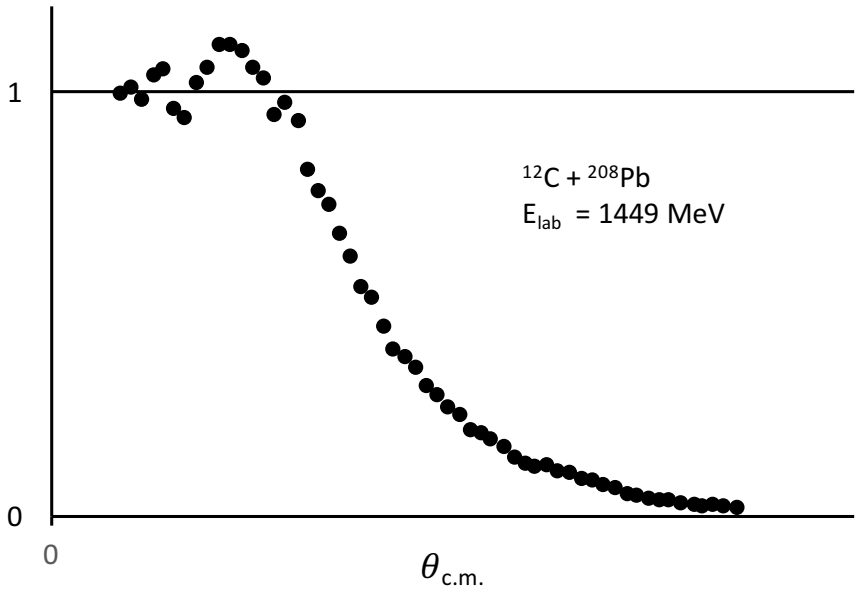
Name _____

Exam Advanced Nuclear Physics 21/08/2017

Question: Nuclear Reactions

These questions will be evaluated on 20 points. You require a minimum of 7/20 points on this part to pass the course. The points will be rescaled to a weight of 6 towards your final grade for the course. You are not allowed any book or notes. You may use a calculator and the given list of formulas for this part of the examination. Please use the attached sheets for your answer; any additional sheet will be discarded.

Consider the data in the figure, which refer to the elastic scattering of ^{12}C on ^{208}Pb at an incident energy $E_{\rm lab} = 1449\,$MeV (data from J. Y. Hostachy et al., Nucl. Phys. A 490 (1988) 441).
[C: $Z = 6$; Pb: $Z = 82$; for the interaction radius use $R = 1.3\,{\rm fm} \times (A_1^{1/3} + A_2^{1/3})$.]



1. (2/20) Add the label to the y axis. Explain why the data points seem to converge to the value 1 for small angles.
2. (4/20) Can you use a diffraction model to describe the behaviour of the data? Explain why and justify *quantitatively* which one.
3. (5/20) Use the model that you discussed in the previous answer to add the expected values of $\theta_{\rm c.m.}$ on the x axis.
4. (5/20) The authors used a phenomenological optical model with a Woods-Saxon real potential to fit the data:

$$V_{\rm OM}(r) = V_0 \left[1 + \exp\left(\frac{r - r_0(A_1^{1/3} + A_2^{1/3})}{a_0} \right) \right]^{-1}$$

They obtained equally good fits with the following sets of parameters:

Set I: $V_0 = -20\,\text{MeV}$, $r_0 = 1.058\,\text{fm}$, $a_0 = 1.173\,\text{fm}$;

Set II: $V_0 = -200\,\text{MeV}$, $r_0 = 0.865\,\text{fm}$, $a_0 = 0.896\,\text{fm}$.

Explain why the two very different sets can both give a good fit. Confirm this by calculating the values of V_{OM} for the two sets at the appropriate distance.

5. (4/20) Describe briefly what is the sharp cut-off model and use it to calculate the reaction cross section integrated on all angles (pay attention to the units).