Acceleration

1

What is Acceleration?

- **Acceleration**
  - **the change in an object's velocity over time.**
- **What are 2 ways that an object's velocity can change?**
  - **change in speed**
  - **change in direction**

Change either one and there is an acceleration

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Average Acceleration

- **To find the acceleration, we can use the following equation:**

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{change in time}}$$

or

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v - v_0}{t - t_0} \qquad units = \frac{m/s}{s} = \frac{m}{s^2}$$

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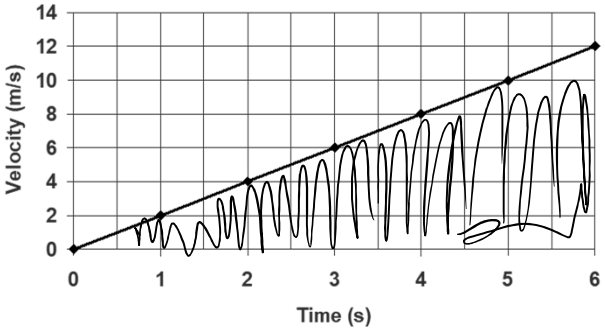
Graphing Acceleration: Velocity vs. Time Graphs



1. SLOPE = ACCELERATION
2. Line is STRAIGHT = acceleration is CONSTANT
3. DISPLACEMENT can be found by finding the AREA under the "curve"

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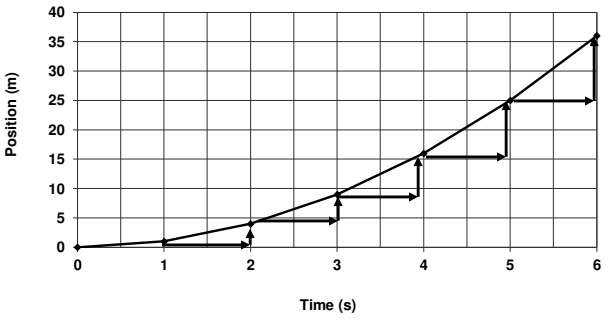
Graphing Acceleration: Position vs. Time Graphs



1. On Position vs. Time graphs a curved line means the object is accelerating.
2. Curved line also means your Velocity changing. Remember slope = velocity.

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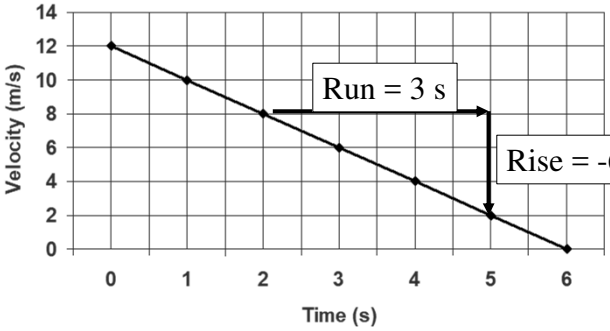
Question



Slope = A

$\frac{\Delta v}{\Delta x} = \frac{-12}{6} = -2\ m/s^2$

Above is a graph showing the velocity of a car over time.

1. How is the velocity of the car changing (speeding up, slowing down, or staying the same)?
2. What is this car's acceleration?

    1. The car is slowing down
    2. Acceleration = rise/run = -6m/s ÷3s = **-2 m/s^2**

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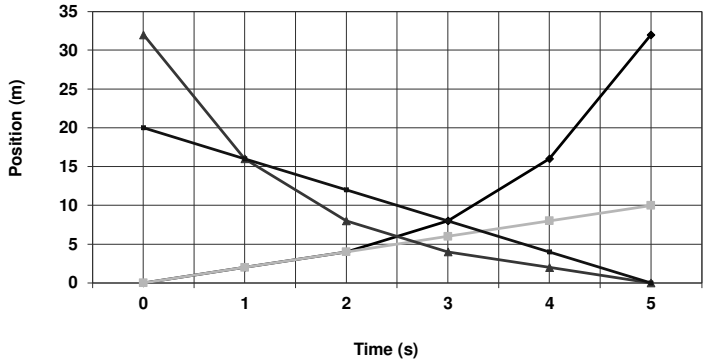
Question



1) Which line represents an object that is accelerating?

