Regents Chemistry Unit 2 - Atomic Concepts & Periodic Table
Study Guide & Pre-Test

Topic 1: Development of the Atomic Model

1.) Match the scientist to the facts, experiments & models of the atom:

<table>
<thead>
<tr>
<th>John Dalton</th>
<th>A. Plum Pudding (choc chip muffin) Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>J.J. Thomson</td>
<td>B. Electron Cloud Model</td>
</tr>
<tr>
<td>Ernest Rutherford</td>
<td>C. Planetary Model</td>
</tr>
<tr>
<td>Neils Bohr</td>
<td>D. Billiard ball Model</td>
</tr>
<tr>
<td></td>
<td>E. Nuclear Model</td>
</tr>
<tr>
<td></td>
<td>F. Discovered electrons</td>
</tr>
<tr>
<td></td>
<td>G. Electrons are in perfect “orbits”</td>
</tr>
<tr>
<td></td>
<td>H. Electrons are in “orbitals”</td>
</tr>
<tr>
<td></td>
<td>I. Atoms are tiny indivisible particles</td>
</tr>
<tr>
<td></td>
<td>J. Cathode Ray Tube experiment</td>
</tr>
<tr>
<td></td>
<td>K. Gold Foil experiment</td>
</tr>
<tr>
<td></td>
<td>L. Atoms have a tiny positive nucleus</td>
</tr>
<tr>
<td></td>
<td>M. Electrons are scattered throughout a</td>
</tr>
<tr>
<td></td>
<td>positive sphere</td>
</tr>
<tr>
<td></td>
<td>N. Atoms are mostly empty space!</td>
</tr>
<tr>
<td></td>
<td>O. Shows “probability” of where e- may</td>
</tr>
<tr>
<td></td>
<td>be found</td>
</tr>
<tr>
<td></td>
<td>P. Most modern idea</td>
</tr>
</tbody>
</table>

2.) **SKETCH** each atomic model and identify which scientist is associated with it: (these aren’t in date order!)

<table>
<thead>
<tr>
<th>“Nuclear”</th>
<th>“Planetary”</th>
<th>“Billiard Ball”</th>
<th>“Plum Pudding”</th>
<th>“Wave Mechanical”</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
<td><img src="image3.png" alt="Diagram" /></td>
<td><img src="image4.png" alt="Diagram" /></td>
<td><img src="image5.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of Scientist</th>
<th>Name of Scientist</th>
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<th>Name of Scientist</th>
<th>Name of Scientist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutherford</td>
<td>Bohr</td>
<td>Dalton</td>
<td>Tomson</td>
<td>Schrödinger</td>
</tr>
</tbody>
</table>
3.) According to the wave-mechanical model of the atom, electrons in an atom
   (1) travel in defined circles
   (2) are most likely found in an excited state
   (3) have a positive charge
   (4) are located in orbitals outside the nucleus

4.) Which sequence represents a correct order of historical developments leading to the modern model of the atom?
   (1) the atom is a hard sphere → most of the atom is empty space → electrons exist in orbitals outside the nucleus
   (2) the atom is a hard sphere → electrons exist in orbitals outside the nucleus → most of the atom is empty space
   (3) most of the atom is empty space → electrons exist in orbitals outside the nucleus → the atom is a hard sphere
   (4) most of the atom is empty space → the atom is a hard sphere → electrons exist in orbitals outside the nucleus

5.) What was concluded about the structure of the atom as the result of the gold foil experiment?
   (1) A positively charged nucleus is surrounded by positively charged particles.
   (2) A positively charged nucleus is surrounded by mostly empty space.
   (3) A negatively charged nucleus is surrounded by positively charged particles.
   (4) A negatively charged nucleus is surrounded by mostly empty space.

Base your answers to questions 6 through 8 on the diagram below.

Shaded areas ○ represent the (+) charged area of the atom. “ ○ “ represent electrons.

6.) Label each drawing as either representing the Thomson model of the atom or the Rutherford model.

7.) Did Thomson believe the atom was neutral overall? Explain why or why not.

