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MULTIPLE CHOICE

1. The earliest atomic theory is generally associated with
   a. Bohr
   b. Leucippus
   c. Democritus
   d. Dalton

   ANS: B
   Although his theory was somewhat vague, Leucippus is most often the earliest person associated with atomic theory.

   REF: 16 OBJ: 1

2. The word *atom* is derived from the Greek word *atomos,* meaning
   a. nuclear
   b. small
   c. indivisible
   d. invisible

   ANS: C
   The Greek word *atomos* means "indivisible."

   REF: 16 OBJ: 1

3. In the early 1800s English chemist John Dalton theorized that
   a. elements form compounds
   b. atoms are unique to each element in size and mass
   c. a chemical reaction results from atoms being rearranged
   d. all of the above

   ANS: D
   As a result of his experiments, John Dalton theorized that elements form compounds, atoms are unique to each element in size and mass, and that a chemical reaction results from atoms being rearranged.

   REF: 16 OBJ: 1

4. Discovery of the electron is attributed to
   a. Dalton
   b. Bohr
   c. Thomson
   d. Rutherford

   ANS: C
   Joseph John "J.J." Thomson determined that the electron was a negatively charged part of the atom.

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REF: 17 OBJ: 1

5. The “plum pudding model” is associated with
   a. Bohr
   b. Rutherford
   c. Dalton
   d. Thomson

   ANS: D
   Based on the physical arrangement of raisins in a plum pudding, Thomson described the atom and surrounding negatively charged particles (electrons).

   REF: 17 OBJ: 1

6. The earliest atomic theory based on an arrangement similar to the solar system is attributed to
   a. Bohr
   b. Rutherford
   c. Dalton
   d. Thomson

   ANS: B
   Rutherford developed the theory that the atom consisted of a very dense nucleus with small electrons rotating around, similar to the sun and planets.

   REF: 17 OBJ: 1

7. The most commonly known modern atomic theory was developed by
   a. Bohr
   b. Rutherford
   c. Dalton
   d. Thomson

   ANS: A
   Niels Bohr refined Rutherford’s atomic theory, based on the solar system, into the most commonly known atomic theory today.

   REF: 18 OBJ: 1

8. The three fundamental particles of the atom are the
   a. element, nucleus, and electron
   b. electron, nucleus, and proton
   c. neutron, electron, and proton
   d. nucleus, proton, and neutron

   ANS: C
   The three fundamental components of the atom are the proton, electron, and neutron.

   REF: 18 OBJ: 2

9. The atomic nucleus contains
   a. protons and neutrons
   b. protons and electrons

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c. electrons and neutrons
d. all of the above

ANS: A
The atomic nucleus contains varying amounts of protons and neutrons, depending on the element.

REF: 18 OBJ: 2

10. The component of the nucleus that has a positive charge and mass is the
a. electron
b. neutron
c. proton
d. none of the above

ANS: C
The proton is the part of the nucleus that has a positive charge and mass.

REF: 18 OBJ: 3

11. The component of the nucleus that has mass but no electrical charge is the
a. electron
b. neutron
c. proton
d. none of the above

ANS: B
The neutron is found in the nucleus; it is very similar to the proton but has no electrical charge (neutral).

REF: 18 OBJ: 3

12. The fundamental component of the atom that has the smallest mass is the
a. electron
b. neutron
c. proton
d. none of the above

ANS: A
The electron has significantly less mass than the neutron or proton.

REF: 18 OBJ: 3

13. The mass of an atom is primarily due to the mass of the
a. neutrons
b. nucleus
c. electrons
d. protons

ANS: B
The nucleus, consisting of both protons and neutrons, accounts for the majority of the mass of an atom.

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REF: 18 OBJ: 3

14. If an atom has more protons than electrons it will
    a. have a negative charge
    b. have a positive charge
    c. be electrically neutral
    d. have neither a positive nor negative charge

    ANS: B
    An atom with more protons than electrons will have a positive charge.

    REF: 19 OBJ: 3

15. If an atom has more electrons than protons it will
    a. have a negative charge
    b. have a positive charge
    c. be electrically neutral
    d. have neither a positive nor negative charge

    ANS: A
    An atom with more electrons than protons will have a negative charge.

    REF: 19 OBJ: 3

16. If an atom has the same number of electrons and protons it will
    a. have a negative charge
    b. have a positive charge
    c. be electrically neutral
    d. none of the above

    ANS: C
    Having the same number of protons and electrons will result in a neutral atom, having neither a negative nor a positive electrical charge.

