 Name: Key

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."

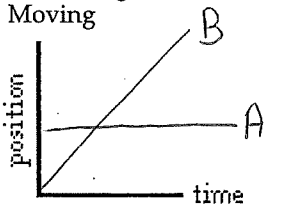
Review:

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) _____

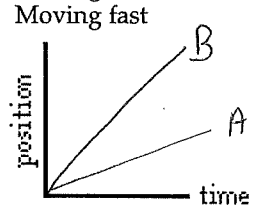
Interpreting Position-Graphs

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

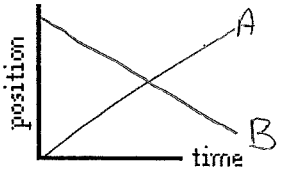
A Remaining at rest
B Moving



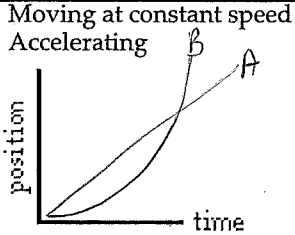
A Moving slow
B Moving fast



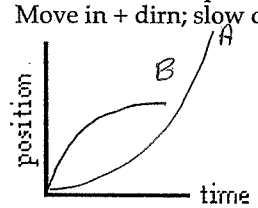
A Moving in + direction
B Moving in - direction



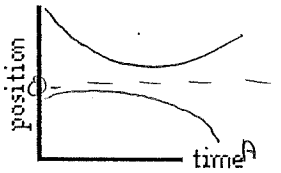
A Moving at constant speed
B Accelerating



A Move in + dirn; speed up
B Move in + dirn; slow dn

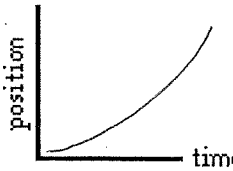


A Move in - dirn; speed up
B Move in - dirn; slow dn

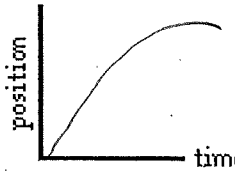


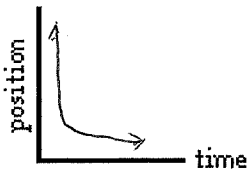
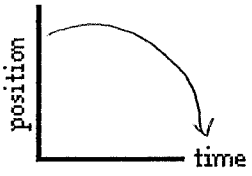
3. For each type of accelerated motion, construct the appropriate shape of a position-time graph.

Moving with a + velocity and a + acceleration

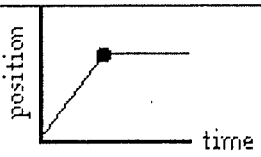


Moving with a + velocity and a - acceleration



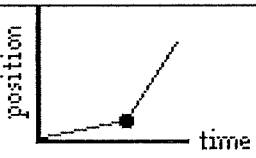
Moving with a - velocity and a + acceleration	Moving with a - velocity and a - acceleration
	

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.



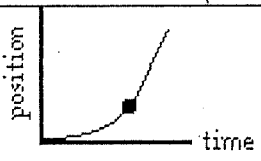
Verbal Description:

⊕ velocity, stopped



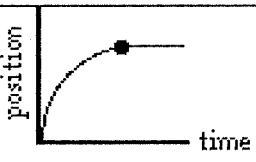
Verbal Description:

slow ⊕ velocity, fast ⊕ velocity



Verbal Description:

⊕ acceleration

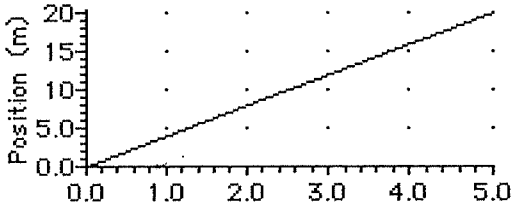


Verbal Description:

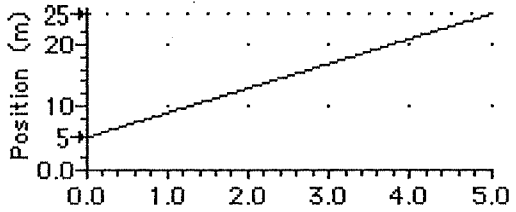
⊕ velocity ⊖ acceleration

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

velocity = slope = $\frac{20m}{5.0s}$ = 4m/s

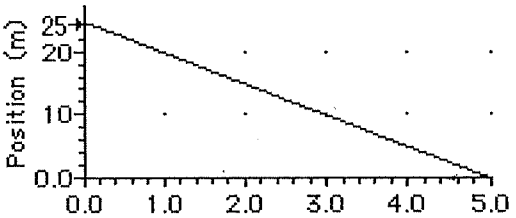


PSYW:



