

Knee Drop n' Spin

Leader Guide



Fashion
through science

- Handout
- Video
- Engineering Design Process Poster (Optional)



We are Engineers!



Movement Improvement



Marvelous Materials



Smart Clothing



Patternmaking Tools n' Tech

Big Picture

Protection from impact is an important function of apparel for many sports and professions. Protective materials absorb the energy of impact and distribute it over a wider area to lessen the force to the body at the point of impact.

What's the goal?

Young designers will test materials to explore properties that influence the effectiveness of impact protective padding.

Grouping

Young designers will work in pairs or groups of four.

Materials

What they need: (per group)

- One set of 9" x 12" pieces of padding materials:
 - Open cell upholstery foam sheet, ½ inch thick (usually green in color)
 - Closed cell foam sheet, ½ inch thick
 - High loft quilt batting, approx. ½ inch
 - viscoelastic polymer from the "Whacky Armor" activity, or ½" memory foam sheeting
- Hard floor surface and space to do knee drops
- Masking or blue painter's tape
- Handout (per person)

Prep Time: 45 Minutes

Activity Time: 60 Minutes

Difficulty: Level 2



Tips

- One source of foams is www.foambyemail.com
- Fabric stores carry quilt batting. If you can't find thick batting, make layers of thinner batting.
- It may be easiest to cut foam sheets with a utility knife or a good rotary cutter.

Let's Get Started!

Introduce the activity and show the one-minute video demonstration of how to do a knee drop and slide. Good protective materials will absorb the energy of **impact** during the dance move, and distribute it over a wider area of the knee to lessen the force to the body at the point of impact.

VOCABULARY

Impact: a shock of short duration at the instant when two objects collide.

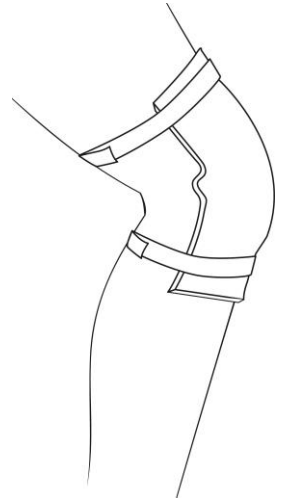
Testing Materials

1. Form groups and hand out materials.
2. Have the young designers examine each material and form a hypothesis about which one will provide the best impact protection. Write the hypothesis on the handout individually.

VOCABULARY

Hypothesis: a guess about how things will work, based on what is known or thought to be known.

3. Ask for a show of hands to count the number of young designers who voted for each material to provide the best impact protection.
4. Each team member should tape a material around the knee that they will use to do a knee drop. They may need to help each other tape. See drawing at right.
5. Have the testers do a *safe* knee drop and spin on a hard surface. Watch the video again and point out that the dancer drops gently on her knee before sliding and spinning. Each team member should wear test each of the four materials.
6. Ask them to observe and record on their handout:
 - Can you feel the floor through the material?
 - Does the material flatten when they put weight on it?
 - Does the material go back to its original shape when they take their knee (pressure) off?
7. Repeat the test for the other materials so that each young designer **wear tests** all four materials.



VOCABULARY

Wear Test: a type of research in which testers users wear a garment or piece of equipment for its intended purpose and evaluate it, in contrast to testing products using laboratory equipment.

Testing Wrap It Up

1. After all tests are complete, ask for another show of hands this time to see which material the young designers found worked best to protect their knee and provide the most **cushioning**. Use the poster, a blackboard, or a large pad of paper to tally results.

- **Discussion Point:** Was the most cushiony material the one they hypothesized would be most protective?

VOCABULARY

Cushioning: helps reduce the force of an impact by extending the time it takes to reach the protected body. Cushioning in protective gear is designed to deform to reduce shock for the wearer.

2. The physical characteristics of a material determine how much energy it can absorb as it flattens, therefore how well it protects. Flattening is called **compression**.

- **Discussion Point:** Which materials compressed most during testing?

VOCABULARY

Compression: an object stressed by impact will compress to absorb energy. A material with an open structure will compress more easily.

- **Discussion Point:** What did the group notice about the open cell foam? It compresses completely because the open cells allow air to be pushed out quickly, like squeezing a sponge (see Figure 1 below). The same is true of batting, which consists of layers of fibers with open air spaces between them. Air is trapped within the structure of closed cell foam and cannot escape. A thin material may compress too quickly to slow impact, therefore offer little protection.

