

Chapter 7: Nuclear Energy and Society

Mini Investigation: Simulating Nuclear Reactions, page 317

Answers may vary. Sample answers:

A. The graph is a curve showing a decline in the number of heads, approaching zero. This is similar to my prediction. It has the shape it does because over time the number of heads decreases exponentially since the tails were eliminated from the each subsequent pool of coins.

B. It took 10 trials for all of the pennies to be removed. Most classmates had results between 9 and 12 trials, but some had higher and some had lower results. Experimental data always includes some variation. By combining everyone's data we could obtain more reliable results.

Section 7.1: Atoms and Isotopes

Tutorial 1 Practice, page 320

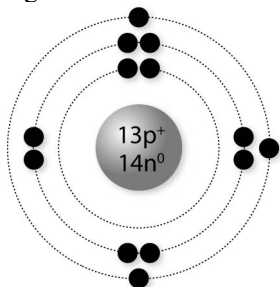
1. Note: After the first printing, the mass numbers for aluminum (28) and silver (110) were added to this question. The answers below assume mass numbers of 27 and 108.

(a) The mass of this isotope is 27.

Subtract the atomic number from the mass number to find the number of neutrons.

$$27 - 13 = 14$$

Aluminum has 14 neutrons. This is the Bohr-Rutherford diagram for aluminum.

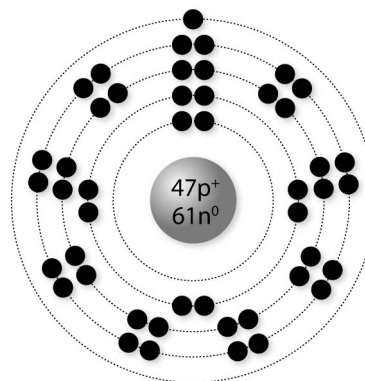


(b) The mass of this isotope is 108.

Subtract the atomic number from the mass number to find the number of neutrons.

$$108 - 47 = 61$$

Silver has 61 neutrons. This is the Bohr-Rutherford diagram for silver.



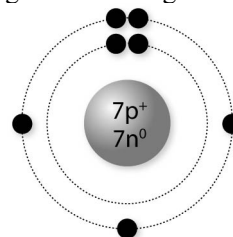
(c) Answers may vary. Sample answers:

The mass of this isotope is 14.

Subtract the atomic number from the mass number to find the number of neutrons.

$$14 - 7 = 7$$

Nitrogen has seven neutrons. This is the Bohr-Rutherford diagram for nitrogen.

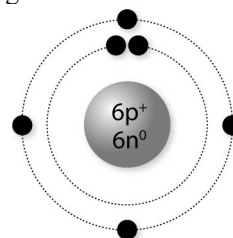


The mass of this isotope is 12.

Subtract the atomic number from the mass number to find the number of neutrons.

$$12 - 6 = 6$$

Carbon has six neutrons. This is the Bohr-Rutherford diagram for carbon.



Research This: Technetium-99m, page 321

A. A meta-stable isotope is not stable but has a long half-life. It could be called “somewhat stable.”

B. Tc-99m is not found in nature. It is formed as molybdenum-99 decays.

C. Answers may vary. Sample answer: Technetium-99m has a half-life of 6.01 h, so it is eliminated from the body quickly.

D. Answers may vary. Sample answer: Technetium-99m gathers around tumours and red blood cells. This means it can be used to detect difficult-to-find cancers and circulatory system disorders. It can also be used to create images of the brain, liver, lungs, kidneys, and skeleton.

E. As with other radioactive materials, exposure to technetium-99m increases the risk of cancer.

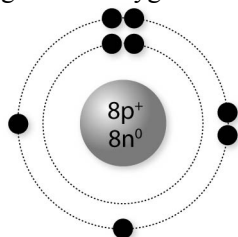
Section 7.1 Questions, page 322

Note: Questions 3 and 6 were switched after the first printing. The answers below reflect this change.

1. (a) The mass of this isotope is 16. Subtract the atomic number from the mass number to find the number of neutrons.

$$16 - 8 = 8$$

Oxygen-16 has eight neutrons. This is the Bohr-Rutherford diagram for oxygen-16.

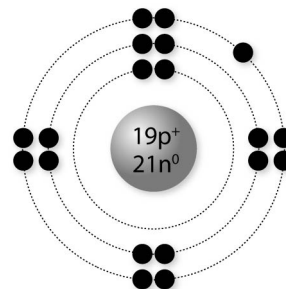


(b) Note: After the first printing, potassium-39 in Question 1(b) was changed to potassium-40. The answer below reflects this change.

The mass of this isotope is 40. Subtract the atomic number from the mass number to find the number of neutrons.

$$40 - 19 = 21$$

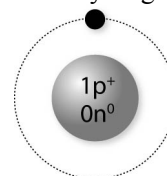
Potassium-40 has 21 neutrons. This is the Bohr-Rutherford diagram for potassium-40.



