Physics 07 **HW CH 30 Radioactivity and Decay**

Name_____

1) Atomic nuclei that are all isotopes of an element all have the same

A) mass. B) number of neutrons.

C) number of protons. D) number of nucleons.

2) The mass number of an atom is equal to the number of what particles in the nucleus?

A) electrons B) protons C) nucleons D) positrons. E) neutrons

3) The symbol for a certain isotope of radium is $^{226}_{88}\text{Ra}$. How many nucleons are there in the nucleus of this isotope?

4) The atomic mass unit is defined as

A) one twelfth the mass of a carbon–12 atom.

B) the mass of an electron.

C) the mass of a hydrogen–1 atom.

D) the mass of a proton.

E) the mass of a carbon–12 nucleus.

5) To a reasonable approximation, the density of a nucleus

A) is greater for large–Z nuclei. B) varies unpredictably for different values of Z.

C) is smaller for large–Z nuclei. D) is independent of the mass number.

6) Which of the following statements is *not* true of the strong nuclear force?

A) The nuclear force affects both neutrons and protons.

B) For two protons that are very close together, the nuclear force and the electric force have about the same magnitudes.

C) A nucleon in a large nucleus interacts via the nuclear force only with nearby nucleons, not with ones far away in the nucleus.

D) The nuclear force does not depend on charge.

E) The nuclear force has a short range, of the order of nuclear dimensions.

7) A fusion reaction releases energy because the binding energy of the resulting nucleus

A) is greater than the binding energy of the original nuclei.

B) is less than the binding energy of the original nuclei.

C) is released in the process.

D) is equal to the binding energy of the original nuclei.

E) is absorbed in the process.

8) A β^+ particle is also known as

A) a high–energy photon. B) a helium nucleus.

C) an electron. D) a positron.

9) What is the mass number of alpha particles?

10) What are the mass number A and the charge (in units of e) for each of the following particles or rays?
(a) beta–plus
(b) beta–minus
(c) gamma ray

11) During β^+ decay
A) a proton is ejected from the nucleus.
B) a neutron is transformed to a proton.
C) a neutron is ejected from the nucleus.
D) the number of nucleons decreases.
E) a proton is transformed to a neutron.

12) When a β^- particle is emitted from an unstable nucleus, the atomic number of the nucleus
A) decreases by 2.
B) increases by 1.
C) increases by 2.
D) decreases by 1.
E) does not change.

13) In β^- decay, the number of neutrons in the nucleus is
A) decreased by 1.
B) increased by 2.
C) increased by 1.
D) decreased by 2.
E) remains unchanged.

14) A radioactive isotope of atomic number Z emits a beta–minus particle, and then the daughter nucleus emits a gamma ray. What is the atomic number of the resulting nucleus after both processes?
A) $Z + 1$ B) $Z - 3$ C) $Z - 1$ D) $Z - 2$

15) When an unstable nucleus decays by emitting an alpha particle, the atomic number Z of the nucleus
A) increases by 4.
B) decreases by 4.
C) increases by 2.
D) decreases by 2.
E) remains unchanged.

16) The half–life of cobalt–60 is 5.3 years, while that of strontium–90 is about 29 years. Suppose you have samples of both isotopes, and that they initially have the same activity (number of decays per second). What must be true of the numbers of cobalt–60 and strontium–90 nuclei in these samples?
A) There are equal numbers of cobalt–60 and strontium–90 nuclei.
B) There are more strontium–90 than cobalt–60 nuclei.
C) There are more cobalt–60 than strontium–90 nuclei.
D) It is not possible to compare numbers of nuclei without knowing the masses of the samples.

17) Two radioactive isotopes, X and Y, both decay to stable products. The half–life of X is about a day, while that of Y is about a week. Suppose a radioactive sample consists of a mixture of these two nuclides. If the mixture is such that the activities arising from X and Y are initially equal, then a few days later the activity of the sample will be due
A) predominantly to Y.
B) to X and Y equally.
C) entirely to Y.
D) predominantly to X.

18) Modern in–air nuclear bomb tests have created an extra high level of ^{14}C in our atmosphere. If future archaeologists date samples from this era, without knowing of this testing, will their carbon–14 dates be too young, too old, or correct? If correct, why?

A) Too old.

B) Too young.

C) Correct, because modern biological materials do not gather ^{14}C from bomb tests.

D) Correct, since ^{14}C from bomb tests is different from that produced naturally.

19) In a head–on collision, an alpha particle ($Z = 2$) of energy 8.20 MeV bounces straight back from a nucleus of charge 80.0 e. How close were the centers of the objects at closest approach? (1 eV = 1.60×10^{-19} J, $e = 1.60 \times 10^{-19}$ C, $1/4\pi\varepsilon_0 = 8.99 \times 10^9$ N • m^2/C^2) HINT: KE before = PE at closest dist}

20) The radius R of a nucleus of mass number A is given by $R = R_0 A^{1/3}$, where $R_0 = 1.2 \times 10^{-15}$ m, calculate the density of a nucleus that has contains 57 protons and 82 neutrons. The mass of a nucleon (proton or neutron) is 1.67×10^{-27} kg. {HINT: density = mass/volume, vol = (4/3) pi*r^3 }

21) What is the approximate nuclear radius of an isotope of sodium with 11 protons and 12 neutrons? {use the R formula in 20}

22) Estimate the mass of a nucleus with radius 2.8×10^{-15} m. (1 u = 1.6605×10^{-27} kg)

23) A summary of the nuclear reactions that power our sun is $4p \rightarrow {}^4He + 2e^-$, with masses of 938.272 MeV/c^2 for a proton, 3727.38 MeV/c^2 for the helium nucleus, and 0.511 MeV/c^2 for each electron. How much energy is released by each of these reactions?

