velocity-time graphs.

$12 \times 8 = 96 \text{ m}$

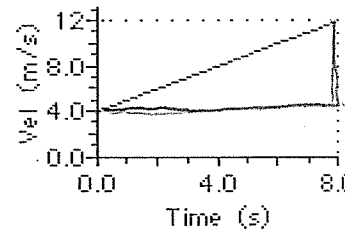


PSYW:



PSYW:

$\frac{12 \times 8}{2} = 48 \text{ m}$

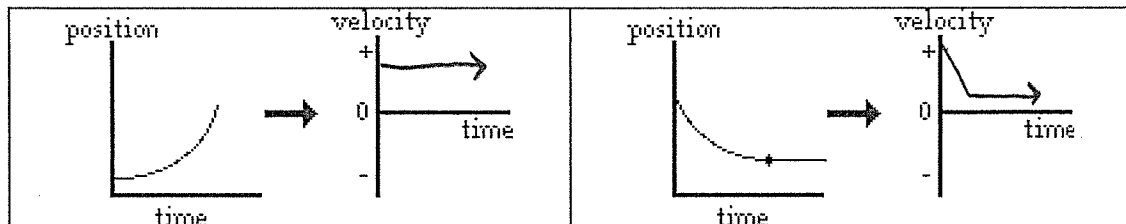


PSYW:

$8 \times 4 = 32$
 $\frac{8 \times 8}{2} = 32$
 $32 + 32 = 64 \text{ m}$

64 m

5. For the following pos-time graphs, determine the corresponding shape of the vel-time graph.



Describing Motion Graphically

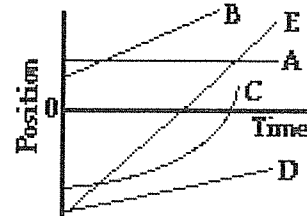
Study Lessons 3 and 4 of the 1-D Kinematics chapter at The Physics Classroom:

<http://www.physicsclassroom.com/Class/1DKin/1DKinTOC.html>

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

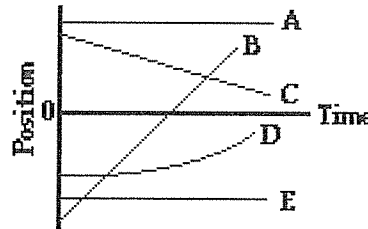
X The slope of the line on a position vs. time graph reveals information about an object's velocity. The magnitude (numerical value) of the slope is equal to the object's speed and the direction of the slope (upward/+ or downward/-) is the same as the direction of the velocity vector. Apply this understanding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

- A horizontal line means _____.
- A straight diagonal line means _____.
- A curved line means _____.
- A gradually sloped line means _____.
- A steeply sloped line means _____.



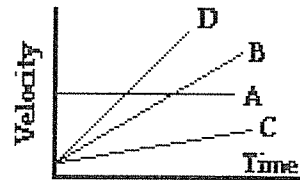
2. The motion of several objects is depicted on the position vs. time graph. Answer the following questions. Each question may have less than one, one, or more than one answer.

- A + E Which object(s) is(are) at rest?
- D Which object(s) is(are) accelerating?
- A + E Which object(s) is(are) not moving?
- X Which object(s) change(s) its direction?
- B Which object is traveling fastest?
- A + E Which moving object is traveling slowest?
- D Which object(s) is(are) moving in the same direction as object B?



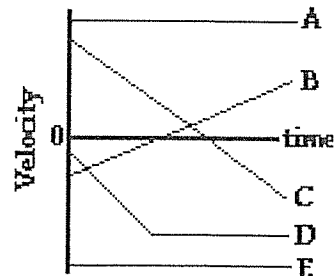
X The slope of the line on a velocity vs. time graph reveals information about an object's acceleration. Furthermore, the area under the line is equal to the object's displacement. Apply this understanding to answer the following questions.

- A horizontal line means _____.
- A straight diagonal line means _____.
- A gradually sloped line means _____.
- A steeply sloped line means _____.



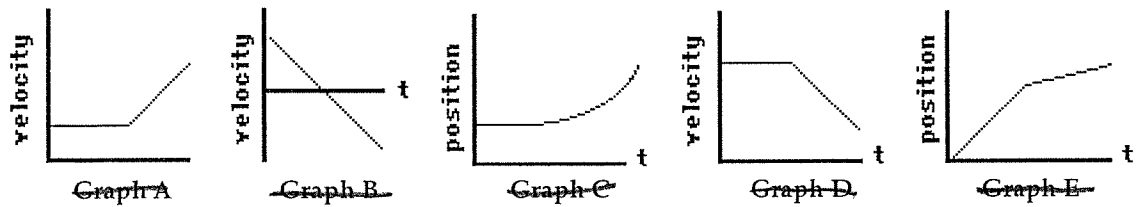
4. The motion of several objects is depicted by a velocity vs. time graph. Answer the following questions. Each question may have less than one, one, or more than one answer.

- X Which object(s) is(are) at rest?
- BCD Which object(s) is(are) accelerating?
- X Which object(s) is(are) not moving?
- X Which object(s) change(s) its direction?
- B Which accelerating object has the smallest acceleration?
- D Which object has the greatest acceleration?
- DC Which object(s) is(are) moving in the same direction as object E?



Motion in One Dimension

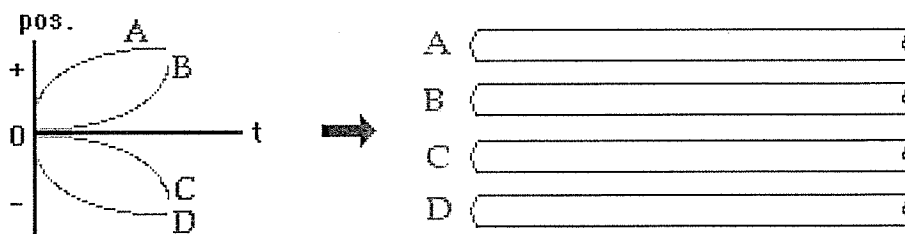
5. The graphs below depict the motion of several different objects. Note that the graphs include both position vs. time and velocity vs. time graphs.



The motion of these objects could also be described using words. Analyze the graphs and match them with the verbal descriptions given below by filling in the blanks.

Verbal Description	Graph
a. The object is moving fast with a constant velocity and then moves slow with a constant velocity.	(E)
b. The object is moving in one direction with a constant rate of acceleration (slowing down), changes directions, and continues in the opposite direction with a constant rate of acceleration (speeding up).	(B)
c. The object moves with a constant velocity and then slows down.	(D)
d. The object moves with a constant velocity and then speeds up.	(A)
e. The object maintains a rest position for several seconds and then accelerates.	(C)

6. Consider the position-time graphs for objects A, B, C and D. On the *ticker tapes* to the right of the graphs, construct a dot diagram for each object. Since the objects could be moving right or left, put an arrow on each *ticker tape* to indicate the direction of motion.



- Consider the velocity-time graphs for objects A, B, C and D. On the *ticker tapes* to the right of the graphs, construct a dot diagram for each object. Since the objects could be moving right or left, put an arrow on each *ticker tape* to indicate the direction of motion.

