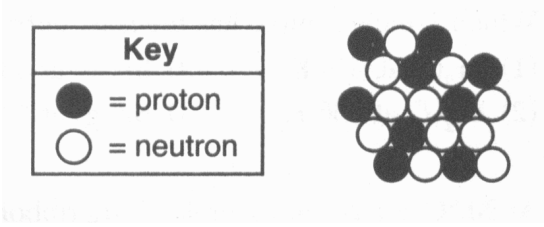
1. In the late 1800s, experiments using cathode ray tubes led to the discovery of the

A) electron B) neutron C) positron D) proton

2. Which subatomic particles are located in the nucleus of an He-4 atom?

A) electrons and neutrons
B) electrons and protons
C) neutrons and protons
D) neutrons, protons, and electrons

3. The diagram below represents the nucleus of an atom.



What are the atomic number and mass number of this atom?

A) The atomic number is 9 and the mass number is 19.
B) The atomic number is 9 and the mass number is 20.
C) The atomic number is 11 and the mass number is 19.
D) The atomic number is 11 and the mass number is 20.

4. A student constructs a model for comparing the masses of subatomic particles. The student selects a small, metal sphere with a mass of 1 gram to represent an electron. A sphere with which mass would be most appropriate to represent a proton?

A) 1g B) $\frac{1}{2}$g C) $\frac{1}{2000}$g **D)** 2000g

5. The major portion of an atom's mass consists of

A) electrons and protons B) electrons and neutrons
C) neutrons and positrons **D) neutrons and protons**

6. Which conclusion was a direct result of the gold foil experiment?

A) An atom is mostly empty space with a dense, positively charged nucleus.
B) An atom is composed of at least three types of subatomic particles.
C) An electron has a positive charge and is located inside the nucleus.
D) An electron has properties of both waves and particles.

7. What is the total charge of the nucleus of a nitrogen atom?

A) +5 B) +2 **C) +7** D) +1

8. An atom is electrically neutral because the

A) number of protons equals the number of electrons
B) number of protons equals the number of neutrons
C) ratio of the number of neutrons to the number of electrons is 1:1
D) ratio of the number of neutrons to the number of protons is 2:1

9. What is the mass number of a carbon atom that contains six protons, eight neutrons, and six electrons?

A) 6 B) 8 **C) 14** D) 20

10. Compared to an atom of phosphorus-31, an atom of sulfur-32 contains

A) one less neutron B) one less proton
C) one more neutron **D) one more proton**

11. The number of neutrons in the nucleus of an atom can be determined by

A) adding the atomic number to the mass number
B) subtracting the atomic number from the mass number
C) adding the mass number to the atomic mass
D) subtracting the mass number from the atomic number

12. The atomic mass unit is defined as exactly $\frac{1}{12}$ the mass of an atom of

A) $^{12}_{6}C$ B) $^{14}_{6}C$ C) $^{24}_{12}Mg$ D) $^{26}_{12}Mg$

13. The nucleus of an atom of cobalt-58 contains

A) 27 protons and 31 neutrons
B) 27 protons and 32 neutrons
C) 59 protons and 60 neutrons
D) 60 protons and 60 neutrons

14. Isotopes of an element must have different

A) atomic numbers **B) mass numbers**
C) numbers of protons D) numbers of electrons

15. For most atoms with an atomic number less than 20, nuclear stability occurs when the ratio of neutrons to protons is 1:1. Which of the following atoms would be most likely to have an unstable nucleus?

A) $^{4}_{2}He$ B) $^{12}_{6}C$ **C)** $^{16}_{7}N$ D) $^{24}_{12}Mg$

16. What information is necessary to determine the atomic mass of the element chlorine?

A) the atomic mass of each artificially produced isotope of chlorine, only
B) the relative abundance of each naturally occurring isotope of chlorine, only
C) the atomic mass and the relative abundance of each naturally occurring isotope of chlorine
D) the atomic mass and the relative abundance of each naturally occurring and artificially produced isotope of chlorine

17. A 100.00-gram sample of naturally occurring boron contains 19.78 grams of boron-10 (atomic mass = 10.01 atomic mass units) and 80.22 grams of boron-11 (atomic mass = 11.01 atomic mass units). Which numerical setup can be used to determine the atomic mass of naturally occurring boron?

