Base your answers to questions **1** through **3** 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.

Naturally Occurring Isotopes of Silicon

Isotope	Atomic Mass (atomic mass units)	Percent Natural Abundance (%)
Si-28	27.98	92.22
Si-29	28.98	4.69
Si-30	29.97	3.09

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

2. Determine the total number of neutrons in an atom of Si-29.

3. A scientist calculated the percent natural abundance of Si-30 in a sample to be 3.29%. Determine the percent error for this value.

4. Write an electron configuration for an atom of aluminum-27 in an excited state.

5. Naturally occurring boron is composed of two isotopes. The percent abundance and the mass of each isotope are listed below.

   - 19.9% of the boron atoms have a mass of 10.013 atomic mass units.
   - 80.1% of the boron atoms have a mass of 11.009 atomic mass units.

   Calculate the atomic mass of boron. Your response must include *both* a correct numerical setup and the calculated result.

   _____ atomic mass units

6. Draw a Lewis electron-dot diagram for a sulfur atom in the ground state.

Base your answers to questions **7** through **9** on the information below.

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.

7. 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.

8. Explain, in terms of electron energy states and energy changes, how hydrogen's bright-line spectrum is produced.

9. Explain how the elements present on the surface of a star can be identified using bright-line spectra.

Base your answers to questions **10** and **11** 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.

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

11. What is the total number of neutrons in this atom?

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12. Explain, in terms of atomic structure, why liquid mercury is a good electrical conductor.

Base your answers to questions **13** through **16** on the table below.

First Ionization Energy of Selected Elements

Element	Atomic Number	First Ionization Energy (kJ/mol)
lithium	3	520
sodium	11	496
potassium	19	419
rubidium	37	403
cesium	55	376

13. On the same grid, plot the data from the table. Circle and connect the points.

14. On a grid, mark an appropriate scale on the axis labeled "First Ionization Energy (kj/mol)." An appropriate scale is one that allows a trend to be seen.

15. State the trend in first ionization energy for the elements in the table as the atomic number increases.

16. Explain, in terms of atomic structure, why cesium has a *lower* first ionization energy than rubidium.

Base your answers to questions **17** through **19** on the information below.

Two isotopes of potassium are K-37 and K-42.

17. Explain, in terms of subatomic particles, why K-37 and K-42 are isotopes of potassium.

18. What is the total number of neutrons in the nucleus of a K-37 atom?

19. How many valence electrons are in an atom of K-42 in the ground state?

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20. In the early 1900s, experiments were conducted to determine the structure of the atom. One of these experiments involved bombarding gold foil with alpha particles. Most alpha particles passed directly through the foil. Some, however, were deflected at various angles. Based on this alpha particle experiment, state *two* conclusions that were made concerning the structure of an atom.

Base your answers to questions **21** through **23** on the information below.

Elements with atomic numbers 112 and 114 have been produced and their IUPAC names are pending approval. However, an element that would be put between these two elements on the Periodic Table has not yet been produced. If produced, this element will be identified by the symbol Uut until an IUPAC name is approved.

21. Identify one element that would be chemically similar to Uut.

22. Draw a Lewis electron-dot diagram for an atom of Uut.

23. Determine the charge of an Uut nucleus. Your response must include both the numerical value and the sign of the charge.

Base your answers to questions **24** through **27** on the information below

The table below lists physical and chemical properties of six elements at standard pressure that correspond to known elements on the Periodic Table. The elements are identified by the code letters, D, E, G, J, L, and Q.

Properties of Six Elements at Standard Pressure

Element D Density 0.00018 g/cm^3 Melting point –272°C Boiling point –269°C Oxide formula (none)	Element E Density 1.82 g/cm^3 Melting point 44°C Boiling point 280°C Oxide formula E_2O_5	Element G Density 0.53 g/cm^3 Melting point 181°C Boiling point 1347°C Oxide formula G_2O
Element J Density 0.0013 g/cm^3 Melting point –210°C Boiling point –196°C Oxide formula J_2O_5	Element L Density 0.86 g/cm^3 Melting point 64°C Boiling point 774°C Oxide formula L_2O	Element Q Density 0.97 g/cm^3 Melting point 98°C Boiling point 883°C Oxide formula Q_2O

24. Identify, by code letter, the element that is a noble gas in the "Properties of Six Elements at Standard Pressure" table.

25. What is the total number of elements in the "Properties of Six Elements at Standard Pressure" table that are solids at STP?

26. An atom of element G is in the ground state. What is the total number of valence electrons in this atom?

27. Letter Z corresponds to an element on the Periodic Table other than the six listed elements. Elements G, Q, L, and Z are in the same group on the Periodic Table, as shown in the diagram below.

Based on the trend in the melting points for elements G, Q, and L listed in the "Properties of Six Elements at Standard Pressure" table, estimate the melting point of element Z, in degrees Celsius.

Base your answers to questions **28** through **31** on the information below.

A metal, *M*, was obtained from a compound in a rock sample. Experiments have determined that the element is a member of Group 2 on the Periodic Table of the Elements.

28. Using the symbol *M* for the element, write the chemical formula for the compound that forms when element *M* reacts with iodine.

