SIEMENS STEM DAY | Science Technology Engineering Math

SIEMENS STEM DAY ACTIVITY

GAME, SET, MATCH!

OBJECTIVES

Students will be able to:

- **Identify** how joints work and how energy is transferred to make different parts of the body move.
- **Design** and construct a working robotic joint using simple materials.

STEM LESSON FOCUS

Engineering Design Cycle

- Creating or Protoyping
- Communicating Results

21st Century Skills

- Collaboration
- Communication
- Critical Thinking
- Creativity

STEM CATEGORY

Science

TOPIC

Robotics

OVERVIEW

Students will investigate how robots work, including robotic parts, and explain how energy is transferred to make different parts move. Students will investigate how human joints such as the elbow and knee function. Students will create a concept map of the working parts such as the knee and elbow joint. Students brainstorm and sketch possible working joints for robots using household items such as string, straws, toilet paper rolls, cardboard, as well as other items.

Students then create the robotic joint and explain the design in terms of energy transformation by modeling movement.

MATERIALS

- a laptop or tablet for each student
- string
- straws
- toilet paper rolls
- cardboard
- rubber bands
- tape
- binder clips
- wire
- craft sticks
- clothespins
- paper clips
- tennis balls
- scissors
- other household items

HAVE YOU EVER WONDERED...

- How our joints work—what makes it possible for us to serve a tennis ball or kick a soccer ball?
- If our joints work in the same way that robotic ones do?

MAKE CONNECTIONS!

How does this connect to students?

Millions of students play or compete in some type of sport in the U.S. and around the globe. Did you ever stop and thank your skeletal system and muscular system for your athletic abilities? The joints in our body make it possible for us to move and do work such as kicking a winning field goal or serving an ace on the court to win the match.

How does this connect to careers?

Mechanical Engineers analyze problems to see how mechanical devices might help solve a particular problem. They design or redesign mechanical devices or systems, develop and test prototypes of devices they design, and analyze the test results and change the design or system as needed.

Physical therapists diagnose and treat individuals of all ages who have medical problems or other health-related conditions that limit their abilities to move and perform functional activities in their daily lives.

Robotics engineers design robots, maintain them, develop new applications for them, and conduct research to expand the potential of robotics.

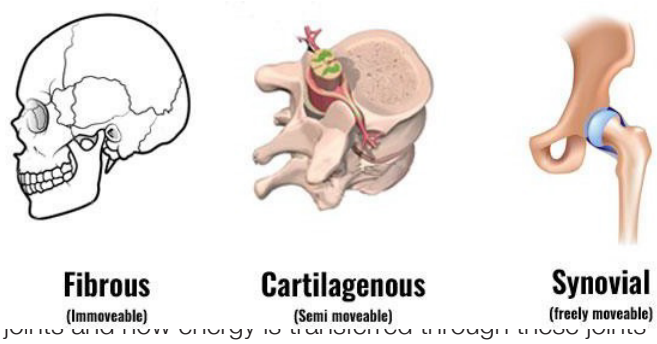
How does this connect to our world?

Kinesthetics is the study of how our bodies move and is important to understand when designing robots that can do what our bodies do, such as lifting and moving objects. As robots are designed to do more and more tasks for us, including manufacturing, transportation, and even replacing parts of our own bodies, the study of how energy is transferred through movement in joints becomes increasingly important.

BLUEPRINT FOR DISCOVERY

WHOLE GROUP—10 minutes

1. Begin the lesson by showing the students the following video clip that shows some of the greatest moments in sports history: https://www.youtube.com/watch?v=sHkJmd0Q6Ks
2. Ask students to think about what made all of these amazing plays in sports possible...what does a body need to dunk a basketball, kick a soccer ball, or serve an ace on the tennis court?
3. Explain to students that without our joints, these amazing feats in sports simply would not be possible. Ask students to identify where joints are on the human body. Record their answers on the board or overhead screen. (Examples will likely be knee, hip, elbow, wrist, etc.)
4. Tell students that joints are where bones of our skeletal system come together. While they may think that all joints move, that is not the case. Display the following images on the overhead screen and explain that there are 3 major categories of joints: fibrous, which do not move; cartilaginous, which are only semi-movable; and synovial, which move freely.



5. Explain that today's activity will focus on synovial joints and how energy is transferred through these joints to create movement. The movement of balls, clubs, rackets, and people in sports is an example of mechanical energy—the energy in an object that is used to do work. Mechanical energy is the combination of potential and kinetic energy.
6. Ask students to do some research on their device and differentiate between potential and kinetic energy. Record student responses on the front board or overhead screen.

PARTNER ACTIVITY—15 MIN

7. Next have students get with a partner. Explain that with their partner they will be focusing on a particular joint in the body and conducting research to see how that joint works and how energy is transferred from potential energy to kinetic energy through the joint to do work.
8. Assign half of the pairs with the elbow joint, and the other half with the knee joint as their topic of research. Student pairs should have one person take on the role of "Researcher" and the other that of "Mapper." The researcher will be in charge of finding information about their joint on the internet, and the mapper will create a simple concept map of how the joint works and how energy is transferred as the joint moves.

   *The "mapper" can use online mind mapping sites such as Coggle, Inspiration, and Mindomo. Some of the sites that are not free do have a free trial period that can be used.

GROUP ACTIVITY—35 MIN

9. When students have finished their concept map, ask them to join a pair that has the joint they do not have (an elbow pair joins with a knee pair) and compare how elbow and knee joints work by looking at their concept maps and discussing what they've learned from their research.
10. Next, explain to students that they will now attempt to use what they have learned about joints and construct a simple working robotic knee or elbow using the materials provided. Their goal is to create a robotic joint that is able to raise a tennis ball if it is an elbow or kick a plastic inflatable ball if it is a knee joint. Give student groups time to design and create their robotic joint.
11. Groups should present and test their robotic joints to the class for the last 10–15 minutes of the class period, explaining how their design uses principles from elbow or knee joints and how the energy is transferred through the joint from potential to kinetic to create movement.

TAKE ACTION!

As an extension to this lesson, students can take a look at how robotic joints can be used in prosthetics for people who have lost limbs and how the technology is advancing to amazing prosthetics that can be controlled by a person's mind or that can actually feel objects it is being used to pick up!
https://www.nytimes.com/2015/05/21/technology/a-bionic-approach-to-prosthetics-controlled-by-thought.html
https://www.livescience.com/43125-man-gets-first-bionic-hand-that-feels.html

NATIONAL STANDARDS

Technology Education	Next Generation Science Standards and International Technology and Engineering Educators Association ITEEA Standards for Technological Literacy Standard 16: Energy and Power Technologies In order to select, use, and understand energy and power technologies, students in Grades 9-12 should learn that J. Energy cannot be created nor destroyed; however, it can be converted from one form to another.
Science	**Next Generation Science Standards** HS-PS3-3: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.