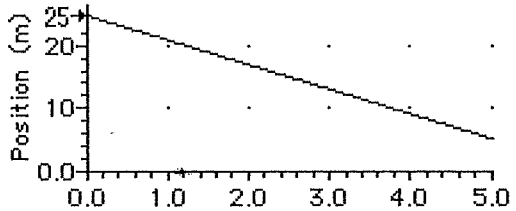
slope = $\frac{20m}{5s}$ = 4m/s

PSYW:



PSYW:

slope = $\frac{-25m}{5s}$ = -5m/s



PSYW:

slope = $\frac{-20m}{5s}$ = -4m/s

Describing Motion with Velocity-Time Graphs

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

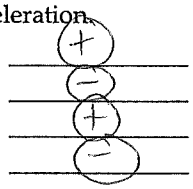
http://www.physicsclassroom.com/Class/1DKin/U1L4a.html
http://www.physicsclassroom.com/Class/1DKin/U1L4b.html
http://www.physicsclassroom.com/Class/1DKin/U1L4c.html
http://www.physicsclassroom.com/Class/1DKin/U1L4d.html

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.

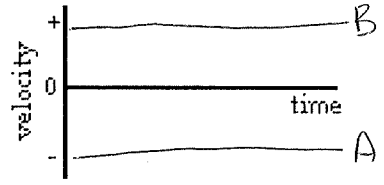


   a. Moving in the + direction and speeding up (getting faster)
   b. Moving in the + direction and slowing down (getting slower)
   c. Moving in the - direction and speeding up (getting faster)
   d. Moving in the - direction and slowing down (getting slower)

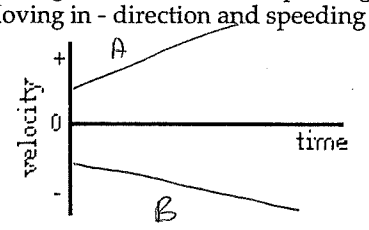
Interpreting Velocity-Graphs

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

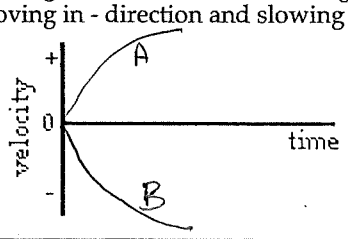
A Moving at constant speed in - direction
B Moving at constant speed in + direction



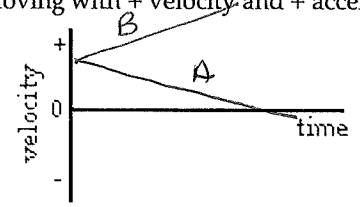
A Moving in + direction and speeding up
B Moving in - direction and speeding up



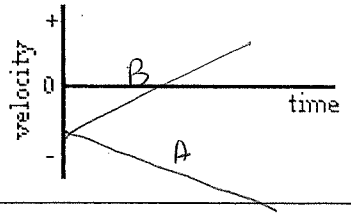
A Moving in + direction and slowing down
B Moving in - direction and slowing down



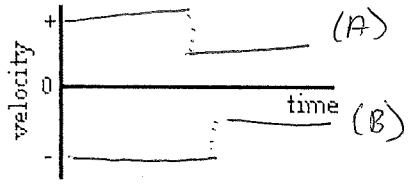
A Moving with + velocity and - accel'n
B Moving with + velocity and + accel'n



A Moving with - velocity and - accel'n
B Moving with - velocity and + accel'n

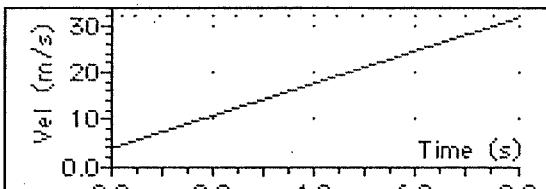


A Moving in + dir'n, first fast, then slow
B Moving in - dir'n, first fast, then slow

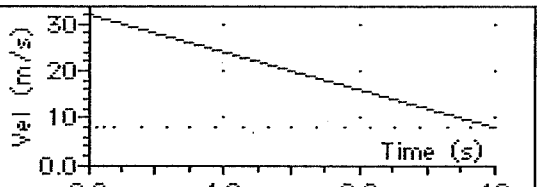


Bonus

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



PSYW:



PSYW:

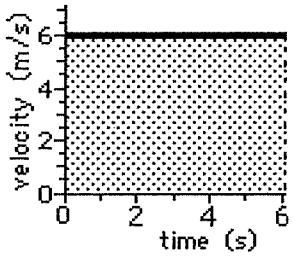
4. The area under the line of a velocity-time graph can be calculated using simple rectangle and triangle equations. The graphs below are examples:

Bonus

If the area under the line forms a ...

