

Playground Physics

See-Saw Physics Teacher's Guide

The students will explore the concept of levers by using levers they are already familiar with: see-saws.

Before the playground

Go over the terms and concepts the students will be using, the importance of units, and have your students fill out the pre-playground worksheet on see-saw physics. Have the students work individually or in small groups to make their hypotheses. If adults unfamiliar with the activity will be helping on the playground, familiarize them with the activity prior to leaving for the playground.

The Theory: (to be explained only after the experiments)

Mass, gravity, and the distance between each mass and the pivot point will all be important in this experiment. For a balanced lever: if forces are at right angles to the lever (and we will assume them to be so for the purposes of the experiment) then a simple equation can be used to relate the distance from the pivot point of each mass and the force exerted on the lever by each mass.

(Force of mass 1) x (the distance from the pivot point to mass 1) = (Force of mass 2) x (the distance from the pivot point to mass 2)

or

$$\mathbf{F_1 \times d_1 = F_2 \times d_2}$$

A force applied by pushing down on one end of the lever can substitute for a mass on one end. The mechanical advantage of using a long lever to lift a heavy weight is apparent: much less force is need to lift a heavy object with a lever if the distance from the pivot point is large compared to the distance of the heavy object from the pivot point.

On the playground

You will need bathroom scales and tape measures with metric units for this experiment.

Ask the students what variables are important when they try to balance on a see-saw and experiments they would like to do to test their hypotheses. If you will be using the

[experiment report form](#) with your students, give the students a chance to read it after they have suggested their own experiments but before they begin the experiments.

The students and if necessary any available adults will be the "masses" for this section of playground physics. If possible, try to have one adult for each group of 3 to 4 children. (I recommend that as many of the adults as possible be parents.) If there are insufficient adults, then pairs of children can be the "large masses" and a single child can be the small mass. I **do not** recommend that children from the same grade be separated into different groups by weight. Have children of approximately the same mass be small mass 1 and small mass 2. For the portions of the experiment involving the two small masses, the 3rd and/or 4th child should make the distance measurements. The student who is small mass 1 will be on the see-saw for all parts of the experiment.

If two children will be combined to act as the large mass and there are only three per group, have the child who has chosen to be small mass 2 and the remaining child be the large mass. An adult will need to help with the making measurements for the parts of the experiment involving the large mass. For groups of 4 children (unless a child is sensitive about his or her weight) have the two remaining children act as the large mass and the child acting a small mass 2 can be responsible for the measurements for the parts of the experiment involving the large mass. When two children are acting as a single mass, try to have them sit as close together as possible. Remember, an adult can always be substituted for the two children to be the large mass.

Measurements of the distance from the pivot point to each mass should be made to the center of mass for the child or children acting as the mass. The center of mass for a child is approximately to the center of the child. When showing the students how to take measurements, make sure that the measurements are made as close to the center of the child (or between the children) as possible. Measurements made to the front or the back of the child will not greatly affect the results, but for two children acting as a single mass the distance should always be measured to between the two children.

The experiment:

First small mass 1 and small mass 2 will balance on the see-saw. The lab partner(s) will measure the distance from the pivot point to the center of the side of each child, and record those measurements. Small mass 1 will then move in, and the students will measure the distances again and make note of which mass moved up and which moved down.

Next the large mass will replace small mass 2 on the see-saw. Small mass 1 and the large mass will balance on the see-saw. The remaining lab partner will make the measurements, or an adult may be needed to help with the tape measure (let the children actually read off the numbers). The large mass will then move toward the pivot point, and the distances will be measured again. Once again, the students will make note of which mass moved up and which moved down.

After the Playground:

Before you leave the playground or the next class, ask the students about how their hypotheses held up. Would they change any of their answers to the questions in the workbook before the playground section? Did they learn anything new? If the experiments didn't work well, discuss what should have happened, and have the students come up with reasons why it didn't. Discuss the student responses, and add your own suggestions if necessary.

For older students, you may wish to have them do some calculations in addition to the experiment report using the equation:

(Force of mass 1) x (the distance from the pivot point to mass 1) = (Force of mass 2) x (the distance from the pivot point to mass 2)

or

$$\mathbf{F_1 \times d_1 = F_2 \times d_2}$$

For instance, have them calculate the force for each mass, and then predict how far a mass will be from the pivot point on a balanced see-saw when they know the two masses and the distance of the other mass from the pivot point. Since students of the target age group are usually unfamiliar with algebra, be sure to give them the equation in words and/or already in the form they will need to use it. So,

(the distance from the pivot point to mass 1) = (Force of mass 2) x (the distance from the pivot point to mass 2) / (Force of mass 1)

or

$$\mathbf{d_1 = (F_2 \times d_2) / F_1}$$

[Back to Introduction](#) or [Student Worksheet](#) or [Experiment Report](#)

