Atomic Theory and Periodic Table Review: Answers

Answers to Practice Multiple Choice Questions:

1. c	11. b	21. a	31. d	41. b	51. d	61. a	71. b	81. d
2. b	12. a	22. b	32. b	42. c	52. b	62. d	72. a	82. c
3. c	13. d	23. d	33. b	43. b	53. b	63. a	73. b	83. b
4. c	14. c	24. d	34. b	44. c	54. d	64. b	74. a	84. b
5. c	15. d	25. b	35. d	45. a	55. c	65. c	75. b	85. a
6. b	16. c	26. a	36. d	46. a	56. d	66. a	76. c	86. b
7. b	17. d	27. a	37. b	47. a	57. a	67. c	77. a	87. c
8. c	18. a	28. b	38. d	48. d	58. a	68. a	78. c	88. c
9. c	19. c	29. d	39. b	49. c	59. a	69. a	79. b	89. d
10. a	20. d	30. c	40. c	50. c	60. c	70. c	80. d	90. d

1. Definitions: see course notes.
2. Refer to answer sheets for Review Questions for Atomic Theory Quiz #1.
3. Why, for some elements, can a lack of reactivity be a desirable property? (see Lab #2) Give 2 examples.

   Metals such as silver, platinum and gold are very unreactive. This makes them useful in situations where there may be acids or other corrosive materials. They also are excellent for jewellery. The Noble Gas elements are also extremely unreactive, so they can be used to protect other elements from oxygen or more reactive gases. For example, light-bulbs are filled with unreactive gases. This increases the lifespan of the metal filament.

4. Silicon has the following three isotopes: the most abundant (92.23%) is Si-28 with an actual atomic mass of 27.9769 u; 4.67% is Si-29 with an actual atomic mass of 28.9765 u and rest is Si-30 with an actual atomic mass of 29.9738 u. What is the average atomic mass of silicon? (answer: 28.09 u)

   * the amount of Si-30 is 100% - (92.23% + 4.67%) = 3.10%

   AAM = (% Si-28 x mass Si-28) + (% Si-29 x mass Si-29) + (% Si-30 x mass Si-30)
   = (0.9223 x 27.9769 u) + (0.0467 x 28.9765 u) + (0.0310 x 29.9738 u)
   = 25.803 u + 1.353 u + 0.929 u
   = 28.085 u
   = 28.09 u (2 decimal places)

5. Write the balanced nuclear equations for the following nuclear reactions:

   a) plutonium-238 undergoes alpha decay: $^{238}_{94}Pu \rightarrow \, ^{4}_{2}He + \, ^{234}_{92}U$

   b) lead-214 undergoes beta decay: $^{214}_{82}Pb \rightarrow \, ^{0}_{1-}e + \, ^{214}_{83}Bi$

   c) oxygen-18 undergoes beta decay $^{18}_{8}O \rightarrow \, ^{0}_{1-}e + \, ^{18}_{9}F$

   d) thorium-230 undergoes alpha decay $^{230}_{90}Th \rightarrow \, ^{4}_{2}He + \, ^{226}_{88}Ra$

   e) thorium-234 undergoes beta decay $^{234}_{90}Th \rightarrow \, ^{0}_{1-}e + \, ^{234}_{91}Pa$

6. Review the material from "Practice Questions: The Quantum Mechanical Model of the Atom".

7. What is the essential difference between the model of the atom proposed by Bohr and the Quantum Mechanical Model?

   Bohr believed that the electrons were arranged in specific predictable energy levels (or orbits) and that all of the electrons in a given energy level were exactly the same distance from the nucleus. The quantum mechanical model of the atom says that, because of the wave-like properties of electrons and electron-electron repulsion, we can't know exactly where an electron is. So, instead of orbits, it describes the location of an electron in orbitals (3-D space around the nucleus where an electron will be found more than 90% of the time). The quantum mechanical model also divides each principal quantum level into sub-levels (types of orbitals) with different types of motion and slightly different amounts of energy (different distances from the nucleus).

8. Explain the significance of:
   a) **<u>Protons</u>**: the number of protons in an atom's nucleus determines the identity of the atom; what kind of element it is
   b) **<u>Neutrons</u>**: the number of neutrons in an atom's nucleus determines the nuclear stability of the atom. If there are too many or too few neutrons, the nucleus will be unstable and break down by radioactive decay
   c) **<u>Electrons</u>**: it is the number and arrangement of the electrons in an atom that determines the atom's physical and chemical properties.

9. Explain why all of the isotopes of an element have the same **chemical** reactivity.

   Isotopes differ in their number of neutrons, and this affects the stability of the atom's nucleus (whether or not it will be a radio-isotope). The chemical reactivity of an element depends only on its electron configuration. All isotopes of an element will have the same electron configuration, so they will have the same chemical properties.