The **black and red lines** represent a objects that are accelerating. Black has a increasing slope, so it must be speeding up. Red is has a decreasing slope, so must be slowing down

Remember: in distance vs. time graphs:
curved line = accelerating, flat line = constant speed

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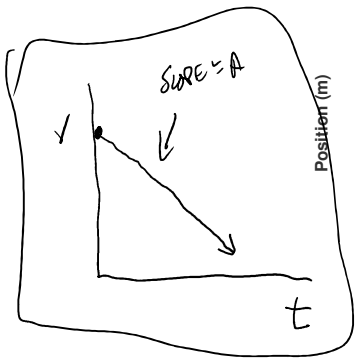
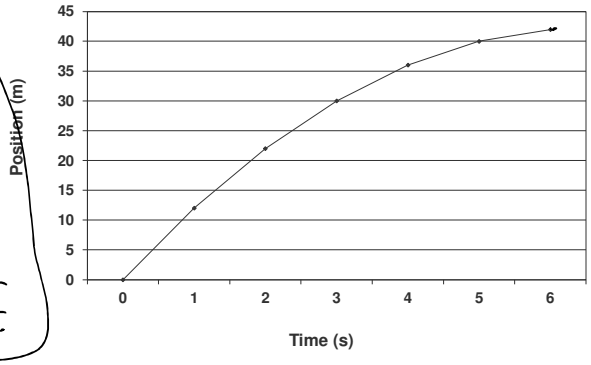
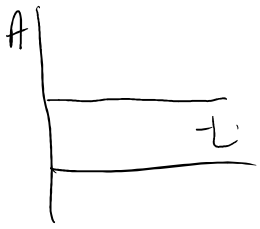
Question







Above is a graph showing the speed of a car over time.
What would a velocity vs. time graph for this look like?

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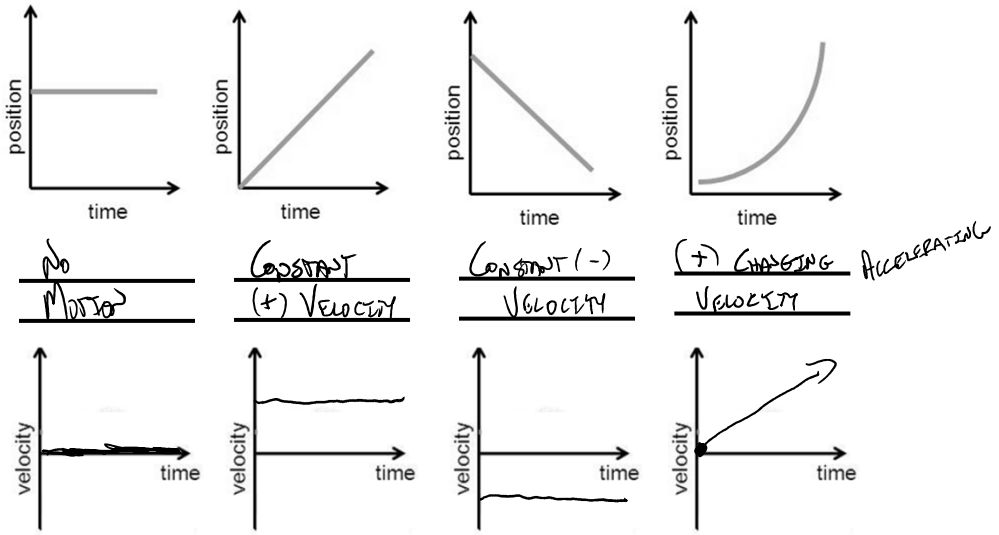
Position-Time Graphs

Describe in words the motion depicted in each graph,
then sketch the velocity vs. time graph that show that motion



