Science Unit: ***The Electron: Conductivity and Chemistry***

Lesson 6: ***Material Classification***

School Year:	2011/2012
Developed for:	Trafalgar Elementary School, Vancouver School District
Developed by:	James Day (scientist); Kathryn Coulter-Boisvert and Christy Shea (teachers)
Grade level:	Presented to grade 7; appropriate for grades 5 – 7 with age appropriate modifications
Duration of lesson:	1 hour and 20 minutes
Notes:	This lesson builds on Lesson 2, Particle Model of Matter, in this science unit (The Electron: Conductivity and Chemistry). Students should be comfortable reading the periodic table of the elements and with the Bohr model of the atom. This lesson also assumes that 30 students are participating in the activity. Only slight modifications will be required for classes of a different size.

Objectives

1. Review the electronic make-up of atoms.
2. Relate electronic to chemical properties of atoms (and, by extension, to molecules/compounds).
3. Introduce classification schemes of various compounds.

Background Information

Materials science plays an important role in our modern age of science and technology. A wide variety of materials can be used in industry, housing, agriculture, transportation, and so on. Of course, the choice of material needs to meet the manufacturing and individual requirements. Selecting a certain material for a certain application is a rather complex process. The choice may be simplified if, for example, the details about the functional requirements (does it need to be strong? be hard? conduct heat? conduct electricity?) and operating parameters (what pressure and temperature will it be used? is it okay if it corrodes?) are known.

One type/subset of materials classification is that of chemical classification. Chemical classification systems usually try to classify chemicals as elements or compounds according to certain chemical functional or structural properties. Whereas the structural properties are largely intrinsic, functional properties – and the derived classifications – usually depend on the type of chemical interaction partners on which the function is exerted. Sometimes other criteria, like purely physical ones (e.g. molecular weight), might also used for building chemical taxonomies.

Regardless of the details of a classification system, the objective of all classifications is the orderly arrangement of a large array of objects so that their differences and similarities can be better understood.

Vocabulary

Ionic bond:	A type of chemical bond formed through an electrostatic attraction between two oppositely charged ions.
Covalent bond:	A form of chemical bonding that is characterized by the sharing of pairs of electrons between atoms.

Classical states of matter:	Solid, liquid, and gas. A solid has a stable, definite shape, and a definite volume, and can only change their shape by force, as when broken or cut. A liquid is a nearly incompressible fluid that conforms to the shape of its container but retains a (nearly) constant volume independent of pressure. A gas is a compressible fluid that will conform to the shape of its container as well as expand to fill the container.
Pure substance:	A form of matter that has constant chemical composition and characteristic properties. It cannot be separated into components by physical separation methods, i.e. without breaking chemical bonds. They can be solids, liquids or gases.
Mixture:	A material system made up by two or more different substances which are mixed but are not combined chemically.

Materials

- pennies (lots of them)

In the Classroom

Introductory Discussion

1. Review how to read the periodic table of the elements.
    - For a given element, how do you determine the number of protons? Neutrons? Electrons?
    - What rules exist for where electrons are to be placed in the atom?

2. Emphasize and remind students that electronic shells have a maximum number of electrons allowed (2 for the first, 8 for the second, 8 for the third, etc.) and that atoms like to have their shells completely filled (or emptied).

3. Briefly describe science activity. Each student will be given a paper schematic/cartoon of an atom (activity sheets include: carbon, chlorine, hydrogen, neon, oxygen, and sodium). Their first task will be to put the appropriate number of electrons (pennies) in the outermost shell (inner shells will be already-filled on the worksheet, with the electrons represented by grey circles). A list of molecules will then be shown at the front of the class. Students will need to find the appropriate partners in the class to build the various molecules AND will need to work as a group to put the atoms together in a way so that each nucleus has a filled outer shell. (Time and technology permitting, spend some time with the 'States of Matter: Basics; Build an Atom; and, Build a Molecule' PhETs, listed in the references below. This is best done if the classroom is equipped with a computer and an associated projector, so that all students can easily watch the teacher build an atom, as an example for the activity to follow.)

