Radioactivity Review (Chapter 7)

1. The alpha decay of radon-222 will yield which of the following?
   a. bismuth-220	en c. astatine-222
   b. francium-222	d. polonium-218

2. Which of the following types of decay will produce daughter nuclei with a different atomic number and mass number than the parent nucleus’s atomic number and mass number?

<table>
<thead>
<tr>
<th>I.</th>
<th>alpha decay</th>
<th>II.</th>
<th>beta decay</th>
<th>III.</th>
<th>gamma decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>I. and III. only</td>
<td>c.</td>
<td>I., II., and III.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>II. and III. only</td>
<td>d.</td>
<td>I. and II. only</td>
<td></td>
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</tbody>
</table>

3. The majority of the energy released from a hydrogen bomb results from:
   a. an uncontrolled fusion chain reaction	en c. an uncontrolled fission chain reaction
   b. a controlled fusion chain reaction	d. a controlled fission chain reaction

4. If an isotope of iodine decays to an isotope of xenon, the type of decay must have been:
   a. gamma	en c. alpha
   b. fission	d. beta

5. Which of the following symbols completes the decay equation below?

\[ ^{211}_{87}\text{Fr} \rightarrow ^{207}_{85}\text{At} + ? \]

   a. \( _0^1\gamma \)	en c. \( _2^4\alpha \)
   b. \( _0^1n \)	d. \( _{-1}^0\beta \)

6. Which of the following represents a nuclear fusion reaction?

   a. \( ^1_1\text{H} + ^1_1\text{H} \rightarrow ^4_2\text{He} + ^1_0n + \text{energy} \)
   b. \( ^{238}_{92}\text{U} \rightarrow ^{234}_{90}\text{Th} + ^4_2\text{He} + \text{energy} \)
   c. \( ^{235}_{92}\text{U} + ^1_0n \rightarrow ^{36}_{36}\text{Kr} + ^{141}_{56}\text{Ba} + 3 ^1_0n + \text{energy} \)
   d. \( ^{56}_{26}\text{Fe} + ^0_{-1}\text{e} \rightarrow ^{55}_{25}\text{Mn} + \text{energy} \)

7. How would you describe the penetrating power of a beta particle?
   a. less penetrating than both alpha and beta radiation
   b. more penetrating than gamma, but less penetrating than alpha radiation
   c. less penetrating than gamma, but more penetrating than alpha radiation
   d. more penetrating than both alpha and gamma radiation
8. Which of the following represents the process whereby a beta particle is produced in the nucleus?
   a. $^4_2\text{He} \rightarrow 2^1_1\text{p} + 2^1_0\text{n}$
   b. $^0_1\text{e} + ^0_{-1}\text{e} \rightarrow 2^0_0\gamma$
   c. $^1_0\text{n} \rightarrow ^1_1\text{p} + ^0_{-1}\text{e}$
   d. $^1_1\text{p} + ^0_{-1}\text{e} \rightarrow ^1_0\text{n}$

9. Which of the following correctly compares gamma rays to microwaves?
   a. Gamma rays have a shorter wavelength, a higher frequency, and carry more energy than microwaves.
   b. Gamma rays have a shorter wavelength, a higher frequency, and carry less energy than microwaves.
   c. Gamma rays have a longer wavelength, a lower frequency, and carry less energy than microwaves.
   d. Gamma rays have a shorter wavelength, a lower frequency, and carry more energy than microwaves.

10. If a radioactive sample of rutherfordium-257 undergoes gamma decay, which of the following will be formed after the release of the gamma radiation?
    a. $^{253}_{103}\text{Lr}$
    b. $^{257}_{105}\text{Db}$
    c. $^{253}_{102}\text{No}$
    d. $^{257}_{104}\text{Rf}$

11. Which of the following is a concern even when a nuclear reactor is operating safely?
    a. Nuclear energy does not produce a lot of electricity.
    b. Nuclear reactors generate a large amount of greenhouse gases.
    c. Some nuclear waste material has a long half-life.
    d. The world’s supply of uranium is very low.

12. Which of the following is true concerning the elements in the periodic table?
    a. The neutron-to-proton ratio increases as the atomic numbers of the elements increase.
    b. The neutron-to-proton ratio decreases as the atomic numbers of the elements increase.
    c. The neutron-to-proton ratio changes randomly as the atomic numbers of the elements increase.
    d. The neutron-to-proton ratio is constant as the atomic numbers of the elements increase.

