Unit 4: *Accelerated Motion*

This unit will take approximately 4-5 weeks. The pace is always determined by the ability of your students. Some areas can be skipped or used as enrichment, while other areas include more challenges to those more advanced students.
This timeline is based on 55-minute periods.

Outline	Teacher Notes:
Day 1 ***Today's Objective***: This introduces a context for learning uniform motion. ***Activity***: Framing Questions - Whiteboard ***Lab:*** Bag of Cars Lab - Again ***Due***: None	Whiteboard Framing Questions, but don't spend a lot of time. You want students to begin thinking about motion. Identify motion → vocabulary Make sure to look at Teacher guide Post-Lab discussion Notes: These are common misconceptions students will have on drawing a-t graphs.
Day 2 ***Today's Objective***: Identify an x-t graph of a car traveling down a ramp. ***Activity***: Discussion: How can we find the position and time for a car that is getting faster? ***Lab:*** Down the Ramp Part 1 ***Due***: None	Set up for this lab might take some time due to method of collecting data. You can use a spark timer, video camera, or just a marker like you did on the bubble tubes (you'll have to find something that accelerated slowly). In any case, getting students to understand the data will require some explanation.
Day 3 ***Today's Objective***: To compare x-t graphs of constant motion to accelerated motion. Students should generate the correlation between motion diagrams, x-t graphs and verbal descriptions. ***Activity***: Discussion of Post Lab, Reading Page: Motion Diagrams I ***Practice*** 4.1 Motion Diagrams with Changing Speed ***Due***: Data from "Down the Ramp" lab	Here, students will develop a qualitative representation of acceleration. Although they've collected data, we want students to identify that the velocity of the car is increasing with every time interval. Finish with reading pages and turn their data into a motion diagram for acceleration.
Day 4 ***Today's Objective***: Use the secant and tangent method to find the slope of a curve at a chose value of time. Use this data to develop a v-t graph. ***Activity***: Whiteboard Practice 4.1 ***Practice*** 4.2 Velocity of a Toy Car ***Due***: Practice 4.1	Now go back to their car on a ramp lab, and have students calculate the instantaneous velocity at several different points on their x-t graph. This data is then used to generate a v-t graph. This graph should be linear (line of best fit). Check the teacher guide to see which problems to do in class and assign the rest as homework. Use Reading Page: Instantaneous Velocity to support student understanding if they need it.

Outline	Teacher Notes:
Day 5 ***Today's Objective***: Describe and calculate the slope of an x-t graph for accelerated motion using either the tangent or secant method. ***Activity***: Whiteboard Practice 4.2 ***Due***: Practice 4.2	There is a reading page here (Calculating a v-t graph for Motion with Changing Speed) to be used as a supplementary source. ***Quiz #1***: Choose problems like those in the practice 4.1 and 4.2
Day 6 ***Today's Objective***: To calculate slopes of secants from an x-t graph to generate a v-t graph from experimentally obtained data, and to generate the formula for acceleration. ***Lab***: Down the Ramp Part 2 ***Due***: None	Review Quiz #1 Teachers can use a variety of methods for collecting this data. Motion Detectors, video analysis or ticker tape timers. If you have something that moves down a ramp with a slow acceleration, you can use the metronome and continue just as you did with previous labs.
Day 7 ***Today's Objective***: Review the curve of best fit (x-t graph), line of best fit (v-t) graph) and create the formula for acceleration. ***Practice*** 4.3 Analyze Uniform Acceleration Data I ***Due***: Lab: Down the Ramp Part 2	After reviewing the lab, Do problem 1 from the Practice 4.3 in class. Have students' whiteboard different segments of the x-t graph, generate v-t graph, and find acceleration. There is a reading page here: Acceleration. Negative acceleration is found in this the reading page that might be useful.
Day 8 ***Today's Objective***: To continue with motion diagrams, but include acceleration into their diagrams. Differences between + and – acceleration are easily identified here. ***Activity***: Quickly review 4.3, then, in small groups do 4.4 in class. Reading Page: Motion Diagrams II, then ***Practice*** 4.5 Motion Diagrams with Constant Acceleration ***Due***: 4.3 / 4.4 (in class)	Start with reviewing 4.3 then continue with doing practice 4.4 in small groups followed by either whiteboarding, or discussion. Introduce motion diagrams that include the acceleration arrows drawn over the position dots of their motion diagrams. Reading Page: Motion Diagrams II
Day 9 ***Today's Objective***: ***Activity***: Whiteboard 4.5 ***Practice*** 4.6 Graphs and Motion Diagrams ***Due***: Practice 4.4	The next 2 reading pages are supplementary. If students need extra help understanding these concepts, these are a great resource. Reading Page: Positive and Negative Velocities Reading Page: Correlating Graphs to Motion Diagrams