10. Draw a diagram or flow chart showing how changes in atomic theory have centred around discoveries about electrons.

Dalton: atoms can not be broken down into smaller parts. Does not know that electrons exist.
(Billiard ball model of the atom)

→

Thomson: Uses the cathode rady tube and discovers the electron. Says that electrons are embedded on the surface of a positive atom
(raisin bun model of the atom)

→

Rutherford: Shoots alpha particles at thin gold foil and discovers the nucleus. Says that electrons are found randomly in the space around the nucleus
(electron cloud model of the atom)

↓

Bohr: Studies the bright line spectrum of hydrogen. Believes that electrons are found orbiting the nucleus in precise, defined orbits.
(planetary model of the atom)

←

Quantum mechanics: Electrons are found in 3-D regions called orbitals (regions in space where electrons are found greater than 90% of the time). Orbitals hold a maximum of two electrons with opposite spin. Electrons in different types of orbitals (sub-levels) have different motion and slightly different potential energy.

11. State Heisenberg's Uncertainty Principle. How is this related to the Quantum Theory?

    Heisenberg stated that we can not know BOTH an atom's location (its distance from the nucleus or potential energy) and its motion (trajectory or where it is going). When we measure one of these factors, we change the other. Also, because of their wave-like properties and electron-electron repulsion, electrons do not travel in precise, defined orbits. For these reasons, we use quantum theory to predict the 3-D regions (called orbitals) where we are most likely to find an electron, more than 90% of the time.

12. What does "n" represent? Which atomic model(s) include "n"?

    "n" represents the Principal Quantum Level (or main energy shells), moving out from the nucleus. Both Bohr's planetary model and the Quantum mechanical model include "n". Principal quantum levels hold a maximum of $2n^2$ electrons.

13. Answer the following questions about electron arrangement in atoms
    a) The number of different types of orbitals when n = 5 is **5**
    b) The number of "s" orbitals in the seventh main energy level (n = 7) is **1**
    c) The maximum number of electrons that can fit in the third energy level (n = 3) is **18**
    d) The number of electrons that can be held in the 5-p orbitals (n = 5) is **6**
    e) The number of different types of orbitals when n = 3 is **3**
    f) The number of "p" orbitals in the fourth main energy level (n = 4) is **3**
    g) The maximum number of electrons that can fit in the fifth energy level (n = 5) is **50**
    h) The number of electrons that can be held in the 3-d orbitals (n = 3) is **10**
    i) The number of different types of orbitals when n = 4 is **4**
    j) The maximum number of electrons that can fit in the second energy level (n = 2) is **8**

14. Write electron configurations for:
    a) aluminum $1s^2 2s^2 2p^6 3s^2 3p^1$
    b) bromine $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$
    c) cesium $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^1$

15. Distinguish between a group and a period on the Periodic Table.

    A group (or family) is a vertical column on the Periodic Table. All elements in a group have the same number of valence electrons.
    A period is a horizontal row on the Periodic Table. All elements in a period have their valence electrons in the same energy level.

16. Understand how electron configurations are related to an element's position on the Periodic Table.

The number in front of the last "s" term of an electron configuration tells us the period of the element.
The sum of the number of "s", "d" and "p" electrons in the highest energy level tells us the group number.

a) What is the last term for the electron configuration of calcium? **$4s^2$**
b) Which group does rubidium belong to? **Group IA** (Alkali metals, Group 1) Which period? **5th period**
c) What is the last term for the electron configuration of sulfur? **$3p^4$**
d) Which group does iodine belong to? **Group VIIA** (Halogens, Group 17) Which period? **5th period**
e) How many electrons are in the outer energy level of fluorine? **7 valence electrons**
f) Which group does argon belong to? **Group VIIIA** (Noble Gases, Group 18) Which period? **3rd period**

17. Be able to write ionization reactions for metals and non-metals.
    a) Write electron configurations to show the **ionization reactions** for

Na $1s^2 2s^2 2p^6 3s^1 \rightarrow Na^{1+}\ 1s^2 2s^2 2p^6 + 1e^-$

Ca $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 \rightarrow Ca^{2+}\ 1s^2 2s^2 2p^6 3s^2 3p^6 + 2e^-$

Al $1s^2 2s^2 2p^6 3s^2 3p^1 \rightarrow Al^{3+}\ 1s^2 2s^2 2p^6 + 3e^-$

S $1s^2 2s^2 2p^6 3s^2 3p^4 + 2e^- \rightarrow S^{2-}\ 1s^2 2s^2 2p^6 3s^2 3p^6$

Cl $1s^2 2s^2 2p^6 3s^2 3p^5 + 1e^- \rightarrow Cl^{1-}\ 1s^2 2s^2 2p^6 3s^2 3p^6$

O $1s^2 2s^2 2p^4 + 2e^- \rightarrow O^{2-}\ 1s^2 2s^2 2p^6$

P $1s^2 2s^2 2p^6 3s^2 3p^3 + 3e^- \rightarrow P^{3-}\ 1s^2 2s^2 2p^6 3s^2 3p^6$

17 b) List three ions that are isoelectronic with Ne:

