# Unit 5: *Forces and Newton's Laws*

This unit will take approximately 4 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. In this outline, you may find that the pace is too quick for your students and may want to insert some "processing time" for them.
*This timeline is based on 55-minute periods.*

| Outline | Teacher Notes |
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| **Day 1**<br>***Today's Objective***: This introduces a context for learning uniform motion.<br>***Activity***: Framing Questions - Whiteboard<br>***Lab:*** Exerting Forces Lab | Whiteboard Framing Questions, but don't spend a lot of time. You want students to begin thinking about forces.<br>Some of these will be fairly easy, while others will identify very common misconceptions.<br>Do the Exerting Forces Lab. This is done to develop a vocabulary for forces. |
| **Day 2**<br>***Today's Objective***: To define common vocabulary for the types of forces, categorize them, and describe the effect of these forces.<br>***Activity***: Discussion of Forces, Reading Page: What is a Force?<br>***Lab***: Finish discussion of Forces Lab<br>***Due***: Exerting Forces Lab | Now take the list of forces you've generated from the lab and categorize them into 2 groups. Field Forces and Contact Forces.<br>Go through the Reading Page: What is a Force? View the animations and re-confirm your vocabulary. You should include symbols for forces as you list them. Ex: $F_g$ – Force of Gravity<br>Next, list all the things that forces can do to an object (Page 6 of Reading Page). Put these notes in your Student Summary Page: Forces. |
| **Day 3**<br>***Today's Objective***: To physically show the connection between forces and motion.<br>***Lab***: Broom Ball – The Game Lab | Look through the Teacher Guide to set up the game. Use the corner of a hallway for your corner. Be aware that the bowling balls can put holes in some softer walls.<br>As they are competing, key on the big ideas, ie., the connection between force and the object's motion. |
| **Day 4**<br>***Today's Objective***: To identify the force, receiver, agent and effect that the force has on an object.<br>***Activity***: Reading Page: Drawing and Analyzing Forces<br>***Practice*** 5.1 Force Challenge<br>***Due***: Broom Ball – The Game Lab | Review the Broom Ball Lab and have students describe how forces affect the motion of an object.<br>Now you are going to show that each force has a name, a receiver, an agent and an effect. The reading pages will cover all the forces acting on an object, but the Practice 5.1 will just key on one force at a time. More detail will come later.<br>Now is a good time to evaluate student understanding of basic forces, agent, receiver and effect. **Quiz #1** Use some of the examples from the Practice pages or come up with some of your own. |

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| **Day 5**<br>***Today's Objective***: To describe the Normal Force acting on an object, along with its direction and magnitude.<br>***Activity***: Whiteboarding / Class Discussion<br>***Lab***: The Normal Force Lab<br>***Due***: Practice 5.1 | This is a fairly simple lab that helps students comprehend the agent, receiver, and effect of the normal force. When students complete the lab, have them share their findings on the whiteboard or large group discussion. You'll also start to get into balanced forces. Another big idea here is that the Normal force always acts in a direction that is perpendicular to the surface that the object is on. Have students put their findings in the Student Summary Page. |
| **Day 6**<br>***Today's Objective***: To identify the units of Force and develop a mathematical relationship between force of gravity and mass.<br>***Activity***: Whiteboarding / Class Discussion<br>***Lab***: The Force of Gravity Lab<br>***Due***: The Normal Force Lab | Students will need to use a variety of materials (anything they can find in the classroom). Be sure to get them to pick a wide range of masses depending on the range of the balance and scales. Remember in finding the slope, the units of the slope are most important.<br>After students have completed the lab, have students report their findings either through whiteboarding or class discussion. Follow this with putting their findings in the Student Summary Page. |
| **Day 7**<br>***Today's Objective***: To calculate the force of gravity acting on an object, even on different planets.<br>***Activity***: Reading Page: Measuring the Force of Gravity<br>***Practice*** 5.2 Force of Gravity and its Strength<br>***Due***: The Normal Force Lab | Review the Reading Page: Measuring the Force of Gravity (Weight). This will help students understand that the gravitational strength (***g***) can vary depending on the planet you are on.<br>Don't go through the entire Reading Page, but hit the key points. Next, do a couple of the Practice 5.2 problems in class, including parts of problem number 10 |
| **Day 8**<br>***Today's Objective***: To describe how an elastic force is affected by the amount of force applied to it, and to identify a spring constant.<br>***Lab***: The Elastic Forces Lab<br>***Practice*** 5.3 Forces in Springs<br>***Due***: Practice 5.2 | Depending you time constraints, you may want to skip this lab. If you want students to understand the concept of an elastic constant (***k***), continue. If not, you can still do this lab qualitatively.<br>If you decide to skip it, whiteboard the Practice 5.2 then move to the Reading Page: Drawing Force Diagrams.<br>If you perform the lab, go through the Practice quickly at the beginning of class. |
| **Day 9**<br>***Today's Objective***: To draw and label all the forces acting on an object, including the receiver, agent and the effect of each force.<br>***Practice*** 5.4 Force Diagrams<br>***Due***: Elastic Forces Lab & Practice 5.3 | Go through some of the Reading Page: Drawing Force Diagrams. Now we will be converting force diagrams from the object to a dot that represents the object. All arrows will point outward from the dot. Provide some practice for the students either from the reading page, or the Practice 5.4. |

