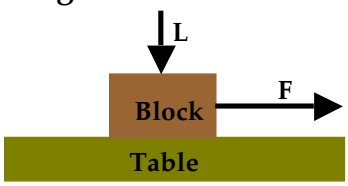
Friction

Friction is a force that resists the motion of objects. A group of students are conducting experiments on friction.

Diagram 1



Experiment 1

Diagram 1 depicts a procedure that is used to measure the friction force. A horizontal force is applied to a block on a table to accelerate it from rest. One observes that the force needed to initiate the motion (accelerate it from rest) is greater than the force needed to sustain the motion at a constant speed. Masses can be added to the block, thus increasing the load (**L**). The force required to initiate the motion is equal to the static friction force ($\mathbf{F_{static}}$). The force required to sustain the motion at a constant speed is equal to the kinetic friction force ($\mathbf{F_{kinetic}}$). **Table 1** represents typical data from such an experiment.

Experiment 2

A student decides to investigate the effect of the surface on the amount of friction. She layers the bottom of the block with coarse sandpaper and then repeats the procedure described in **Experiment 1**. Her data is shown in **Table 2**.

Table 1

Trial	L (N)	F_{static} (N)	$F_{kinetic}$ (N)
1	2.41	1.56	1.39
2	2.91	1.89	1.68
3	3.41	2.20	1.98
4	3.91	2.55	2.28
5	4.41	2.87	2.53
6	4.91	3.18	2.85

Table 2

Trial	L (N)	F_{static} (N)	$F_{kinetic}$ (N)
1	2.42	1.87	1.59
2	2.92	2.28	1.93
3	3.42	2.67	2.25
4	3.92	3.06	2.59
5	4.42	3.45	2.95
6	4.92	3.84	3.25

Experiment 3

Another student makes an effort to determine if the area of contact between the block and the table affects the amount of friction. The scientist finds a rectangular block with three unequal length sides. The three areas of the face of the block are:

Side A	Side B	Side C
65 cm^2	42 cm^2	78 cm^2

The student pulls the block (without the sandpaper) along each of the sides at a constant speed. The data are shown in **Table 3**.

Table 3

L (N)	Side A - $F_{kinetic}$ (N)	Side B - $F_{kinetic}$ (N)	Side C - $F_{kinetic}$ (N)
3.58	2.04	2.01	2.05
4.08	2.38	2.31	2.37
4.58	2.61	2.63	2.62
5.08	2.90	2.94	2.95

Questions:

1. In what way do the students control the **load** in these experiments?
   a. They cause more friction to be present. This in turn affects the load.
   b. They pull with a different force. The amount of load varies with changing force.
   c. They place the block on various sides. Varying the contact area affects the load.
   d. They add or remove masses to of from the block. The load varies with the mass.

2. What information is learned in **Experiment 2** that had not previously been learned in **Experiment 1**?
   a. The students learn the effect that the surface might have upon the force of friction.
   b. The students learn the relative strengths of the static and the kinetic friction force.
   c. The students learn the effect of load on the amount of friction experienced by the block.
   d, The students learn the effect that the contact area between surfaces has upon the friction.

3. Which is an independent variable in **Experiment 3**?
   a. The amount of load on the block.
   b. The force of friction acting on the block.
   c. The amount of force needed to pull the block.
   d. The contact area between the block and the surface.

4. Which statement is consistent with the data collected in **Experiment 1** and **Experiment 2**?
   a. A greater contact area between block and surface results in greater friction force.
   b. Changing the contact area has little to no effect upon the amount of friction force.
   c. Varying the mass of the block does not have any effect upon the amount of friction.
   d. For the same load, a sandpaper surface causes more friction than a plain wood surface.

5. Which of the following relationships were not studied in **Experiments 1**, **2** and **3**?
   a. Effect of contact area on friction force.
   b. Effect of pulling speed on friction force.
   c. A comparison of static and kinetic friction.
   d. Effect of surface material on friction force.

6. A group of students are dragging a block with a constant speed across the same surface used in **Experiment 3**. Its contact area is twice that of Side B and the load is 4.58 N. Use the results of **Experiment 3** to predict the force that must be applied to the block.
   a. 1.32 N b. 2.62 N
   c. 5.26 N d. 9.16 N

7. Which of the following set of characteristics would result in the greatest force of kinetic friction?
   a. Small Load, Sandpaper on bottom of block, Largest contact area
   b. Large Load, No sandpaper on bottom of block, Largest contact area
   c. Small Load, No Sandpaper on bottom of block, Smallest contact area
   d. Large Load, Sandpaper on bottom of block, Smallest contact area

8. In which case was the amount of kinetic friction the greatest?
   a. Use a load of 2.91 N and no sandpaper on the bottom of the wood block.
   b. Use a load of 3.42 N and sandpaper on the bottom of the wood block.
   c. Use a load of 4.41 N and no sandpaper on the bottom of the wood block.
   d. Use a load of 3.92 N and sandpaper on the bottom of the wood block.

9. An effort is being made to initiate the motion of a wood block having a load of 5.91 N. What would be a reasonable estimate of the amount of static friction?
   a. Approximately 3.18 N
   b. Approximately 3.44 N
   c. Approximately 3.50 N
   d. Approximately 3.83 N

10. In **Experiment 1**, a force is applied to the block until it is set into motion. Once set in motion, the force is applied to pull the block at a constant speed. Which graph represents how the force varies over time during a trial?