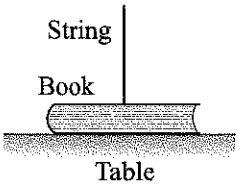
1. A string is tied to a book and pulled lightly as shown at right. The book remains in contact with the table and does not move.



   a. Draw a free-body diagram for the book. Label each of the forces exerted on the book as you were instructed in the tutorial *Forces*.

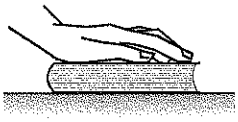
   b. How do the forces exerted on the book in this case compare to the forces exerted on the book when the string is not present? List any forces that are the same (*i.e.*, same type of force, same direction, and same magnitude) in both cases. Make a separate list of forces that change (or are not present) when the string is pulled.

   c. Consider the following statement made by a student about a book at rest on a level table:

   "The two forces exerted on the book are the normal force directed up and the weight of the book directed down. These are equal and opposite to one another. By Newton's third law they are a third law (action-reaction) force pair, so the normal force is always equal to the weight of the book."

   Do you agree with the student? Explain why you agree or disagree.

   d. Consider a book on top of a level table while the book is being pressed *straight down* by a hand.



      i. In the space below, draw a free-body diagram for the book. Label the forces as you did in the tutorial *Forces*.

      ii. How do the forces exerted on the book in this case compare to the forces exerted on the book when the hand is not pushing? List any forces that are the same (*i.e.*, same type of force, same direction, and same magnitude) in both cases. Make a separate list of forces that change (or are not present) when the hand is pressing down on the book.

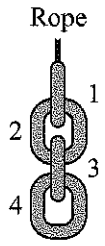
      iii. When the hand is pushing down on the book, is the magnitude of the weight equal to the magnitude of the normal force exerted by the table on the book? How can you tell?

e. Review your answer to part c. In addition, reread the portion of your physics text that discusses Newton's third law. Then consider a book on a level table:

- Which force completes the Newton's third law (or action-reaction) force pair with the normal force exerted on the book by the table?

- Which force completes the Newton's third law (or action-reaction) force pair with the weight of the book?

2. A chain is suspended by a rope as shown at right. The chain is composed of four identical links and does not move.



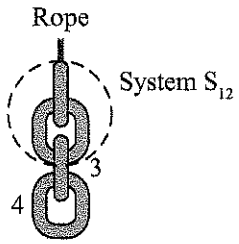
a. In the spaces below, draw a free-body diagram for each of the four links. Label each of the forces as you were instructed in the tutorial *Forces*.

Free-body diagram for link 1	Free-body diagram for link 2	Free-body diagram for link 3	Free-body diagram for link 4

b. Identify all the Newton's third law (action-reaction) force pairs in your diagrams by placing one or more small "×" symbols through each member of the pair *(i.e.,* mark each member of the first pair as →×←, each member of the second pair as →××←, *etc.)*.

c. Rank the forces on your diagrams according to magnitude, from largest to smallest. Explain your reasoning, including how you used Newton's second and third laws.

3. Let S_{12} represent the system consisting of links 1 and 2 of the chain in problem 2 (*i.e.*, treat links 1 and 2 as a single object).



Free-body diagram for system S_{12}

   a. In the space at right, draw and label a free-body diagram for system S_{12}.

   b. Compare the forces that appear on your free-body diagram for system S_{12} to those that appear on your diagrams for links 1 and 2 in problem 2.

      i. For each of the forces that appear on your diagram for system S_{12}, list the corresponding force (or forces) on your diagrams for links 1 and 2.

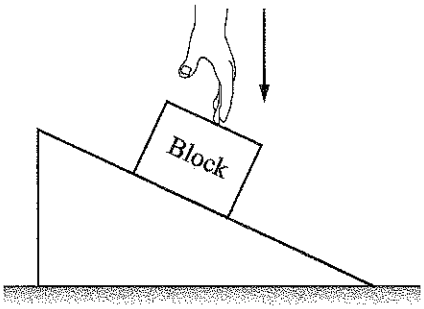
      ii. Are there any forces on your diagrams for links 1 and 2 that you did not list? If so, what characteristic do these forces have in common that none of the others share?

   c. Let C represent the system consisting of the whole chain. Draw and label a free-body diagram for C. Make sure that your diagram is consistent with the reasoning you used in part b.

Free-body diagram for system C

4. A block is at rest on an incline as shown below at right. A hand pushes straight down with a constant force. The block remains at rest on the incline.

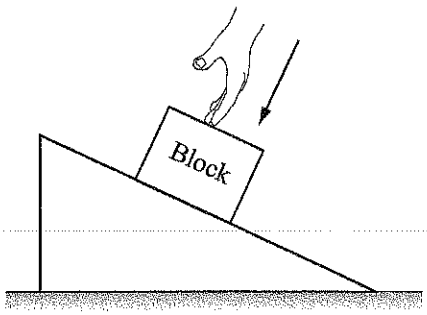
Free-body diagram for block



a. In the space provided above, draw a free-body diagram for the block. Label the forces as you did in the tutorial *Forces*.

b. For each force that appears on your free-body diagram, identify the corresponding force that completes the Newton's third law (action-reaction) force pair.

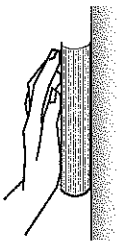
c. Suppose that the hand were to push with a constant force directed as shown at right. The block remains at rest on the incline.



i. Is the magnitude of the net force on the block in this case *greater than, less than,* or *equal to* that when the hand pushes straight down? Explain.

ii. Is the magnitude of the frictional force exerted on the block by the incline in this case *greater than, less than,* or *equal to* that when the hand pushes straight down? Explain.

5. A person pushes a book against a wall so that the book does not move.



   a. Draw a free-body diagram for the book. Label the forces as you did in the tutorial *Forces*.

   b. For *each* force that appears on your free-body diagram, identify the corresponding force that completes the Newton's third law (or action-reaction) force pair.