    REF: 19 OBJ: 3

17. When an atom becomes negatively or positively charged it is usually due to a change in the number of
    a. protons
    b. electrons
    c. neutrons
    d. all of the above

    ANS: B
    In that there is a weaker bond, the addition or loss of electrons typically produces a charged atom.

    REF: 19 OBJ: 3

18. A negative ion is
    a. an electron
    b. an atom with more protons than electrons

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c. an atom with more neutrons that electrons
d. an atom with more electrons than protons

ANS: D
A negative ion is a charged atom with more electrons than protons.

REF: 19 OBJ: 3

19. A positive ion is
a. a proton
b. an atom with more protons than electrons
c. an atom with more neutrons that electrons
d. an atom with more electrons than protons

ANS: B
A positive ion is a charged atom with more protons than electrons.

REF: 19 OBJ: 3

20. The force that holds the protons and neutrons together in the nucleus is the
a. nuclear binding energy
b. electron binding energy
c. atomic energy
d. proton/neutron energy

ANS: A
The force that holds the protons and neutrons together in the nucleus is the nuclear binding energy.

REF: 19 OBJ: 3

21. If a particle strikes a nucleus with the same amount of energy as the atom's nuclear binding energy
a. the atom will become a positive ion
b. the atom will become a negative ion
c. it can split the atom
d. it can fuse the atom

ANS: C
If a particle strikes a nucleus with the same amount of energy as the atom's nuclear binding energy, it can break the atom apart.

REF: 19 OBJ: 3

22. The electrons stay in orbit around the nucleus because of
a. their attraction to the protons
b. their attraction to the neutrons
c. their attraction to the other electrons
d. all of the above

ANS: A
The electrons stay in orbit because of their attraction to the positively charged protons in the nucleus.

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REF: 19 OBJ: 3

23. The electron binding energy depends on
    a. how close it is to the nucleus
    b. how many neutrons there are in the nucleus
    c. how many protons there are in the nucleus
    d. A and B
    e. A and C

    ANS: E
    The electron binding energy depends on how close it is to the nucleus and how many protons there are in the nucleus.

    REF: 19 OBJ: 3

24. The electron binding energy is stronger when
    a. there are more protons and the electron is closer to the nucleus
    b. there are fewer protons and the electron is closer to the nucleus
    c. there are fewer protons and the electron is farther from the nucleus
    d. there are more protons and the electron is farther from the nucleus

    ANS: A
    The electron binding energy is greater when the electron is closer to the nucleus and there are more protons in the nucleus.

    REF: 19 OBJ: 3

25. The electron shell closest to the nucleus is lettered
    a. "E"
    b. "H"
    c. "K"
    d. "M"

    ANS: C
    The innermost electron shell is the "K" shell.

    REF: 20 OBJ: 3

26. The L shell can hold _____ electrons.
    a. 1
    b. 2
    c. 4
    d. 8

    ANS: D
    Based on the formula $2n^2$, the L (second) shell can hold 2×2^2 electrons, or 8.

    REF: 20 OBJ: 3

27. The N shell can hold _____ electrons.
    a. 4

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b. 8
c. 32
d. 64

ANS: C
Based on the formula $2n^2$, the N (fourth) shell can hold 2×4^2 electrons, or 32.

REF: 20 OBJ: 3

28. Except for the K shell, the maximum number of electrons that can be in the outermost shell of an atom is
a. 4
b. 8
c. 16
d. 32

ANS: B
With the exception of the K shell, no more than 8 electrons can be in the atom's outermost shell. This is called the octet rule.

REF: 20 OBJ: 3

29. If an atom has 15 electrons, which will be the outermost shell?
a. "L"
b. "M"
c. "N"
d. "O"

ANS: B
With 15 electrons, 2 will fill the K shell, 8 will fill the L shell, and 5 will fill the M shell.

REF: 20 OBJ: 3

30. The number of protons in an atom's nucleus is reflected in its
a. atomic number
b. atomic mass number
c. element
d. compound

ANS: A
The atomic number indicates the number of protons in the nucleus.

REF: 21 OBJ: 4

31. The number of protons and neutrons in the atom's nucleus is the
a. atomic number
b. atomic mass number
c. element
d. compound

ANS: B
The sum of the protons and neutrons in an atom's nucleus is its atomic mass number.

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REF: 21 OBJ: 4

32. The simplest form of the substances that form matter is the
    a. atomic number
    b. atomic mass number
    c. element
    d. compound

    ANS: C
    The element, such as hydrogen or oxygen, is the simplest form of substances that form matter.

