Name _____

Exam Advanced Nuclear Physics 29/08/2016

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.
The questions serve as a leading trace for the oral examination, during which other aspects and details may be explored.

Consider the reaction: elastic scattering of α particles ($M = 4$, $Z = 2$) on ^{28}Si ($Z = 14$) at a beam energy of 100 MeV.
Prepare to answer the following questions *quantitatively* when needed. You will explain how you calculate the quantities during the oral examination.
For the interaction radius use $R = 1.4\,\text{fm} \times (A_1^{1/3} + A_2^{1/3})$.

- (8/20) Which behaviour do you expect for the differential cross section? Explain why.
- (4/20) Draw the quantity $(d\sigma/d\Omega)/(d\sigma/d\Omega)_{\text{Ruth}}$ as function of the scattering angle $\theta_{\text{c.m.}}$. Identify quantitatively the main features of the plot.
- (5/20) Which models can one use to fit the angular distribution? Be prepared to briefly explain and discuss the models.
  Which information do the models provide about the reaction and about the nuclei?
- (3/20) The beam rate is 10^8 particles per second; the thickness of the ^{28}Si foil is 10^{18} nuclei cm^{-2}. If we have a detector of surface 1 cm^2 at a distance of 10 cm, how long do we have to measure to obtain a precision of 1% on the elastic cross section at 4 degrees?