4. Students will focus on making observations and recording their results into scientific notebooks, as well as drawing conclusions about how various molecules are formed.

5. Once the groups have formed the molecules, the scientist will review: ionic bonds, covalent bonds, and inert elements. Be sure to highlight that this is one way of classifying matter (how/if it bonds to other things).

6. Continuing with the topic of classifying. Ask students (brainstorm) how matter can be classified. Be certain to cover the difference between pure substances (elements or compounds) and mixtures (mechanical mixture, suspension, solution). Must also cover phases of matter: solid, liquid, gas. Time permitting, could also cover: conductivity; hardness; magnetic; and so on.

Science Activity

Activity Title: Building molecules

Purpose of Activity: To form and strengthen the concept of the electron's role in chemistry.

Prediction or Hypothesis: Have the students answer the two following questions (i.e., create a hypothesis). Will all of the atoms react to form a molecule? Can any molecule imaginable be created?

Methods and Instructions:
Set-up prior to experiment: 30 separate atomic templates must be created, with all electrons shells but the outermost. Collect more than enough pennies for the remaining electrons.

Brief description of how students will work in groups or pairs.

1. Hand out an atomic template to each student. The students should consult their periodic table of the elements to determine how many electrons they require. They will use pennies to fill the outermost electronic shell of their element.

2. Put students into groups that will (or not) form molecules (e.g., H_2O, CO, CO_2, NaCl, and Ne). Give the students some time to figure out how electrons can be shared between atoms to create the molecules (or not, in the case of neon).

3. Explain the difference between ionic and covalent bonds, and why some elements are inert (i.e., neon, which doesn't react at all).

4. Students will use their scientific notebooks to draw the atom they were given and the molecule they created. They should also keep note of the different classification schemes covered.

Closure Discussion

1. Segue from the classification of bonds to the classification of materials. Have students brainstorm on different ways in which matter can be classified. Must cover solids, liquids, and gases. Time permitting, open the PhET “States of Matter: Basics” and discuss the general properties of solids, liquids, and gases.

2. Does anyone know of other ways to classify materials?

3. Not all materials fit easily into the classifications above. How would you classify: jello; sand; playdough; silly putty?

