1. (2pts) Did Democritus have experimental evidence that atoms existed? Yes or No

2. (2pts) Who discovered electrons? _______________________

3. (2pts) The Plum Pudding model of the atom was accepted after the gold foil experiment. Yes or No

4. (6pts) Atoms of $^{12}C$ and $^{13}C$ isotopes have _______ protons.
Do they have the same number of neutrons? (Yes or No)
Do they have the same number of electrons? (Yes or No)

5. (8pts) Group 7A elements are called _______________.
Group 1 A elements are called ____________________.
Elements in group 3B-2B are called ___________________ elements.
The elements in the rest of the periodic table are called ___________________ elements.

6. (4pts) Which is more abundant in nature, $^{79}Br$ or $^{81}Br$?

7. (4pts) As you move across the periodic table, metallic character _______________(increases or decreases).

8. (4pts) A fluorescent bulb is filled with Hg gas. When light from this bulb is separated, a ______________ (continuous or line) spectrum is observed.
When light from the sun is separated, a ______________ (continuous or line) spectrum is observed.

9. (9pts) Write out the full electron configuration for chlorine (Cl). Circle the valence electrons.
Write out the full electron configuration for chloride ion (Cl$^{-}$). Circle the valence electrons.

Using the electron configurations above, explain why chlorine is more chemically reactive than chloride ion.
10. (4pts) Name three different kinds of electromagnetic radiation and order them by increasing energy.

11. (6pts) In the visible spectrum, which color of light is composed of waves with the highest frequency? What color of light is composed of waves with the longest wavelength? Which color of light is composed of waves with photons of the highest energy?

12. (6pts) In the Bohr model of the hydrogen atom below only four energy levels are shown. Show where the electron has to start and where it has to end to release light of the longest wavelength. Make sure you indicate the direction of the electron (whether it is falling in toward the nucleus or ”jumping” away from the nucleus as it releases light— show only ONE direction).

13. (8pts) Which has a lower ionization energy, K or Ca? Which is more chemically reactive, K or Ca? Which element is more similar to Ca in its physical and chemical properties, K or Mg? Explain in 1-2 sentences.

14. (4pts) Draw a resonance structure for the azide ion, N\(_{3}^{−}\), drawn below.
Draw Lewis structures for the following:

15) (4pts) Li₂S

16a) (4pts) Draw the structure of SO₃²⁻.
b) (4pts) Indicate the electron geometry
c) (4pts) Indicate the molecular shape
d) (4pts) Is the molecule polar or non-polar?

17) (8pts) a) Draw 2 possible isomers (structures that fit the rules but are different—they are NOT resonance structures) for the cyanate ion, CNO⁻¹. (Note: this is not the same as cyanide ion). Please use a triple bond in both structures.
b) Using the HONC rule, circle the structure of cyanate that is more likely.
18. (8pts) Determine whether the bond formed between each of the following pairs of atoms is non-polar covalent, polar covalent, or ionic. (Pauling values: H=2.1, Rb=0.8, Cl=3.0, S=2.5, O=3.5).

a) H and H

b) Rb and Cl

c) S and O

d) For any above that are polar covalent, draw the bond and indicate the dipole using the cross arrow or δ+ and δ- signs.

19. (6pts) Europium has two naturally occurring isotopes: Eu-151 with a mass of 150.9198 and a natural abundance of 47.8% and Eu-153. Use the atomic mass of europium to find the mass and natural abundance of Eu-153. Show your work and use significant figures for full credit.

20. (12pts) Complete the following table:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Atomic number</th>
<th>Mass number</th>
<th># of protons</th>
<th># of electrons</th>
<th># of neutrons</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>²⁵Mg²⁺</td>
<td>25</td>
<td>25</td>
<td>13</td>
<td>10</td>
<td>0</td>
<td>-2</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>32</td>
<td>8</td>
<td>10</td>
<td>0</td>
<td>-2</td>
</tr>
</tbody>
</table>

Extra Credit Joke: Why is hamburger lower in energy than steak?