Chapter 11 Study Questions
Name: _____________________  Class: __________________

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

___ 1. The discovery of which particle proved that the atom is NOT indivisible?
   a. proton  
   b. neutron  
   c. electron  
   d. nucleus

___ 2. In his gold foil experiment, Rutherford concluded that the atom is mostly empty space with a small, massive, positively charged center because
   a. most of the particles passed straight through the foil.
   b. some particles were slightly deflected.
   c. a few particles bounced back.
   d. All of the above

___ 3. How many protons does an atom with an atomic number of 23 and a mass number of 51 have?
   a. 23  
   b. 28  
   c. 51  
   d. 74

___ 4. An atom has no overall charge if it contains equal numbers of
   a. electrons and protons.  
   b. neutrons and protons.  
   c. neutrons and electrons.  
   d. None of the above

___ 5. Which statement about protons is true?
   a. Protons have a mass of \( \frac{1}{1,840} \) amu.
   b. Protons have no charge.
   c. Protons are part of the nucleus of an atom.
   d. Protons circle the nucleus of an atom.

___ 6. Which statement about neutrons is true?
   a. Neutrons have a mass of 1 amu.
   b. Neutrons circle the nucleus of an atom.
   c. Neutrons are the only particles that make up the nucleus.
   d. Neutrons have a negative charge.

___ 7. Which of the following determines the identity of an element?
   a. atomic number  
   b. mass number  
   c. atomic mass  
   d. overall charge

___ 8. Isotopes exist because atoms of the same element can have different numbers of
   a. protons.  
   b. neutrons.  
   c. electrons.  
   d. None of the above

___ 9. What did Democritus, Dalton, Thomson, Rutherford, and Bohr all have in common?
   a. They each identified new elements.
   b. They each identified new isotopes of atoms.
   c. They each contributed to the development of the atomic theory.
   d. They each conducted experiments in which particles collided.

___ 10. In Thomson’s “plum-pudding” model of the atom, the plums represent
    a. atoms.  
    b. protons.  
    c. neutrons.  
    d. electrons.

___ 11. An atom of gold with 79 protons, 79 electrons, and 118 neutrons would have a mass number of
    a. 39.  
    b. 158. 
    c. 197.  
    d. 276.
12. Which of the following has the LEAST mass?
   a. nucleus          c. neutron
   b. proton           d. electron

13. The isotope of uranium used in nuclear reactors, uranium-235, contains 92 protons. Another isotope, uranium-238, contains ____ electrons.
   a. 92               c. 143
   b. 95               d. 146

14. The smallest particle into which an element can be divided and still be the same substance is a(n)
   a. electron         c. atom.
   b. proton           d. molecule.

15. The Greek philosopher who gave the atom its name was
   a. Democritus.
   b. Dalton.
   c. Thomson.
   d. Rutherford.

16. ____ proposed that all atoms are small, hard particles made of a single material formed into different shapes and sizes.
   a. Dalton
   b. Democritus
   c. Thomson
   d. Rutherford

17. ____ was first to propose that atoms are always moving and that they can form different materials by joining together.
   a. Rutherford
   b. Dalton
   c. Thomson
   d. Democritus

18. How did people respond when Democritus proposed the idea of an "uncuttable" particle?
   a. They accepted his idea and Democritus became famous.
   b. They accepted his idea when they saw the results of his experiments.
   c. They did not believe Democritus because Aristotle disagreed with him.
   d. They did not believe Democritus because the electron has already been discovered.

19. ____ performed experiments with different substances. His results demonstrated that elements combine in specific proportions because they are made of individual atoms.
   a. Bohr
   b. Dalton
   c. Rutherford
   d. Democritus

20. What sparked Dalton's interest in atoms?
   a. He heard of Thomson's discovery of the electron.
   b. He read Democritus' papers about atoms.
   c. He wanted to know why elements combine in specific proportions to form compounds.
   d. He was tired of being a school teacher and was looking for other work.

