$v_f = v_i + a \cdot \Delta t$
$\Delta x = v_i \cdot \Delta t + \frac{1}{2} a (\Delta t)^2$
$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$
$v_f^2 = v_i^2 + 2a \cdot \Delta x$

The Kinematic Equations:

The kinematic equations are relatively straightforward when objects move only forward. If objects are moving in *two-different directions* (forward and backwards), then the kinematic equations become slightly more complex.

Note that kinematic equations are only used when the equations are positive.

Setting up a coordinate axis:
- One direction is selected to be *positive* and the other is selected to be *negative*.
- It is a good practice to draw a diagram indicating the positive and negative directions.

Conventions:
Traditionally, for horizontal motion.
RIGHT is POSTIIVE and LEFT is negative

Traditionally, for vertical motion:
UP is positive and DOWN is negative.

Note that you do not need to follow these conventions.
You may flip them if you feel it is make the problem easier.

Always explicitly indicate if you flip the signs. It is a good idea to indicate the positive and negative directions even if you use the conventions.

An important point

Assigning direction as a sign is an *intermediary step* to help mathematically model the situation.
At the conclusion of a problem, in your final analysis, you should always write the direction of vectors or represent vectors as arrows.

Part 1: Using the definition of acceleration to find final velocity

Guidelines:
For each question in this section, please fill out the boxes in full.
In particular, *explicitly* indicate the positive and negative directions on each question.
You may follow the convention or no, but either way explicitly indicate the positive and negative directions.
At the conclusion of each problem, please list both the magnitude and direction of velocity.
Give the magnitude as a positive number and the direction as right or left.

$$v_f = v_i + a \cdot \Delta t$$

1.1. An object is moving right with a speed of 4 m/s and is accelerating to the right at a rate of 2 m/s^2. What is its velocity (magnitude and direction) after a time of 5 seconds?

Set up a coordinate axis:		
Looking For $v_f = ?$	Formula $v_f = v_i + a \cdot \Delta t$	
Already Know		
Magnitude of velocity:	*Direction* of velocity: [list as right or left]	

1.2. An object is moving right with a speed of 10 m/s and is accelerating to the left at a rate of 3 m/s^2. What is its velocity (magnitude and direction) after a time of 2 seconds?

Set up a coordinate axis:		
Looking For $v_f = ?$	Formula $v_f = v_i + a \cdot \Delta t$	
Already Know		
Final *magnitude* of acceleration:	Final *direction* of velocity:	

1.3. An object is moving left with a speed of 7 m/s and is accelerating to the right at a rate of 2 m/s^2. What is its velocity (magnitude and direction) after a time of 10 seconds?

Set up a coordinate axis:		
Looking For $v_f = ?$	Formula $v_f = v_i + a \cdot \Delta t$	
Already Know		
Final *magnitude* of acceleration:	Final *direction* of velocity:	

1.4. An object is moving left with a speed of 2 m/s and is accelerating to the left at a rate of 1.5 m/s^2. What is its velocity (magnitude and direction) after a time of 8 seconds?

Set up a coordinate axis:		
Looking For $v_f = ?$	Formula $v_f = v_i + a \cdot \Delta t$	
Already Know		
Final *magnitude* of acceleration:	Final *direction* of velocity:	

Part 2: Speeding up or Slowing down:

Speeding up vs. Slowing Down

If acceleration and velocity are in the same direction, an object is speeding up.

If acceleration and velocity are in opposite directions, an object is slowing down.

Guidelines:
For each of these problems, an object is moving with a constant acceleration. Determine the magnitude and direction of the velocity *and* whether an object is speeding up or slowing down at the end or the problem.

For each problem, please show the work you did to solve the problem. In particular, *always* write a formula before inserting numbers into the formula.

2.1 An object is moving to the right with a speed of 3 m/s
and accelerating at a rate of 2 m/s^2 to the right.
a) Is it speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

b) A time of 4 s passes. After this time, what is the magnitude and direction of velocity? [Please *show* the work you did to solve this problem.]

c) Is the object now speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

2.2 An object is moving at 5 m/s to the right and accelerating at a rate of 3 m/s^2 to the left.
a) Is it speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

b) A time of 2 s passes. After this time, what is the magnitude and direction of velocity? [Please *show* the work you did to solve this problem.]

c) Is the object now speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

2.3 An object is moving at 4 m/s to the left and accelerating at a rate of 1.5 m/s^2 to the left.
a) Is it speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

b) A time of 2 s passes. After this time, what is the magnitude and direction of velocity? [Please *show* the work you did to solve this problem.]

c) Is the object now speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

2.4 An object is moving at 10 m/s to the right and accelerating at a rate of 2 m/s^2 to the left.
a) Is it speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

b) A time of 12 s passes. After this time, what is the magnitude and direction of velocity? [Please *show* the work you did to solve this problem.]

c) Is the object now speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

2.5 An object is moving at 2 m/s to the right
and accelerating at a rate of 0.4 m/s^2 to the left.
a) Is it speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

b) A time of 3 s passes. After this time, what is the magnitude and direction of velocity? [Please *show* the work you did to solve this problem.]

c) Is the object now speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

2.6 An object is moving at 3 m/s to the left
and accelerating at a rate of 2 m/s^2 to the right.
a) Is it speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

b) A time of 5 s passes. After this time, what is the magnitude and direction of velocity? [Please *show* the work you did to solve this problem.]

c) Is the object now speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

2.7 An object is moving at 2 m/s to the right
and accelerating at a rate of 4 m/s^2 to the right.
a) Is it speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

b) A time of 3 s passes. After this time, what is the magnitude and direction of velocity? [Please *show* the work you did to solve this problem.]

c) Is the object now speeding up or slowing down? Defend your answer by referring explicitly to the principle above.

Answers:

1.1. 14 m/s right
1.2. 4 m/s left
1.3. 3 m/s right
1.4. 14 m/s left

2.1
a) It is speeding up because its velocity and acceleration are both to the right.
b) 11 m/s right
c) It is still speeding up because its velocity and acceleration are both to the right.

2.2
a) It is slowing down because its velocity is to the right and its acceleration is to the left.
b) 1 m/s left
c) It is now speeding up because its velocity is now left, the same direction as acceleration.

2.3
a) It is speeding up because velocity and acceleration are both to the left
b) 7 m/s left
c) It is still speeding up because velocity and acceleration are both to the left.

2.4
a) It is slowing down because velocity is to the right and acceleration is to the left.
b) 2 m/s left
c) It is now speeding up because velocity is now left, the same direction as acceleration.

2.5
a) It is slowing down because velocity is to the right and acceleration is to the left.
b) 0.6 m/s right
c) It is still slowing down because velocity is still to the right and acceleration is to the left.

2.6
a) It is slowing down because velocity is to the left and acceleration is to the right.
b) 4 m/s right.
c) It is now speeding up because velocity and acceleration are now both to the right.

2.7
a) It is speeding up because velocity and acceleration are both to the right.
b) 14 m/s right.
c) It is still speeding up because velocity and acceleration are still both to the right.