611-0080 (40-378) Friction Box

Warranty and Parts:
We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Intended for children 13 years of age and up. This item is not a toy. It may contain small parts that can be choking hazards. Adult supervision is required.

Description:
Our 40-378 Friction Box is used to determine the coefficient of friction with loads. Our high quality wood box features an open top, ring at one end and a non-slip bottom. 15 x 7 x 8 cm in size.

Curriculum Fit: Static Friction, Friction on an Inclined Plane, Vectors.

Safety Note: Please wear safety glasses when using this product.

Friction on an Inclined Plane Including Vector Analysis

Kit Components Needed: Friction Box, Inclined Plane, gram masses, string
Additional Materials Needed: Masking Tape

General Idea:
1. Students will investigate vectors and perform mathematical calculations.
2. Students will demonstrate that friction is a force that acts in the opposite direction to the motion of a moving object.
3. Demonstration of static friction.

Procedure:

Part I. Vectors

1. Students should find the mass, m, of the "plain" wood friction box by weighing it on a top-loading laboratory balance. Record this mass.
   Mass (m) = _____________(g)
2. Students should set up the inclined plane, at an angle such that when the friction box is placed on the inclined plane near the top that it does not slide back down the plane. An angle of approximately 30° should be acceptable. Record this angle.
   Angle (θ) = _______________°
3. The students should calculate the weight, W, of the friction box as follows:
   Example Calculation:
   W = mg
   m = mass of the block (grams)
   g = acceleration due to gravity = -9.8 m/s^2
   Result will be in terms of N (Newtons)
4. Sin and Cos should be calculated.
   Example Calculation:
   cos (θ) =_________
   sin (θ) = _________
5. See Diagram 1 and fill in Table 1 below.

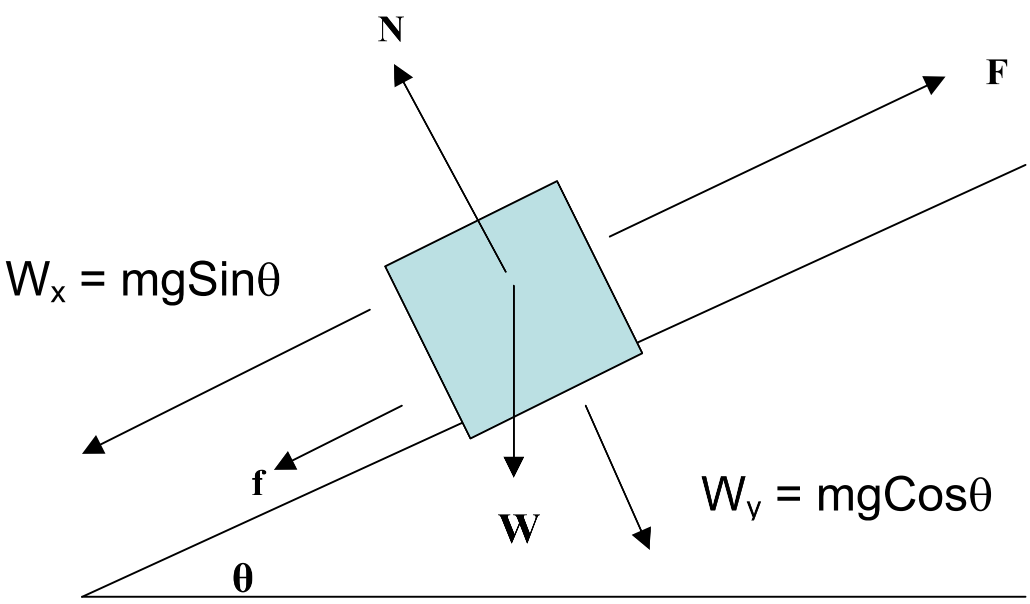

Diagram 1

Mass (g)	Acceleration (m/sec^2)	Weight (N)	Angle (θ)	cos (θ)	sin (θ)	W_x
F	N	W_y				

Table 1

6. W should be resolved into its components.
   Example Calculation:
   $W_x = W\cos\theta$
   $W_y = W\sin\theta$
7. N (Normal Force) should be calculated.
   Example Calculation:
   $N = -W_y$
8. Calculate F.
   Example Calculation:
   $F = -W_x$

Discussion: With the box at rest on the inclined plane, the sum of all forces is equal to zero. Mathematically, this is represented as follows:

F total = W + F + N = 0

Part II. Determination of Static Friction

1. Students should place an inclined plane on a flat surface, such as a laboratory bench or tabletop, so that the end with the pulley assembly is over the edge of the table.
2. Students should attach one end of the string to the eyehook located on the friction box and allow the other end of the string to hang down over the pulley.
3. Make a loop at the end of the string that is hanging down over the pulley. This is for the attachment of weights. See Diagram 2.
4. Add weights to the loop until the block just begins to move. Record the amount of weight required to move the box with no mass added to the box. Repeat step four with 50, 100, 150 and 200 g masses added to the box.
   Suggestions: Keep the box in the middle of the inclined plane. Lift the box and lower it onto the plane. Keep the box still for approximately 5 seconds before releasing it. If the box does not move, then too little weight has been added. If the box moves quickly, then too much weight has been added to the box. If it moves only a little, then the weight added is sufficient.

   Example Calculation:
   F = ma
   m = mass suspended from loop
   $a = 9.8\ m/s^2$
   $m = m_b + m_w$
   m_b = mass of block
   m_w = mass of weights
   0 g F=________________N
   50 g F=________________N
   100 g F=________________N
   150 g F= _______________ N
   200 g F=________________N
5. Students should make a plot of F versus the normal force, N, of the surface of the box.
   $N = (m_b + m_w)a$
6. The slope of the straight line is equal to the coefficient of static friction, μ_s.

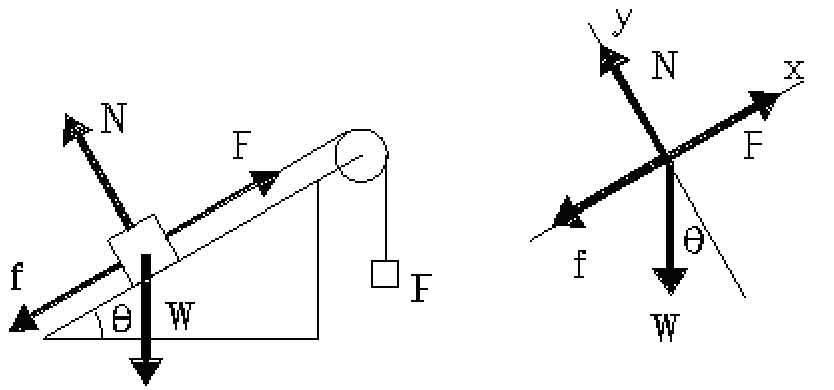

Diagram 2 Incline Plane Setup and the free-body diagram.

Related Products:

Science First® *is a designer and manufacturer of hands-on science labs. Our products are available from most science education distributors. For more information contact us.*

615-3015 Friction Rod Kit - Learn about static energy the way the ancients did - create electric charges and experiment with them. Contains 3 rods, 3/16 x 8" long - glass, acrylic and hard rubber; and 3 pads - cotton (12 x 12"), faux fur (fabric pad) and silk (12 x 12"). Instructions include experiments. Meets many curriculum requirements!

611-0082 Friction Cube-4 Surface- Show how different frictional characteristics affect the force required to move a stationary body. The friction cube includes 4 different surfaces on a two inch wood cube. The friction cube comes with a hook on one side for towing against inclined planes or other surfaces.