21. Which of the following statements in Dalton's atomic theory was shown to be incorrect by the results of Thomson's cathode-ray tube experiment?
   a. All substances are made of atoms.
   b. Atoms are small particles that cannot be created, divided, or destroyed.
   c. Atoms of the same element are exactly alike, and atoms of different elements are different.
   d. Atoms join with other atoms to make new substances.

22. Who discovered that there are small particles inside the atom?
   a. Bohr
   b. Dalton
   c. Thomson
   d. Rutherford

23. In the cathode-ray tube experiment, a positively charged plate attracted a beam. This showed that the beam was made of
   a. molecules.
   b. atoms.
   c. positively charged particles.
   d. negatively charged particles.
24. How could Thomson be certain that the gas inside the tube was not responsible for deflecting the negatively charged beam?
   a. He removed almost all of the gas from the tube.
   b. He tried the experiment once without charging the plates to serve as a control, then tried the experiment again to see how the charged plates would affect the beam.
   c. He used only gas that was not charged.
   d. Both (a) and (b)

25. What Thomson called corpuscles are now called
   a. atoms.
   b. electrons.
   c. protons.
   d. neutrons.

26. Who performed an experiment proving that electrons exist?
   a. Bohr
   b. Dalton
   c. Thomson
   d. Rutherford

27. How did Thomson realize that positive charges must also exist within an atom?
   a. All atoms have a positive overall charge, so positive charges must exist within an atom.
   b. All atoms have a negative overall charge, but positive charges must exist within the atom to attract the negatively charged beam.
   c. Atoms have no overall charge, so positive charges must exist within an atom to balance the charges of the electrons.
   d. none of the above

28. A representation of an object or system is a(n)
   a. theory.
   b. model.
   c. law.
   d. experiment.

29. Why did Thomson change Dalton's atomic theory?
   a. Thomson had experimental evidence of atoms, and Dalton did not.
   b. Thomson's discovery that atoms were made up of even smaller particles showed that part of Dalton's theory was wrong.
   c. Thomson's discovery of the nucleus showed that Dalton's plum-pudding model was wrong.
   d. none of the above

30. Thomson's model of the atom resembled
   a. chocolate-chip ice cream.
   b. gelatin.
   c. the solar system.
   d. a balloon.

31. Who performed an experiment proving the existence of an atomic nucleus?
   a. Thomson
   b. Dalton
   c. Democritus
   d. Rutherford

32. If Thomson's model of the atom were correct, then the particles in Rutherford's experiment would have
   a. bounced directly back to the source.
   b. been deflected to the left.
   c. been deflected to the right.
   d. continued in a straight line.

33. How did Rutherford know where the particles went after being "shot" at the gold foil?
   a. A computer told him where the particles landed.
   b. An electronic mesh surrounding the foil beeped where the particles collided.
   c. The foil was surrounded with a screen coated with zinc sulfide, which glowed where the particles struck.
   d. He did not know where the particles went.

34. What happened to the particles that Rutherford used in his experiment?
   a. A few particles bounced back.
   b. Some particles were deflected.
   c. Most particles continued moving in a straight line.
35. How does Rutherford's model of the atom differ from Thomson's model of the atom?
   a. Rutherford's model was just like the plum-pudding model, except that now it contained positive charges.
   b. Rutherford's model had a tiny, dense positively charged nucleus at the atom's center.
   c. Rutherford's model had a tiny, dense negatively charged nucleus at the atom's center.
   d. Rutherford's model had electrons located in electron clouds.

36. Rutherford reasoned that positively charged particles would
   a. bounce back if they headed straight for the nucleus.
   b. be deflected if they passed close by the nucleus.
   c. pass straight through the gold foil if atoms were mostly empty space.
   d. All of the above

37. In his model of the atom, Rutherford calculated that the diameter of the nucleus was ____ times smaller than the atom.
   a. 100
   b. 1,000
   c. 10,000
   d. 100,000

38. Rutherford's model of the atom is best described as
   a. a dense, positively charged nucleus with electrons moving around the nucleus.
   b. a dense nucleus of electrons with very little empty space.
   c. a dense, positively charged nucleus with electrons on its surface.
   d. had a nucleus of electrons, about which positively charged particles would orbit.