... **rectangle**, then use

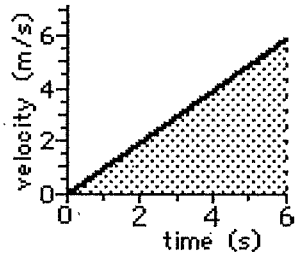
area = base*height



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

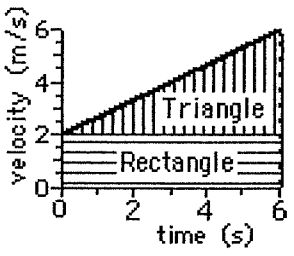
... **triangle**, then use

area = 0.5 * base*height



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

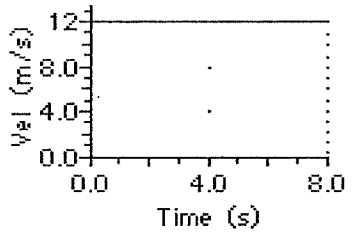
... **trapezoid**, then make it into a rectangle + triangle and add the two areas.



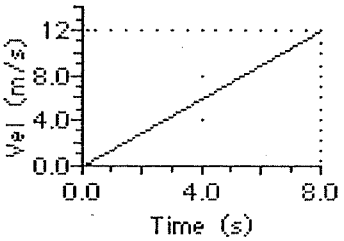
$A_{total} = A_{rectangle} + A_{triangle}$

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

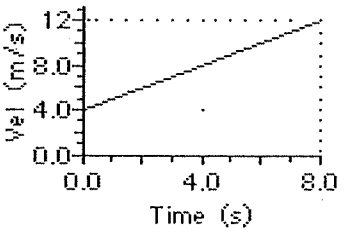
Find the displacement of the objects represented by the following velocity-time graphs.



PSYW:

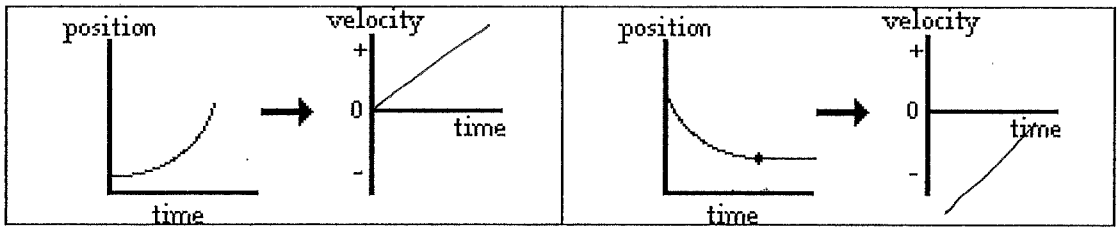


PSYW:



PSYW:

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



Energy

Read from **Lesson 1** of the **Work, Energy and Power** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/energy/u5l1b.html
http://www.physicsclassroom.com/Class/energy/u5l1c.html
http://www.physicsclassroom.com/Class/energy/u5l1d.html

MOP Connection: Work and Energy: sublevels 3 and 4

1. Read each of the following statements and identify them as having to do with kinetic energy (KE), potential energy (PE) or both (B).

KE, PE or B?	Statement:
KE	1. If an object is at rest, it certainly does NOT possess this form of energy.
PE	2. Depends upon object mass and object height.
KE	3. The energy an object possesses due to its motion.
B	4. The amount is expressed using the unit joule (abbreviated J).
PE	5. The energy stored in an object due to its position (or height).
PE	6. The amount depends upon the arbitrarily assigned *zero level.*
KE	7. Depends upon object mass and object speed.
PE	8. If an object is at rest on the ground (zero height), it certainly does NOT possess this form of energy.

2. A toy car is moving along with 0.40 joules of kinetic energy. If its speed is doubled, then its new kinetic energy will be _____.
   a. 0.10 J b. 0.20 J c. 0.80 J d. 1.60 J e. still 0.40 J
   KE = 0.4 J

3. A young boy's glider is soaring through the air, possessing 0.80 joules of potential energy. If its speed is doubled and its height is doubled, then the new potential energy will be _____.
   a. 0.20 J b. 0.40 J c. 1.60 J d. 3.20 J e. still 0.80 J

4. Which would ALWAYS be true of an object possessing a kinetic energy of 0 joules?
   a. It is on the ground. b. It is at rest. c. It is moving on the ground
   d. It is moving. e. It is accelerating. f. It is at rest above ground level
   g. It is above the ground. h. It is moving above ground level.

5. Which would ALWAYS be true of an object possessing a potential energy of 0 joules?
   a. It is on the ground. b. It is at rest. c. It is moving on the ground
   d. It is moving. e. It is accelerating. f. It is at rest above ground level
   g. It is above the ground. h. It is moving above ground level.

