Name_____

PHYS102 - Fall '12 - Good Nukes, Bad Nukes - Quiz #2

This quiz is open notes, but you must work without assistance from others. It is not enough to just give the answers, but you **must** explain your reasoning in words about how you got your answers. All questions are equally weighted. Questions start on the next page. Here is some potentially useful data.

Potentially useful data

The relative biological effectiveness (RBE) of X, γ, and β radiation is 1, of protons is 5, and of α particles is 20.

The half-life of $^{99}{}_{43}$Tc is 6.0 hours. The half-life of $^{14}{}_{6}$C is 5730 years. The half-life of $^{238}{}_{92}$U is 4.47 billion years. The half-life of tritium ($^{3}{}_{1}$H) is 12.32 years. The energy equivalent of 1 amu is 931.5 MeV.

The mass of a neutron is 1.008664916 amu
The mass of a proton is 1.007276466812 amu
The mass of $^{1}{}_{1}$H is 1.007825032 amu
The mass of $^{2}{}_{1}$H is 2.014101778 amu
The mass of $^{3}{}_{1}$H is 3.0160492675 amu
The mass of $^{3}{}_{2}$He is 3.016029309
The mass of $^{4}{}_{2}$He is 4.0026032497
The mass of $^{6}{}_{2}$He is 6.018886 amu
The mass of $^{8}{}_{2}$He is 8.03392 amu
The mass of $^{6}{}_{3}$Li is 6.0151223 amu
The mass of $^{7}{}_{3}$Li is 7.0160040 amu
The mass of $^{12}{}_{6}$C is 12.000000 amu
The mass of $^{13}{}_{6}$C is 13.0033548378 amu
The mass of $^{14}{}_{6}$C is 14.003241982 amu

A 1 g sample of carbon taken from something living today has an activity of 14 decays per minute (dpm).

1. While investigating a fatal accident at a small nuclear reactor, high radiation levels were measured close to the damaged reactor, such that a person standing near the reactor for an hour would receive an effective dose of 1200 rem. (This would be a fatal dose.) To get photographs to assess the damage to the reactor, two photographers separately spent 30 seconds each in that high radiation field. Estimate the effective dose they each received (in rems).

2. A candidate reaction for producing power by nuclear fusion is:

$$^{3}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + n^{0} + n^{0}$$

Calculate the energy released in this reaction (in MeV).

3. Imagine that Professor Sullivan is working in a room with a source of gamma radiation. It takes him 30 minutes to record some results in his lab book while standing 8.2 feet away from the source. During that time, he receives a dose of 21.2 mrad. Professor Sullivan then moves to a control panel that is 2.4 feet from the source and works there for 30 minutes. What dose (in mrad) does he receive while working at the control panel?

4. A slightly shady looking antiquities dealer brings you a quiver of arrows that he claims were used at the famous battle at Marathon (490 BC) where Athenian Greeks repelled a Persian invasion. If he can demonstrate their authenticity, he stands to make a fortune. So he allows you to carbonize one of the arrows, from which you obtain a 121 g sample of carbon. What activity (in dpm) would you expect to measure if the arrow was indeed old enough to have been used at the battle of Marathon?