Bragg's Law Activity Sheet Name______________________

"ON A COLD WINTER DAY IN DECEMBER, 1955, Robert Wentorf Jr. walked down to the local food co-op in Niskayuna, New York, and bought a jar of his favorite crunchy peanut butter. This was no ordinary shopping trip, for Wentorf was about to perform an experiment of unsurpassed flamboyance and good humor. Back at his nearby General Electric lab he scooped out a spoonful, subjected it to crushing pressures and searing heat, and accomplished the ultimate culinary tour de force: he transformed peanut butter into tiny crystals of diamond."

- from *The Diamond Makers* by Robert M. Hazen (1999), Cambridge University Press

So, how can we determine whether an experiment designed to produce diamonds has actually delivered the intended result? One diagnostic test we can perform is X-ray diffraction, a technique that depends upon Bragg's Law.

This activity is designed to help you understand Bragg's Law and how it applies to X-ray diffraction techniques used in the performance of high pressure research at beamlines, such as X17B2 at the National Synchrotron Light Source at Brookhaven National Laboratory.

1) First, we will locate Brookhaven National Laboratory and the National Synchrotron Light Source on Google Earth. Link to the:
National Synchrotron Light Source location file for Google Earth.
In what state is it located?

2) Next, link to the:
National Synchrotron Light Source Floor Plan for Google Earth.
Find the X-ray ring and the beamlines in the floor plan.
a) Do the electrons move through the ring in a clockwise or counterclockwise direction at the National Synchrotron light source?

b) How can you tell?

c) What is the diameter of the X-ray ring?

d) What is the circumference of the X-ray ring?

3) Link to the Bragg's Law Applet. What is the Bragg's Law formula?
What do the following terms represent in the formula?
n

λ

d

θ

4) What is the significance of the variable *n* in the formula?

5) With increasing values of d, do we need higher or lower values of θ to achieve constructive interference?

6) Starting with $\lambda = 1.4$, distance = 1.87 Å, and $\theta = 5.0$, click the details button. Do we have a Bragg condition (constructive interference)?

7) Increase θ until we achieve a Bragg condition. At what value of θ does this occur?

8) Continue to increase the value of θ. Can we achieve a Bragg condition again by doing this? If so, at what value of θ does this occur?

9) The carbon atoms in graphite are arranged into planes that are separated by a d-spacing of 3.35Å. Assuming that the sample we are examining still contains graphite, that n is 1, and that λ is 1.54Å, at what value for θ do we have constructive interference?

10) Diamond has d-spacings of 1.075Å, 1.261Å, and 2.06Å. Assuming that the sample we are examining is diamond, that n is 1 and that λ is 1.54Å, then at what values for θ do we have constructive interference for each of the d-spacings?

Additional Resources
(Ctrl-click links on electronic version of this sheet)

SERC: Bragg's Law
Hyperphysics: Bragg's Law
Wikipedia: Diamond anvil cell
Bragg's Law Applet
High Pressure Laboratory Applet
Wikipedia: Electromagnetic spectrum
Wikipedia: Bragg's Law
Wikipedia: Diffraction
Wikipedia: Bragg diffraction
Wikipedia: Diffraction grating
Wikipedia: X-ray crystallography
NSLS Beamline X17B1
NSLS Beamline X17B2
NSLS Beamline X17B3
NSLS Beamline X17C