A) (0.1978)(10.01) + (0.8022)(11.01)
B) (0.8022)(10.01) + (0.1978)(11.01)
C) (0.1978)(10.01)/(0.8022)(11.01)
D) (0.8022)(10.01)/(0.1978)(11.01)

18. What is the total number of valence electrons in an atom of germanium in the ground state?

A) 8 B) 2 C) 14 **D) 4**

19. Which two notations represent different isotopes of the same element?

A) $^{6}_{4}\mathrm{Be}$ **and** $^{9}_{4}\mathrm{Be}$ B) $^{7}_{3}\mathrm{Li}$ and $^{7}_{3}\mathrm{Li}$ C) $^{14}_{7}\mathrm{N}$ and $^{14}_{6}\mathrm{C}$ D) $^{32}_{15}\mathrm{P}$ and $^{32}_{16}\mathrm{S}$

20. Element *X* has two isotopes. If 72.0% of the element has an isotopic mass of 84.9 atomic mass units, and 28.0% of the element has an isotopic mass of 87.0 atomic mass units, the average atomic mass of element *X* is numerically equal to

A) $(72.0 + 84.9) \times (28.0 + 87.0)$
B) $(72.0 - 84.9) \times (28.0 + 87.0)$
C) $\frac{(72.0 \times 84.9)}{100} + \frac{(28.0 \times 87.0)}{100}$
D) $(72.0 \times 84.9) + (28.0 \times 87.0)$

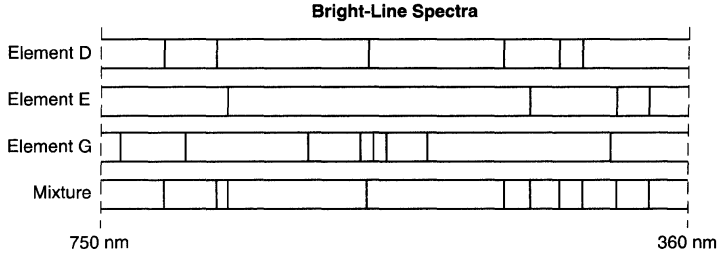
21. Which statement describes the relative energy of the electrons in the shells of a calcium atom?

A) An electron in the first shell has more energy than an electron in the second shell.
B) An electron in the first shell has the same amount of energy as an electron in the second shell.
C) An electron in the third shell has more energy than an electron in the second shell.
D) An electron in the third shell has less energy than an electron in the second shell.

22. What is the electron configuration of a sulfur atom in the ground state?

A) 2–4 B) 2–6 C) 2–8–4 **D) 2–8–6**

23. Given the bright-line spectra of three elements and the spectrum of a mixture formed from at least two of these elements:



Which elements are present in this mixture?

A) *E* and *D*, only B) *E* and *G*, only
C) *D* and *G*, only D) *D*, *E*, and *G*

24. Which electron configuration represents an atom of lithium in an excited state?

A) 1-1 **B) 1-2** C) 2-1 D) 2-2

25. As an electron moves from its ground state to an excited state, the potential energy of the atom

A) decreases **B) increases**
C) remains the same

26. As an electron in an atom moves from the ground state to the excited state, the electron

A) gains energy as it moves to a higher energy level
B) gains energy as it moves to a lower energy level
C) loses energy as it moves to a higher energy level
D) loses energy as it moves to a lower energy level

27. Which electron transition represents a gain of energy?

A) from 2nd to 3rd shell B) from 2nd to 1st shell
C) from 3rd to 2nd shell D) from 3rd to 1st shell

28. When the electrons of an excited atom return to a lower energy state, the energy emitted can result in the production of

A) alpha particles B) isotopes
C) protons **D) spectra**

29. Which principal energy level change by the electron of a hydrogen atom will cause the greatest amount of energy to be absorbed?

