RH = CH1 = CH2 =

PHYS 252 TEST #5 DR. HOLMES 4/29/19 NAME Key

Do all nine problems. The worth of each problem is [ ] by the space for the answer. Show your work for partial credit.

Mass of Hydrogen atom (proton + electron) = 1.00782 amu;
mass of neutron = 1.008665 amu; mass of electron = .00055 amu;
rest mass energy of an amu = 931.5 MeV.

If you do not know the symbol of an element but only know its atomic number and mass number, then use X as the symbol of the element.

1) a) What is the total nuclear binding energy for Radon-212 ($_{86}Rn^{212}$) which has an atomic mass of 211.9907 amu)?

[5] **1,652 MeV**. b) What is the binding energy per nucleon?

[3] **7.793 Mev/amu**.

c) Is this binding energy per nucleon greater, the same, or less than that for lead-208 ($_{82}Pb^{208}$ has an atomic mass of 207.9766 amu)?

[2] **less**.

2) Fill in the missing particle(s), given that there are no stable isotopes of Radon (Rn); there is 1 stable isotope of cobalt (Cs) at 59; there are three stable isotopes of Oxygen: (O): 16, 17, and 18.

[2] $_{86}Rn^{212}$ goes to $_{84}X^{208}$ + alpha + energy

[3] $_{27}Co^{58}$ goes to $_{26}X^{58}$ + $_{+1}\beta^{0}$ + $_{0}\nu^{0}$

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

[3] $_{8}O^{19}$ goes to $_{9}X^{19}$ + $_{-1}\beta^{0}$ + anti- $_{0}\nu^{0}$

3) a) What is the activity of a sample of 1 gram of $_{86}Rn^{212}$ given that its half life is 23 minutes?

in Bq: in Curies:

[4] **1.42×10^{18} Bq** [2] **3.84×10^{7} Ci**.

b) What will be the activity of the 1 gram sample of Rn^{212} (in Bq) after 1 day?

[6] **0.2 Bq**.

4) C^{14} has a half life of 5730 years, and the ratio of C^{14} to C^{12} is 1.3×10^{-12}.

a) What is the present activity of **3 grams** of carbon taken from a modern "bone" ? Express your answer in two forms: in dis/minute: and in Curies:

[4] **44.9** [2] **20.2 pCi**.

b) 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 **3 grams** of carbon taken from the bone have an activity of 4 dis/minute ?

[6] **20,000 years**.

5) a) What are the three main mechanisms for x-ray absorption?

[2] **Photoelectric Effect**, [2] **Compton Scattering**, [2] **Pair Production**.

b) Which mechanism dominates at very low x-ray energies? [1] **Photoelectric Effect**.

which at extremely high x-ray energies? [1] **Pair Production**.

c) Can exposure to β-rays make atoms radioactive? [1] **No**.

d) Can exposure to neutrons make atoms radioactive? [1] **Yes**.

e) Can exposure to γ-rays make atoms radioactive? [1] **No**.

f) If the answers to d, e, and f are ALL NO, THEN explain what can make atoms radioactive:

(If any or all of the answers to d, e, and f are YES, then simply write N/A as the answer) [1] **N/A**.

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6) a) Uranium decays until it reaches lead or bismuth. If you start with $_{92}U^{235}$, which of the following stable isotopes will you end up with: $_{82}Pb^{206}$, $_{82}Pb^{207}$, $_{82}Pb^{208}$ or $_{83}Bi^{209}$? (answer by specifying 206, 207, 208 or 209):

[4] **207**. b) How many alphas and how many betas will be emitted in the process of going from the $_{92}U^{235}$ down to the heaviest stable isotope?

# of alphas: [2] **7**. # of betas: [2] **4**.

7) a) Define the four measures of radioactivity and tell what each measures (absorbed dose, exposure dose, activity).

1) Roentgen: [2]

2) Curie: [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**.

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

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

8) a) What is the purpose of a moderator in a fission reactor? [2]

b) Why is it needed? [2]

c) What are three characteristics of a good moderator?

(1) [1]

(2) [1]

(3) [1]

d) Name two materials commonly used as moderators?

(1) [1] _____ (2) [1] _____

e) Can a nuclear reactor explode as a nuclear bomb? [1] _____.

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

9. a) Fill in the blank on this fusion reaction: [4] $\_\_{}_{1}H^{2}\_\_ + {}_{1}H^{1}$ goes to $\overset{3}{\underset{1}{H}} + \overset{0}{\underset{+1}{\beta}} + \nu$ + energy

b) Given the masses for the following particles:
${}_{0}n^{1}$ = 1.008665 amu; ${}_{1}H^{1}$ = 1.007825 amu; ${}_{1}H^{2}$ = 2.01410 amu; ${}_{1}H^{3}$ = 3.016049 amu;
${}_{2}He^{3}$ = 3.01603 amu; ${}_{2}He^{4}$ = 4.002603 amu; $\beta^{-} = \beta^{+}$ = .00055 amu.
What is the Q value for the reaction in part a) above?

[5] ___**4.45 MeV**___ .