4. Introduce the following lesson (building an electric motor).

References

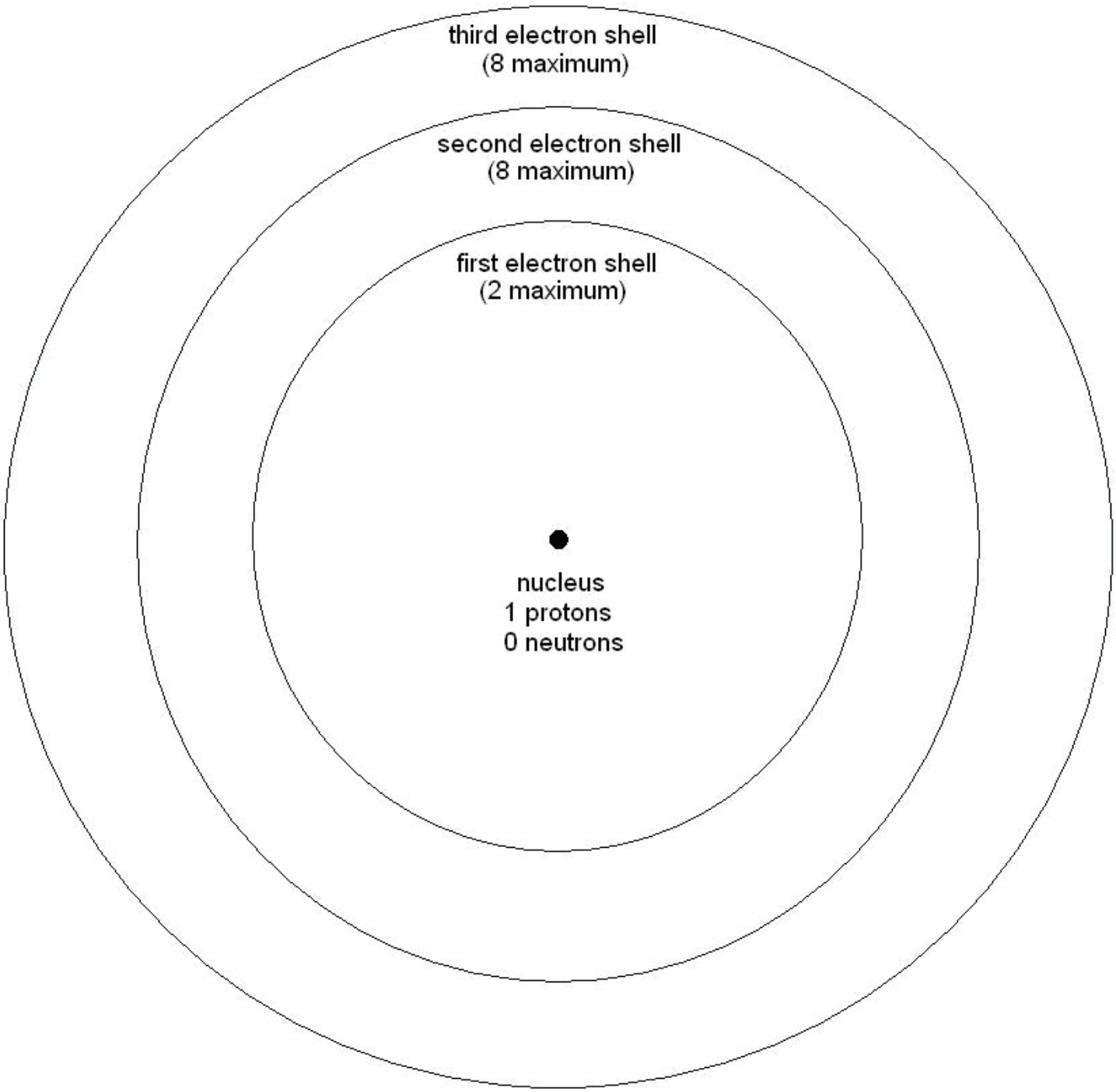
1. <http://en.wikipedia.org/wiki/Covalent_bond> 'Covalent bond' entry on Wikipedia [Provides an excellent description of a covalent bond, with some helpful graphics.]

2. <http://en.wikipedia.org/wiki/Ionic_bond> 'Ionic bond' entry on Wikipedia [Provides an excellent description of a ionic bond, with some helpful graphics.]

3. <http://phet.colorado.edu/en/simulation/states-of-matter-basics> 'States of Matter: Basics' PhET (*Ph*ysic *E*ducation *T*echnology) from the University of Boulder, Colorado. One of many from a suite of research-based interactive computer simulation for teaching and learning physics, chemistry, math, and other sciences. [Small, simple program that allows the user to heat, cool and compress atoms and molecules and watch as they change between solid, liquid and gas phases.]

4. <http://phet.colorado.edu/en/simulation/build-an-atom> 'Build an Atom' PhET (*Ph*ysic *E*ducation *T*echnology) from the University of Boulder, Colorado. One of many from a suite of research-based interactive computer simulation for teaching and learning physics, chemistry, math, and other sciences. [Small, simple program that allows the user to drag and drop protons/neutrons/electrons into an atom, thereby building an atom. This is the virtual analog to part of the hands-on activity described in this lesson.]