    REF: 21 OBJ: 4

33. Two or more atoms that bond together form a(n)
    a. atomic number
    b. atomic mass number
    c. element
    d. compound

    ANS: D
    More than one atom bonded together, such as two atoms of H and one of O (H_2O), form a compound.

    REF: 21 OBJ: 4

34. In a neutral atom, the atomic number indicates the number of
    a. protons
    b. neutrons
    c. electrons
    d. A and B
    e. A and C

    ANS: E
    In a neutral atom, the atomic number indicates the number of protons (by definition) but also the number of electrons (which are equal to the number of protons).

    REF: 21 OBJ: 4

35. An atom of helium (^4_2He) has
    a. two protons
    b. four protons
    c. four neutrons
    d. four electrons

    ANS: A
    The atomic number, the number of protons, is the lower number, two.

    REF: 21 OBJ: 4

36. An atom of oxygen ($^{16}_8O$) has
    a. eight protons
    b. eight neutrons

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c. eight electrons
d. all of the above

ANS: D
The atomic mass number (16) less the atomic number (number of protons—8) equals the number of neutrons (8). The number of electrons equals the number of protons (8).

REF: 21 OBJ: 4

37. How many neutrons does $^{7}_{3}Li$ (lithium) have?
a. 3
b. 4
c. 7
d. 10

ANS: B
Subtracting the atomic number (3) from the atomic mass number (7) determines the number of neutrons (4).

REF: 21 OBJ: 4

38. How many electrons does a neutral atom of carbon ($^{12}_{6}C$) have?
a. 3
b. 6
c. 12
d. 18

ANS: B
A neutral atom has the same number of protons and electrons, in this case 6.

REF: 21 OBJ: 4

39. For the chemical element sodium ($^{22}_{11}Na$), the atomic number is
a. eleven
b. twenty-two
c. thirty-three
d. none of the above

ANS: A
The atomic number, number of protons in the nucleus, is the lower number, 11.

REF: 21 OBJ: 4

40. For the chemical element sodium ($^{22}_{11}Na$), the atomic mass number is
a. 11
b. 22
c. 33
d. none of the above

ANS: B
The atomic mass number, which equals the number of protons and neutrons in the nucleus, is the upper number, 22.

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REF: 21 OBJ: 4

41. Atoms with the same number of protons but different number of neutrons are
    a. isotopes
    b. isotones
    c. isobars
    d. isomers

    ANS: A
    As isotope is an atom that has the same number of protons but different number of neutrons as compared with the element.

    REF: 21 OBJ: 4

42. Atoms with the same atomic number but different atomic mass numbers are
    a. isotopes
    b. isotones
    c. isobars
    d. isomers

    ANS: A
    Having the same atomic number (number of protons) and different atomic mass number (number of neutrons are different) results in an atom being classified as an isotope.

    REF: 21 OBJ: 4

43. Atoms with the same number of neutrons but different number of protons are
    a. isotopes
    b. isotones
    c. isobars
    d. isomers

    ANS: B
    An isotone has the same number of neutrons but different number of protons.

    REF: 21 OBJ: 4

44. Atoms with different number of protons but the same combined number of protons and neutrons are
    a. isotopes
    b. isotones
    c. isobars
    d. isomers

    ANS: C
    An isobar has a different number of protons but the atomic mass number (protons and neutrons) is the same.

    REF: 21 OBJ: 4

45. Atoms with different atomic numbers but the same atomic mass numbers are
    a. isotopes

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b. isotones
c. isobars
d. isomers

ANS: C
Isobars have different number of protons (atomic number) but the atomic mass number (protons and neutrons) is the same.

REF: 21 OBJ: 4

46. Atoms with the same atomic number and atomic mass number but have different energy within their nuclei are
a. isotopes
b. isotones
c. isobars
d. isomers

ANS: D
The isomer has the same number of protons and neutrons but the energy level within the nucleus is different.

REF: 21 OBJ: 4

47. $^{23}_{11}Na$ is an _____ of $^{22}_{11}Na$.
a. isotopes
b. isotones
c. isobars
d. isomers

ANS: A
$^{23}_{11}Na$ is an isotope of $^{22}_{11}Na$ because it has the same number of protons (11) and different number of neutrons, as seen in the increased atomic mass number.