A) $n = 2$ to $n = 4$ **B) $n = 2$ to $n = 5$**
C) $n = 4$ to $n = 2$ D) $n = 5$ to $n = 2$

30. In the electron cloud model of the atom, an orbital is defined as the most probable

A) charge of an electron
B) conductivity of an electron
C) location of an electron
D) mass of an electron

31. The wave-mechanical model of the atom is required to explain the

A) mass number and atomic number of an atom
B) organization of atoms in a crystal
C) radioactive nature of some atoms
D) spectra of elements with multielectron atoms

32. Which of these phrases best describes an atom?

A) a positive nucleus surrounded by a hard negative shell
B) a positive nucleus surrounded by a cloud of negative charges
C) a hard sphere with positive particles uniformly embedded
D) a hard sphere with negative particles uniformly embedded

33. Which list of nuclear emissions is arranged in order from the *least* penetrating power to the greatest penetrating power?

A) alpha particle, beta particle, gamma ray
B) alpha particle, gamma ray, beta particle
C) gamma ray, beta particle, alpha particle
D) beta particle, alpha particle, gamma ray

34. Given the nuclear equation:

$$^{1}_{1}\mathrm{H} + X \rightarrow {}^{6}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$$

The particle represented by *X* is

A) $^{9}_{4}\mathrm{Li}$ **B)** $^{9}_{4}\mathrm{Be}$ C) $^{10}_{5}\mathrm{Be}$ D) $^{10}_{6}\mathrm{C}$

35. Which isotope will spontaneously decay and emit particles with a charge of +2?

A) ^{53}Fe B) ^{137}Cs C) ^{198}Au **D)** ^{220}**Fr**

36. Which nuclear emission has the greatest penetrating power?

A) alpha particle B) beta particle
C) gamma radiation D) positron

37. Which reaction is an example of natural transmutation?

A) $^{239}_{94}\mathrm{Pu} \rightarrow {}^{235}_{92}\mathrm{U} + {}^{4}_{2}\mathrm{He}$
B) $^{27}_{13}\mathrm{Al} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{30}_{15}\mathrm{P} + {}^{1}_{0}\mathrm{n}$
C) $^{238}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{239}_{94}\mathrm{Pu} + 2\ {}^{0}_{-1}\mathrm{e}$
D) $^{239}_{94}\mathrm{Pu} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{147}_{56}\mathrm{Ba} + {}^{90}_{38}\mathrm{Sr} + 3\ {}^{1}_{0}\mathrm{n}$

38. Atoms of I-131 spontaneously decay when the

A) stable nuclei emit alpha particles
B) stable nuclei emit beta particles
C) unstable nuclei emit alpha particles
D) unstable nuclei emit beta particles

39. Which notation of a radioisotope is correctly paired with the notation of its emission particle?

A) $^{37}\mathrm{Ca}$ and $^{4}_{2}\mathrm{He}$ B) $^{235}\mathrm{U}$ and $^{0}_{+1}\mathrm{e}$
C) $^{16}\mathrm{N}$ and $^{1}_{1}\mathrm{p}$ **D)** $^{3}\mathrm{H}$ and $^{0}_{-1}\mathrm{e}$

40. Given the nuclear equation:

$$^{19}_{10}\mathrm{Ne} \rightarrow X + {}^{19}_{9}\mathrm{F}$$

What particle is represented by *X*?

A) alpha B) beta C) neutron **D) positron**

41. What is the total number of years that must pass before only 25.00 grams of an original 100.0-gram sample of C-14 remains unchanged?

A) 2865 y B) 5730 y
C) 11 460 y D) 17 190 y

42. Which fraction of an original 20.00-gram sample of nitrogen-16 remains unchanged after 36.0 seconds?

A) $\frac{1}{5}$ B) $\frac{1}{8}$ C) $\frac{1}{16}$ **D)** $\frac{1}{32}$

43. A change in the nucleus of an atom that converts the atom from one element to another element is called

A) combustion B) neutralization
C) polymerization **D) transmutation**

44. Which nuclear equation represents a natural transmutation?

A) $^{9}_{4}\mathrm{Be} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{6}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$
B) $^{27}_{13}\mathrm{Al} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{30}_{15}\mathrm{P} + {}^{1}_{0}\mathrm{n}$
C) $^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{17}_{8}\mathrm{O} + {}^{1}_{1}\mathrm{H}$
D) $^{235}_{92}\mathrm{U} \rightarrow {}^{231}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$