6. Calculate the kinetic energy of a 5.2 kg object moving at 2.4 m/s. **PSYW**

$$KE = \frac{mv^2}{2} = \frac{(5.2\text{kg})(2.4\text{m/s})^2}{2} = 14.976\text{ J}$$

7. Calculate the potential energy of a 5.2 kg object positioned 5.8 m above the ground. **PSYW**

$$PE = mgh = (5.2\text{kg})(10\text{m/s}^2)(5.8\text{m}) = 301.6\text{ J}$$

8. Calculate the speed of a 5.2 kg object that possesses 26.1 J of kinetic energy. **PSYW**

$$KE = \frac{mv^2}{2} = 26.1\text{ J} = \frac{5.2\text{kg}\,v^2}{2}$$

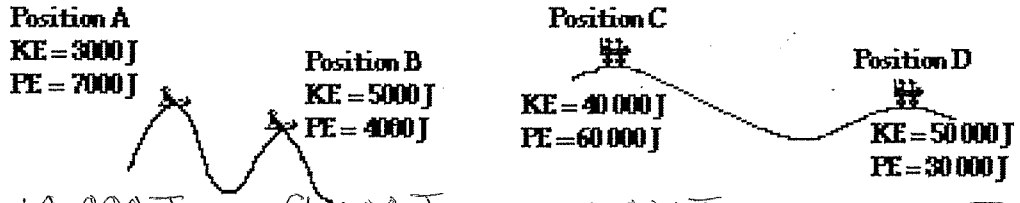
$$\frac{52.2\text{ J}}{5.2\text{kg}} = \frac{5.2\text{kg}\,v^2}{5.2\text{kg}} = \sqrt{10.038 = v^2}$$

$$v = 3.16\text{ m/s}$$

9. The total mechanical energy of an object is the _____.
   a. KE minus the PE of the object
   b. PE minus the KE of the object
   c. the initial KE plus the initial PE of the object
   d. KE plus the PE of the object at any instant during its motion
   e. final amount of KE and PE minus the initial amount of KE and PE

10. If an object moves in such a manner as to conserve its total mechanical energy, then _____.
   a. the amount of kinetic energy remains the same throughout its motion
   b. the amount of potential energy remains the same throughout its motion
   c. the amount of both the kinetic and the potential energy remains the same throughout its motion
   d. the sum of the kinetic energy and the potential energy remains the same throughout its motion

11. Determine the total mechanical energy (TME) of the objects at positions A, B, C and D.



A: 10 000 J B: 9000 J C: 100 000 J D: 80 000 J

12. Calculate the total mechanical energy (TME) of a 5.2 kg object moving at 2.4 m/s and positioned 5.8 m above the ground. **PSYW**

$PE = mgh = (5.2\text{kg})(5.8\text{m})(10\text{m/s}^2) = 301.6\text{J}$

$KE = \frac{1}{2}(mv^2) = \frac{1}{2}(5.2\text{kg})(2.4\text{m/s})^2 = 14.976\text{J}$

$TME = PE + KE$

$TME = 301.6\text{J} + 14.976\text{J}$

316.576 J

13. Read the following descriptions and indicate whether the objects' KE, PE and TME increases, decreases or remains the same (=). If it is impossible to tell, then answer ???.

   a. A marble begins at an elevated position on top of an inclined ruler and rolls down to the bottom of the ruler.
   KE: ↑ ↓ = ??? PE: ↑ ↓ = ??? TME: ↑ ↓ = ???

   b. A marble is rolling along a level table when it hits a note card and slides to a stop.
   KE: ↑ ↓ = ??? PE: ↑ ↓ = ??? TME: ↑ ↓ = ???

   c. A cart is pulled from the bottom of an incline to the top of the incline at a constant speed.
   KE: ↑ ↓ = ??? PE: ↑ ↓ = ??? TME: ↑ ↓ = ???

   d. A physics student runs up a staircase at a constant speed.
   KE: ↑ ↓ = ??? PE: ↑ ↓ = ??? TME: ↑ ↓ = ???

   e. A force is applied to a root beer mug to accelerate it from rest across a level countertop.
   KE: ↑ ↓ = ??? PE: ↑ ↓ = ??? TME: ↑ ↓ = ???

   f. A pendulum bob is released from rest from an elevated position and swings to its lowest point.
   KE: ↑ ↓ = ??? PE: ↑ ↓ = ??? TME: ↑ ↓ = ???

   g. A car skids from a high speed to a stopping position along a level highway.
   KE: ↑ ↓ = ??? PE: ↑ ↓ = ??? TME: ↑ ↓ = ???