Problem#3

Calculate the magnetic moment of the nuclei ^{15}O, ^{15}N, ^{17}O, and ^{17}F in the independent-particle model. The magnetic moment is defined by

$$\mu = \langle JM_J = J | \hat{\mu}_z | JM_J = J \rangle , \tag{1}$$

where for A nucleons the magnetic moment operator (in first quantization) is given by

$$\vec{\mu}^A = \sum_{i=1}^{A} \left\{ g_\ell(i)\vec{\ell}_i + g_s(i)\vec{s}_i \right\} . \tag{2}$$

The orbital angular momentum factor g_ℓ is 1 in units of nuclear magnetons for protons and 0 for neutrons. The notation above assumes that the orbital and spin angular momentum are in units of $\hbar$. A nuclear magneton is given by $e\hbar/2m_pc$. In the same units the spin factor g_s is 5.58 for protons and -3.82 for neutrons. Assume that the nuclei listed above are either a missing $p_{1/2}$ proton or neutron in the closed-shell ^{16}O or $d_{5/2}$ proton or neutron added to it. Employ the second quantized operator for the magnetic moment. You then also need to calculate the magnetic moment sp matrix elements. To do this, use the projection theorem (see Eq.(3.10.40) in Sakurai). In addition, you will need an argument to demonstrate that closed shells don't contribute. Express your final results in nuclear magnetons. Experimental data will be provided for comparison during the meeting on Monday, September 11, at 3pm.