Homework Assignment #5

Projection Radiography

(Hendee Ch 6, 13)

Due Oct 12

1. Hendee 6-1
2. Hendee 6-2

3. (Hobbie, 3rd ed) The atomic cross sections for the materials in a gadolinium oxysulfide intensifying screen for 50-keV photons are:

<table>
<thead>
<tr>
<th>Element</th>
<th>Cross section per atom (m²)</th>
<th>Atomic Mass (amu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gd</td>
<td>1.00x10^{-25}</td>
<td>157</td>
</tr>
<tr>
<td>S</td>
<td>3.11x10^{-27}</td>
<td>32</td>
</tr>
<tr>
<td>O</td>
<td>5.66x10^{-28}</td>
<td>16</td>
</tr>
</tbody>
</table>

a. What is the cross section per target molecule of GdO₂S?
b. How many target molecules per unit area are there in a thickness $\rho dx$ of material?
c. What is the probability that a photon interacts in traversing 1.2 kg m⁻² of GdO₂S?

4. (Hobbie, 3rd ed) As a simple model for mammography, consider two different tissues: a mixture of 2/3 fat and 1/3 water, with a composition by weight of 12% hydrogen, 52% carbon and 36% oxygen; and glandular tissue, composed of 11% hydrogen, 33% carbon and 56% oxygen. The density of the fat and water combination is 940 kg/m³, and the density of the glandular tissue is 1020 kg/m³. What is the attenuation in 1 mm of fat and in 1 mm of glandular tissue for
   a. 50-keV photons
   b. 30-keV photons

5. (Hobbie, 3rd ed) Assuming 10,000 photons were incident on the tissue described in problem 4, determine the difference in optical density of the tissue for each of the photon energies given. Which photon energy would be preferred if you were attempting to image the glandular tissue?

6. (Hobbie, 3rd ed) A dose of 1.74 x 10⁻⁴ Gy was estimated for part of the body just in front of an unscreened x-ray film. Suppose that a screen permits the dose to be reduced by a factor of 20. Calculate the skin dose on the other side of the body (the entrance skin dose) assuming 50-keV photons and a body thick of 0.2 m. Assume that only unattenuated photons are detected, and that dose is proportional to the number of photons.