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Velocity-Time Graphs

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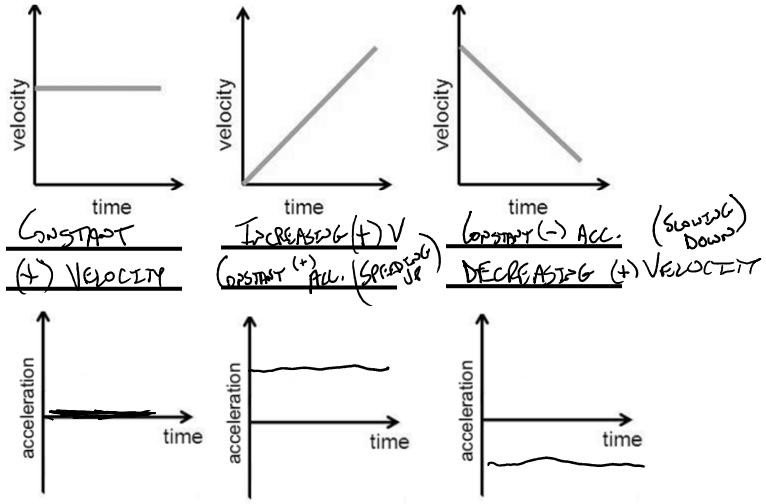

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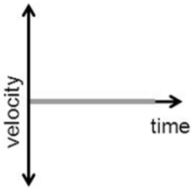
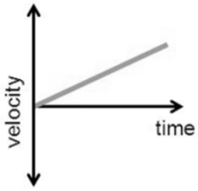
Velocity-Time Graphs

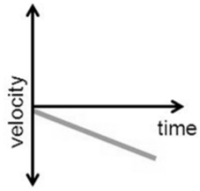
Describe in words the motion depicted in each graph, then sketch the velocity vs. time graph that show that motion



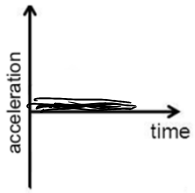
Not Moving

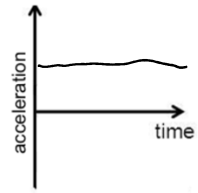


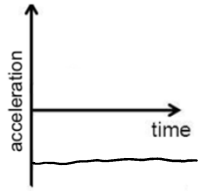
Increasing (+) v (speeding up)
Constant (+) Acc.



Increasing (−) v (speeding up)
Constant (−) Acc.







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Constant Acceleration Equations

- **When acceleration is constant, we can find other information about the object's motion using the following equations:**

(1) $v = v_0 + at$

(2) $x = x_0 + v_0 t + \frac{1}{2} a t^2$

(3) $v^2 = v_0^2 + 2a(x - x_0)$ Not

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Falling Objects

- Gravity acts on all falling (and rising) objects.
- Down is considered to be in the negative direction. Up is positive.
- Acceleration due to gravity is $9.80\ m/s^2$ downward ($-9.80\ m/s^2$)

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Helpful Hints

- List the variables that are given and the one you are looking for
- Look for the words "from rest" and "stop"
- Choose the equation with all variables in it.
- Remember all direction conventions

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Sample Problem #1

x	1350
x_0	0
v	
v_0	0 m/s
a	3 m/s
t	30 s

- **An airplane starts from rest and accelerates at a constant 3.00 m/s² for 30.0 seconds before leaving the ground.**
  - **How far did it move?**

$$x = x_0 + v_0 t + \tfrac{1}{2} a t^2$$
$$= 0 + 0(30) + \tfrac{1}{2}(3)(30)^2$$
$$= 1350\text{m}$$

  - **How fast was it going when it took off?**

$$v = v_0 + at$$
$$= 0 + (3)(30) = 90\text{m/s}$$

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Sample Problem #2

x	
x_0	0m
v	
v_0	0 m/s
a	-9.8m/s^2
t	4 s

$v_0 = 0 + a = -9.8\text{m/s}^2$

- **A painter drops a can of paint off the side of his scaffolding as he works on a building.**
  - **What is the velocity of the can of paint after 4.0 seconds?** $v = v_0 + at$

$$= 0 + (-9.8)(4) = -39.2\text{m/s}$$

  - **How far does the can of paint fall during this time?** $x = x_0 + v_0 t + \tfrac{1}{2} a t^2$

$$= 0 + 0 + \tfrac{1}{2}(-9.8)(4)^2$$
$$= -78.4\text{m}$$

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