Physics Unit 3 Study Guide
Accelerated Motion

Essential Questions:

1) **How would you describe accelerated linear motion?**
2) **How is accelerated motion represented graphically and analytically?**
3) **How does an x vs. t graph differ between constant and accelerated motions?**

Words to define!

- Acceleration
- Derivative
- Integral
- Gravity

Equations to use!

$$\mathbf{v} = \frac{\Delta \mathbf{x}}{\mathbf{t}} \quad \rightarrow \quad \mathbf{x_f} = \mathbf{vt} + \mathbf{x_o}$$ ***Constant Motion***

$$\mathbf{a} = \frac{\Delta \mathbf{v}}{\mathbf{t}} \quad \rightarrow \quad \mathbf{v_f} = \mathbf{at} + \mathbf{v_o}$$

$$\Delta \mathbf{x} = \frac{\mathbf{1}}{\mathbf{2}}\mathbf{at^2} + \mathbf{v_o t}$$

$$\mathbf{v_f}^2 = \mathbf{v_o}^2 + \mathbf{2a\Delta x}$$

$$\mathbf{g} = \mathbf{9.8}\,{}^{\boldsymbol{m}}/_{\boldsymbol{s^2}}$$

Accelerated Motion

Skills to have!

S1 – Determine an unknown value by using the following process:

Step 1: What do you know? List the information that's given to you in the problem.

Step 2: What are you looking for? Determine the unknown variable that you want.

Step 3: What equation(s)? Figure out which equation or equations you need to get from what you have (from Step 1) to what you need (from Step 2).

Step 4: Solve and interpret! Plug your numbers into the equations and isolate your variable. Interpret what your answer means and don't forget to include units with your answer.

S2 – A graph has a lot of useful information. You have learned how to use a linear (straight line) graph to determine values like slope, *y*-intercept, and the linear equation. In Physics, these values mean something. Therefore, we start with a $y = mx + b$ format and put values and variables into the equation that have meaning. For example, for a Velocity vs. Time graph, the *y*-axis is "velocity" and the *x*-axis is "time." So, the equation changes to $v = mt + b$. We then use what we learned from Algebra to put in the values for slope (*m*) and *y*-intercept (*b*). We will never leave the equation with the generic *x* and *y* because those variables have no meaning in Physics.

Concepts to know!

C1 – For a Velocity vs. Time graph:

A) Slope (rise/run) represents acceleration. A negative slope means that the object is accelerating in the negative direction, but the velocity can still be in the positive direction.

B) The *y*-intercept represents the initial velocity.

C) *Y* values above the *x*-axis means that the object is moving in the positive direction; below the *x*-axis means it's moving in the negative direction.

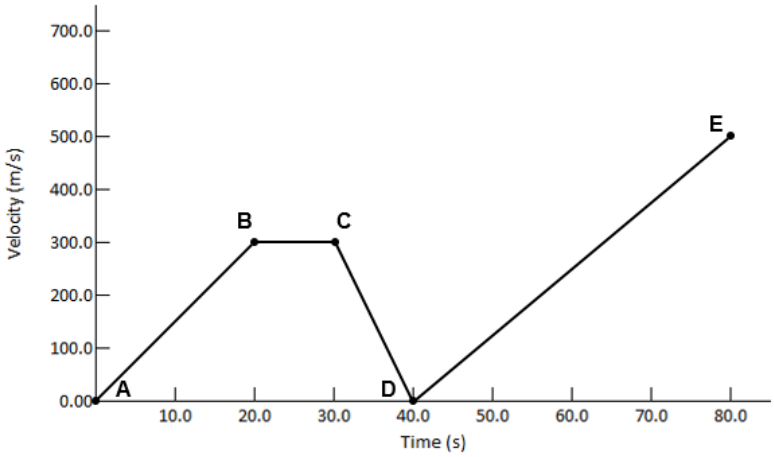
D) The area for a given time interval represents the displacement (Δx) or change in position.

C2 – When velocity and acceleration are in the same direction, the object will speed up; when in opposite directions, the object will slow down.

C3 – Any object in free-fall, whether the object is moving up or down, will have an acceleration of $-9.8\ ^{m}/_{s^2}$ (the acceleration due to gravity at Earth's surface).

Example Problems!

1. Use the Velocity vs. Time graph to the right to calculate the following of the object whose motion is plotted on the graph.



   A) What is the acceleration between the points on the graph labeled *A* and *B*? ($\mathbf{15.0}\ ^{\boldsymbol{m}}/_{\boldsymbol{s^2}}$)

   B) What is the acceleration between the points on the graph labeled *B* and *C*? ($\mathbf{0}\ ^{\boldsymbol{m}}/_{\boldsymbol{s^2}}$)

   C) What is the acceleration between the points on the graph labeled *C* and *D*? ($\mathbf{-30.0}\ ^{\boldsymbol{m}}/_{\boldsymbol{s^2}}$)

   D) What is the total distance that the object travels between points *C* and *D*? ($\mathbf{1500\ m}$)

2. If you throw a ball straight upward, it will rise into the air and then fall back down toward the ground. Imagine that you throw the ball with an initial velocity of $13.7\ ^{m}/_{s}$.

   A) How long does it take the ball to reach the top of its motion? ($\mathbf{1.40\ s}$)

   B) How far will the ball rise before it begins to fall? ($\mathbf{9.58\ m}$)

   C) What is its average velocity during this period? ($\mathbf{6.84}\ ^{\boldsymbol{m}}/_{\boldsymbol{s}}$)

3. A hot air balloon is rising at a constant speed of 1.00 m/s. The pilot accidentally drops his pen when the balloon is 10.0 m high. How fast is the pen traveling when it hits the ground, ignoring air resistance? ($\mathbf{14.0}\ {}^{\boldsymbol{m}}/_{\boldsymbol{s}}$)

4. A sudden gust of wind increases the velocity of a sailboat relative to the water surface from 3.0 m/s to 5.5 m/s over a period of 3.0 s.
   A) What is the average acceleration of the sailboat? ($\mathbf{0.833}\ {}^{\boldsymbol{m}}/_{\boldsymbol{s^2}}$)
   B) How far does the sailboat travel during the period of acceleration? ($\mathbf{12.75}\ \boldsymbol{m}$)

5. On the surface of Mars, the acceleration due to gravity is 3.71 $^{m}/_{s2}$. A robot on Mars pushes a rock over a 500.0-m cliff.
   A) How long does it take the rock to reach the ground below the cliff? ($\mathbf{16.4}\ \boldsymbol{s}$)
   B) How fast is the rock traveling when it reaches the surface? ($\mathbf{60.9}\ {}^{\boldsymbol{m}}/_{\boldsymbol{s}}$)
   C) How long would it take the rock to fall the same distance on the surface of Earth? ($\mathbf{10.1}\ \boldsymbol{s}$)