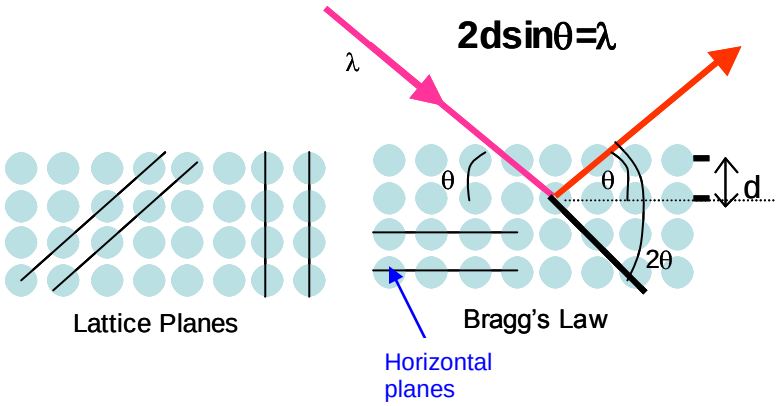
Introduction to X-ray Diffraction (XRD)
Learning Activity

Basic Theory: Instrument Design

Instrument Design for Analysis of Powders

Let's reexamine the simple description of Bragg's law. In the example shown below, diffraction is only being measured from the *horizontal* planes of a crystal as function of 2θ. For a complete analysis of a material, the diffraction from all the possible lattice planes should be examined.



1. Based on this above statement what do you think are important considerations in the instrumental design for XRD analysis?

2. In Powder XRD analysis, the assumption is that *all* orientations are present in the sample and interact with the X-ray source *simultaneously*. What effect does this have on the collection of the diffraction pattern?

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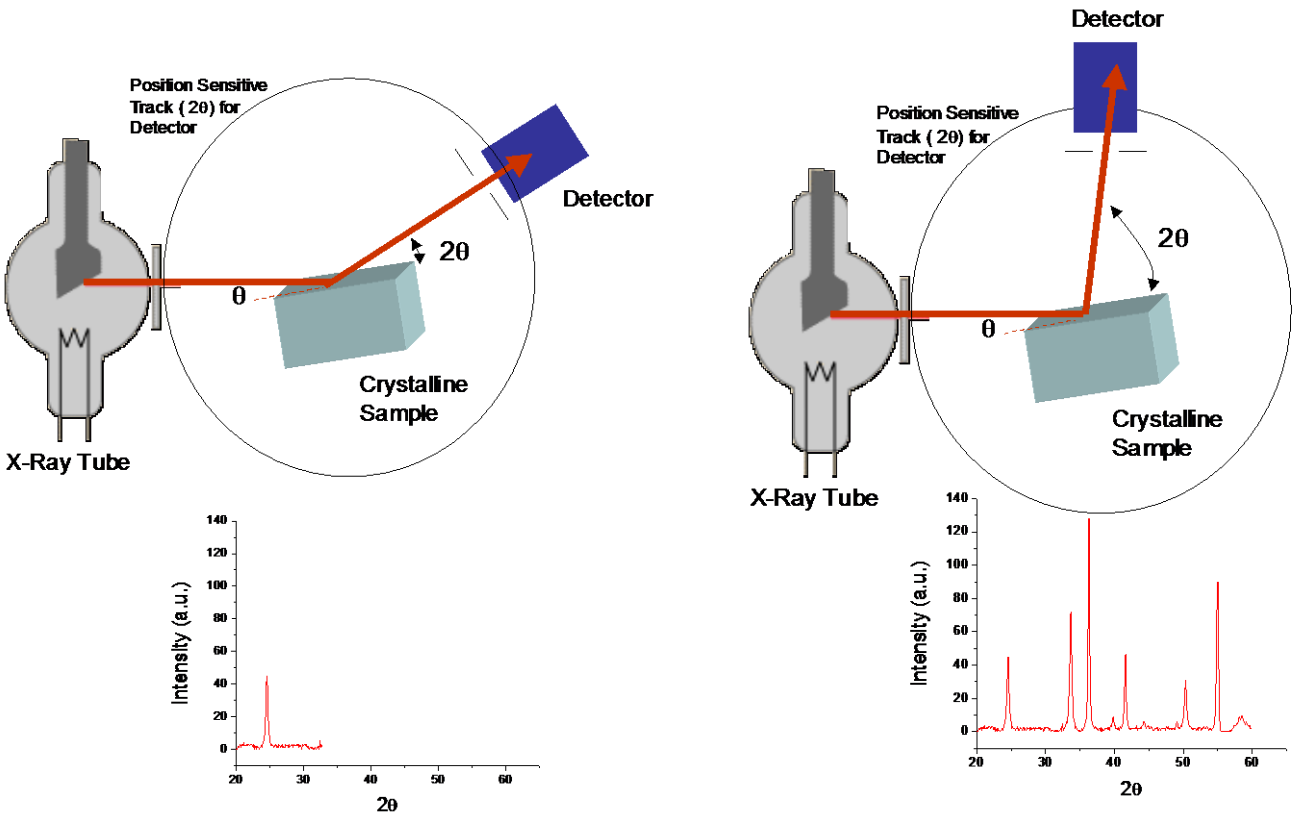
Answer: Diffraction occurs at all the angles of 2θ simultaneously in powder samples. In order to obtain a diffraction pattern, the detector (in most designs) rotates to various 2θ angles to measure diffraction from the sample.

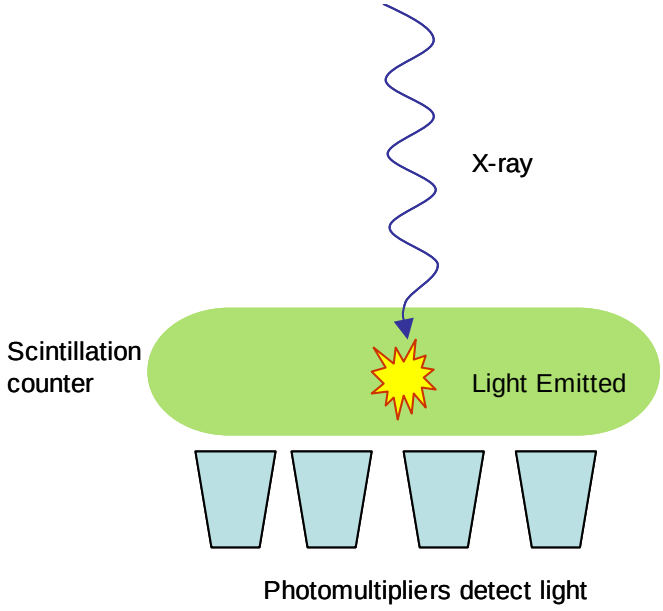
Below is a schematic diagram for a powder X-ray diffractometer, showing the rotating detector.



The source shown is an X-ray tube, which is the most common source of X-rays. Filters are used to provide a narrow wavelength range for analysis.

3. Why is a monochromatic source desirable for XRD analysis?

Typical detectors are scintillation counters. These are materials that release photons of energy when X-ray radiation passes through the scintillation counter. The photons of energy are measured using a photomultiplier tube.



4. What effect does detector collection time have on the analysis?

Hint: Think about S/N