H. Assignment #9 Problem 9-2

In[1389]:=
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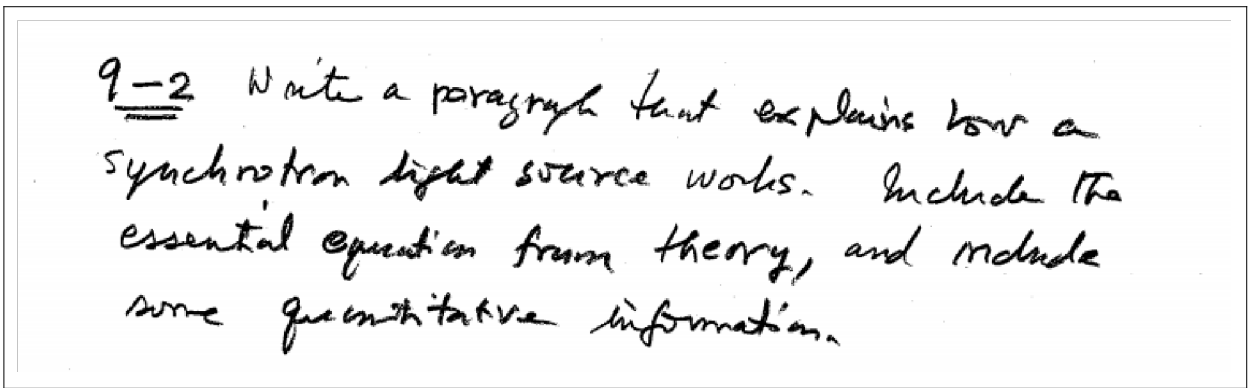
Out[1389]=



A synchrotron light source is an electron storage ring that produces beams of electromagnetic waves by synchrotron radiation. One common application of a synchrotron light source is to study the structure of condensed materials by X-ray diffraction.

A schematic diagram of a synchrotron light source is shown below. The synchrotron radiation intensity is peaked in the direction of the velocity, i.e., tangent to the ring. Therefore beam lines tangent to the ring direct the light to the target.

The essential equation from theory is

$$\frac{dP}{d\Omega} = \frac{e^2}{4\pi c^3} \frac{\left\{\hat{n} \times \left[\left(\hat{n} - \vec{\beta}\right) \times \vec{a}\right]\right\}^2}{\left(1 - \hat{n}.\vec{\beta}\right)^5}$$

As an example, the National Synchrotron Light Source II at Brookhaven National Laboratory uses an electron storage ring with these parameters:
electron energy = 3 GeV
ring circumference = 792 m
Radiation spectrum includes X-rays from 2 to 10 keV

Questions:
The frequency of the fundamental harmonic is $\omega_0 = v/R$.
But this is very small compared to X-ray frequencies. So how are X-rays produced?

What is the formula for “critical photon energy” in synchrotron radiation ?

Grading

-storage ring; a perp to v

-formula for dP/dΩ
-radiation predominantly tangent to the ring
-numerical parameters
4 points
neatness counts