29. What is the phase of element *M* at STP?

30. Explain, in terms of electrons, why element *M* is a good conductor of electricity.

31. Explain why the radius of a positive ion of element *M* is *smaller* than the radius of an atom of element *M*.

32. Explain, in terms of electron configuration, why selenium and sulfur have similar chemical properties.

33. Explain, in terms of atomic structure, why the atomic radius of iodine is greater than the atomic radius of fluorine.

Atom & PT Part 2 Worksheet
Answer Key

1. (27.98)(0.9222) + (28.98)(0.0469) + (29.97)(0.0309)

2. 15

3. 6.5%

4. *Examples:* – 2-7-4 – 1-8-4 – 2-6-2-3

5. • *Correct Numerical Setup Examples:*
   — (10.013)(0.199) + (11.009)(0.801)
   — $\frac{(19.9)(10.013) + (80.1)(11.009)}{100}$
   — (10.013)(19.9%) + (11.009)(80.1%)
   • *Calculated Result Examples:*
   —10.8 atomic mass units
   —10.81 atomic mass units
   —10.8108 atomic mass units

6. 

7. % error = $\frac{647 \text{ nm} - 656 \text{ nm}}{656\text{nm}} \times 100$

   $\frac{647 - 656}{656} \times 100$

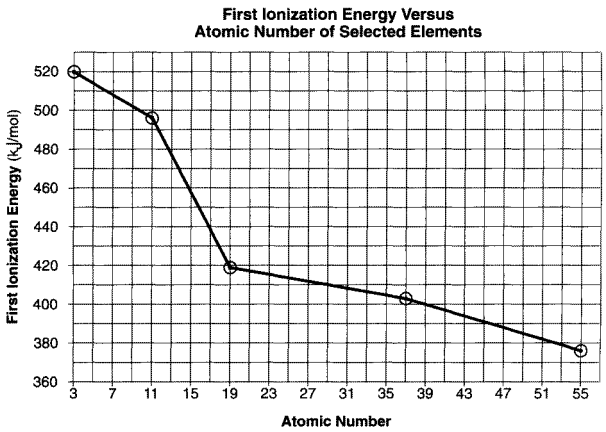
8. *Examples*: – The electron of hydrogen absorbs energy and jumps to a higher energy state. The excited electron returns to a lower energy state, releasing light energy – The e^- absorbs energy and jumps to a higher level. The e^- falls back to a lower level and releases energy related to a particular color.

9. *Example*: The spectrum from a star is compared to spectra of known elements.

10. *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

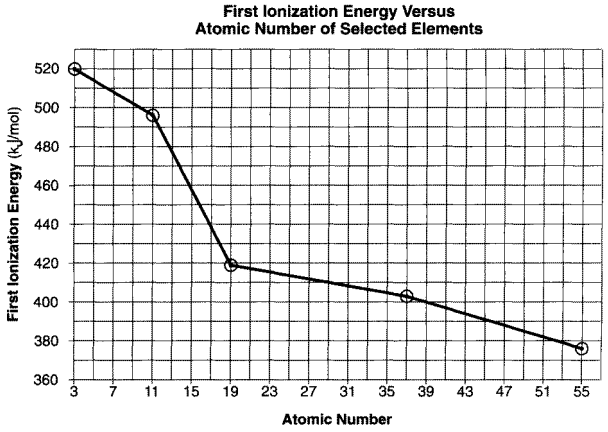
11. 10

12. Examples: – Electrons in liquid mercury are mobile. – valence electrons free to move and conduct electric current

13. 

Allow credit for plotting all the points correctly (±0.3 grid space). Plotted

points do *not* need to be circled or connected.

14. 

Allow credit for marking an appropriate linear scale. An appropriate scale is one that allows a trend to be seen.

15. Acceptable responses include, but are not limited to:
As atomic number increases, first ionization energy decreases. Ionization energy decreases.

16. Acceptable responses include, but are not limited to:
As atomic radius increases, valence electrons are more easily removed.
The force of attraction between the nucleus and the valence electrons decreases down the group.
cesium has more shells, easier to remove electrons

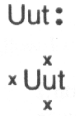
17. Acceptable responses include, but are not limited to:
same number of protons, different number of neutrons
K-37 has fewer neutrons than K-42.
same element; different number of neutrons

18. 18.

19. 1 or one.

20. The nucleus is small. The nucleus is positively charged. The atom is mostly empty space. The nucleus is dense.

21. *Examples:* – Ti – boron

22. 

23. +113

24. *D or He*

25. 4

26. 1

27. temperature value below 64°C

28. MI_2

Atom & PT Part 2 Worksheet
Answer Key

29. solid

30. Examples: – Metals have freely moving v alence electrons. – mobile valence electrons – sea of mobile electrons – Electrons are del ocalized.

31. Examples: – The ionic radius is smaller be cause the atom loses two electrons. – The ion has one less occupied energy level.

32. Examples: – An atom of each element has six ele ctrons in its outer shel l. – same number of valence electrons

33. Examples: – An iodine aton has mo re elect ron shells than a fluorine atom. – A fluorine atom has fewer electron shells.