13. A major obstacle associated with the development of fusion reactors for commercial energy production is:
    a. the fact that the energy available from fusion reactors is much less than that from fission reactors
    b. that fusion reactors will generate much more radioactive waste than fission reactors generate
    c. the huge temperatures required to initiate and maintain nuclear fusion
    d. the worldwide shortage of available hydrogen for fuel
14. Which of the following is true concerning the isotopes potassium-41 and potassium-39?
   a. Potassium-41 has two more protons than potassium-39.
   b. Potassium-41 has two more neutrons than potassium-39.
   c. Potassium-41 has one more proton and one more electron than potassium-39.
   d. Potassium-41 has one more proton and one more neutron than potassium-39.

15. Which of the following correctly lists the types of emissions from slowest to fastest?

<table>
<thead>
<tr>
<th></th>
<th>Slowest</th>
<th>Fastest</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>(\alpha)</td>
<td>(\beta)</td>
</tr>
<tr>
<td>b.</td>
<td>(\alpha)</td>
<td>(\gamma)</td>
</tr>
<tr>
<td>c.</td>
<td>(\beta)</td>
<td>(\alpha)</td>
</tr>
<tr>
<td>d.</td>
<td>(\gamma)</td>
<td>(\beta)</td>
</tr>
</tbody>
</table>

   a. d  b. b  c. a  d. c

16. After a radioactive nucleus has decayed via beta emission, the daughter nucleus has:
   a. a mass number that is unchanged, and an atomic number increased by one
   b. an atomic number decreased by four, and a mass number decreased by two
   c. a mass number decreased by four, and an atomic number decreased by two
   d. both a mass number and an atomic number decreased by two

17. When uranium-235 undergoes fission, a number of possible fission products can result. The following represents one possible fission result:

\[ {^1}_0 n + {^{235}}_92 U \rightarrow {^{92}}_{36} Kr + ? + 3 {^1}_0 n + \text{energy} \]

Which of the following represents the missing daughter nucleus?

a. \(^{144}_{56}\)Ba  
   b. \(^{140}_{60}\)Nd  
   c. \(^{94}_{42}\)Mo  
   d. \(^{143}_{55}\)Cs

18. Which of the following correctly compares nuclear fusion to nuclear fission?
   a. Nuclear fusion is much easier to initiate and produces less energy than nuclear fission.
   b. Nuclear fusion is much easier to initiate and produces more energy than nuclear fission.
   c. Nuclear fusion is much more difficult to initiate and produces more energy than nuclear fission.
   d. Nuclear fusion is much more difficult to initiate and produces less energy than nuclear fission.
19. The half-life of plutonium-242 is about 400 000 years. How long would it take for a 10.0 g sample of this radioisotope to decay to 1.25 g?
   a. 800 000 years   c. 1 200 000 years
   b. 1 600 000 years   d. 2 000 000 years

20. To initiate a uranium fission reaction in a nuclear reactor, uranium-235 nuclei must absorb:
   a. alpha particles   c. neutrons
   b. beta particles   d. gamma rays

21. The half-life of magnesium-28 is 21 hours. If a 40 g sample of this radioisotope began decaying now, how many hours would pass before only 2.5 g remained?
   a. 126 hours   c. 105 hours
   b. 84 hours   d. 63 hours

22. If nickel-60 undergoes gamma decay, the nucleus produced will be:
   a. iron-56   c. iron-58
   b. copper-60   d. nickel-60

23. Which of the following nuclear decay processes would form a daughter nucleus with an atomic number larger than the parent nucleus?
   a. α-decay   c. λ-decay
   b. γ-decay   d. β-decay

24. The half-life of zinc-71 is 2.4 min. If you began with 50.0 g of this substance, what mass remains after 9.6 min?
   a. 3.12 g   c. 6.25 g
   b. 12.5 g   d. 25.0 g

25. Which of the following represents a nuclear fission reaction?
   a. \(^{239}\text{U} \rightarrow ^{234}\text{Th} + ^{4}\text{He} + \text{energy}\)
   b. \(^{2}_{1}\text{H} + ^{3}_{1}\text{H} \rightarrow ^{4}_{2}\text{He} + ^{1}_{0}\text{n} + \text{energy}\)
   c. \(^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{92}_{36}\text{Kr} + ^{141}_{56}\text{Ba} + 3^1_{0}\text{n} + \text{energy}\)
   d. \(^{55}_{26}\text{Fe} + ^{0}_{-1}\text{e} \rightarrow ^{55}_{25}\text{Mn} + \text{energy}\)

26. Consider the following nuclear equation:
   \(^{4}_{2}\text{He} + ^{14}_{7}\text{N} \rightarrow ? + ^{1}_{1}\text{H}\)

