Modern Physics
Problem 1

A monochromatic particle beam consist of particles whose total energy is 100 times their rest mass. The rest lifetime of the particles is 0.10 ns. In the laboratory, the distance between the point where the particles are generated and the detector is 6.0 m. What fraction of the generated particles reach the detector.

Modern Physics
Problem 2

Describe briefly, with equations or sketches as needed, the following famous effects or experiments:

(a) The Auger Effect
(b) Bragg diffraction
(c) Rutherford scattering
(d) The Mössbauer effect
(e) The Stern-Gerlach experiment

Modern Physics
Problem 3

Consider the reaction

$$p + p \rightarrow p + p + \Lambda + \bar{\Lambda}$$

Assume that the masses of proton and Lambda are 1 GeV/c^2.

(a) Consider a laboratory frame in which one of the two initial state protons is at rest. What is the "threshold" energy, i.e. the minimum energy that the incident proton must have for the reaction to be kinematically possible? (Hint: What does this mean in terms of final state momenta in the center-of-mass frame?)

(b) For the reaction at threshold as described in part (a), what is the mean distance that the Lambda travels before it decays? (the mean lifetime of the Lambda in its rest frame is $\tau \approx 2.6 \cdot 10^{-10} s$)

(c) What is the probability that at least one of the two Lambdas travels the distance determined in (b)?

Modern Physics
Problem 4

Define the following properties of a solid, and explain how each can be measured

(a) electrical resistivity
(b) magnetic susceptibility
(c) specific heat
(d) thermal conductivity
(e) dielectric constant