Industrial Activities

Pendulum Impact Activities
A variety of tests have been developed to determine plastic's or plastic products' ability to withstand a variety of impacts. Different plastic products are designed to withstand different impacts:

- Car bumpers need to absorb energy upon collision.
- Plastic foodware should not break if dropped.
- A notebook should open without the spine cracking.

Different kinds of impact tests involve doing different things to samples:

- *Tensile* tests pull samples apart.
- *Compression* tests squeeze and push samples together.
- *Flex* tests bend samples.
- *Torsion* tests twist samples.

The Izod Impact test is a very popular impact test that requires the use of a pendulum.

Before the pendulum is released, the hammer represents full potential energy (PE). Potential energy is the stored energy that occurs as a result of the relative positions of objects in a system. When the pendulum is released, the potential energy changes to kinetic energy (KE). Kinetic energy is the energy of a moving object resulting from its motion. The PE is completely changed to KE at the bottom of the arc, assuming there is no friction.

The pendulum will continue to swing to the other side to the same height as it started at which point all the kinetic energy is changed to potential energy. The pendulum swings back and forth unless something interrupts the swing.

What happens when a plastic test sample interrupts the swing?

- The pendulum doesn't swing as high.
- The sample is broken.
- There is a sound on impact.
- There are vibrations on impact.

Activity 1
Using a child's toy golf club as the pendulum, compare the differences between a variety of rigid plastic foam samples *(Rigid foam samples are available at home construction and supply stores. Thickness may vary.)*
Cut samples approximately 20cm x 5cm.

Clamp approximately half of the sample, keeping it in a vertical position.

Swing the golf club so that it impacts the top of the sample. Briefly describe the amount of energy it takes to break the sample.

Did you hear the sample break? What happened? (Energy at impact was transformed into sound energy.)

Did you feel vibrations when the pendulum hit the sample? What happened? (Energy at impact was transformed into vibrations.)

Activity 2
Compare the impact resistance of samples cut from different types of foamed material.

Activity 3
Compare the impact resistance of samples with varied depths, maintaining the 20cm height and 5cm width.

Activity 4
Compare the impact resistance of samples cut with the grain of the foam sheet to samples cut against the grain (Foam sheeting with a grain will appear to have fine lines running the length of the sheet.)

Activity 5
Compare the impact resistance of notched samples versus unnotched samples.

Activity 6
Impact the sample on the face with the notch (Izod A), a tensile test.

Compare this to impacting the sample on the face opposite the notch (Izod E), a compression test.

Keep a journal of all tests, procedures and results, including diagrams of test samples.

Fatigue Resistance Activities
Plastics in some applications need to withstand flexing, stretching, compressing and twisting.

For example, a plastic chair is stressed each time someone sits in it or leans back in it.

When the stress is repeated over and over, the material needs to be resistant to "fatigue". The fatigue life of a material is described as the number of cycles or times the sample is deformed.

A product or material that does not have good fatigue resistance may not withstand normal usage and will crack, whiten, discolor, or break.

A material's fatigue resistance is very important in many applications.

List some products you can think of that need good fatigue resistance.

For the following set of activities, you will need several rectangular pieces of plastic, consistently the same thickness and size. We recommend samples to be about 2mm thick and about 3cm by 15cm in size.

Consider using lids from butter containers, lids from coffee cans, or lids from food storage containers. You can also use solid plastic binders. *You can also use plastic plates either solid or foam plates, as students may understand better a plate holding up to the weight of food*.

Activity 1
Develop a test to determine the number of cycles needed to break a sample when flexing the sample back and forth.

- Describe what various loads do to a sample under stress (e.g., color change or whitening, a break, permanent change in shape).
- Describe how these results could affect the looks or performance of a product, such as a chair, box lid, food container, or a car bumper.

Different plastic behaves differently at various temperatures.

Using samples chilled in the freezer, refrigerator, or in ice water, develop a test to determine the number of cycles needed to break a sample when flexing the sample back and forth.

Using samples that have been heated in warm or boiling water, develop a test to determine the number of cycles needed to break a sample when flexing the sample back and forth.

How does varying the temperature affect the fatigue resistance of the plastic sample?

Activity 2
Develop a test to determine the number of cycles needed to break a sample when twisting it.

- Describe what various loads do to a sample under stress (e.g., color change or whitening, a break, permanent change in shape).
- Describe how these results could affect the looks or performance of a product, such as a chair, box lid, food container, or a car bumper.

Different plastic behaves differently at various temperatures.

Using samples chilled in the freezer, refrigerator, or in ice water, develop a test to determine the number of cycles needed to break a sample when twisting it.

Using samples that have been heated in warm or boiling water, develop a test to determine the number of cycles needed to break a sample when twisting it.

How does varying the temperature affect the fatigue resistance of the plastic sample?

Activity 3
Develop a test that applies a constant stress (load) that deflects (bends) a sample.

- Describe what various loads do to a sample under stress (e.g., color change or whitening, a break, permanent change in shape).
- Describe how these results could affect the looks or performance of a product, such as a chair, box lid, food container, or a car bumper.

Using samples chilled in the freezer, refrigerator, or in ice water, develop a test that applies a constant stress (load) that deflects (bends) a sample.

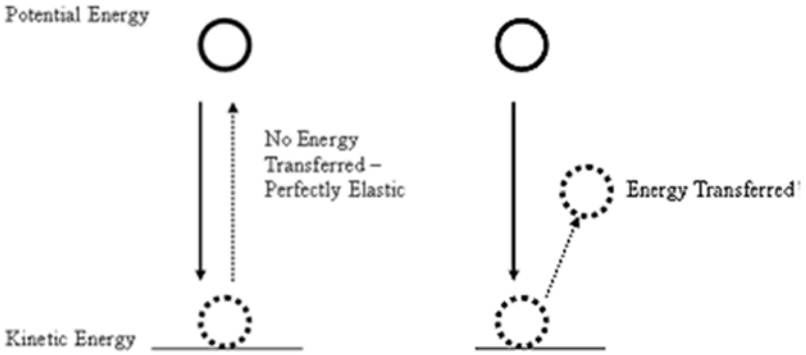
Using samples that have been heated in warm or boiling water, develop a test that applies a constant stress (load) that deflects (bends) a sample.

How does varying the temperature affect the fatigue resistance of the plastic sample?

Different plastic behaves differently at various temperatures.

Rebound Activity

You work for the AJAX Ball Company and you have been asked to test their product line of balls. There have been complaints about the rebound height of some of the products and you need to determine which balls are defective. Keep in mind that different materials and different construction will affect the rebound height of the ball, therefore a low rebound height may be appropriate in certain situations. You will also need to calculate the Percent Energy Transferred.



What types of energy transfers occur in the second example?

You will test the rebound height of each sample and then determine if the rebound height is appropriate for the use.

Procedure:

1. Tape the meter tape such that the “zero” mark is flush to the floor and the tape extends up the wall past the 100 cm mark.
2. Place the ball to be tested so the bottom of the ball is even with the 100 cm mark.
3. Release the ball and note the height the bottom of the ball rebounds to + 0.1 cm.
4. Repeat the test 4 more times (total of 5).
5. Average the results.
6. Determine the Percent Energy Transferred for the sample tested:

(Height Dropped – Average Rebound Height) X 100 = Percent Energy Transferred Height Dropped

Rebound Height Data Sheet
Describe the sample you are going to test.

Data

1. _____ Calculate the Percent Energy Transferred
2. _____
3. _____
4. _____
5. _____

Average Rebound Height _____

Analysis of Data:

Your Recommendation: