CRISP Kit Teacher Module

Title of Module:

Exploring Materials: Graphene

Subject(s) or Unit of Study:

Conductivity, Energy, Properties of Materials

Grade Level(s):

5+

Est. Length of Activity:

N/A

Student Objectives:

Students will understand that:

- Graphene is a single layer of carbon atoms arranged in a honeycomb (hexagonal) pattern.
- Graphene can be a semi-conductor

Vocabulary:

Atom, conductivity, graphite, semiconductor, nanoplatelets

Materials:

- Flakes of graphite
- Plastic tweezers with a pointed tip
- Scotch tape
- White activity cards (or index cards)
- Soft drawing pencils (6B is best)
- Pencil sharpener
- Battery and buzzer circuit (9V battery, snap connector, alligator clip, and buzzer)
- "Graphene" image sheet
- Bag printed with graphene ink

Learner Background:

Graphene is a one-atom-thick layer of carbon atoms arranged in a hexagonal lattice (honeycomb pattern). One atom thick is only a fraction of a nanometer - which is a **billionth of a meter** - that's the thinnest material known to man. Graphene is also incredibly strong - about 200 times stronger than steel, and an excellent conductor of heat and electricity. Graphite, which is commonly found in pencil lead, is made up of graphene. Graphene has a very high thermal conductivity, it carries heat better than any other material – even better than silver or copper which are excellent heat conductors. In 2004, Andre Geim and Konstantin Novoselov were the first to isolate graphene, earning them the Nobel Prize in 2010.

Every day, scientists and engineers are making new, nano-sized materials and devices. Graphene has a lot of potential in nanotechnology because of its useful properties: it's flexible, super-strong, nearly transparent, and conducts electricity. The graphene ink on the fabric can be used to make flexible, wearable circuits. Computer chip manufacturers are developing circuits from graphene, by modifying it to make it a semiconductor. One day, graphene could be used to make see-through, bendable electronic displays, and tiny, fast computer chips.

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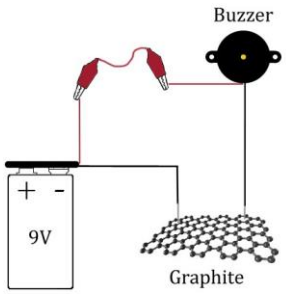
Learning Activity or Procedure:

Activity 1:

1. Take a piece of tape about 3 inches long. Fold over the two ends so you have small, non-sticky tabs to hold.
2. Use the tweezers to put a flake of graphite on the sticky side of the tape.
3. Fold the tape in half over the graphite and peel it apart again. Do this several more times.
4. Stick your tape onto a white card.

Activity 2:

1. Set up the battery and wires to the buzzer
2. Use the pencil to color in the box on your card. Be sure to fill it in completely. You're creating a thin layer of graphite.
3. Touch the two wires to the layer of graphite
4. Try this with the canvas bag



Assessment:

See last page

Additional Resources:

http://www.explainthatstuff.com/graphene.html

Teacher Notes:

When assembling the buzzer and battery circuit use the alligator clip to connect the black wire of the battery to the black wire of the buzzer. Then use the red wires to touch the layer of graphite on the paper. The buzzer will not work if it is connected in the wrong direction to the battery. If the buzzer sound is faint, try putting the wires closer together on the graphite or put down a thicker layer of graphite.

If you have a molecular model set, you can build a model of graphene to supplement the illustrations in this activity.

Safety:

Students work with wires and batteries with caution.

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STEM Careers:

Materials Scientist
Researcher
Engineer
Environmental Engineer
Solar Energy Systems Engineers
Nano-technologist
Aerospace Engineers
Computer Hardware Engineers
Materials Engineers
Mechatronics Engineers
Nanosystems Engineers
Nanotechnology Engineering Technologists
Nanotechnology Engineering Technicians

Standards:

Next Generation Science Standards:

NGSS Performance Tasks	**MS-PS1-1.** • Develop models to describe the atomic composition of simple molecules and extended structures.
NGSS - (DCI) Disciplinary Core Ideas	**PS3.A: Definitions of Energy** • Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
NGSS - (CC) Cross-Cutting Concepts	**CC-3 Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. **CC-5 Energy and Matter** • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.
NGSS - (SEP) Science and Engineering Practices	**SEP 2 – Developing and Using Models** • Develop a model to describe unobservable mechanisms.

Common Core Standards:

CC ELA/Literacy Standards	**RST.6-8.7** • Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS1-1)
CC Math	**MP.2** • Reason abstractly and quantitatively. (MS-PS1-1) **MP.4** • Model with mathematics. (MS-PS1-1)

Student Worksheet: Graphene

1. What does graphene look like? Draw in the space below.

2. What are some properties of graphene?

3. What are some applications of graphene?

4. What are nanoplatelets?

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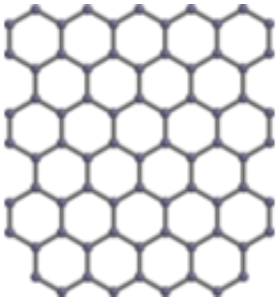
1. What does graphene look like? Draw in the space below.



2. What are some properties of graphene?

Electrical conductivity, thermal conductivity, extremely strong but light and nearly transparent

3. What are some applications of graphene?

Computer chips, electronic displays, semiconductors, pencils, metal alloys, solar cells

4. What are nanoplatelets?

Nanoplatelets are tiny stacks of graphene. Nanoplatelets are electrically conductive. The ink used to print on the canvas bag contains nanoplatelets, which is why the buzzer went off when the two wires were touched to the ink of the bag.

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