45. The nuclear reaction:

$$^{4}_{2}\mathrm{He} + {}^{27}_{13}\mathrm{Al} \rightarrow {}^{30}_{15}\mathrm{P} + {}^{1}_{0}\mathrm{n}$$

Is an example of

A) nuclear fusion B) nuclear fission
C) natural transmutation **D) artificial transmutation**

46. Which isotope is used to treat cancer?

A) C-14 B) U-238 **C) Co-60** D) Pb-206

47. Given the balanced equation representing a nuclear reaction:

$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{142}_{56}\mathrm{Ba} + {}^{91}_{36}\mathrm{Kr} + 3X + \text{energy}$

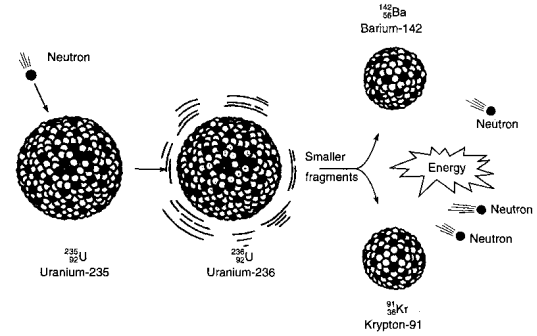
Which particle is represented by *X*?

A) $^{0}_{-1}\mathrm{e}$ B) $^{1}_{1}\mathrm{H}$ C) $^{4}_{2}\mathrm{H}$ **D)** $^{1}_{0}\mathrm{n}$

48. What is one benefit associated with a nuclear fission reaction?

A) The products are not radioactive.
B) Stable isotopes are used as reactants.
C) There is no chance of biological exposure.
D) A large amount of energy is produced.

49. The diagram below represents a nuclear reaction in which a neutron bombards a heavy nucleus.



Which type of reaction does the diagram illustrate?

A) fission B) fusion
C) alpha decay D) beta decay

50. Which statement best describes a primary occurrence in an uncontrolled fission reaction?

A) Mass is created and energy is released.
B) Mass is created and energy is stored.
C) Mass is converted to energy, which is released.
D) Mass is converted to energy, which is stored.

51. Which balanced equation represents a fusion reaction?

A) $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{93}_{36}\mathrm{Kr} + {}^{140}_{56}\mathrm{Ba} + 3\,{}^{1}_{0}\mathrm{n}$
B) $^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$
C) $^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{17}_{8}\mathrm{O} + {}^{1}_{1}\mathrm{H}$
D) $^{226}_{88}\mathrm{Ra} \rightarrow {}^{222}_{86}\mathrm{Rn} + {}^{4}_{2}\mathrm{He}$

52. In which type of reaction do two lighter nuclei combine to form one heavier nucleus?

A) combustion B) reduction
C) nuclear fission **D) nuclear fusion**

53. Nuclear fusion *differs* from nuclear fission because nuclear fusion reactions

A) form heavier isotopes from lighter isotopes
B) form lighter isotopes from heavier isotopes
C) convert mass to energy
D) convert energy to mass

54. The decay of which radioisotope can be used to estimate the age of the fossilized remains of an insect?

A) Rn-222 B) I-131 C) Co-60 **D) C-14**

55. Explain, in terms of protons and neutrons, why U-235 and U-238 are different isotopes of uranium.

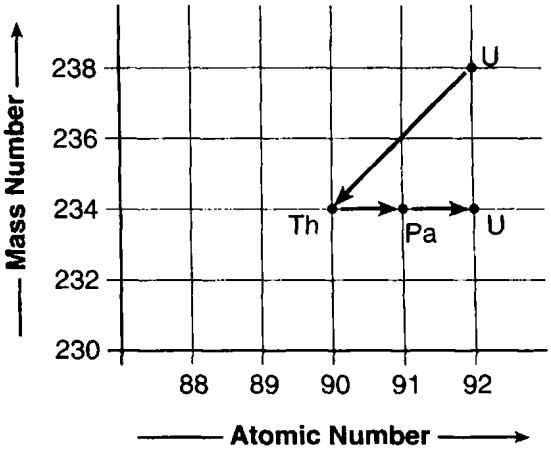
56. High energy is a requirement for fusion reactions to occur because the nuclei involved

