PHYS 3550 Physics for War, Physics for Peace Name: _____
Spring 2018 – Assignment 5

Quote from the Opinions Page in the January 8th 2004 edition of the Modesto Bee, in an article titled "Let's face it - man will never go to Mars", on the perils of interplanetary travel

> "If the average person on Earth absorbs about 350 millirems of radiation every year, an astronaut traveling to Mars would absorb about 130,000 millirems of a particularly virulent form of radiation that would probably destroy every cell in his body."

Assume that the trip to Mars takes a total of two years, six months each way, plus a year on the surface of Mars.

Questions

1. How long would it take a person on the Earth to receive the same total dose of radiation as the astronauts? 130,000 / 360 = 360 years. (Note if you used a figure of 260,000 over 2 years then you will get an answer of 720 years, but strictly speaking the quotation did say a total exposure of 130,000 mrem regardless of the time.)

2. Bearing in mind your answer to the previous question, do you think this falls under the category 'Acute Radiation' or 'Chronic Radiation'? Why? It is a very large dose of radiation, about 180 times normal background if we assume a constant rate. On the other hand to qualify as acute radiation it should be delivered in a short time (hours?) not over two years. That seems to suggest that the exposure they will get fall somewhere between chronic and acute radiation.

3. Assuming that it can be classified as chronic radiation would it kill 100% of the people? Can you estimate what fraction of the crew members it would kill?
   a. For chronic radiation the mortality rate is estimated at 0.04% of the population per rem of exposure.
   b. Exposure = 130,000 mrem = 130 rem.
   c. Percentage of crew expected to die from chronic radiation = 0.04 % * 130 rm = 5.2%

4. Assuming that it can be classified as acute radiation would it kill 100% of the people? Can you estimate what fraction of the crew members it would kill?
   a. The LD50 dose is estimated at about 450 rem[1].
   b. The dose quoted is less than this, meaning that the percentage of crew members killed should be less than 50%.
   c. Assuming a mortaility rate proportinal to the dose, the estimated number of crew members killed would be about $\frac{130}{450} * 50 = 14.4\%$.

   In neither scenario (chronic or acute) is the expected mortality rate even close to 100 %.

1 https://www.nrc.gov/reading-rm/basic-ref/glossary/lethal-dose-ld.html

5. What is “virulent” about radiation? (Added: Most people gave a meaning of virulent to mean harmful or poisonous, which are really 'soft' definitions. Virulent doesn't really equate to either. For example, I could hit you over the head with a 2x4, which would certainly be harmful but there's nothing virulent about it. So, look up a precise definition of the word. Ask yourself what is the stem of virulent. Then try answering this question again.)
   a. Virulent means virus-like.
   b. Viri can cause infected cells in the body to replicate the virus, allowing it to spread.
   c. Radiation does not cause a cell to produce more radiation, and so does not spread “virus like”.

6. What do you think about the claim that the absorbed radiation would “probably destroy every cell in his body”? (Hint: think about your answers to questions 3 and 4). If that were true (or even close to true) then every crew member would die, and we have already seen that this is not the case. The claim is hyperbolic in the extreme.