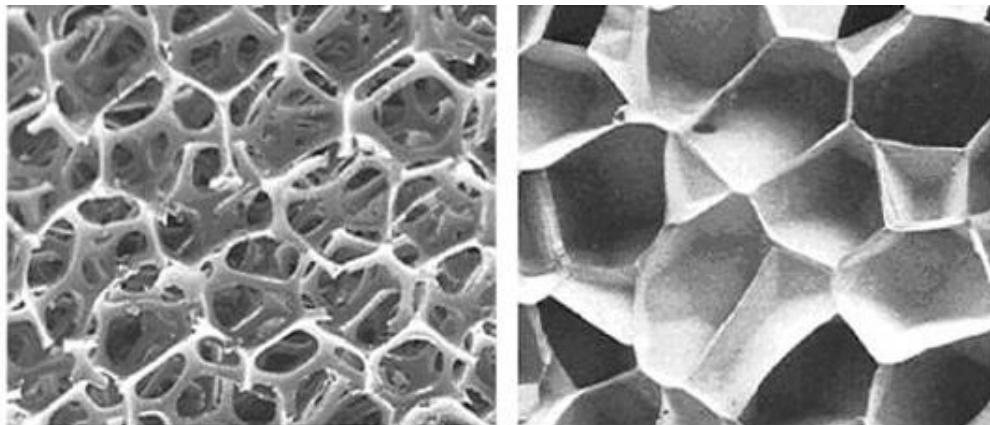


Figure 1: Image on the left is a close-up view of open cell foam. See all the breaks between the cells? The image on the right is a close-up view of closed cell foam. Notice that there are no breaks between the cells.

Image source: <http://greencomplianceplus.markenglisharchitects.com/technical/insulation/qii-hers-credit-now-allows-open-cell-spray-foam/>

3. Materials that return to their original shape after impact are called **resilient**.

- **Discussion Point:** Which tested materials were resilient?
- If you used the Whacky Armor material, remember that it is a **viscoelastic polymer** exhibiting **shear thickening** behavior.
- If you used Memory foam, this is a polyurethane material with added chemicals to increase its viscosity and density. It is often referred to as viscoelastic polyurethane **foam**, or low-resilience polyurethane **foam** (LRPu). So it is also a viscoelastic polymer, but does not exhibit shear thickening behavior.

VOCABULARY

Resilience: the ability of a material to return to its original shape following impact and compression. Resilient materials can be hit repeatedly and will continue to absorb impact. Material such as rigid Styrofoam compress and remain compressed, so must be replaced following impact.

Viscoelastic polymer: a fluid, whose viscosity is affected by shear stress such as squeezing, stirring, or hitting.

Shear thickening: the behavior of a fluid that thickens and hardens when shear stress (such as an impact) is applied, but returns to its more liquid state with time or when the stress is removed.

Foam: a dispersion of gas bubbles in a solid, as foam glass, foam rubber, polyfoam, or foamed metal.

Apply the Materials

1. If time allows, have the teams work together to combine the materials to make an 'ideal' kneepad to protect their knee during the knee drop. Give the teams a few minutes to come up with their design and test their solutions. Share the solutions in a large group.

- **Discussion Point:** What combination of materials did the team's choose for their 'ideal' kneepad? Why? What would they change about the kneepad ?

2. Reference the Engineering Design Process Poster and follow the team's process throughout the process.

- **Discussion Point:** What parts of the Engineering Design Process did you just experience? Where would you go next in the process?

Take it Further

1. Test different thicknesses of the same material. Does thickness matter?
2. Some types of impact protective gear have a hard shell over a resilient material. Think of hockey shin pads. See what happens when you add rigid material to a layer of resilient material by cutting liter beverage bottles in half and taping them over knee padding.
 - **Discussion Point:** Addition of a rigid layer introduces the problem of accommodating body movement. Ask young designers how they could keep a rigid outer shell and still allow body movement. Supply scissors, duct tape, and additional beverage bottles for them to test ideas to allow hard shells to allow body movement.

For More Information

- Watch “The Activewear Advantage – Impact Protection”, <https://www.youtube.com/watch?v=tDd3f6G04xl>, produced at Cornell University.
- Search the internet for sports padding for your favorite sport to see what materials are used.
- Ask someone older who used to play a sport requiring padding about materials used in the past, even just a few years ago (e.g. leather helmets).