13. RADIOACTIVITY & RADIATION PROTECTION

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The International Commission on Radiation Units and Measurements (ICRU) recommends the use of SI units. Therefore we list SI units first, followed by cgs (or other common) units in parentheses, where they differ.

• **Unit of activity** = becquerel (curie):
 1 Bq = 1 disintegration s^{-1} [$= 1/(3.7 \times 10^{10})$ Ci]

• **Unit of absorbed dose** = gray (rad):
 1 Gy = 1 joule kg^{-1} ($= 10^4$ erg g^{-1} = 100 rad)
 $= 6.24 \times 10^{12}$ MeV kg^{-1} deposited energy

• **Unit of exposure**, the quantity of x- or γ- radiation at a point in space integrated over time, in terms of charge of either sign produced by showering electrons in a small volume of air about the point:
 = 1 coul kg^{-1} of air (roentgen; 1 $R = 2.58 \times 10^{-4}$ coul kg^{-1})
 = 1 esu cm^{-3}(= 87.8 erg released energy per g of air)

Implicit in the definition is the assumption that the small test volume is embedded in a sufficiently large uniformly irradiated volume that the number of secondary electrons entering the volume equals the number leaving. This unit is somewhat historical, but appears on many measuring instruments.

• **Unit of equivalent dose** (for biological damage) = sievert [= 100 rem (**r**oentgen **e**quivalent for **m**an)]: Equivalent dose in Sv = absorbed dose in grays $\times$ w_R, where w_R (radiation weighting factor, formerly the quality factor Q) expresses long-term risk (primarily cancer and leukemia) from low-level chronic exposure. It depends upon the type of radiation and other factors, as follows [1]:

Table 13.1: Radiation weighting factors.

Radiation	w_R
X- and γ-rays, all energies	1
Electrons and muons, all energies	1
Neutrons < 10 keV	5
10–100 keV	10
> 100 keV to 2 MeV	20
2–20 MeV	10
> 20 MeV	5
Protons (other than recoils) > 2 MeV	5
Alphas, fission fragments, & heavy nuclei	20