A) attract each other because they have like charges
B) attract each other because they have unlike charges
C) repel each other because they have like charges
D) repel each other because they have unlike charges

57. Which conditions are required to form $^{4}_{2}He$ during the fusion reaction in the Sun?

A) high temperature and low pressure
B) high temperature and high pressure
C) low temperature and low pressure
D) low temperature and high pressure

58. The chart below shows the spontaneous nuclear decay of U-238 to Th-234 to Pa-234 to U-234.



What is the correct order of nuclear decay modes for the change from U-238 to U-234?

A) β^- decay, γ decay, β^- decay
B) β^- decay, β^- decay, α decay
C) α decay, α decay, β^- decay
D) α decay, β^- decay, β^- decay

59. Which radioactive isotope is used in geological dating?

A) uranium-238
B) iodine-131
C) cobalt-60
D) technetium-99

60. Which radioisotope is used for diagnosing thyroid disorders?

A) U-238 B) Pb-206 **C) I-131** D) Co-60

61. The course of a chemical reaction can be traced by using a

A) polar molecule
B) diatomic molecule
C) stable isotope
D) radioisotope

62. Radioisotopes used for medical diagnosis must have

A) long half-lives and be quickly eliminated by the body
B) long half-lives and be slowly eliminated by the body
C) short half-lives and be quickly eliminated by the body
D) short half-lives and be slowly eliminated by the body

63. A radioisotope which is sometimes used by doctors to pinpoint a brain tumor is

A) carbon-12
B) lead-206
C) technetium-99
D) uranium-238

64. Radiation used in the processing of food is intended to

A) increase the rate of nutrient decomposition
B) kill microorganisms that are found in the food
C) convert ordinary nutrients to more stable forms
D) replace chemical energy with nuclear energy

65. Which statement explains why nuclear waste materials may pose a problem?

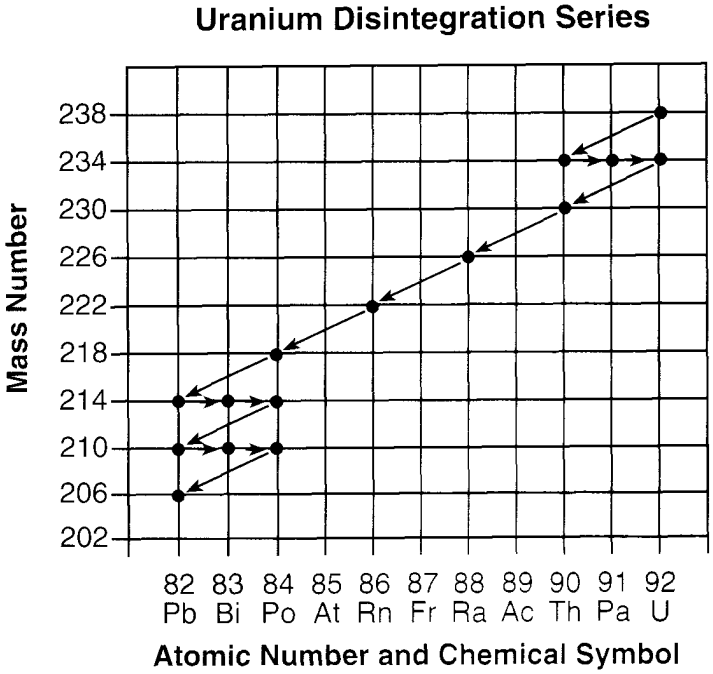
A) They frequently have short half-lives and remain radioactive for brief periods of time.
B) They frequently have short half-lives and remain radioactive for extended periods of time.
C) They frequently have long half-lives and remain radioactive for brief periods of time.
D) They frequently have long half-lives and remain radioactive for extended periods of time.