Yes. The positively charged sphere was balanced out by the negative embedded electrons.

8.) What did Rutherford’s model have that Thomson’s did not?

A nucleus!
Review:

9.) A 10.0-gram sample of which element has the *smallest volume* at STP?
   (1) aluminum  (3) titanium
   (2) magnesium  (4) zinc

10.) Explain your answer to question 9 with words or math.  ▶ look up density in Table S!

   $A_1: \frac{2.70}{x} = \frac{10g}{3.7cm^3}$
   $\Rightarrow x = 2.2cm^3$

   $Mg: \frac{1.74}{x} = \frac{10g}{5.7cm^3}$
   $\Rightarrow x = 1.40cm^3$

   $Zn: \frac{1.134}{x} = \frac{10g}{1.40cm^3}$
   $\Rightarrow x = 0.72cm^3$

   zn has the largest density. You can pack the most mass in the smallest amount of space.

Topic 2: Subatomic Particles & Symbols

11.) Fill in the following table:

<table>
<thead>
<tr>
<th>Particle</th>
<th>Charge</th>
<th>Mass</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>neutron</td>
<td>0</td>
<td>1</td>
<td>inside nucleus</td>
</tr>
<tr>
<td>proton</td>
<td>+1</td>
<td>1</td>
<td>inside nucleus</td>
</tr>
<tr>
<td>electron</td>
<td>-1</td>
<td>0</td>
<td>outside nucleus</td>
</tr>
</tbody>
</table>

12.) The number of neutrons in the nucleus of an atom can be determined by
   (1) adding the atomic number to the mass number
   (2) subtracting the atomic number from the mass number
   (3) adding the mass number to the atomic mass
   (4) subtracting the mass number from the atomic number

13.) The atomic number of an atom is always equal to the number of its
   (1) protons, only  (2) neutrons, only  (3) protons plus neutrons  (4) protons plus electrons

14.) The nucleus of an atom of K-42 contains
   (1) 19 protons and 23 neutrons  (3) 19 protons and 42 neutrons
   (2) 20 protons and 19 neutrons  (4) 23 protons and 19 neutrons

15.) Which particles are found in the nucleus of an atom?
   (1) electrons, only  (3) neutrons, only
   (2) protons and electrons  (4) protons and neutrons
16.) What is the total number of neutrons in an atom of an element that has a mass number of 19 and an atomic number of 9?
   (1) 9  (2) 19  (3) 10  (4) 28  \[19 - 9 = 10\]

17.) Which statement is true about the charges assigned to an electron and a proton?
   (1) Both an electron and a proton are positive.
   (2) An electron is negative and a proton is positive.
   (3) An electron is positive and a proton is negative.
   (4) Both an electron and a proton are negative.

18.) What is the charge of the nucleus in an atom of oxygen-17?
   (1) 0  (2) -2  (3) +8  (4) +17

19.) Which atom has a partially filled third electron shell?
   (1) argon  (2) phosphorus  (3) carbon  (4) helium

20.) An atom is electrically neutral because the
   (1) number of protons equals the number of electrons
   (2) number of protons equals the number of neutrons
   (3) ratio of the number of neutrons to the number of electrons is 1:1
   (4) ratio of the number of neutrons to the number of protons is 2:1

21.) What is the charge on the nucleus of...
   a) a Cr atom? \[+24\]  b) a Ni atom? \[+28\]  c) a sodium atom? \[+11\]

22.) Two isotopes of potassium are K-37 and K-42. What is the total number of neutrons in the nucleus of a K-37 atom?
   \[37 - 19 = 18\]

**Topic 3: Subatomic Particles & Isotopes**

23.) Which two notations represent different isotopes of the same element?
   (1) \(^{9}\text{Be}\) and \(^{9}\text{Be}\)
   (2) \(^{7}\text{Li}\) and \(^{7}\text{Li}\)
   (3) \(^{14}\text{N}\) and \(^{14}\text{C}\)
   (4) \(^{32}\text{P}\) and \(^{32}\text{S}\)

24.) The total number of protons, electrons, and neutrons in each of four different atoms are shown in the table below.

