Talking Points for CNT balloon

Main Points:

1. A CNT is really really small. The balloon is an enlarged model.
2. CNTs have unique physical properties such as enhanced electrical and heat conduction, and tensile strength.

- Carbon Nanotubes (CNTs) are carbon structures with special properties that make them useful in a wide range of scientific and everyday applications.
- A CNT is one of four distinct forms of carbon. Like its counterparts (diamonds, graphites, and fullerenes) the unique properties of CNTs are determined by the unique arrangement of atoms within it.
    - This balloon structure represents a CNT, but an actual CNT is so small that it can only be seen with special tools. The balloon is an incredibly enlarged model.
- As shown by the balloon, a CNT is made up bonded carbon hexagons rolled up into a cylinder.
- CNTs exist in three different forms: armchair, zig- zag, and chiral. The form is determined by the orientation of the carbon hexagons.
    - Show graphic examples of different orientations.
    - Though each type's sturcutre is only slightly different from the others these small differences cause the arm- chair, zig- zag, and chiral types to have their own unique properties.

- CNTs are different from other materials found in nature. Its incredibly small size and unique structure allow it to do things other materials cannot do. These special properties include increased electrical conductivity, thermal conductivity, and tensile strength.
    - First, CNTs are highly effective conductors of electricity. Other equally small nanomaterials, such as copper nanowires, do not conduct electricity as well, which means this characteristic results not only from the CNT's small size but also its physical structure.
        - CNTs are better conductors of electricity than copper nanowires because there is less scatter of electrons. In a copper nanowire, tens of thousands of electrons travel through the center of the wire together. Imagine if many people rushed to get through a narrow door together. In a similar way, electrons rush together and bump into stationary atoms. As a result, the electrons move forwards, sideways and even backwards- this is called scattering. This scattering generates a lot of heat and wastes energy. On the other hand, in a CNT there is not as much scattering, so the nanotubes do not lose as much heat and do not waste as much energy.
        - This is important because…What does this allow a CNT to do?
    - Second, CNT's conduct heat very well. A nanotube's thermal conductivity is predicted to be ten times higher than silver. Unlike metals that conduct

heat by moving electrons, CNT's conduct heat by wiggling the bonds between the carbon atoms themselves.
        - This is important because…What does this allow a CNT to do?
    - Finally, CNTs are incredibly strong. Based on small- scale experiments and theoretical calculations, a one inch thick rope made of CNTs is predicted to be 100 times stronger than steel and 1/6 the weight of steel.
        - Seems like a good spot for a wow moment…something like imagine a building built with ropes instead of steel or imagine an elephant on a platform supported by CNT ropes. We could show a picture.

- The special properties of these tiny structures make CNTs useful for several current and future applications in the electronics, security, medical, and environmental fields:
    - *Flat panel display screens*: Several companies are exploiting this unusual electronic behavior to make thinner, lighter display screens.
        - An electrified nanotube will shoot electrons from its end like a small cannon. If those electrons are allowed to bombard a phosphor screen, an image can be created.
    - *Nanocomposite materials*:
        - Mixing nylon with carbon fibers (100- 200 nm in diameter) creates a nonocomposite material that can be injected into the world's smallest gear mold. The carbon fibers have excellent thermal conductivity properties that cause the nonocomposite material to cool more slowly and evenly, allowing for better molding characteristics of the nonocomposite. The tiny gears are currently being made for use in watches.
    - *Chemical sensors*: In the future, nanotube sensors could be used for security and environmental applications as a smaller, faster, and more sensitive alternative to conventional sensors.
        - Semiconducting CNTs display a large change in their ability to conduct charges in the presence of certain gases. Researchers have been able to use nanotubes as sensors by exposing them to gas and measuring the change in charges.
    - *Nanoscale electronics*: Sceintists have been able to use semiconducting nanotubes as compact, more efficient alternatives to conventional transistors.
        - The mechanical and electrical properties of CNTs can produce molecular electronic devices. One of the most significant applications is nanotube transistors. Transistors are devices that can act like an on/off switch or an amplifier for currents and are used in nearly every piece of electronic equipment used today.