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| **Day 10**<br>***Today's Objective***: To<br>***Activity***: Whiteboard Practice 5.4<br>***Due***: 5.4 Force Diagrams | Take your time whiteboarding this assignment. Some of the problems can be difficult. **Quiz #2** should cover normal and elastic forces, and force diagrams. |
| **Day 11**<br>***Today's Objective***: To describe inertia and to explore the relationship between mass and inertia.<br>***Activity***: Whiteboard the Post Lab<br>***Lab***: Newton's First Law Lab<br>***Practice*** 5.5 Newton's First Law | Review Quiz #2.<br>Try to get the students through each station, but time may not allow each student to finish. Have each group of student's whiteboard their observations from each station. Guide a discussion to come up with the big ideas. Go through the Reading Page: Nowton's First Law to reinforce their findings. Add these findings to their Student Summary Page. |
| **Day 12**<br>***Today's Objective***: To review how forces affect the motion of an object.<br>***Activity***: The Broom Ball Lab - Revisited<br>***Due***: Practice 5.5 | Quickly review the Practice 5.5<br>The Broom Ball Lab – Revisited. This is a good activity to do in class. Have students work in groups to complete the activity, but then have them whiteboard their findings when everyone has completed the activity. |
| **Day 13**<br>***Today's Objective***: To identify action and reaction forces, and to compare their direction and magnitude, and explain how Newton's Third Law works.<br>***Lab***: Newton's Third Law Lab<br>***Practice*** 5.5 Identifying Pairs of Forces<br>***Due***: The Broom Ball Lab - Revisited | This lab works extremely well with Force Probes, but can work with some success with spring scales.<br>You may use the Reading Page: Newton's Third Law to reinforce some of the findings from the lab.<br>Have students write their findings in the Student Summary Page.<br>If there is time, do a couple of problems from the Practice 5.6 in class, and assign some of the problems as homework. |
| **Day 14**<br>***Today's Objective***: To review paired forces and Newton's Third Law.<br>***Lab***: Newton's Second Law Lab<br>***Due***: Practice 5.5 | Pick and choose a couple of these problems to whiteboard. Typically choose the ones most often missed. These can change depending on what you assigned.<br>The next lab, "Newton's Second Law Lab" will take 2 class periods, so we will start today and continue on the next day. |

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| **Day 15**<br>***Today's Objective***: To develop a mathematical model that summarize the relationship between force, mass and acceleration.<br>***Lab***: Continue Newton's Second Law Lab<br>***Practice*** 5.7 Newton's Second Law Problems<br>***Due***: Newton's Second Law Lab | After completing the lab activity, Have students share their observations from the Post-Lab Discussion.<br>Use the Reading Page: Newton's Second Law to reinforce their findings.<br>List these big ideas on the board and have students report their findings in the Student Summary Page.<br>If there is time, begin with some of the Practice 5.7 in class. |
| **Day 16**<br>***Today's Objective***: To draw free body diagrams for objects, calculate the net force and use Newton's Second Law to predict it's motion.<br>***Activity***: Whiteboard Practice 5.7<br>***Practice*** 5.8 Forces, Motion and Newton's Laws<br>***Due***: Practice 5.7 | Whiteboard Practice 5.7.<br>Now it's time to put everything together.<br>It's a good time to evaluate their understanding of Newton's Laws.<br>**Quiz #3** should include problems like those modeled in each lab and the Practice 5.5, 5.6 and 5.7.<br>If there is time in class, start some of the problems in Practice 5.8 |
| **Day 17**<br>***Today's Objective***: To analyze problems and construct answers involving multiple representations of forces and the resulting motion.<br>***Activity***: Whiteboard Practice 5.8<br>***Due***: Practice 5.8 | Review Quiz #3.<br>Whiteboard Practice 5.8<br>This is an activity that puts everything together including some concepts covered in Units 3 and 4. |
| **Day 18**<br>***Today's Objective***: To review Forces and Newton's Laws<br>***Activity***: Whiteboard Framing Questions Revisited | After going back to the Framing Questions, have groups of students share their answers on the whiteboard.<br>Evaluate the success students have had in understanding the concepts. |
| **Day 19**<br>***Today's Objective***: Unit 5 Assessment | You may find that another day of reviewing can help those struggling students get caught up.<br>Once everyone has had ample time to grasp the concepts, administer the Unit 5 assessment: Forces and Newton's Laws |