

The Shroud of Turin

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All living matter contains the same percentage of the radioactive isotope carbon-14. (Carbon-12 and carbon-13 are not radioactive.) The carbon-14 activity in living matter is 15.3 decays/minute/gram of carbon (dmg) and carbon-14 has a half-life of 5730 years. "Dead matter" is no longer replenishing carbon-14, so its count rate is less and depends on how much time has passed since it "died."

Radiocarbon measurements made in 1988 on the Shroud of Turin, a religious relic thought by some among the faithful to be the burial shroud of Christ, gave a carbon-14 decay rate of 14.1 dmg. What is the age of the Shroud of Turin?

$$D_t = D_o \cdot \left(\frac{1}{2}\right)^{\frac{t}{t_{HL}}} \qquad 14.1 \cdot \text{dmg} = 15.3 \cdot \text{dmg} \cdot \left(\frac{1}{2}\right)^{\frac{t}{5730 \cdot \text{yr}}} \quad \left| \begin{array}{l} \text{solve, } t \\ \text{float, } 3 \end{array} \right. \rightarrow 675.0 \cdot \text{yr}$$

Assuming the carbon-14 results are accurate, the Shroud of Turin is only 675 years old and therefore dates from the middle ages (14th century) and can't be the burial shroud of Christ. The following calculation shows that for the shroud to be 2,000 years old would require a carbon-14 count of 12.0 dmg. In other words, the present measurement would have to be in error by 15%.

$$x = 15.3 \cdot \text{dmg} \cdot \left(\frac{1}{2}\right)^{\frac{2000 \cdot \text{yr}}{5730 \cdot \text{yr}}} \quad \left| \begin{array}{l} \text{solve, } x \\ \text{float, } 3 \end{array} \right. \rightarrow 12.0 \cdot \text{dmg}$$