5. <http://phet.colorado.edu/en/simulation/build-a-molecule> 'Build an Molecule' PhET (*Ph*ysic *E*ducation *T*echnology) from the University of Boulder, Colorado. One of many from a suite of research-based interactive computer simulation for teaching and learning physics, chemistry, math, and other sciences. [Small, simple program that allows the user to, starting from atoms, build a number of different. Once constructed, the moecules may be represented in 3D. This is the virtual analog to part of the hands-on activity described in this lesson.]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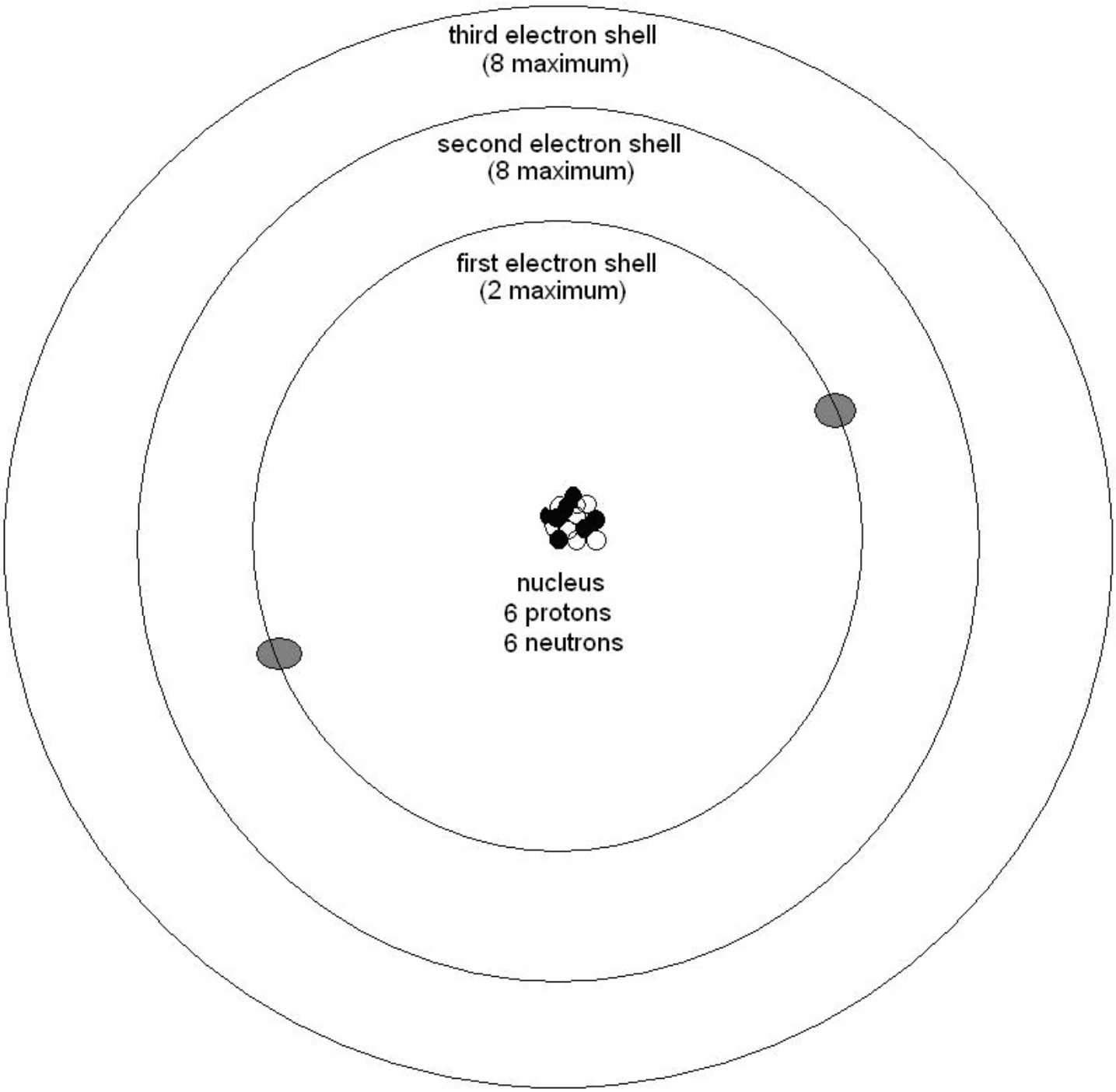
