

## Volume 6: Force, Instructor Materials Table of Contents

Contents	Page No.
I. Introduction	
A. Overview of the Unit	1
B. Acknowledgments and Origin of Ideas	3
C. Safety Considerations	4
II. Student Notions About Force	
A. The Students' Prior Beliefs as Described in the Research on Student Conceptions	5
B. Conceptions that Students Can Develop in this Unit	6
III. Cognitive Rationale	
General Comments	9
Specific Comments	10
IV. The Force Unit	
A. Suggestions for Implementation in the Larger Group Setting with Separate Laboratory Class	17
B. Materials and Equipment	19
V. Sample Assessment Materials	20
VI. Selected Bibliography/References	30
VII. Student Investigations with Embedded Instructor Notes	
<i>Investigation 1: Examining our initial ideas about force</i>	
Activity F1.1: What do we mean by the term, force, in this context?	31
Activity F1.2: How might we explain the 'at rest' condition of an object in terms of forces which might be acting on it?	34
Activity F1.3: What would the forces be like on an object so that the object maintains a constant velocity?	40
Activity F1.4: What would the forces be like on an object so that it maintains a constant acceleration?	45
<i>Investigation 2: Forces on objects that move</i>	
Activity F2.1: Given our conclusions, so far, about how forces relate to motion, what do you think the motion of the cart will be and what the force on it will be while moving this way?	51
Activity F2.2: How do the motion of the cart and the actual force compare with our predictions?	56
Activity F2.3: How does it appear that force is related to motion?	66
<i>Investigation 3: Extending the Scheme: Friction and Slowing Down</i>	
Activity F3.1: According to the scheme about forces we have worked out so far, how big do you think the friction force should be compared to the pulling force when an object moves with constant velocity?	71
Activity F3.2: The final extension of the scheme-what should the force be like to result in a constant slowing down of the cart?	79

<i>Investigation 4: Feeling the Force</i>	
Activity F4.1: How do you think the motions of two falling objects of the same size compare if one object is metal and one is wood?	86
Activity F4.2: How do you think the forces on two falling objects of the same size compare if one object is metal and one is wood?	91
Activity F4.3: What makes a “fair” race?	95
Activity F4.4: What are all the influences which would affect a race between carts on a horizontal table?	99
Activity F4.5: So, what can we decide about the forces on falling spheres?	103
<i>Investigation 5: Forces between objects</i>	
Activity F5.1: If two objects are pulling on opposite ends of a rope, one which is larger and more powerful than the other, but neither is moving, what are the forces between them like?	107
Activity F5.2: If two objects are attached to opposite ends of a rope and the larger, more powerful object is pulling the smaller one toward it, what force if any, does each feel from the other?	112
Activity F5.3: If two objects are attached to opposite ends of a rope and the smaller object is pulling itself toward the larger, what force, if any, does each feel from the other?	116
Activity F5.4: Would it make any difference in the forces if both vehicles are moving in the same direction, <u>the larger pulling the smaller</u> along?	120
Activity F5.5: Would it make any difference in the forces if both vehicles are moving in the same direction, <u>the smaller pulling the larger</u> along?	124