REF: 21 OBJ: 4

48. $^{131}_{53}I$ and $^{132}_{54}Xe$ are
a. isotopes
b. isotones
c. isobars
d. isomers

ANS: B
$^{131}_{53}I$ and $^{132}_{54}Xe$ are isotones because they have the same number of neutrons (131 – 53 = 132 – 54) but different number of protons (53 vs. 54).

REF: 21 OBJ: 4

49. $^{7}_{3}Li$ and $^{7}_{4}Be$ are
a. isotopes
b. isotones
c. isobars
d. isomers

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ANS: C
$^{7}_{3}$Li and $^{7}_{4}$Be are isobars because they have the same atomic mass numbers (7) but different numbers of protons (3 vs. 4).

REF: 21 OBJ: 4

50. The periodic table of elements classifies by period and group. The period is the
    a. row
    b. column
    c. group
    d. type of element

ANS: A
The periodic table of elements includes seven periods, the rows of the table.

REF: 21 OBJ: 4

51. The periodic table of elements classifies by period and group. The group is the
    a. row
    b. column
    c. period
    d. type of element

ANS: B
The periodic table of elements includes eight groups, the columns of the table.

REF: 21 OBJ: 4

52. Atoms in each period have the same number of
    a. electrons in the outermost shell
    b. atomic mass number
    c. electrons
    d. electron shells

ANS: D
Atoms in each period have the same number of electron shells.

REF: 21 OBJ: 4

53. Atoms in each group have the same number of
    a. electrons in the outermost shell
    b. atomic mass number
    c. electrons
    d. electron shells

ANS: A
Atoms in each group have the same number of electrons in the outermost shell, increasing from left to right.

REF: 21 OBJ: 4

54. A compound consists of

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a. at least two molecules
b. at least two elements
c. at least two different materials
d. all of the above

ANS: B
A compound is a molecule that consists of atoms of at least two different elements.

REF: 23 OBJ: 5

55. When the bond between two atoms is due to their sharing an outer-shell electron, this is called a
a. molecular bond
b. ionic bond
c. compounding bond
d. covalent bond

ANS: D
Covalent bonding is based on atoms sharing an outer-shell electron.

REF: 23 OBJ: 5

56. When the bond between two atoms is due to one atom giving up an electron and the other atom gaining an electron, it is called a
a. molecular bond
b. ionic bond
c. compounding bond
d. covalent bond

ANS: B
Ionic bonding is based on one atom giving up an electron (becoming a positive ion) and the other gaining an electron (becoming a negative ion) and then being attracted to each other.

REF: 23 OBJ: 5

TRUE/FALSE

1. The electrons rotate around the nucleus at a single energy level.

ANS: F
The electrons rotate around the nucleus at different energy levels, based on their distance from the nucleus.

REF: 19 OBJ: 3

2. Electron shells are the hard coating around the electron.

ANS: F
Electron shells are the defined energy levels around the atomic nucleus.

REF: 19-20 OBJ: 3

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3. Each electron shell has a specific limit to the amounts of electrons it can hold.

   ANS: T
   There is a specific limit to how many electrons each shell can hold.

   REF: 20 OBJ: 3

4. The outermost shell of an atom can hold fewer than 8 electrons.

   ANS: T
   Although there can be no more than 8 electrons in the outermost shell, there can be fewer than 8.

   REF: 20 OBJ: 4

5. Each element has an unchanging number of protons.

   ANS: T
   Each element (H, O, C, etc.) has an unchanging number of protons.

   REF: 21 OBJ: 4

6. Elements can only occur naturally.

   ANS: F
   Although there are 92 naturally occurring elements, more than a dozen have been created artificially.

   REF: 21 OBJ: 4

7. The atoms of the elements at the top of the periodic table of elements are the most complex.

   ANS: F
   The atoms at the elements at the bottom of the table have more electron shells and are more complex.

   REF: 21 OBJ: 3

8. In the middle of the periodic table of elements there are elements that don't fit exactly into one of the eight groups.

   ANS: T
   The inner transitional metals, located in the middle of the table, do not fit into the eight groups.

   REF: 21 | 23 OBJ: 4

9. All compounds are molecules and all molecules are compounds.

   ANS: F
   All compounds are molecules, containing atoms of at least two elements, but not all molecules are compounds, occurring when multiple atoms of the same element combine.

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REF: 23 OBJ: 4

10. An ionic bond results in an electrically charged molecule or compound.

ANS: F
An ionic bond is the result of two charged atoms being attracted to each other, creating a neutral molecule or compound.

REF: 23 OBJ: 5

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