66. According to Table N, which radioactive waste can be stored for decay and then safely released directly into the environment?

A) N-16 B) Sr-9O C) Cs-137 D) Pu-239

Base your answers to questions **67** and **68** on the information below.

A U-238 atom decays to a Pb-206 atom through a series of steps. Each point on the graph below represents a nuclide and each arrow represents a nuclear decay mode.



67. Explain why the U-238 disintegration series ends with the nuclide Pb-206.

68. Based on this graph, what particle is emitted during the nuclear decay of a Po-218 atom?

69. in the space below, write an electron configuration for a silicon atom in an excited state.

Base your answers to questions **70** through **72** on the information below.

In the early 1800s, John Dalton proposed an atomic theory that was based on experimental observations made by several scientists. Three concepts of Dalton's atomic theory are stated below.

Statement *A*: Atoms are indivisible and cannot be destroyed or broken down into smaller parts.
Statement *B*: Atoms of one element cannot be changed into atoms of another element.
Statement *C*: All atoms of one element have the same mass.

70. The decay of N-16 is represented by the balanced equation below.

$^{16}_{7}N \longrightarrow {}^{0}_{-1}e + {}^{16}_{8}O$

State evidence that indicates statement *B* is *not* always true.

71. Explain, in terms of particles in the atoms of an element, why statement *C* is *false.*

72. Explain, in terms of particles, why statement *A* is no longer accepted.

Base your answers to questions **73** and **74** on in the information below.

When a uranium-235 nucleus absorbs a slow-moving neutron, different nuclear reactions may occur. One of these possible reactions is represented by the complete, balanced equation below.

Equation 1: $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{92}_{36}Kr + {}^{142}_{56}Ba + 2{}^{1}_{0}n + \text{energy}$

For this reaction, the sum of the masses of the products is slightly less than the sum of the masses of the reactants. Another possible reaction of U-235 is represented by the incomplete, balanced equation below.

Equation 2: $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{92}_{38}Sr + \_\_\_\_ + 2{}^{1}_{0}n + \text{energy}$

73. Identify the type of nuclear reaction represented by equation 1.

74. Determine the half-life of krypton-92 if only 6.0 milligrams of an original 96.0-milligram sample remains unchanged after 7.36 seconds.

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75. Complete the nuclear equation *below*. Include the symbol, atomic number, and mass number for the missing particle.

