1. Notice that alpha decay is an example of a nuclear reaction in which the Center of Mass system (CMS) coincides exactly with the Laboratory System. (1) Calculate the recoil energy of the decay of the rare isotope $^{233}\text{U}$ that decays with $Q_{\alpha}=4.908$ MeV. (2) Calculate the Coulomb barriers for the reverse reaction in the CMS and in the Lab system.

2. Make a rough estimate of the reaction cross section in barns for the neutron capture reaction $(n,\gamma)$ on $^{235}\text{U}$ at a neutron kinetic energy of 1 eV.

3. $^{32}\text{P}$ is a beta-minus emitting nuclide that is used extensively in biological and biochemical studies. This nuclide is made in nuclear reactors by the $(n,\alpha)$ reaction. The target material for the production is usually ammonium chloride (NH$_4$Cl) because it is a simple ionic solid. Determine all of the nuclear reaction products from $(n,\gamma)$ and WHERE POSSIBLE $(n,\alpha)$ reactions on the six nuclei present in this sample. Use the format of the following table to present your results for the six isotopes in the sample.

Table 1: Table of target nuclei and products for neutron irradiation of NH$_4$Cl.

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Isotopic Abundance</th>
<th>Nuclear Reaction</th>
<th>Reaction Product</th>
<th>Half-life</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^1\text{H}$</td>
<td>99.989%</td>
<td>$(n,\gamma)$</td>
<td>$^2\text{H}$</td>
<td>stable</td>
</tr>
<tr>
<td>$^1\text{H}$</td>
<td>99.989%</td>
<td>$(n,\alpha)$</td>
<td>NOT possible</td>
<td></td>
</tr>
</tbody>
</table>