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Chapter 02: Structure of the Atom

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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.

REF: 17 OBJ: 1

5. The “plum pudding model” is associated with
- Bohr
 - Rutherford
 - Dalton
 - 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
- Bohr
 - Rutherford
 - Dalton
 - 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
- Bohr
 - Rutherford
 - Dalton
 - 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
- element, nucleus, and electron
 - electron, nucleus, and proton
 - neutron, electron, and proton
 - 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
- protons and neutrons
 - protons and electrons

- 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.

REF: 18 OBJ: 3

14. If an atom has more protons than electrons it will
- have a negative charge
 - have a positive charge
 - be electrically neutral
 - 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
- have a negative charge
 - have a positive charge
 - be electrically neutral
 - 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
- have a negative charge
 - have a positive charge
 - be electrically neutral
 - 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
- protons
 - electrons
 - neutrons
 - 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
- an electron
 - an atom with more protons than electrons

- c. an atom with more neutrons than 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 than 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.

REF: 19 OBJ: 3

23. The electron binding energy depends on
- how close it is to the nucleus
 - how many neutrons there are in the nucleus
 - how many protons there are in the nucleus
 - A and B
 - 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
- there are more protons and the electron is closer to the nucleus
 - there are fewer protons and the electron is closer to the nucleus
 - there are fewer protons and the electron is farther from the nucleus
 - 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
- “E”
 - “H”
 - “K”
 - “M”

ANS: C

The innermost electron shell is the “K” shell.

REF: 20 OBJ: 3

26. The L shell can hold _____ electrons.
- 1
 - 2
 - 4
 - 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.
- 4

- 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.

REF: 21 OBJ: 4

32. The simplest form of the substances that form matter is the
- atomic number
 - atomic mass number
 - element
 - 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)
- atomic number
 - atomic mass number
 - element
 - compound

ANS: D

More than one atom bonded together, such as two atoms of H and one of O (H₂O), form a compound.

REF: 21 OBJ: 4

34. In a neutral atom, the atomic number indicates the number of
- protons
 - neutrons
 - electrons
 - A and B
 - 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 (⁴₂He) has
- two protons
 - four protons
 - four neutrons
 - 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 (¹⁶₈O) has
- eight protons
 - eight neutrons

- 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 ${}^7_3\text{Li}$ (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 (${}^{12}_6\text{C}$) 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 (${}^{22}_{11}\text{Na}$), 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 (${}^{22}_{11}\text{Na}$), 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.

REF: 21

OBJ: 4

41. Atoms with the same number of protons but different number of neutrons are
- isotopes
 - isotones
 - isobars
 - 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
- isotopes
 - isotones
 - isobars
 - 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
- isotopes
 - isotones
 - isobars
 - 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
- isotopes
 - isotones
 - isobars
 - 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
- isotopes

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

ANS: A

$^{23}_{11}\text{Na}$ is an isotope of $^{22}_{11}\text{Na}$ 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. $^{131}_{53}\text{I}$ and $^{132}_{54}\text{Xe}$ are
- a. isotopes
 - b. isotones
 - c. isobars
 - d. isomers

ANS: B

$^{131}_{53}\text{I}$ and $^{132}_{54}\text{Xe}$ 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_3Li and ^7_4Be are
- a. isotopes
 - b. isotones
 - c. isobars
 - d. isomers

ANS: C

${}^7_3\text{Li}$ and ${}^7_4\text{Be}$ 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
- row
 - column
 - group
 - 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
- row
 - column
 - period
 - 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
- electrons in the outermost shell
 - atomic mass number
 - electrons
 - 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
- electrons in the outermost shell
 - atomic mass number
 - electrons
 - 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

- 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

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.

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