39. Who suggested that electrons travel around the nucleus in definite paths?
   a. Dalton
   b. Rutherford
   c. Bohr
   d. Thomson

40. Bohr's model of the atom suggested that electrons could jump from one level to another. Which of the following best models this process?
   a. climbing up stairs
   b. diving underwater
   c. changing lanes on a highway
   d. walking up a ramp

41. The current model of the atom suggests that
   a. electron clouds surround the nucleus.
   b. proton clouds surround the nucleus.
   c. electrons travel in definite paths around the nucleus.
   d. the exact path of a moving electron can be predicted.

42. Heisenberg discovered that the exact path of a moving electron cannot be predicted. Which model of the atom does his discovery reinforce?
   a. the plum-pudding model
   b. the gold-foil model
   c. the Dalton model
   d. the electron-cloud model

43. The size of atoms
   a. are exactly the same.
   b. vary widely.
   c. vary only a little bit.
   d. cannot be measured.

44. Atoms are composed of
   a. electrons and neutrons.
   b. protons and neutrons.
   c. electrons, protons, and neutrons.
   d. atomic mass units.

45. What particles make up a nucleus?
   a. electrons and neutrons
   b. neutrons
   c. protons and neutrons
   d. electrons, protons, and neutrons

46. The SI unit used to express the masses of particles in atoms is the
   a. kilogram (kg).
   b. gram (g).
   c. newton (N).
   d. atomic mass unit (amu).
47. The least massive particles of an atom are
   a. protons.                      c. electrons.
   b. neutrons.                    d. Both (a) and (b)

48. Neutrons are particles that
   a. help make up the nucleus and have no charge.
   b. help make up the nucleus and are positively charged.
   c. are located outside of the nucleus and are negatively charged.
   d. are located outside of the nucleus and have no charge.

49. Electrons are particles that
   a. help make up the nucleus and are negatively charged.
   b. help make up the nucleus and are positively charged.
   c. are located outside of the nucleus and are negatively charged.
   d. are located outside of the nucleus and have no charge.

50. An atom becomes an ion when
   a. there are equal numbers of protons and electrons.
   b. there are equal numbers of protons, neutrons, and electrons.
   c. there are unequal numbers of protons and electrons.
   d. None of the above

51. The atomic number of an atom is the total number of
   a. protons and electrons
   b. protons and neutrons
   c. protons
   d. neutrons

52. Which of the following statements describes isotopes?
   a. Isotopes are atoms of the same element.
   b. Isotopes have the same number of protons but have different numbers of neutrons.
   c. Isotopes have the same atomic number but have different mass numbers.
   d. all of the above

53. Isotopes have different
   a. atomic numbers.
   b. mass numbers.
   c. chemical properties.
   d. charges.

54. If a boron atom has 5 protons, 6 neutrons, and 5 electrons, it has a mass number of
   a. 11.
   b. 10.
   c. 6.
   d. 5.

55. Atoms that are isotopes of each other
   a. are the same element.
   b. are different elements.
   c. have different charges.
   d. have different properties.

56. All atoms of an element are the same because
   a. the number of protons in each atom is the same.
   b. the number of neutrons in each atom is the same.
   c. the number of electrons in each atom is the same.
   d. they are not isotopes.

