Test for **X-Ray Crystallography** Activity
Name_____ Teacher _____
Date_____Class_____

Check one:
___ Pretest
___ Posttest

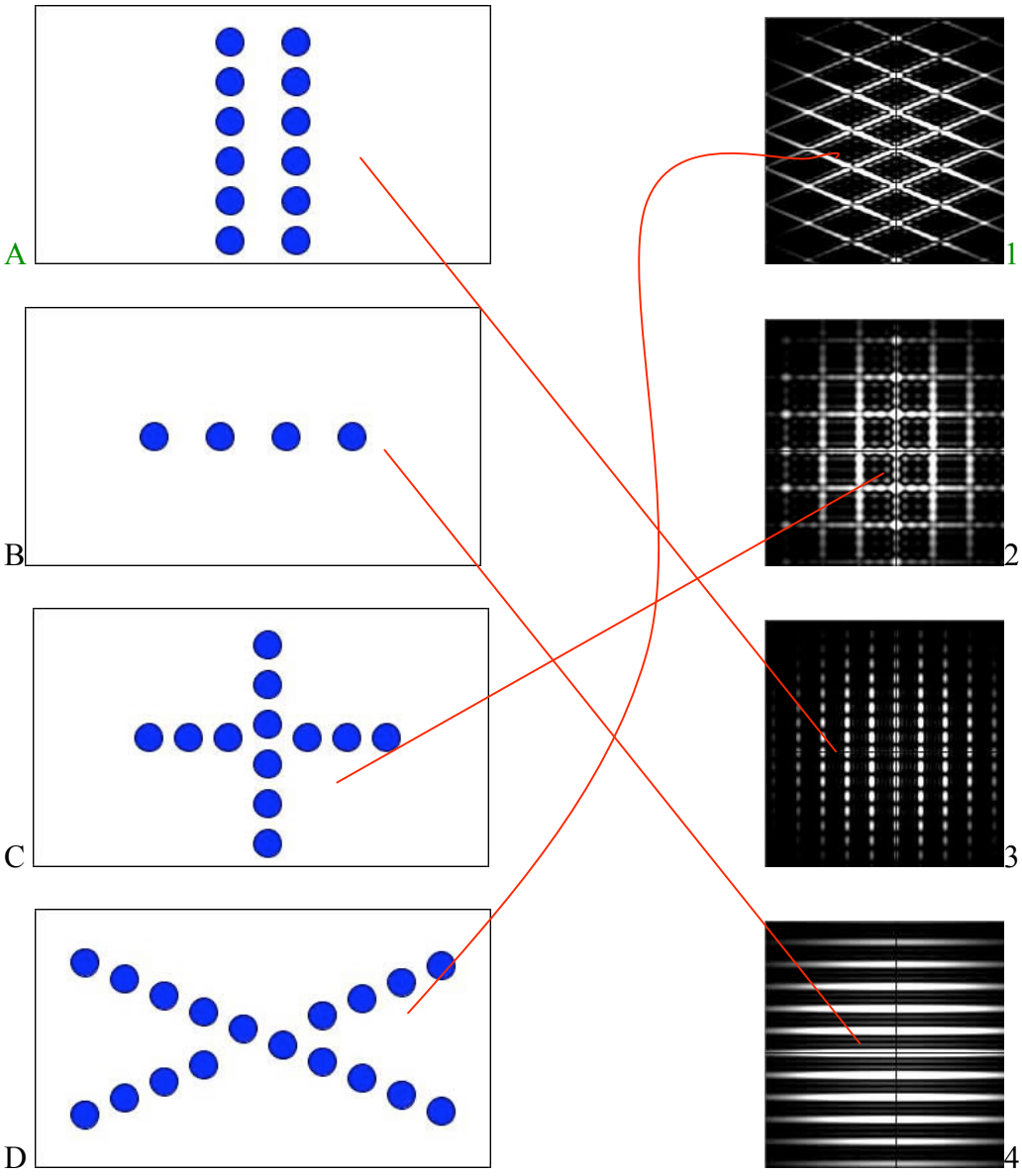
1. List 3 things that X-Ray Crystallography can reveal about crystal structure.

Answer: Position or arrangement of atoms; Bond lengths; Distance between atoms; Defects in crystals; Size of atoms

Explanation Score

	Response includes…
Complete (3)	List **three** correct things X-Ray crystallography reveals from the list above.
Mostly complete (2)	Only lists **two** accurate things X-Ray crystallography reveals.
Partial (1)	Lists only **one** accurate thing X-Ray crystallography reveals
Incorrect (0)	Other

2. Draw a line matching each arrangement of atoms on the left to its X-ray diffraction pattern on the right.



Response includes…	
One point for each correct correlation. [A-3, B-4, C-2, D-4]	1
0 where it is incorrect.	0

3. Select one of the X-ray diffraction patterns from the previous question, and describe which features of the image you used to match it to the correct arrangement of atoms.

First X-ray pattern: This one has an x-shaped pattern in it with particular angles (acute at the sides, obtuse on top and bottom), which reflects exactly how the atoms are arranged.

Second X-ray pattern: The x-ray image shows a grid of lines at right angles. The atoms are arranged in two lines at right angles to each other.

Third X-Ray: reflects atoms lined up in parallel vertical lines and the x-ray has only vertical lines.

Response includes…	
Correlates geometry of the x-ray to the correct alignment of the crystal. (see descriptions above.)	2
Response refers to crystal and X-Ray having the "same structure" but response doesn't elaborate on the structure.	1
Other	0

4. How do impurities and defects in a crystal show up in an X-ray diffraction pattern?

Response includes…	
Defects in a crystal, such as one atom missing from a hexagonal grid of atoms, appear as a blurring, fuzziness or squiggliness throughout the image (not in a particular spot). It's easiest to see when the crystallogram viewer is in log-scaled mode. (Response describes the fuzziness/decrease in resolution or accuracy AND points out the defect does not affect one particular spot.)	
Describes decrease in resolution but does not describe how.	2
Vague response indicating that there would be a "different diffraction pattern" but gives no indication about how or why.	1
Other	0

5. Rosalind has isolated a protein, and she is trying to find out its structure. She has made a purified crystal of the protein, and made X-ray diffraction images of it.

She has a problem: the images do not show any hydrogen atoms on the surface of the protein, but she knows they must be there.

What can she change in her procedure to make the hydrogen atoms show up?
Why will this help?

She should cool the sample. Lower temperatures result in less movement of atoms within a molecule relative to each other (bond vibrations). The hydrogen atoms are attached on the surface, and they're small and light, so at a higher temperature they move around a lot, and at a lower temperature they won't move around as much. They show up better in the crystallogram when they aren't moving around because making a crystallogram is like taking a photograph. If the movement of an object is fast compared to the length of the exposure, the object will appear blurry (like taking a picture of a car driving by, which shows up as a streak).

So, at a high temperature, the hydrogen atoms move around a lot, and the exposure is so blurry you can't see them at all. If she does it at a lower temperatures, the hydrogen atoms will hold still, so she'll get a sharper picture of them.

Explanation Score

	Response includes…
Complete (3)	Describes lowering temperature Explains how lowering temperature results in less movement of the atom Then connects it to the procedure: This allows the crytallogram to capture the existence of the hydrogen
Mostly complete (2)	Describes lowering temp, and slowing of atom, leaves out relationship to capturing the image.
Partial (1)	Includes only lowering temperature, but does not include reasons why this makes a difference.
Incorrect (0)	Other