Master on Nuclear Engineering. FNE_RP

Threshold Exam Number 1. 2014 – 10 – 23

Full Name: _ _ _____ _____

1. Write the equations for energy conservation in a decay of one parent yielding two ejectiles. What masses should be used in this equations?

$X \rightarrow Y + a$

$M_X c^2 = E_Y + M_Y c^2 + E_a + M_a c^2$

$(M_X - M_Y - M_a)c^2 = E_Y + E_a$

unified atomic masses

NUCLEAR

(6)

2. What is the meaning of a microscopic cross-section?.

it is a unit of area → ~~meaning~~ indicating the probability of an interaction. Measured in barns (1barn $\times 10^{-25} cm^2$) (σ)

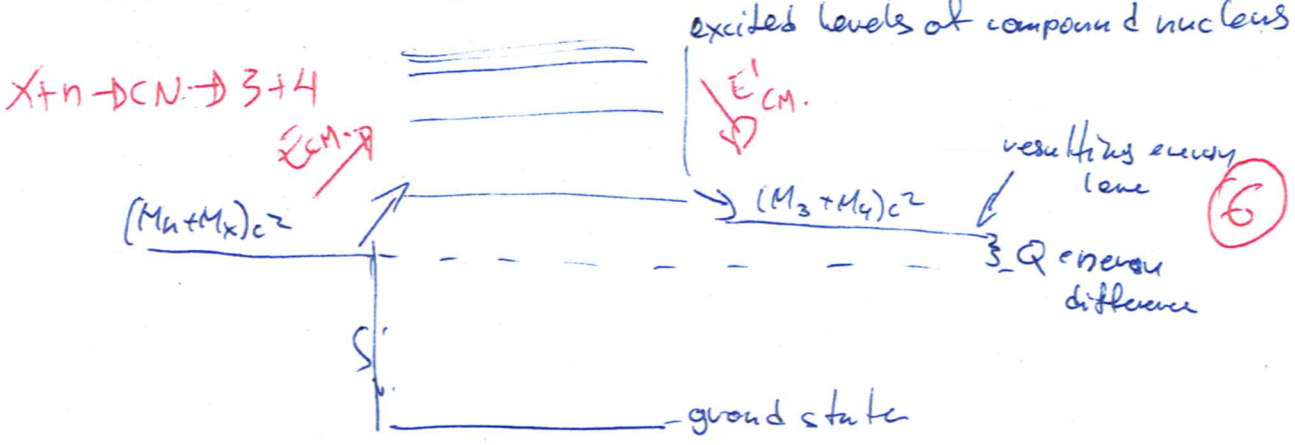
There are different types of σ. σ_a absorption [capture – radiative capture; fission]

σ_s collision [elastic; inelastic]

"reaction" at a given energy.

(7)

3. Draw the energy diagrams of a nuclear reaction going through a compound nucleus. Indicate what the main magnitudes in the diagram are,



(6)

4. How are the energies of alpha particles emitted in the decay of a typical alpha-emitter? Give a short explanation.

α particle (^4_2He) has a very strong binding energy. The energies are emitted as gamma-rays $X \rightarrow Y + \alpha + \gamma$

(4)

5. Describe qualitatively the distinction between the excitation and the ionization of an atom.

- Excitation energy is an amount of energy needed to promote at least one atomic part (eg electron) to a higher energy state, then the lowest possible (ground state)
- Ionization energy is an amount of energy needed to expell an electron out of the atom. (from any energy level)

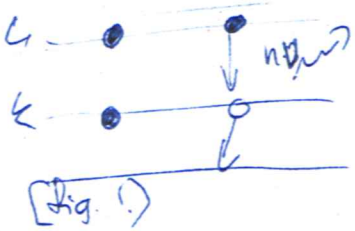
9

6. Explain the difference between the electronic stopping power and the nuclear stopping power for alpha particles. For each one of the two terms, describe briefly the elastic or inelastic processes involved. Stopping power $S(E) = -\frac{dE}{dx}$ [eV·cm²]

