NUCLEAR CROSS SECTIONS

1

DEFINE the following terms:

a. Atom density
b. Neutron flux
c. Microscopic cross section
d. Barn
e. Macroscopic cross section
f. Mean free path

2

A block of aluminum has a density of 2.699 g/cm^3. If the gram atomic weight of aluminum is 26.9815 g, calculate the atom density of the aluminum.

3

Find the macroscopic thermal neutron absorption cross section for iron, which has a density of 7.86 g/cm^3. The microscopic cross section for absorption of iron is 2.56 barns and the gram atomic weight is 55.847 g.

4

An alloy is composed of 95% aluminum and 5% silicon (by weight). The density of the alloy is 2.66 g/cm^3. Properties of aluminum and silicon are shown below.

Element	Gram Atomic Weight	σ_a (barns)	σ_s (barns)
Aluminum	26.9815	0.23	1.49
Silicon	28.0855	0.16	2.20

1. Calculate the atom densities for the aluminum and silicon.
2. Determine the absorption and scattering macroscopic cross sections for thermal neutrons.
3. Calculate the mean free paths for absorption and scattering.

5

Calculate the total macroscopic cross sections and mean-free-path length for l-MeV neutrons in $^{nat}UO_2$ (density 10g/cm^3, molecular weight 270) from the data in table.

Isotope	n_i	σ_t at 1 MeV [b]
^{235}U	0.007	6.84
^{238}U	0.993	7.10
^{16}O	2.000	8.22

6

What thickness of Al is needed to reduce the intensity of a beam of thermal neutrons to 1/100 of its initial value? Neutron absorption cross section in aluminum for thermal neutrons is 0.23 barn. Density of Al is 2.7 g/cm^3.

7

Cadmium has a neutron absorption cross section of 20 barns for thermal neutrons. What fraction of the thermal neutrons will be transmitted by a 0.3 mm foil of cadmium of density 8.6 g/cm^3?

8

Calculate the mean free path of thermal neutrons in:
(**a**) water for which σ=0.33 barn and ρ= 1 g/cm^3, and
(**b**) graphite for which σ =2.6 barns and ρ =2250 kg/m^3.

9

A 0.1 cm thick Fe sheet (ρ =7.8 g/cm^3) reduces a beam of 10^4 neutrons by 10%. Calculate:
(a) macroscopic cross section of Fe, and (b) mean free path.