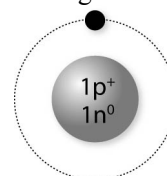
2. (a) The mass of this isotope is 1. Subtract the atomic number from the mass number to find the number of neutrons.

$$1 - 1 = 0$$

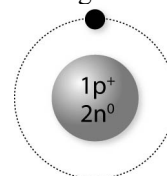
Hydrogen has no neutrons. This is the Bohr-Rutherford diagram for hydrogen.



Deuterium has one proton and one neutron. This is the Bohr-Rutherford diagram for deuterium.



Tritium has one proton and two neutrons. This is the Bohr-Rutherford diagram for tritium.



(b) The diagrams all have one proton and one electron in the lowest energy level. Hydrogen has no neutrons, deuterium has one neutron, and tritium has two neutrons.

3. (a) (i) The atomic number is the number of protons: 7. The mass number is the number of protons and neutrons: $7 + 5 = 12$.

(ii) The atomic number is the number of protons: 13. The mass number is the number of protons and neutrons: $13 + 13 = 26$.

(b) (i) Using the periodic table, the element is nitrogen, N. The isotope has seven protons and a mass number of 12 so the chemical name is $^{12}_7\text{N}$.

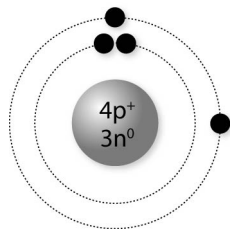
(ii) Using the periodic table, the element is aluminum, Al. The isotope has 13 protons and a mass number of 26 so the chemical name is $^{26}_{13}\text{Al}$.

4. (a) (i) The isotope ${}^7_4\text{Be}$ has a mass of 7.

Subtract the atomic number from the mass number to find the number of neutrons.

$$7 - 4 = 3$$

The isotope has three neutrons. This is the Bohr-Rutherford diagram for the isotope ${}^7_4\text{Be}$.

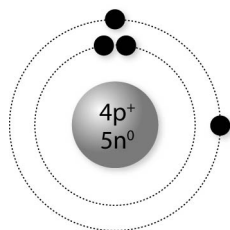


(ii) The isotope ${}^9_4\text{Be}$ has a mass of 9.

Subtract the atomic number from the mass number to find the number of neutrons.

$$9 - 4 = 5$$

The isotope has five neutrons. This is the Bohr-Rutherford diagram for the isotope ${}^9_4\text{Be}$.

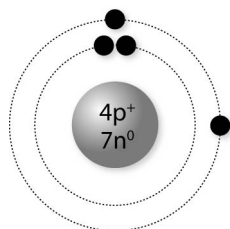


(iii) The isotope ${}^{11}_4\text{Be}$ has a mass of 11.

Subtract the atomic number from the mass number to find the number of neutrons.

$$11 - 4 = 7$$

The isotope has seven neutrons. This is the Bohr-Rutherford diagram for the isotope ${}^{11}_4\text{Be}$.



(b) These models all show beryllium with four protons and four electrons. They show different numbers of neutrons.

(c) The isotope ${}^9_4\text{Be}$ is the most common in nature.

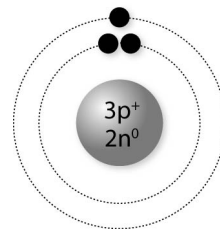
In the periodic table, the atomic mass of beryllium is given as 9.

5. (a) (i) The isotope ${}^5_3\text{Li}$ has a mass of 5.

Subtract the atomic number from the mass number to find the number of neutrons.

$$5 - 3 = 2$$

The isotope has two neutrons. This is the Bohr-Rutherford diagram for the isotope ${}^5_3\text{Li}$.

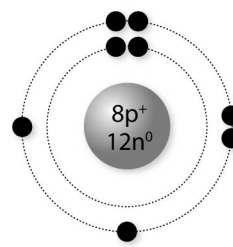


(ii) The isotope ${}^{20}_8\text{O}$ has a mass of 20.

Subtract the atomic number from the mass number to find the number of neutrons.

$$20 - 8 = 12$$

The isotope has 12 neutrons. This is the Bohr-Rutherford diagram for the isotope ${}^{20}_8\text{O}$.



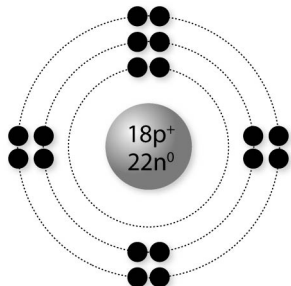
(b) The mass number of lithium's most common isotope is 7, so it has four neutrons ($7 - 3 = 4$). Lithium-5 has two fewer neutrons than the most common isotope. The mass number of oxygen's most common isotope is 16, so it has eight neutrons ($16 - 8 = 8$). Oxygen-20 has four more neutrons than the most common isotope.

6. (a) There are 14 protons, so this is silicon. There are 14 neutrons, so the mass number is 28 ($14 + 14 = 28$). This is silicon-28.