24) The following masses are known:

^1_0n 1.008665 u

^1_1H 1.007825 u

$^{226}_{88}Ra$ 226.025403 u

What is the binding energy of $^{226}_{88}Ra$? (1 u = 931.5 MeV/c^2)

25) Uranium–238 decays into thorium–234 plus an alpha particle. The known masses are

^4_2He: 4.002603 u

$^{224}_{90}Th$: 234.043583 u

$^{238}_{92}U$: 238.050786 u

How much energy is released in this process? (1 u = 931.5 MeV/c^2)

26) The neutral helium atom, $^{4}_{2}\mathrm{He}$, has a mass of 4.002603 u, a neutron has a mass of 1.008665 u, a proton has a mass of 1.007277 u, and a neutral hydrogen atom has a mass of 1.007825 u. What is the binding energy of the $^{4}_{2}\mathrm{He}$ nucleus? (1 u = 931.5 MeV/c^2)

27) The carbon in our bodies was formed in nuclear reactions in long-dead stars. How much energy was released when the right number of $^{4}\mathrm{He}$ nuclei combined to make $^{12}\mathrm{C}$? The mass of 4He is 3728.40 MeV/c2 and the mass of 12C is 11,177.93 MeV/c2.

28) In the radioactive decay equation $^{238}_{92} \rightarrow {}^{234}_{90}\mathrm{Th} + \mathrm{X}$, what is X?

29) An oxygen-15 nucleus, $^{15}_{8}\mathrm{O}$, decays to another atomic nucleus by emitting a β^+ ray. What is the other atomic nucleus?

A) $^{15}_{6}\mathrm{C}$ B) $^{14}_{8}\mathrm{C}$ C) $^{16}_{8}\mathrm{F}$ D) $^{15}_{7}\mathrm{N}$ E) $^{17}_{7}\mathrm{N}$

30) A nuclear reaction is shown: $^{10}_{5}\mathrm{B} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{1}_{1}\mathrm{H} + ?$. Which one of the following isotopes is the missing nuclear product?

A) $^{13}_{7}\mathrm{N}$ B) $^{12}_{9}\mathrm{F}$ C) $^{21}_{7}\mathrm{N}$ D) $^{13}_{6}\mathrm{C}$ E) $^{14}_{7}\mathrm{N}$

31) The decay constant of a radioactive nuclide is $4.6 \times 10^{-3}\ \mathrm{s}^{-1}$. What is the half-life of this isotope, in minutes?

32) Americium-243 has a decay constant of $9.39 \times 10^{-5}\ \mathrm{years}^{-1}$. How long will it take for a sample of americium-243 to lose one-third of its nuclei?

33) Suppose that in a certain collection of nuclei there were initially 1024 billion nuclei, and 20.0 minutes later there was only 1.00 billion nuclei left, the others having decayed. On the basis of this information, how many nuclei would you estimate decayed in the first 6.00 minutes?

34) A 1.0-mol sample of an isotope is decaying with a half-life of 28 y. After 61 y, how many moles of this isotope are left and what is its activity in Bq?

35) A thallium source with a half-life of 3.7 years was certified at 10 kBq ten years ago. What is its activity now?

36) The half-life of a radioactive material is 4.5 days. How many days are required for a sample, with an initial activity of 1.0×10^5 Bq, to decay to an activity of 100 Bq?

37) An archaeologist finds the $^{14}\mathrm{C}$ in a sample of 2.10 g of material to be decaying at 107 Bq. A modern 1.00-g sample of the same material decays at 151 Bq,and assume this rate has also held in the past. The half-life of $^{14}\mathrm{C}$ is 5730 years. How old is the sample?

Answer Key
Testname: CH30_RADIOACTIVITY

1) C
2) C
3) 226
4) A
5) D
6) B
7) A
8) D
9) 4
10) (a) 0, 1 (b) 0, –1 (c) 0, 0
11) E
12) B
13) A
14) A
15) D
16) B
17) A
18) B
19) 2.81×10^{-14} m
20) 2.3×10^{17} kg/m^3
21) 3.4×10^{-15} m
22) about 2.1×10^{-26} kg
23) 24.69 MeV
24) 1700 MeV
25) 4.28 MeV
26) 28.3 MeV
27) 7.27 MeV
28) $^4_2$He (α particle)
29) D
30) D
31) 2.5 min
32) 4.32×10^3 y
33) 896 billion
34) 0.22 mol, 1.0×10^{14} Bq
35) 1.5 kBq
36) 45 days
37) 8980 years