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Day 10 ***Today's Objective***: Qualitatively translate; x-t, v-t, verbal diagrams and motion diagrams of constant acceleration. ***Activity***: Whiteboard 4.6 ***Due***: Practice 4.6	Review constant acceleration. ***Quiz #2***: Use questions from the lab (Down the Ramp 2) and the homework 4.2-4.6. Use some of the 4.6 questions as assessment questions. Students can put everything they've learned about acceleration into their Student Summary Page.
Day 11 ***Today's Objective***: To combine uniform motion and accelerated motion in multiple representations. ***Activity***: Practice 4.7 Motion Diagrams, x-t and v-t graphs. ***Due***:	Review Quiz #2 Do practice 4.7 in class. Make sure students can combine uniform and accelerated motion in multiple representations.
Lab: Motion along an Incline – Photogate Lab. This is a tough lab and requires photogate timers.	This is a good lab if you have equipment and want to challenge students. For a regular or lower level class, this would not work well.
Day 12 ***Today's Objective***: Calculating displacement from a v-t graph. Generate a formula for calculating displacement. ***Activity***: Reading Page: How far do accelerating objects travel? ***Practice*** 4.8 (Do some of these in class) Assign the rest for homework. ***Due***: None	Review how to calculate displacement of constant motion from a v-t graph. Then either show students how to calculate displacement (of acceleration) from a v-t graph. Students should be able to generate $\Delta x = v_i \Delta t + \frac{1}{2} v_f \Delta t$. From the teacher may have to substitute $v_f \; with \; a\Delta t$ to generate the equation $\Delta x = v_f \Delta t + \frac{1}{2} a \Delta t^2$ This equations is may be used extensively in the remainder of the unit.
Day 13 ***Today's Objective***: For students to predict x-t, v-t and a-t graphs. This will include both the positive and negative directions. ***Activity:*** Whiteboard 4.8 ***Lab***: Speeding Up and Slowing Down Lab ***Due***: Practice 4.8	Whiteboard the remainder of 4.8 first, then start the lab: Speeding Up and Slowing Down. This is only useful if students make predictions first. You my want to try the first couple in small groups (whiteboarding), and then as a class. You will have to show students how to "zero" the motion detector as it will change throughout the lab. Also re-enforce that moving away from the detector is moving in a positive direction.
Day 14 ***Today's Objective***: Turning a pictorial description of motion and translate it into a: motion diagram, x-t, v-t, and a-t graph. ***Activity***: Finish lab: Speeding Up and Slowing Down.	This can be done as supplementary content depending on how detailed you want your students to be at translating motion into different representations.

Outline	Teacher Notes:
Practice 4.9 in class. What you don't finish is homework. ***Due***: None	
Day 15 ***Today's Objective***: This is a review of yesterday, ***Activity***: Whiteboard 4.9 (teacher choice), do 4.10 in class ***Due***: Practice 4.9 and / or Practice 4.10	If you did Practice 4.9, you can either whiteboard it in class, review it as a class (teacher directed) or just collect as homework. Start Practice 4.10 in class. This is a simulation to reinforce understanding. ***Quiz #3***. You can use problems from the practice problems and especially problems from assignments you might have assigned.
Day 16 ***Today's Objective***: Using the three equations of motion to solve numerical problems. ***Activity***: Start Practice 4.11 in class. Assign some as homework. ***Due***: None	Review Quiz #3 Review motion equations before assigning this homework. Pick some of the practice to do in class. There are good suggestions in the teacher guide. You may look at using the Reading Page: Using Motion Equations to Generate Graphs to support student understanding.
Day 17 ***Today's Objective***: Reviewing the three equations to solve numerical problems. ***Activity***: Whiteboard 4.11 in class. ***Due***: Practice 4.11	After whiteboarding the practice 4.11, You've reached a point in the unit where you may end the unit depending on the abilities of your students. It would be useful to include Practice 4.14 Motion with Acceleration - Stacks of Graphs. At this point you could spend a day reviewing the content and follow with a unit assessment.
Day 18 – If you choose to go on… ***Today's Objective***: This is practice generating x-t or v-t tables and graphs from given information. ***Activity***: Practice 4.12 Motion with Acceleration – Data Tables and Graphs. ***Practice*** 4.13 ***Due***:	If you wish to challenge students here, you can continue with the practice pages and the labs. Do Practice 4.12 in class (groups or individually).Continue with part of Practice 4.13 in class. Look at the teacher guide for recommendations.
Day 19 ***Today's Objective***: Translate between verbal, mathematical, pictorial and graphical representations of accelerated motion. ***Activity***: Whiteboard Practice 4.13 ***Practice*** 4.14 Motion with Acceleration – Stack of Graphs	Whiteboard 4.13. This could take a whole class period.

Outline	Teacher Notes:
Due: Practice 4.13	
Day 20 ***Today's Objective***: Generate data for uniform and accelerated motion and calculate displacement from an x-t and v-t graph. ***Lab***: Two Accelerating Objects – Conceptual Lab ***Due***: Practice 4.14	Review the practice 4.14 quickly, then move on to the conceptual lab. Students will need to plot data from two cars on an x-t graph to identify where they will meet. No quiz this week as the Unit Test is quickly approaching.
Day 21 ***Today's Objective***: Interpret the meaning of the intersection of lines on a graph from both a positive and negative slope. **Activity**: Review the lab ***Lab***: Testing Cars – Application Lab **Due**: Two Cars Accelerating – Conceptual Lab	Review the Two Accelerating Objects Lab, and propose the Testing Cars – Application Lab This may take 2 class periods depending on how quickly students can collect the data and construct their graphs.
Day 22 ***Today's Objective***: Determine if students can accurately collect data and plot the data on an x-t graph. ***Activity***: Framing Questions Review ***Due***: Two Cars Accelerating – Conceptual Lab	After finishing the lab, review the Framing Questions and review anything students may have concern with.
Day 23 ***Today's Objective***: Unit Assessment ***Due***: None	**Unit 4 Assessment**: Constant Acceleration