Thought Lab 14.1: Nanotubes, Buckyballs, and Allotropes Answer Key

Answers to Procedure Questions

1. Since the geometric form of the C_{60} allotrope reminded scientists of the geodesic domes and structures popularized by the architect Buckminster Fuller, the term "fullerene" was coined for the generic name of this allotrope.

2. The properties of graphite and diamond are almost the opposite of each other. You could produce a chart similar to the following:

	Graphite	Diamond
Electrical conductivity	Excellent – a conductor	Poor – an insulator
Structural characteristics	Sheets of interconnected hexagonal rings. Adjacent sheets are loosely bonded together by van der Waals forces.	Tetrahedral arrangements of carbon atoms forming a partially filled face-centred cubic arrangement.
Hardness	Soft	Extreme
Colour	Opaque grayish-black with a metallic sheen.	Transparent and colourless, but structural flaws and impurities will result in coloured appearance.

3. Depending on their precise structure, fullerenes can be either metallic conductors or semiconductors. Fullerenes in the form of nanotubes can carry the highest electric current density of any known material.

4. Carbon nanotubes are tubes of planar interconnected hexagonal rings about a nanometer in diameter. Nanotubes have metallic conductivity, extreme thermal conductivity, and are the stiffest and strongest known fibres. Technological uses for nanotubes include as strengtheners for carbon-epoxy composites, as molecular wires, as capsules for delivery of drugs on a molecular scale, and as possible additives for higher temperature superconducting materials.

Answers to Analysis Questions

1. Diamond is composed of carbon atoms bonded to each other in a rigid 3-dimensional lattice structure. In graphite, carbon atoms are tightly bonded together in sheets, with adjacent sheets being only loosely attracted to each other by van der Waals forces. The ability of adjacent sheets to slide relative to each other makes graphite "soft."

2. Nanotubes are extremely stiff but also amazingly elastic and able to stretch beyond 20% of their length. Replacing the carbon fibres presently used in carbon composite materials with nanotubes is expected to produce materials with many times the structural strength.

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3. From a structural point of view, nanotubes are one special case of a fullerene. Although nanotubes exhibit many different properties, those properties are within the range observed for fullerenes in general.