- electronic stopping power - energy needed to stop an electron. NO
- -> elastic for when the target absorbs electron energy (kinetic energy, NO but does not change its state -> electron is slowing down. Inelastic -> electron is absorbed by an atom which either expells another electron or gets excited NO
- Nuclear stopping power energy needed to stop an nucleus. NO
- elastic -> the kinetic energy is being transfered.
- inelastic: is absorbed.
- electron stopping power is much lower then eg. protons * 6.

10

7. After a photoelectric absorption has taken place, the target atom has been left with a vacancy in its innermost shell, the K shell. Describe qualitatively the relaxation process that follows and the possible types of emitted radiation. In particular, justify if this radiation will have a continuous or discrete spectrum.



[fig. 1]

1) an electron from a higher energy level falls to a lower -> change in energy $\Delta E = h\nu$ which is emitted as a energy photon (x-ray). This process continues until again all electrons are in the lowest possible level. Thus the energy release is descrete!
The overall energy levels may decrease to a point, where the electron in the highest level is then released out of the atom (β decay).

? NO !

7

8. In a photon field, write the equation that relates the absorbed dose rate at a certain point in space and the photon spectral flux density at that point. What is the name of the coefficient appearing in this formula? Explain whether or not this coefficient depends on: the material composition at the considered point; the material mass density; the photon energy; the photon direction of flight.

$$\frac{dD}{dt} = \int_E dE \cdot E \left(\frac{\mu_{en}}{\rho}\right) \phi(E)$$

Mass energy absorption coefficient

It depends on material composition -> for each material the dose is different. It does on material mass density, higher the photon energy -> higher the dose. NO!

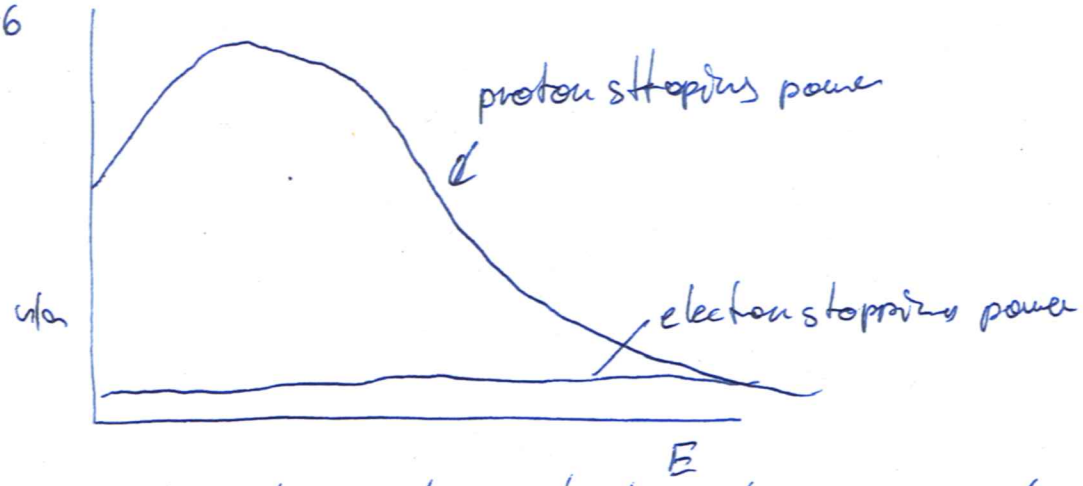
$\phi = \phi(E)$

$\phi(E) = \frac{dT}{a\,d\Omega}$

~~It does not depend on direction~~ there is different dose at different angle. NO!

6

*6



- an important role in electron stopping power plays the coulomb forces → electron is either attracted or repelled by neighbouring atom.
- An α particle collides with other atoms until looses its energy.