1. In this problem we will investigate the nuclear and magnetic neutron (unpolarised) scattering from the antiferromagnetic crystal AuMn (see figure below). For a temperature below the ordering temperature ($T_N$), the magnetic moments are colinear with the z-axis as shown. Notice that the antiferromagnetic order has a unit cell that is double the chemical unit cell length along the x-axis.

(a) Calculate $d\sigma/d\Omega$ for nuclear scattering ($T>T_N$). Your final result should give the cross section for the different classes of reflections.

(b) For $T<<T_N$, calculate $d\sigma/d\Omega$ for the magnetic (HK0) reflections when the crystal z-axis is perpendicular to the diffraction plane. Note that these Miller indices refer to the nuclear lattice so that half-integer indices arise for the antiferromagnetic reflections.

(c) Evaluate the ratio of cross sections for the (1.5 0 0) to (2 0 0). Now we need to make some assumptions about the Mn magnetic scattering length: assume Mn(2+) so it is spin only ($S=5/2$) so that $b_{mag}=1.35\times10^{-12} \text{ cm at } Q=0$. Then use the normalized magnetic form factor given graphically below. The lattice constant of the nuclear unit cell is $a=3.26\text{Å}$.

![Figure 156. The antiferromagnetic structure of AuMn.](image)

![Figure 139. Determination of the form-factor curve of Mn$^{2+}$.](image)