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See-Saw Physics

Key Words:

hypothesis

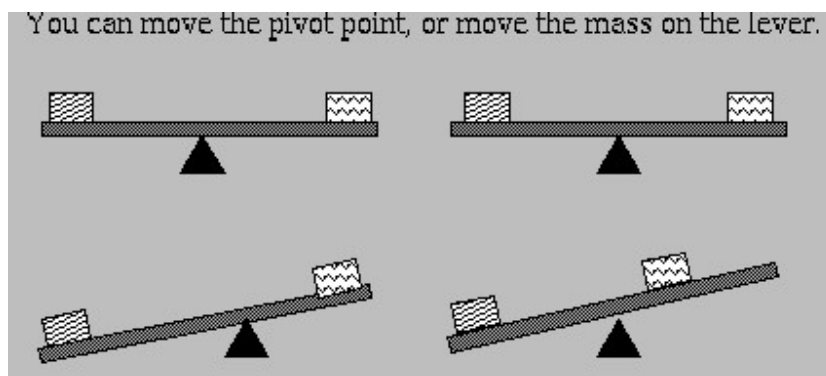
lever

pivot point

mass

weight

When you play on a see-saw you are really working with **levers**. A lever consists of a rigid (unbendable) bar or board and a pivot. The point where the board or bar rests on the pivot is the pivot point.



Some of the other uses for levers include moving heavy objects and making scales to weigh things. Think about how you might build a scale. Can you make one with common objects around your home?

Before the playground

We will experiment with see-saws as levers on the playground. Before we do, you will need to think about what experiments you would like to do with the see-saw.

First: Make your own hypotheses about how the see-saw will work under different conditions.

Remember, a hypothesis is an educated guess based on your previous experience. Before you make your own hypothesis about each of the following cases, think about what you have done on see-saws in the past. It is perfectly OK to make an incorrect hypothesis...scientists do that all the time. The **only** thing you could do wrong if you make an incorrect hypothesis is if you change your observations to match your hypothesis instead of changing your hypothesis to match your observations. That is cheating and **not** real science.

- 1) If you want to see-saw with a grownup (who weighs much more than you do), where on the see-saw do you need to sit? Where does the grownup need to sit?
- 2) How would you find out if you and your friend weigh the same?
- 3) Would a see-saw work on the Moon? Why or why not?
- 4) Can you think of how you could use a lever like a see-saw to move something that is very heavy?
- 5) How does a see-saw really work? What allows you and a friend to move up and down?
- 6) Why do most playground see-saws have fixed pivot points? Are there any disadvantages to fixed pivot points?

On the playground

Now comes the fun part! We will experiment with the see-saw and test our hypotheses.

What experiments should we perform? (You can't test #3 on the playground, so that is a thought experiment only.)

How did each of your hypotheses work? Can you think of any other experiments you might like to do either with the see-saw or with levers you can build yourself?

Playground Physics

See-Saw Physics Experiment Report

Who are your experiment partners?

What is the purpose of this experiment?

Choose a "large mass" and two "small masses" (small mass 1 and small mass 2). The large mass can be an adult or two kids (one may also be a small mass). The two small masses should have approximately the same weight. Now using a bathroom scale, measure mass of the large mass and the two small masses. If the large mass is composed of two kids, add their masses together.

mass of large mass:

mass of small mass 1:

mass of small mass 2:

For the two small masses	
Distance from pivot point to small mass 1	Distance from the pivot point to small mass 2

Balanced		
Small mass 1 moved closer to the pivot point		

What happens when you move small mass 1 closer to the pivot point? Which mass is higher and which is lower?

For the large mass and small mass 1		
	Distance from pivot point to large mass	Distance from the pivot point to small mass 1
Balanced		
Large mass moved closer to the pivot point		

Does the large mass need to be closer to or farther away from the pivot point than the small mass to balance the see-saw?

What happens if the large mass and the small mass are equal distances from the pivot point?

Can you think of any other experiments you might like to do either with the see-saw or with levers you can build yourself?

Now that your experiment is over, will you change any of your answers to the questions below?

- 1) If you want to see-saw with a grownup (who weighs much more than you do), where on the see-saw do you need to sit? Where does the grownup need to sit?
- 2) How would you find out if you and your friend weigh the same?
- 3) Would a see-saw work on the Moon? Why or why not?
- 4) Can you think of how you could use a lever like a see-saw to move something that is very heavy?
- 5) How does a see-saw really work? What allows you and a friend to move up and down?
- 6) Why do most playground see-saws have fixed pivot points? Are there any disadvantages to fixed pivot points?

Finally, write a brief paragraph about what you learned in this experiment.