1. V^{3+} has two 3d electrons, calculate S, L, and J using Hund's rules.

2. We will derive the magnetic susceptibility for permanent moments in a paramagnet, assuming the moments are immobile and independent (the Curie law).

   - Magnetisation is
   $$M = \frac{N}{Z} \sum_{J_z=-J}^{J} (-g\mu_B J_z) e^{-\beta E_{J_z}}$$
   where $Z = \sum_{J_z=-J}^{J} e^{-\beta E_{J_z}}$ is the partition function and $E_{J_z} = g\mu_B B J_z$ is the energy and $\beta = 1/k_B T$.
   - Show that
   $$M = -\frac{N k_B T^2}{B} \frac{\partial \ln Z}{\partial T}.$$
   - Calculate Z using the geometric series
   $$\sum_{k=0}^{n} r^k = \frac{1 - r^{n+1}}{1 - r}.$$
   - Calculate the magnetisation, and find a simple expression by expanding in the small paramter $x = g\mu_B B J \beta$.
   - Show that $\chi = C/T$ with $C = Ng^2 J(J+1)\mu_B^2 \mu_0 \beta/2$ (C is the Curie constant.)