   The missing element is:
   a. fluorine   c. oxygen
   b. sodium   d. neon
27. If the daughter nucleus formed as a result of alpha decay is \(^{192}_{77}\text{Ir}\) then the parent nucleus was an isotope of which element?
   a. thallium
d. gold
   b. mercury
c. lead

28. Which of the following emissions is not part of the electromagnetic spectrum?
   a. X-radiation
   b. gamma radiation
d. ultraviolet radiation
   c. beta radiation

29. Consider the following two isotopes of uranium:

\[
\begin{align*}
\text{\(^{235}_{92}\text{U}\)} & \quad \text{and} \quad \text{\(^{238}_{92}\text{U}\)}
\end{align*}
\]

Which of the following is true?
   a. One of the isotopes has 235 neutrons, and the other has 238 neutrons.
   b. One of the isotopes has 143 protons, and the other has 146 protons.
   c. One of the isotopes has 143 neutrons, and the other has 146 neutrons.
   d. One of the isotopes has a mass of 327, and the other has a mass of 330.

30. Which of the following applies to isotopes of an element?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>I.</td>
<td>They have the same number of protons.</td>
</tr>
<tr>
<td>II.</td>
<td>They have the same number of neutrons.</td>
</tr>
<tr>
<td>III.</td>
<td>They have the same number of electrons.</td>
</tr>
<tr>
<td>IV.</td>
<td>They have the same atomic number.</td>
</tr>
<tr>
<td>V.</td>
<td>They have the same mass number.</td>
</tr>
</tbody>
</table>

   a. I., II., and III. only
d. III., IV., and V. only
   b. I., III., and IV. only
c. II., III., and IV. only

31. Which of the following is correct concerning atomic number, mass number, and neutron number for any nucleus?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>I.</td>
<td>atomic number = mass number - neutron number</td>
</tr>
<tr>
<td>II.</td>
<td>mass number = atomic number + neutron number</td>
</tr>
<tr>
<td>III.</td>
<td>neutron number = mass number - atomic number</td>
</tr>
<tr>
<td>IV.</td>
<td>atomic number = mass number + neutron number</td>
</tr>
<tr>
<td>V.</td>
<td>mass number = atomic number - neutron number</td>
</tr>
<tr>
<td>VI.</td>
<td>neutron number = mass number - atomic number</td>
</tr>
</tbody>
</table>

   a. II., IV., and VI. only
d. III., IV., and V. only
   b. II., III., and IV. only
c. I., V., and VI. only
32. Using the below symbols, which of the following represents an alpha particle?

![Diagram of symbols](image)

- a. symbol A
- b. symbol B
- c. symbol C
- d. symbol D

33. After a radioactive nucleus has decayed via alpha emission, the daughter nucleus has:

- a. an atomic number decreased by four, and a mass number decreased by two
- b. both a mass number and an atomic number decreased by two
- c. a mass number that is unchanged, and an atomic number increased by one
- d. a mass number decreased by four, and an atomic number decreased by two

34. Considering the fact that the mass of a proton is approximately 1840 times the mass of an electron, which of the following is true?

- a. A beta particle is more than 7000 times the mass of an alpha particle.
- b. An alpha particle is almost 4000 times the mass of a beta particle.
- c. A beta particle is almost 4000 times the mass of an alpha particle.
- d. An alpha particle is more than 7000 times the mass of a beta particle.

35. What nucleus will be formed when $^{216}_{84}$Po first undergoes alpha decay and then the daughter nucleus formed from that decay undergoes beta decay?

- a. $^{214}_{81}$Tl
- b. $^{214}_{85}$Bi
- c. $^{214}_{82}$Pb
- d. $^{216}_{85}$At

36. Which of the following symbols completes the decay equation below?

$^{201}_{79}$Au $\rightarrow$ $^{201}_{80}$Hg + ?

- a. $^{0}_{-1}\beta$
- b. $^{0}_{0}\gamma$
- c. $^{4}_{2}\alpha$
- d. $^{1}_{0}n$
37. Which of the following decay products will be repelled by a positively charged surface?
   a. an alpha particle  
   b. a beta particle  
   c. a gamma ray  
   d. a neutron

38. Which of the following will have the greatest amount of charge relative to its mass, that is, the greatest charge-to-mass ratio?
   a. an alpha particle  
   b. a beta particle  
   c. a neutron  
   d. a gamma ray

39. What percentage of carbon-14 will be left in a fossilized organism if the organism died approximately 29,000 years ago?
   a. 1.56 percent  
   b. 3.12 percent  
   c. 6.25 percent  
   d. 12.5 percent

40. A geologist attempts to date a sample of volcanic rock using potassium-40 as a “radioactive clock.” She finds that the ratio of argon-40 to potassium-40 in the rock is 7 to 1. She will estimate the age of the rock to be approximately:
   a. 1.3 billion years  
   b. 2.6 billion years  
   c. 3.9 billion years  
   d. 5.2 billion years

41. Which of the following isotope pairs is likely to have a daughter-to-parent ratio of 3 to 1 after approximately 1.5 billion years?