$^{42}_{19}K \rightarrow {}^{0}_{-1}e + \_\_\_\_\_$

76. Base your answer to the following question on the information below.

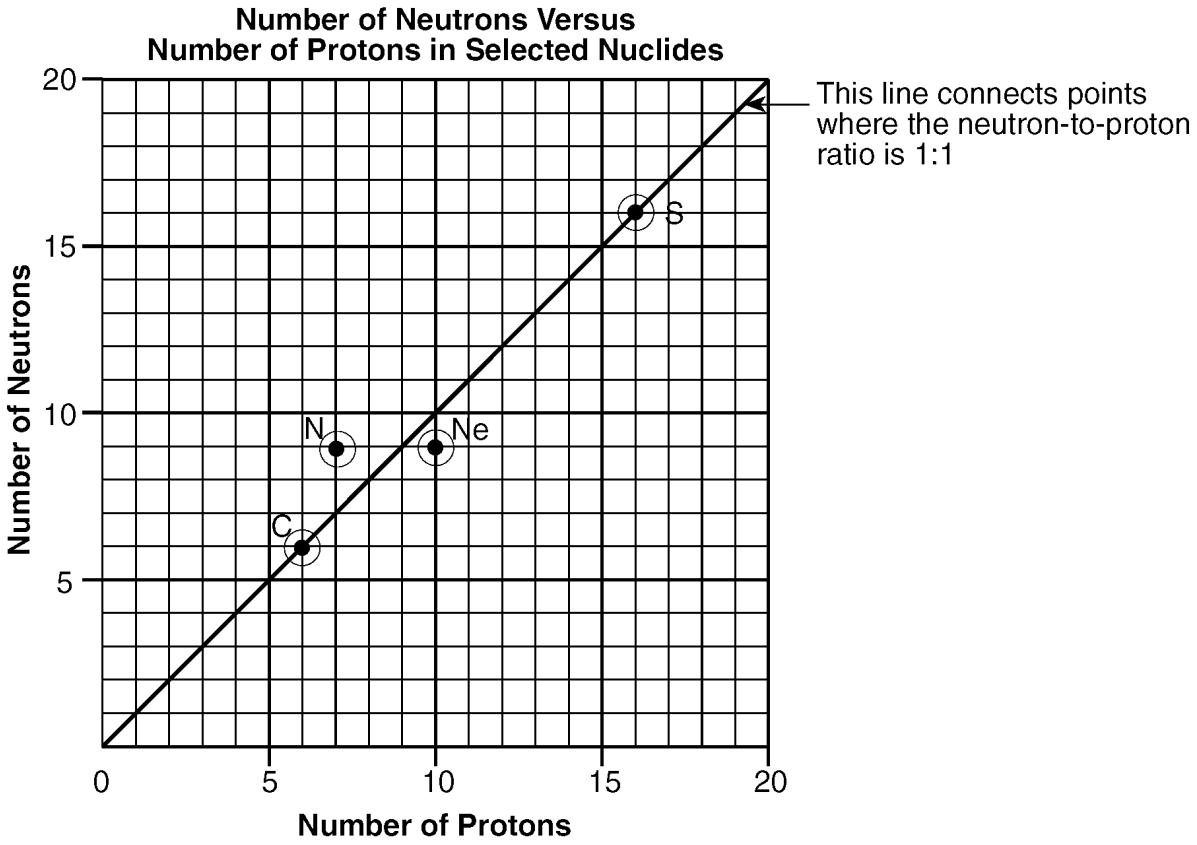
Some radioisotopes used as tracers make it possible for doctors to see the images of internal body parts and observe their functions. The table below lists information about three radioisotopes and the body part each radioisotope is used to study.

Medical Uses of Some Radioisotopes

Radioisotope	Half-life	Decay Mode	Body Part
^{24}Na	15 hours	beta	circulatory system
^{59}Fe	44.5 days	beta	red blood cells
^{131}I	8.1 days	beta	thyroid

It could take up to 60. hours for a radioisotope to be delivered to the hospital from the laboratory where it is produced. What fraction of an original sample of ^{24}Na remains unchanged after 60. hours?

77. Base your answer to the following question on the information below, which relates the numbers of neutrons and protons for specific nuclides of C, N, Ne, and S.



Element	Number of Protons	Number of Neutrons	Mass Number	Nuclide
C	6	6	12	C-12
N	7	9	16	N-16
Ne	10			
S	16	16	32	S-32

Based on your Reference Tables, complete the decay equation for N-16:

$^{16}_{7}\mathrm{N} \rightarrow$ _____ + _____

Base your answers to questions **78** and **79** on the information below.

In the gold foil experiment, a thin sheet of gold was bombarded with alpha particles. Almost all the alpha particles passed straight through the foil. Only a few alpha particles were deflected from their original paths.

78. Explain, in terms of charged particles, why some of the alpha particles were deflected.

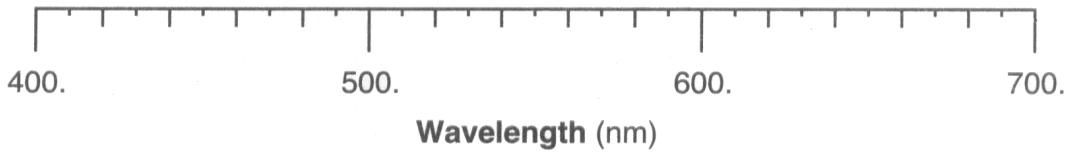
79. State *one* conclusion about atomic structure based on the observation that almost all alpha particles passed straight through the foil.

80. 40% of the isotopes of an element have a mass of 16 amu. 60% of the isotopes have a mass of 18 amu. Calculate the average atomic mass. Show all work.

Base your answers to questions **81** and **82** on the information below

The Balmer series refers to the visible bright lines in the spectrum produced by hydrogen atoms. The color and wavelength of each line in this series are given in the table below.