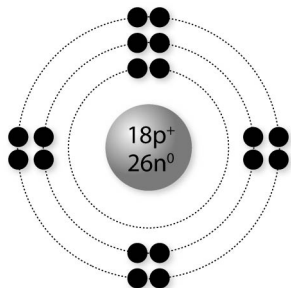
(b) There are 10 protons, so this is neon. There are 12 neutrons, so the mass number is 22 ($10 + 12 = 22$). This is neon-22.

7. An isotope with 16 protons has an atomic number of 16. Using the periodic table, the element is sulfur, S.

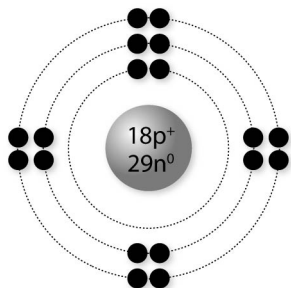
8. (a) (i) Argon-40 has a mass of 40.
 Subtract the atomic number from the mass number
 to find the number of neutrons.
 $40 - 18 = 22$
 The isotope has 22 neutrons. This is the Bohr-
 Rutherford diagram for the isotope ${}^{40}_{18}\text{Ar}$.



(ii) Argon-44 has a mass of 44.
 Subtract the atomic number from the mass number
 to find the number of neutrons.
 $44 - 18 = 26$
 The isotope has 26 neutrons. This is the Bohr-
 Rutherford diagram for the isotope ${}^{44}_{18}\text{Ar}$.

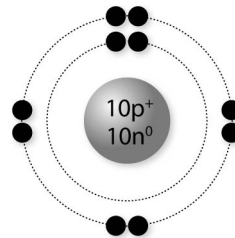


(iii) Argon-47 has 18 protons.
 Subtract the atomic number from the mass number
 to find the number of neutrons.
 $47 - 18 = 29$
 The isotope has 29 neutrons. This is the Bohr-
 Rutherford diagram for the isotope ${}^{47}_{18}\text{Ar}$.

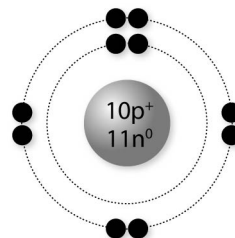


(b) (i) These isotopes are alike because they all
 have 18 protons and 18 electrons at the same
 energy levels.
(ii) These isotopes are different because they have
 different numbers of neutrons, which also gives
 them different atomic masses. Argon-47 has the
 greatest mass, and argon-40 has the least mass.

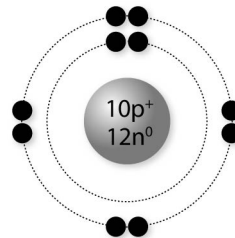
9. (a) Neon-20 has a mass of 20.
 Subtract the atomic number from the mass number
 to find the number of neutrons.
 $20 - 10 = 10$
 The isotope has 10 neutrons. This is the Bohr-
 Rutherford diagram for the isotope ${}^{20}_{10}\text{Ne}$.



Neon-21 has a mass of 21.
 Subtract the atomic number from the mass number
 to find the number of neutrons.
 $21 - 10 = 11$
 The isotope has 11 neutrons. This is the Bohr-
 Rutherford diagram for the isotope ${}^{21}_{10}\text{Ne}$.

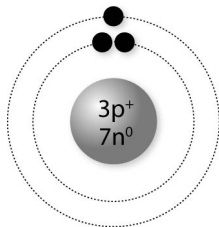


Neon-22 has a mass of 22.
 Subtract the atomic number from the mass number
 to find the number of neutrons.
 $22 - 10 = 12$
 The isotope has 12 neutrons. This is the Bohr-
 Rutherford diagram for the isotope ${}^{22}_{10}\text{Ne}$.

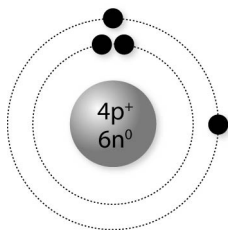


(b) These models all have 10 protons and
 10 electrons in the same energy levels. Neon-20
 has 10 neutrons, neon-21 has 11 neutrons, and
 neon-22 has 12 neutrons.

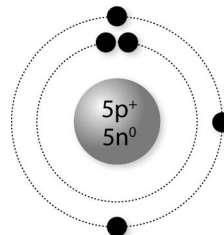
10. (a) Lithium-10 has a mass of 10.
 Subtract the atomic number from the mass number
 to find the number of neutrons.
 $10 - 3 = 7$
 The isotope has seven neutrons. This is the Bohr-
 Rutherford diagram for the isotope $^{10}_3\text{Li}$.



Beryllium-10 has a mass of 10.
 Subtract the atomic number from the mass number
 to find the number of neutrons.
 $10 - 4 = 6$
 The isotope has six neutrons. This is the Bohr-
 Rutherford diagram for the isotope $^{10}_4\text{Be}$.



Boron-10 has a mass of 10.
 Subtract the atomic number from the mass number
 to find the number of neutrons.
 $10 - 5 = 5$
 The isotope has five neutrons. This is the Bohr-
 Rutherford diagram for the isotope $^{10}_5\text{B}$.



(b) These models all show isotopes with atomic
 mass of 10. They have different numbers of
 protons and electrons because they are different
 elements.