<table>
<thead>
<tr>
<th>Parent</th>
<th>Daughter</th>
</tr>
</thead>
<tbody>
<tr>
<td>thorium-235</td>
<td>lead-206</td>
</tr>
<tr>
<td>rubidium-87</td>
<td>strontium-87</td>
</tr>
<tr>
<td>potassium-40</td>
<td>argon-40</td>
</tr>
<tr>
<td>uranium-235</td>
<td>lead-207</td>
</tr>
</tbody>
</table>

   a. a  
   b. b  
   c. c  
   d. d

42. A bone found at a newly discovered ancient burial site is dated using carbon-14. A sample of the bone is found to contain approximately 12.5 percent of the carbon-14 present in a living sample. The age of the fossil is approximately:
   a. 18,000 years  
   b. 24,000 years  
   c. 30,000 years  
   d. 36,000 years

Matching

Match the description of the nuclear changes with the correct type of decay. Each type of decay may be used more than once.

   a. alpha decay  
   b. beta decay  
   c. gamma decay

43. A nucleus releases energy in the form of electromagnetic radiation.
44. A high-speed negative particle is ejected from the nucleus.

45. A particle composed of two of each of the subatomic particles contributing mass to the atom is ejected from the nucleus.

46. The mass of the daughter nucleus is less than that of the parent nucleus.

47. Neither the mass number nor the atomic number of the nucleus changes following this decay.

48. The positive charge on the daughter nucleus is greater than that of the parent nucleus.

Match each description regarding the amount of daughter and parent nuclei present to the correct parent isotope and half-life. Each description may be used only once.

a. After 11 460 years, 25 percent of the parent isotope remains.

b. After one month, approximately 87.5 percent of the parent isotope has decayed.

c. Twice as much daughter isotope exists as parent isotope after 1.4 billion years.

d. After 650 million years, approximately 25 percent of the parent isotope has decayed.

e. Approximately 3 percent of the parent isotope remains after 140 years.

49. strontium-90 / 28 years

50. iodine-131 / 8 days

51. carbon-14 / 5730 years

52. potassium-40 / 1.3 billion years

53. uranium-235 / 710 million years

When uranium-235 absorbs a neutron, there are many possible fission products. Match the missing fission product to the correct nuclear equation below. Each fission product may be used only once.

a. $^{92}_{32}$Ge

b. $^{90}_{37}$Rb

c. $^{36}_{16}$Kr

d. $^{116}_{42}$Mo

54. $^{235}_{92}$U + $^1_0$n $\rightarrow$ ? + $^{143}_{55}$Cs + 3 $^1_0$n

55. $^{235}_{92}$U + $^1_0$n $\rightarrow$ ? + $^{115}_{50}$In + 3 $^1_0$n

56. $^{235}_{92}$U + $^1_0$n $\rightarrow$ ? + $^{141}_{56}$Ba + 3 $^1_0$n

57. $^{235}_{92}$U + $^1_0$n $\rightarrow$ ? + $^{140}_{60}$Nd + 3 $^1_0$n
Match the atomic symbol with the correct description below. Each symbol may be used only once.

a. $^{238}_{92}\text{U}$

b. $^{131}_{54}\text{Xe}$

c. $^{141}_{56}\text{Ba}$

d. $^{257}_{104}\text{Rf}$

e. $^{206}_{82}\text{Pb}$

58. This nucleus with 153 neutrons will be produced when rutherfordium-257 undergoes gamma decay.

59. This stable isotope with 114 neutrons is the final product in the decay series of uranium-238.

60. This non-fissionable nucleus contains 146 neutrons.
Radioactivity Review (Chapter 7)
Answer Section

MULTIPLE CHOICE

1. D
2. D
3. A
4. D
5. C
6. A
7. C
8. C
9. A
10. D
11. C
12. A
13. C
14. B
15. C
16. A
17. A
18. C
19. C
20. C
21. B
22. D
23. D
24. A
25. C
26. C
27. D
28. C
29. C
30. B
31. C
32. D
33. D
34. D
35. B
36. A
37. A
38. B
39. B
40. C
41. D
42. A

MATCHING

43. C
44. B
45. A
46. A
47. C
48. B

49. E
50. B
51. A
52. D
53. C

54. B
55. D
56. C
57. A

58. D
59. E
60. A