How does a Generator Work?

*a SAM Animation lesson*

Recommended grade level:
6–12
Suggested time:
2 class periods

This lesson is paired with
WindWise Lesson 7: How does a Generator Work?

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**SAM Animation Lesson:**

**What Causes Wind?**

**Learning objective**
Generate a model of how a generator converts motion into electricity. To be included in the animation are explanations of the general layout of generators, flux fields, and moving electrons.

**Challenge/Prompt**
1. Create an animation illustrating how magnets induce magnetic fields in metallic objects.
2. Apply those same ideas to an animation explaining how generators work to create a current. Ask students to think about the following:
   - What exactly is electricity?
   - Why do metals become temporary magnets?
   - How can a magnet be used to help create electricity?

**Materials**
- Free DEMO version of SAM Animation (www.samanimation.com)
- Storyboard
- Provided props, i.e., arrows
- Craft-based props such as arrows, red “dots” for air electrons, etc
- Whiteboard and markers

**Procedure**
1. Show example animations (if students have neither done nor seen an animation before)
2. Split students into groups of two or three per computer and webcam set
3. Before building an animation, ask students to create a storyboard and brainstorm content and structure of the animation. Planning is an important component to creating stop-motion videos.
4. Plan, collect and make props (see Materials above)
5. Create animations (see the FAQ on www.samanimation.com for support)
6. After 30 minutes check progress of the animations
7. Encourage audio recording where it makes sense (e.g., narrate text such as introductions)
8. Encourage the class to have a “Film Festival” by exporting SAM projects to QuickTime, play the movies on “loop”, and encourage students to share their work and be excited about what they have just completed.

**Hints**
- Provide props such as red arrows to motion of electrons. The more props students have available to them, the more time they can spend creating the animation as opposed to making the props.
- Provide backgrounds. These make for more colorful and vibrant final videos.
- Encourage splitting the animation into two parts: 1. How do magnets affect electrons? Why? 2. How can this be used to generate electricity?
- Encourage playback while students build up their animations so they can monitor their progress and see how their animated model looks in real-time.
- Encourage small movements of props by using the onionskin feature. This results in more realistic animations.
In the classroom

1. Model the relationship between charges, magnets, and electricity.

Electricity and magnetism is a difficult subject for many students, primarily because you cannot see the object you are supposed to be learning about. When teaching electricity and magnetism, the use of hands-on technologies, such as SAM Animation, can help students “see” the material better. While the demonstration in the WindWise unit stimulates curiosity for students, the explanation and underlying mechanisms are not immediately obvious; a model in stop-motion form can be useful in supporting students’ efforts to make sense of what they observe. Different charges can have a significant effect on forces, as the students may have already seen through static electricity. The animated medium allows students to model how the electrons actually move. Here are some examples of how to complete these animations, which the students can be seeded with as they design and create their own model explaining the process.

What effects do magnets have on metallic objects?

This shows how temporary poles can be induced in a metallic object.

2. Applying the model

Applying the model generated as a means for explaining the magnetic demonstration to everyday phenomena using animation is a powerful learning opportunity. After completing the animation showing the effects of magnets on metallic objects, students can extend this model to explain the use of magnets in inducing a current, which can be used for power generation. Using arrow props, students can create an animation demonstrating the direction current flow within a circuit based on the movement of a magnet. Animation provides a simple and clarifying approach to help students understand models and how models may explain phenomena from the everyday world. In addition, the animated models become objects of discussion and debate, furthering the students’ understandings of the concepts as well as the use of models (such as animations) as strong or weak representations of science.

How can a spinning magnet create a current in a coil of wire?
Note in part 2, your students may come across some challenges in developing an animation that shows how a generator works. For example, generator activity is a largely 3-D process, which can be especially difficult to show in an animation form. Here are a couple of hints to give your students:

- “Flatten” 3D objects into 2D shapes (as shown above with a coil) to simplify the animation process.
- Encourage the use of custom-made props (e.g. bits of cut pipe cleaners as electrons) in place of markers.

In addition, generators are difficult to understand, which will make it challenging for students to create an animation illustrating how one works. Here are

- Encourage group discussion and debate as well as research to solidify the concepts.
- Suggest an incremental approach to understanding. First learn how magnets work, then think about what happens when a magnet is passed through a coil. By breaking this concept into parts, the students will be able to better understand the basic concepts behind a generator, and this breaking down process naturally occurs as they create the animation.

Extensions
1. How does a coil of wire react to a magnet passing through the center? Create an animation to show the flow of electrons.
2. Further application of the model: How does a magnet help to create energy in a wind turbine? How is the energy transformed from mechanical (wind) to electrical (electricity)?