57. How can you distinguish between isotopes?
   a. Look at the atomic number.
   b. Look at the number of protons.
   c. Look at the mass number.
   d. All of the above

58. Atomic mass is calculated by finding the
   a. sum of the masses of all the isotopes of an element.
   b. sum of the masses of all the naturally occurring isotopes of an element.
   c. weighted average of the masses of the radioactive isotopes of an element.
   d. weighted average of the masses of all the naturally occurring isotopes of an element.
59. An atom of oxygen with 8 protons, 8 electrons, and 8 neutrons would have a mass number of
   a. 4  c. 16
   b. 8  d. 24

60. ____ basic forces are at work everywhere, even within the atom.
   a. One  c. Three
   b. Two  d. Four

61. The ____ acts between all objects all the time.
   a. gravitational force  c. strong force
   b. electromagnetic force  d. weak force

62. The amount of gravity between objects depends on their
   a. atomic number and mass number.
   b. charge.
   c. mass and the distance between them.
   d. All of the above

63. The effects of gravity on two objects is that of
   a. repulsion.
   b. attraction.
   c. either attraction or repulsion.
   d. None of the above

64. The gravitational force between particles that make up atoms is very small because the particles
   a. have very little mass.
   b. are very far apart.
   c. have no charge.
   d. All of the above

65. The effects of the electromagnetic force on two charged particles is that of
   a. repulsion.
   b. attraction.
   c. either attraction or repulsion, depending on their masses.
   d. either attraction or repulsion, depending on their charges.

66. The ____ holds the electrons around the nucleus.
   a. gravitational force  c. strong force
   b. electromagnetic force  d. weak force

67. Protons push away from one another in the nucleus because of the
   a. gravitational force.
   b. electromagnetic force.
   c. strong force.
   d. weak force.

68. The ____ overcomes the electromagnetic force in an atomic nucleus, holding the nucleus together.
   a. gravitational force  c. strong force
   b. electromagnetic force  d. weak force

69. The ____ plays a key role in radioactive decay in which a neutron changes into a proton and an electron.
   a. gravitational force  c. strong force
   b. electromagnetic force  d. weak force

70. A lithium atom has 3 protons, 3 neutrons, and 3 electrons. Which of the following sets of particles represents
    an isotope of this atom?
    a. 4 protons, 3 neutrons, and 4 electrons  c. 3 protons, 3 neutrons, and 2 electrons
    b. 3 protons, 4 neutrons, and 3 electrons  d. 4 protons, 4 neutrons, and 4 electrons

71. Which of the following sets of particles represents an ion?
    a. 19 protons, 19 neutrons, and 19 electrons
    b. 20 protons, 19 neutrons, and 20 electrons
    c. 19 protons, 20 neutrons, and 19 electrons
    d. 19 protons, 19 neutrons, and 18 electrons

72. An atom of aluminum-27 will have all of the following EXCEPT
   a. 13 protons.
   b. 13 neutrons.
   c. 13 electrons.
   d. an atomic number of 13.
An atom of nickel has an atomic number of 28 and a mass number of 58.

73. How many protons are in this atom of nickel?
   a. 28               c. 58
   b. 30               d. 86

74. How many neutrons are in this atom of nickel?
   a. 28               c. 58
   b. 30               d. 86

An certain atom of iron has 26 protons, 28 neutrons, and 26 electrons.

75. What is the atomic number of this iron atom?
   a. 23               c. 54
   b. 26               d. 77

76. What is the mass number of this iron atom?
   a. 2               c. 54
   b. 49               d. 77

Examine the illustration below and answer the questions that follow.

77. This is an illustration of an atom of
   a. hydrogen-2.
   b. hydrogen-3.
   c. helium-3.
   d. helium-4.

78. What is the mass number of this atom?
   a. 1               c. 3
   b. 2               d. 5

79. This atom is a(n) ____ of helium-4.
   a. ion               c. atomic mass unit (amu)
   b. isotope            d. None of the above

80. What is this atom's atomic number?
   a. 1               c. 3
   b. 2               d. 4

Short Answer

81. Study the models below, and answer the questions that follow:
a. Which models represent isotopes of the same element?
b. What is the atomic number for (a)?
c. What is the mass number for (b)?

82. Predict how the direction of the moving particle in the figure below will change, and explain what causes the change to occur.

83. Draw a model of a hydrogen-3 atom. Be sure to illustrate and label the protons, neutrons, and electrons.