<table>
<thead>
<tr>
<th>Atom</th>
<th>Total Number of Protons</th>
<th>Total Number of Electrons</th>
<th>Total Number of Neutrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>X</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Z</td>
<td>8</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Which two atoms are isotopes of the same element?
(1) A and D  (2) A and Z  (3) X and D  (4) X and Z
25.) If the two isotopes of Cl are Cl-35 and Cl-37, which is more abundant? Explain by using the atomic mass of Cl in your periodic table.

Cl-35. It is closer to the average mass (35.453) given on the periodic table.

Base your answers to questions 26 through 30 on the information below and on your knowledge of chemistry.

The diagrams below represent four different atomic nuclei.

<table>
<thead>
<tr>
<th>Four Atomic Nuclei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nucleus 1</td>
</tr>
<tr>
<td>p+9 n+9</td>
</tr>
</tbody>
</table>

26.) Identify the element that has atomic nuclei represented by nucleus 1.

Fluorine

27.) Determine the mass number of the nuclide represented by nucleus 2.

\[ p+ + n+ \quad 8 + 10 = 18 \]

28.) Explain, in terms of subatomic particles, why nucleus 2 and nucleus 4 represent the nuclei of two different isotopes of the same element.

Nucleus 2 & 4 have the same # of protons but a different # of neutrons.

29.) Identify the nucleus above that is found in an atom that has a stable valence electron configuration.

Nucleus 3 (Neon)

30.) What does a stable valence electron configuration tell you about the reactivity of the substance?

The substance is unreactive.
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.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Atomic Mass (atomic mass units)</th>
<th>Percent Natural Abundance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si-28</td>
<td>27.98</td>
<td>92.22</td>
</tr>
<tr>
<td>Si-29</td>
<td>28.98</td>
<td>4.69</td>
</tr>
<tr>
<td>Si-30</td>
<td>29.97</td>
<td>3.09</td>
</tr>
</tbody>
</table>

31.) State, in terms of subatomic particles, why these atoms are isotopes of silicon.

They have the same number of protons but a different number of neutrons.

**Topic 4: Electrons in Atoms**

32.) Which Lewis electron-dot diagram represents an atom for a Group 13 element?

![Lewis dot diagram with 3 valence electrons]

33.) Elements that have atoms with stable valence electron configurations in the ground state are found in

(1) Group 1  
(2) Group 8  
(3) Group 11  
(4) Group 18

(4) Group 18

34.) Compared to an electron in the first electron shell of an atom, an electron in the third shell of the same atom has

(1) less mass  
(2) less energy  
(3) more mass  
(4) more energy

(4) more energy

35.) Is an electron in the first shell closer to or further from the nucleus than an electron in the third shell?

First shell = closer to nucleus

36.) State the number of valence electrons in an atom of:

a. sulfur  
2  

b. calcium  
2  

c. chlorine  
7  

d. arsenic  
5

37.) Draw Lewis electron-dot diagram for each of the atoms in #36.

![Lewis dot diagrams]
38.) Draw Bohr diagrams for the following (include protons and neutrons in nucleus):

a. \( {\text{Ca}^{40}} \)

b. \( {\text{S}^{32}} \)

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**Topic 5: Organizing the Elements - Periodic Table Introduction**

39.) The elements in Group 2 have similar chemical properties because each atom of these elements has the same

1. atomic number (3) number of electron shells
2. mass number (4) number of valence electrons

40.) Rubidium and cesium have similar chemical properties because, in the ground state, the atoms of both elements each have

1. one electron in the outermost shell (3) one neutron in the nucleus
2. two electrons in the outermost shell (4) two neutrons in the nucleus

41.) Which element has both metallic and nonmetallic properties?

1. \( {\text{Rb}} \) (3) \( {\text{Si}} \)
2. \( {\text{Rn}} \) (4) \( {\text{Sr}} \)

42.) Which element is classified as a metalloid?

