1. In the space below, write an electron configuration for a silicon atom in an excited state.

Base your answers to questions 2 and 3 on the information below.

In the gold foil experiment, a thin sheet of gold was bombarded with alpha particles. Almost all the alpha particles passed straight through the foil. Only a few alpha particles were deflected from their original paths.

2. Explain, in terms of charged particles, why some of the alpha particles were deflected.

3. State one conclusion about atomic structure based on the observation that almost all alpha particles passed straight through the foil.

4. Base your answer to the following question on the information below.

   In 1897, J. J. Thomson demonstrated in an experiment that cathode rays were deflected by an electric field. This suggested that cathode rays were composed of negatively charged particles found in all atoms. Thomson concluded that the atom was a positively charged sphere of almost uniform density in which negatively charged particles were embedded. The total negative charge in the atom was balanced by the positive charge, making the atom electrically neutral.

   In the early 1900s, Ernest Rutherford bombarded a very thin sheet of gold foil with alpha particles. After interpreting the results of the gold foil experiment, Rutherford proposed a more sophisticated model of the atom.

   State one aspect of the modern model of the atom that agrees with a conclusion made by Thomson.

Base your answers to questions 5 and 6 on the information below.

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 unit)</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>

5. Show a correct numerical setup for calculating the atomic mass of Si.

6. Determine the total number of neutrons in an atom of Si-29.
In living organisms, the ratio of the naturally occurring isotopes of carbon, C-12 to C-13 to C-14, is fairly consistent. When an organism such as a woolly mammoth died, it stopped taking in carbon, and the amount of C-14 present in the mammoth began to decrease. For example, one fossil of a woolly mammoth is found to have 1/32 of the amount of C-14 found in a living organism.

State, in terms of subatomic particles, how an atom of C-13 is different from an atom of C-12.

Base your answers to questions 8 through 10 on the information below.

Two isotopes of potassium are K-37 and K-42.
9. How many valence electrons are in an atom of K-42 in the ground state?
10. What is the total number of neutrons in the nucleus of a K-37 atom?

Base your answers to questions 11 and 12 on the data table below, which shows three isotopes of neon.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Atomic Mass (atomic mass units)</th>
<th>Percent Natural Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{20}$Ne</td>
<td>19.99</td>
<td>90.9%</td>
</tr>
<tr>
<td>$^{21}$Ne</td>
<td>20.99</td>
<td>0.3%</td>
</tr>
<tr>
<td>$^{22}$Ne</td>
<td>21.99</td>
<td>8.8%</td>
</tr>
</tbody>
</table>

11. In terms of *atomic particles*, state one difference between these three isotopes of neon.

12. Based on natural abundances, the average atomic mass of neon is closest to which whole number?
Many advertising signs depend on the production of light emissions from gas-filled glass tubes that are subjected to a high-voltage source. When light emissions are passed through a spectroscope, bright-line spectra are produced.

13. Explain the production of an emission spectrum in terms of the energy states of an electron.

14. Identify the two gases in the unknown mixture.

15. Draw a Lewis electron-dot structure for an atom of phosphorus.

A glass tube is filled with hydrogen gas at low pressure. An electric current is passed through the gas, causing it to emit light. This light is passed through a prism to separate the light into the bright, colored lines of hydrogen's visible spectrum. Each colored line corresponds to a particular wavelength of light. One of hydrogen's spectral lines is red light with a wavelength of 656 nanometers.

Tubes filled with other gases produce different bright-line spectra that are characteristic of each kind of gas. These spectra have been observed and recorded.

16. A student measured the wavelength of a hydrogen's visible red spectral line to be 647 nanometers. Show a correct, numerical setup for calculating the student's percent error.

17. Explain how the elements present on the surface of a star can be identified using bright-line spectra.
18. Base your answer to the following question on the information below.

An atom has an atomic number of 9, a mass number of 19, and an electron configuration of 2–6–1.

Explain why the number of electrons in the second and third shells show that this atom is in an excited state.

19. Base your answer to the following question on In the early 1900s, evidence was discovered that atoms were not “hard spheres.” It was shown that atoms themselves had an internal structure. One experiment involved gold metal foil.

\[ \text{79 protons} \]  \[ \text{neutrons} \]  \[ \text{electrons} \]

\( a \) Complete the simple model for an atom of gold-197 by placing the correct numbers in the two blanks.

\( b \) In the gold-foil experiment, alpha particles were directed toward the foil. Most of the alpha particles passed directly through the foil with no effect. This result did not agree with the “hard spheres model” for the atom. What conclusion about the internal structure of the atom did this evidence show?

\( c \) In the same experiment, some of the alpha particles returned toward the source. What does this evidence indicate about the charge of the atom’s nucleus?
1. •2-7-5 •1-8-5 •2-8-3-1

2. –Alpha particles are positive and are repelled by the nucleus that is also positive.  
–Both protons and alpha particles are positively charged so they repel each other.  
–Protons and alpha particles have the same charge.

3. Atoms are mostly empty space

4. An atom has equal amounts of negative and positive charge;  
An atom has an equal number of protons and electrons; All atoms contain electrons;  
Electrons are negatively charged.

5. \((27.98)(0.9222) + (28.98)(0.0469) + (29.97)(0.0309)\)

6. 15

7. A C-13 atom has seven neutrons and a C-12 atom has six neutrons.

8. Acceptable responses include, but are not limited to:  
same number of protons, different number of neutrons  
K-37 has fewer neutrons than K-42.  
same element; different number of neutrons

9. 1 or one.

10. 18.

11. Acceptable responses: Each isotope has a different number of neutrons; different number of neutrons;  
Ne-22 has two more neutrons than Ne-20 and one more neutron than Ne-21.

12. 20

13. Acceptable responses: Energy is released when an electron falls from a high state (excited)  
to a low state (ground), excited state to ground state, high energy to low energy.

14. Allow credit for A and D.

15. Allow credit for any acceptable arrangement of five dots around the element symbol P.

16. \(\text{Example: The spectrum from a star is compared to spectra of known elements.}\)

17. \(\text{Examples: – The third shell has one electron before the second shell is completely filled – The electron configuration is not 2-7, which is the ground state for an atom with atomic number 9}\)

18. \(\text{a) 118 neutrons, 79 electrons. b) Acceptable responses include, but are not limited to, these examples: – The atom’s internal structure is mostly empty space or – mostly empty space}\)

19. \(\text{c) Acceptable responses include, but are not limited to, these examples: – The nucleus of the gold atoms have a positive charge. or – Both the nucleus of the gold atoms and the alpha particles have the same charge. or – positive charge}\)