

PHYS 202 TEST #5 DR. HOLMES 4/29/19 NAME Key

Do all the problems. The worth of each problem is marked [] beside the problem. Show your work for partial credit. If you do not know the name of an element but only know its atomic number and mass number, then use X as the name of the element.

1) a) Is there a maximum or a minimum (other than zero) x-ray energy from an x-ray machine?

[1] maximum. b) What is this (maximum or minimum) energy of the photons from an x-ray machine using 9,500 volts?

[4] 9,500 eV = 1.52 x 10⁻¹⁵ J. c) Is there a maximum or a minimum (other than zero) photon wavelength from an x-ray machine?

[1] minimum. d) What is this (maximum or minimum) wavelength of the photons from an x-ray machine using 9,500 volts?

[4] 1.31 x 10⁻¹⁰ m. e) Is this wavelength much smaller than, about the same size as (within a factor of 100), or much larger than the size of an atom?

[1] about the same. f) If ${}_{27}\text{Co}$ (Cobalt) is the target material and the above voltage is used, will characteristic radiation occur?

[1] Yes. g) If ${}_{13}\text{Al}$ (Aluminum) is the target material and the above voltage is used, will characteristic radiation occur?

[1] Yes.

2) a) Explain what happens in alpha decay: [3]

b) Explain what happens in β^- decay: [3]

c) Explain what happens in β^+ decay: [3]

d) Can α , β , or γ radiations make atoms radioactive?

[1] No

e) If yes, which of these can; if no, what can? [1] neutrons

3) Fill in the missing particle(s):

[1] ${}_{90}\text{Th}^{230}$ goes to ${}_{88}\text{X}^{226}$ + alpha + energy

[3] ${}_{53}\text{I}^{131}$ goes to ${}_{54}\text{X}^{131}$ + ${}_{-1}\beta^0$ + anti- ${}_{\nu}^0$

[3] ${}_{53}\text{I}^{122}$ goes to ${}_{52}\text{X}^{122}$ + ${}_{+1}\beta^0$ + ${}_{\nu}^0$

[3] ${}_{27}\text{Co}^{60}$ goes to ${}_{28}\text{X}^{60}$ + ${}_{-1}\beta^0$ + anti- ${}_{\nu}^0$

(the one stable isotope of ${}_{53}\text{I}$ is 127; the one stable isotope of ${}_{27}\text{Co}$ is 59)

4) a) Given that the half life of ${}_{27}\text{Co}^{60}$ is 5.27 years, what is the decay constant, λ , for this isotope?

[4] $4.17 \times 10^{-9} / \text{sec}$. b) How many atoms of Co^{60} are there in 1 gram? [1] 1.0×10^{22} .

c) What is the activity of 1 gram of Co^{60} in dis/sec? In Curies? [3] 4.17×10^{13} . [1] 1,130.

d) What will be the activity of this one gram after 100 years (in dis/sec)? [4] 8.09×10^7 .

5) C^{14} has a half life of 5,730 years, and the ratio of C^{14} to C^{12} is 1.3×10^{-12} . a) What is the decay constant, λ , for C^{14} ?

[3] $3.84 \times 10^{-12} / \text{sec}$. b) How many atoms of C^{14} are there in **6 grams** of carbon, assuming the ratio given above?

[1] 3.9×10^{11} . c) What is the present activity of **6 grams** of carbon taken from a modern "bone" (this assumes the present ratio of C^{14} to C^{12})? Express your answer in two forms: in dis/sec: and in Curies:

[3] 1.5 [1] 4.05×10^{-11} .

d) Assuming the ratio of C^{14} to C^{12} in the atmosphere has remained the same, what should the age of a bone be if 6 grams of carbon taken from the bone have an activity of 0.32 counts/sec?

[5] 12.800 years.

6) The half life of ${}_{53}\text{I}^{122}$ is 3.5 minutes and the half life of ${}_{53}\text{I}^{131}$ is 8 days.

a) If there is one gram of each, which (I^{122} or I^{131}) will have the higher activity initially?

[3] I^{122} . b) Which will have the higher activity after 1 month?

[3] I^{131} .

7) The radioactive isotope ${}_{90}\text{Th}^{230}$ is found in nature (part of the uranium decay sequence).

a) Which stable isotope will it eventually decay into?

[3] ${}_{82}\text{Pb}^{206}$.

b) How many alphas will be emitted as it does decay to this stable isotope?

[3] 6.

c) How many betas will be emitted in this decay process?

[3] 4.

8) a) **Tell what each measures** (absorbed dose, exposure dose, activity), and **define** the four measures of radioactivity

1) Curie: [2]

2) Roentgen: [2]

3) Rad: [2]

4) Rem: [2]

b) What is the average background radiation (in millirems/year) ?

[1] 200 - 300.

c) What acute dose of radiation will begin to cause some people to die of radiation sickness (in millirems) ?

[1] 200,000.

9) a) What is the linear hypothesis as applied to long-term dangers from radiation? [2]

b) What is the idea of hormesis as applied to long-term dangers from radiation? [2]

10) a) What is a chain reaction with respect to nuclear energy? [2]

b) Why is a moderator used in a nuclear reactor:

1. what does it do? [2]

2. why is it necessary? [2]

c) Name two materials that can be effectively used as a moderator in a nuclear reactor:

1. [1]

2. [1]

d) Can a nuclear reactor explode as a nuclear bomb?

[1] _____.

e) Explain your answer to part d above: [2]