1. \( {\text{Cr}} \) (3) \( {\text{Sc}} \)
2. \( {\text{Cs}} \) (4) \( {\text{Si}} \)

43.) At STP, which element is a good conductor of electricity?

1. chlorine (3) silver
2. iodine (4) sulfur

44.) A solid element that is malleable, a good conductor of electricity, and reacts with oxygen is classified as a

1. metal (3) noble gas
2. metalloid (4) nonmetal

45.) At STP, an element that is a brittle solid and a poor conductor of heat and electricity could have an atomic number of

1. 12 (3) 16
2. 13 (4) 17

46.) An element that is malleable and a good conductor of heat and electricity could have an atomic number of

1. 16 (3) 29
2. 18 (4) 35
47.) Which Group 14 element is classified as a metal?
(1) carbon  (2) germanium  (3) silicon  (4) tin

48.) The current Periodic Table of Elements is arranged in order of increasing atomic number.

49.) Where, generally, are the metals located on the periodic table?

50.) Where, generally, are the nonmetals located on the periodic table?

51.) List three physical properties of metals and one chemical property.
luster, malleable, conduct electricity reacts with acid.

52.) List three physical properties of nonmetals and one chemical property.
dull, brittle, poor conductors do not react with acid.

53.) What kinds of properties do metalloids have?
Properties of both metals & nonmetals.

54.) What is a period? How many are there in the periodic table?

55.) What is a group (also called a family)? How many are there in the periodic table?

56.) Why do all the members of a group have similar properties?
Same # of valence electrons.

Base your answers to questions 57 through 58 on the information below and on your knowledge of chemistry.

There are six elements in Group 14 on the Periodic Table. One of these elements has the symbol Uuq, which is a temporary, systematic symbol. This element is now known as flerovium.

57.) Identify an element in Group 14 that is classified as a metalloid. Si or Ge

58.) State the expected number of valence electrons in an atom of the element flerovium in the ground state.
59.) Tell which **period** you would find the following elements
   a.) Ar; 2-8-8 _3_  
   b.) Rb; 2-8-18-8-1 _5_

60.) How can you tell which period an element is in when only given its electron configuration?
   Look at the number of rings, that tells you the Period (row) number.

61.) Tell which **group** you would find the following elements
   a.) Be; 2-2 _2_  
   b.) N; 2-5 _15_

62.) How can you tell which group an element is in when only given its electron configuration?
   Look at the number of valence electrons.

63.) How is the group number related to chemical properties of elements? Give an example.
   Elements in the same group have similar chemical properties (b/c they have the same # of valence electrons)
   **Ex:** Na & K would have similar properties
Vocabulary Practice:

1. The total number of protons and neutrons in the nucleus of an atom.
2. A vertical column on the periodic table.
3. The number of protons in the nucleus of an atom.
4. A classification of an element that is dull in appearance, brittle, and does not react with acid.
5. Atom of an element that has a specific number of protons and neutrons.
6. Scientist who discovered that electrons must reside in fixed energy levels around the nucleus.
7. An element that has both metallic and nonmetallic properties.
8. The weighted average mass of all naturally-occurring isotopes in a sample of an element.
9. These negatively-charged subatomic particles can be found in a “cloud” surrounding the positive nucleus of an atom.
10. A horizontal row on the periodic table.
11. A non-reactive element that can be found in Group 18 on the periodic table.
12. A subatomic particle with no charge, that can be found in the nucleus of an atom.
13. The outer electrons of an atom.
15. Scientist whose use of cathode ray tubes led to the discovery of the electron.
16. A subatomic particle with positive charge that tells the identity of an atom.
17. A type of element that conducts electricity, has luster, is malleable, and reacts with acid.
18. Scientist who performed the gold foil experiment, and concluded that an atom must be composed of mostly empty space with a small, dense, positively-charged nucleus.
19. An electron configuration tells how many electrons belong in each _________.
20. The smallest part of an element.
21. The most current model of the atom states that electrons are found in “orbitals” – regions of most probable location.
22. Atoms are so small that we cannot measure their mass in grams. We must use ___.