Color	**Wavelength** (nm)
red	656.3
blue green	486.1
blue	434.1
violet	410.2



81. Explain, in terms of both subatomic particles and energy states, how the Balmer series is produced.

82. On the diagram above draw four vertical lines to represent the Balmer series.

83. In the box below, draw a Lewis electron-dot diagram for an atom of boron.

Base your answers to questions **84** and **85** on the information below.

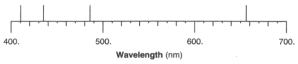
The accepted values for the atomic mass and percent natural abundance of each naturally occurring isotope of silicon are given in the data table below.

Naturally Occuring Isotopes of Silicon

Isotope	**Atomic Mass** (atomic mass unit)	**Percent Natural Abundance** (%)
$Si-28$	27.98	92.22
$Si-29$	28.98	4.69
$Si-30$	29.97	3.09

84. Show a correct numerical setup for calculating the atomic mass of Si.

85. Determine the total number of neutrons in an atom of Si-29.

1. **A**
2. **C**
3. **B**
4. **D**
5. **D**
6. **A**
7. **C**
8. **A**
9. **C**
10. **D**
11. **B**
12. **A**
13. **A**
14. **B**
15. **C**
16. **C**
17. **A**
18. **D**
19. **A**
20. **C**
21. **C**
22. **D**
23. **A**
24. **B**
25. **B**
26. **A**
27. **A**
28. **D**
29. **B**
30. **C**
31. **D**
32. **B**
33. **A**
34. **B**
35. **D**
36. **C**
37. **A**
38. **D**
39. **D**
40. **D**
41. **C**
42. **D**
43. **D**
44. **D**
45. **D**
46. **C**
47. **D**
48. **D**
49. **A**
50. **C**
51. **B**
52. **D**
53. **A**
54. **D**
55. – A U-235 atom has 92 protons and 143 neutrons, and a U-238 atom has 92 protons and 146 neutrons. – A U-235 atom and a U-238 atom have the same number of protons but a different number of neutrons.
56. **C**
57. **B**
58. **D**
59. **A**
60. **C**
61. **D**
62. **C**
63. **C**
64. **B**
65. **D**
66. **A**
67. Examples: – The nucleus of Pb-206 is stable. – Pb-206 is not radioactive. – If Pb-206 were not stable, it would spontaneously decay.
68. Examples: – $^{4}_{2}\mathrm{He}$ – alpha particle – α
69. •2-7-5 •1-8-5 •2-8-3-1
70. Acceptable responses include, but are not limited to: • An atom of nitrogen (atomic number 7) changed into an atom of oxygen (atomic number 8). • The decay of N-16 atoms produced O-16 atoms. • Radioactive decay results in an element being changed into another element.
71. Acceptable responses include, but are not limited to: • Atoms of different isotopes of an element have different masses because they have different numbers of neutrons. • Atoms of an element can differ in the number of neutrons and, therefore, masses.
72. Acceptable responses include, but are not limited to: • Smaller parts of atoms exist, such as protons, neutrons, and electrons. • During some nuclear reactions, unstable atoms can spontaneously decay into smaller particles. • Atoms can lose electrons.
73. fission *or* transmutation
74. 1.84 s
75. $^{42}_{20}\mathrm{Ca}$
76. Examples: $\frac{1}{16}$ *or* 0.0625 *or* $6\frac{1}{4}\%$
77. $^{0}_{-1}\mathrm{e} + {}^{16}_{8}\mathrm{O}$
78. –Alpha particles are positive and are repelled by the nucleus that is also positive. –Both protons and alpha particles are positively charged so they repel each other. –Protons and alpha particles have the same charge.
79. Atoms are mostly empty space
80. 17.2 amu
81. *Examples:* – When the electron in an excited hydrogen atom returns from a higher energy state to a lower energy state, a specific amount of energy is emitted. – Light is emitted when the excited electron drops from a higher electron shell to a lower electron shell.
82. 

83. 
84. (27.98)(0.9222) + (28.98)(0.0469) + (29.97)(0.0309)
85. 15