(8 maximum)
second electron shell
(8 maximum)
first electron shell
(2 maximum)
nucleus
1 protons
0 neutrons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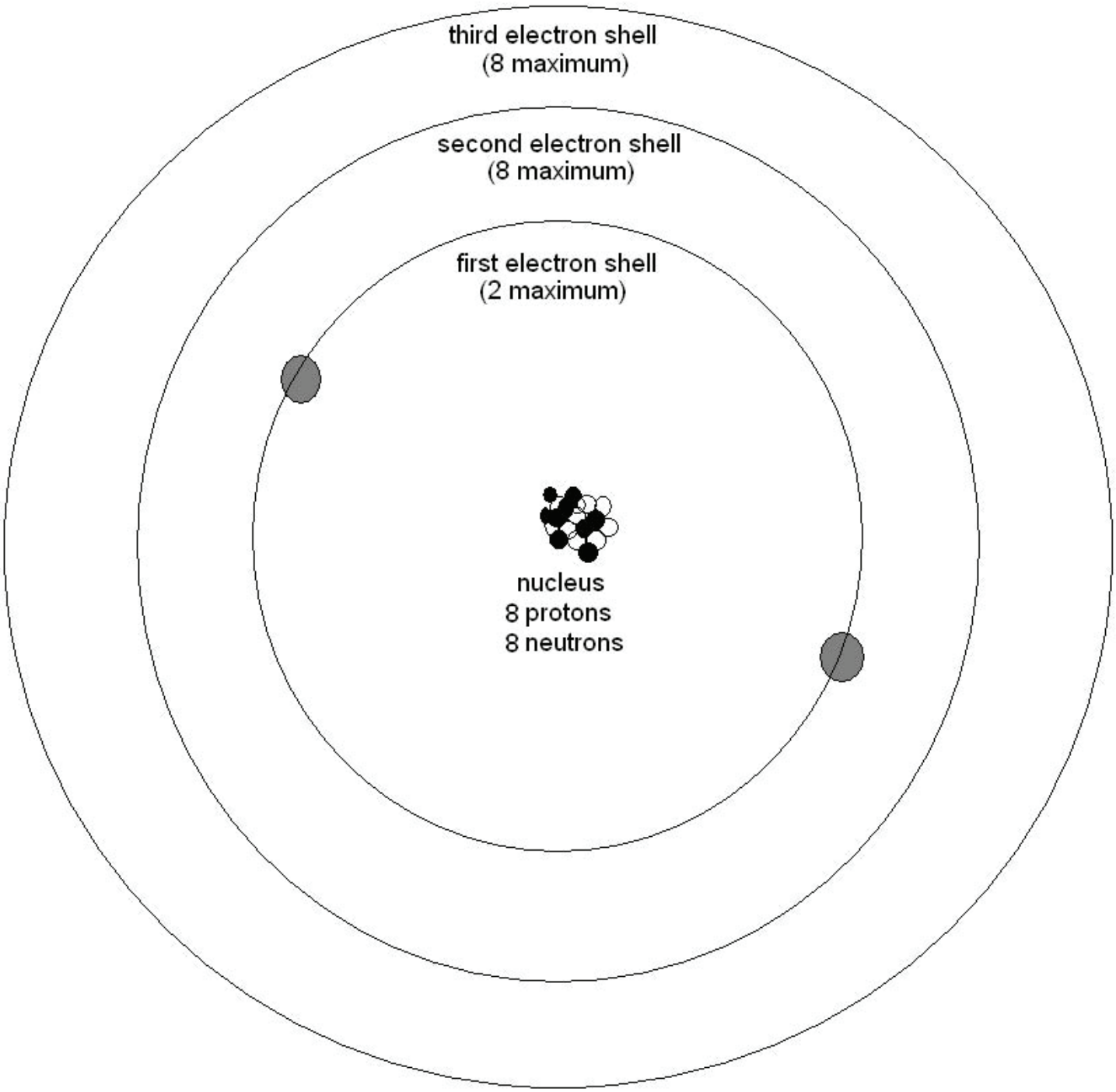
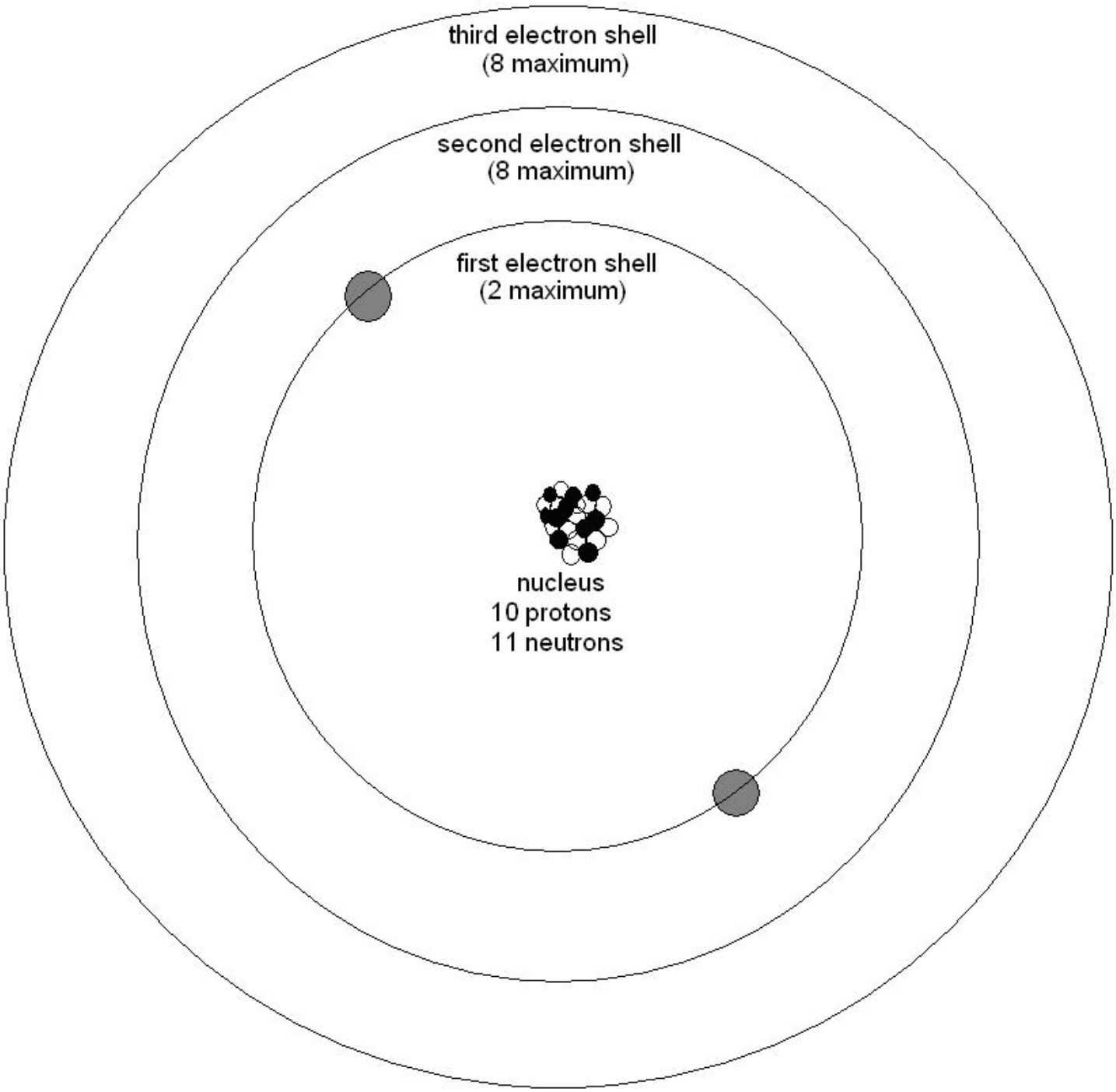
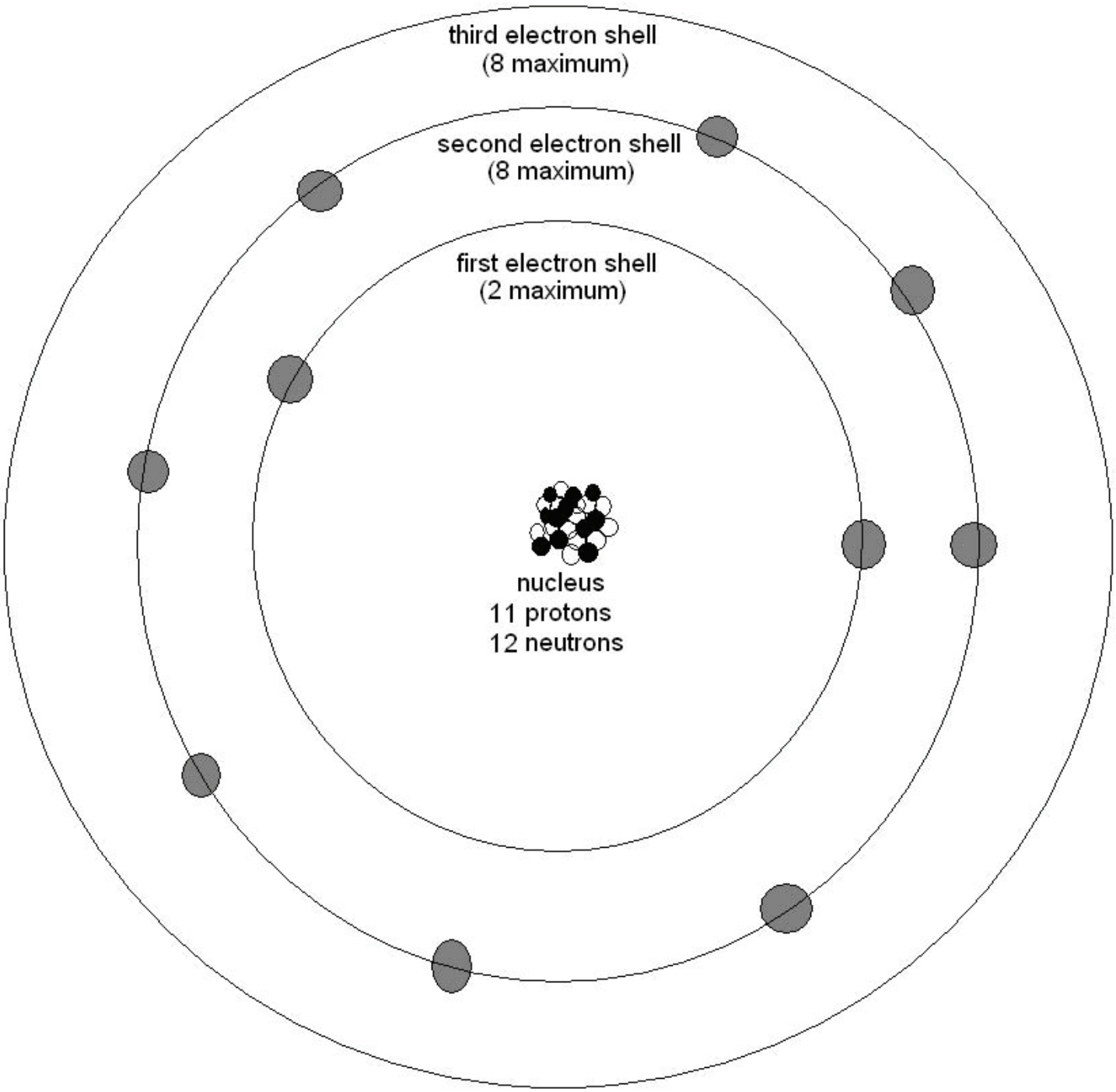
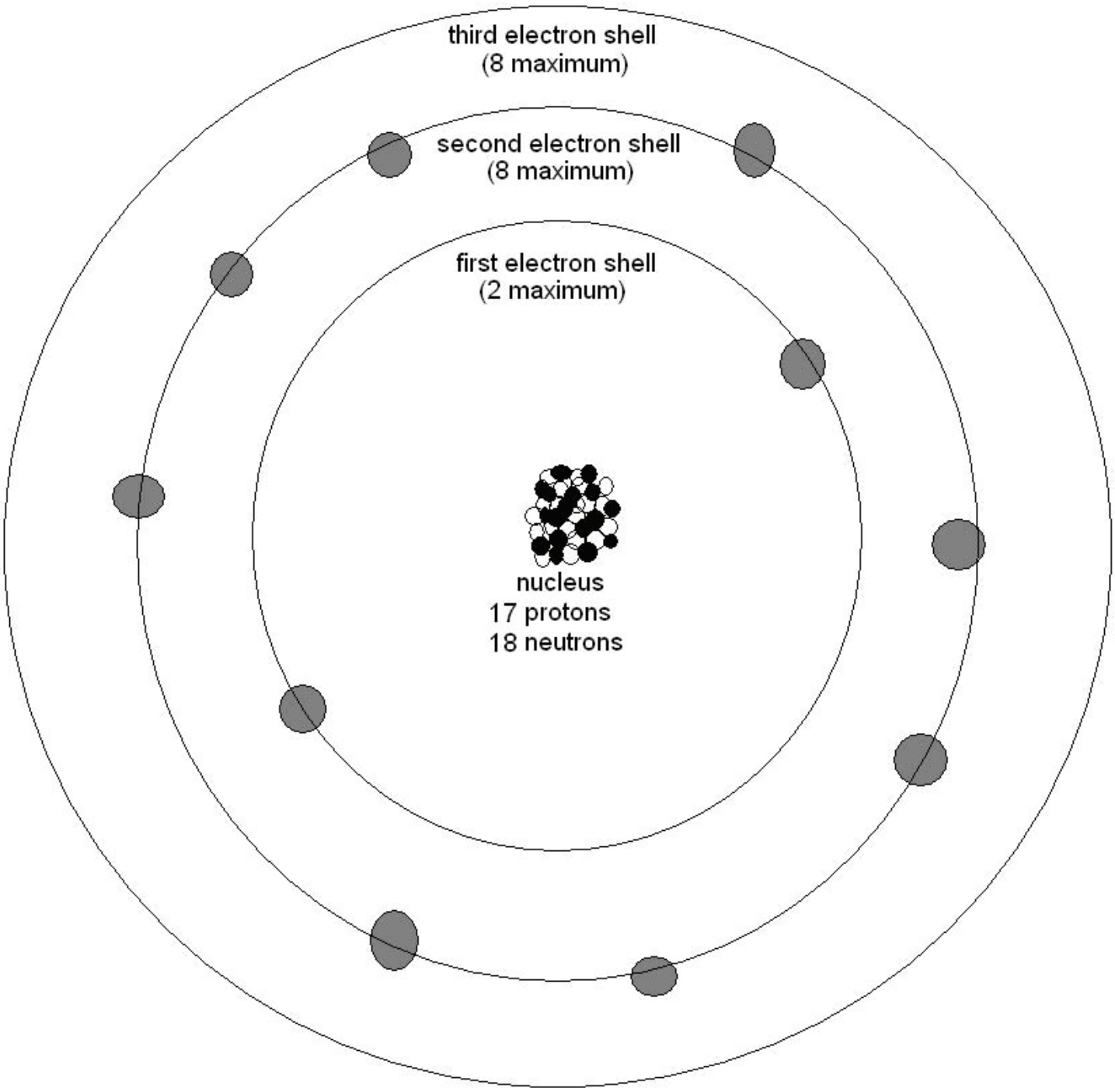
(8 maximum)
second electron shell
(8 maximum)
first electron shell
(2 maximum)
nucleus
6 protons
6 neutrons


third electron shell
(8 maximum)
second electron shell
(8 maximum)
first electron shell
(2 maximum)
nucleus
8 protons
8 neutrons


third electron shell
(8 maximum)
second electron shell
(8 maximum)
first electron shell
(2 maximum)
nucleus
10 protons
11 neutrons


third electron shell
(8 maximum)
second electron shell
(8 maximum)
first electron shell
(2 maximum)
nucleus
11 protons
12 neutrons


third electron shell
(8 maximum)
second electron shell
(8 maximum)
first electron shell
(2 maximum)
nucleus
17 protons
18 neutrons