Any ion that has 10 electrons is isoelectronic, eg. C^{4-} , N^{3-}, O^{2-} , F^{1-}, Na^{1+} , Mg^{2+} , Al^{3+}

c) List three atoms or ions that are isoelectronic with Na^{1+}:

Any ion or atom that has 10 electrons is isoelectronic, eg. C^{4-} , N^{3-}, O^{2-} , F^{1-}, Ne, Mg^{2+} , Al^{3+}

18. Be able to predict physical and chemical properties of metals and non-metals. Include the following:
    a) when a metal reacts with water, the type of solution that is produced: **basic**
    b) when a metal reacts with acid, the type of gas that is produced: **hydrogen gas**
    c) when a non-metal reacts with water, the type of solution that is produced: **acidic**

19. Be familiar with the elements from different groups. Prepare a chart summarizing the properties of the elements of Group I, Group II, Group VII and Group VIII with regard to:

	Group I	**Group II**	**Group VII**	**Group VIII**
Group's common name	Alkali Metals	Alkaline Earth Metals	Halogens	Noble Gases
metal or non-metal	metal	metal	non-metal	non-metal
usual state(s) at room temperature	solid	solid	solid, liquid or gas	gas
malleable or brittle	malleable	malleable	brittle	brittle
conductor or non-conductor of electricity	conductor	conductor	non-conductor	non-conductor
does it react with air?	yes forms a metal oxide	yes forms a metal oxide	yes forms a non-metal oxide	unreactive
does it react with water? what are the products?	yes, products are hydrogen gas and a basic solution	yes, products are hydrogen gas and a basic solution	yes, product is an acidic solution	unreactive
does it produce an acidic, basic or neutral solution when dissolved in water?	basic	basic	acidic	neutral

20. Explain how the electron arrangement of the elements of Group IA is related to the chemical properties of the Group IA elements.

Group IA elements have only one electron in their outer "s" orbital. To obtain a stable octet electron arrangement, all Group IA elements will react to lose this one electron during a chemical reaction. The Group IA elements have a very low net nuclear attraction (*Zeff*), so they have a very weak attraction for this valence electron. They will react strongly with other elements to lose this valence electron which makes them very reactive non-metals.

21. Explain how the electron arrangement of the elements of Group VIIA (Group 17) is related to the chemical properties of these elements.

Group VIIA elements have seven electrons in their outer "s" and "p" orbitals (s^2p^5). To obtain a stable octet electron arrangement, all Group VIIA elements will react to gain one electron during a chemical reaction. Because these elements have a very strong net nuclear attraction (*Zeff*), they have a very strong attraction for a new electron and will react strongly with other elements to obtain an additional electron which makes them very reactive non-metals.

22. Use the concepts of shielding effect and net nuclear attraction (*Zeff*) to explain the following trends on the Periodic Table. Discuss the trends within a period, and within a group.

a) electronegativity:

Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction(*Zeff*) increases. This means that the atom's attraction for the electrons in a bond will increase from left to right (excluding the Noble Gases).

Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electrons are further and further from the nucleus, so electronegativity will decrease (there is less attraction for the electrons in a bond).

b) reactivity of metals:

***Metals tend to lose electrons to become stable**

Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction(*Zeff*) increases. This means that the atom's attraction for its valence electrons will increase and it will be harder for the atom to lose those electrons. This will make a metal atom less reactive.

Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electrons are further and further from the nucleus, so the valence electrons will be less strongly attracted to the nucleus and they will be easier to lose. So, the reactivity of metals increases moving down a group.

c) reactivity of non-metals

***Non- metals tend to gain electrons to become stable (except the Noble Gases)**

Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction (*Zeff*) increases. This means that the atom's attraction for its valence electrons will increase and it will be easier for the atom to gain extra electrons. This will make a non-metal atom more reactive (except for the Noble Gases).

Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electrons are further and further from the nucleus, so the valence electrons will be less strongly attracted to the nucleus. The nucleus will have a weaker attraction for new electrons, and this will make a non-metal less reactive moving down a group.

d) ionization energy

Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction(*Zeff*) increases. This means that the atom's attraction for its valence electrons will increase and it will require more energy to remove an electron from an atom. Ionization energy increases moving left to right across a period.

Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electrons are further and further from the nucleus, so the valence electrons will be less strongly attracted to the nucleus. This means that it will require less energy to remove an electron from an atom. Ionization energy decreases moving down a group.

e) **atomic radius**

Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction (Z*eff*) increases. This means that the atom's attraction for its valence electrons will increase and it will pull the valence electrons in more closely to the nucleus, so atomic radius decreases moving left to right across a period.

Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electrons are further and further from the nucleus. As the atoms get larger, the radius of the atom will increase moving down a group.

23. Use the concepts of shielding effect net nuclear attraction to explain why:

a) **oxygen is more reactive than selenium**

Oxygen and selenium are both in Group 16/VIA, with oxygen above selenium. Because they are non-metals, both will be more stable if they gain two electrons. The atoms have the same net nuclear attraction, but the shielding effect is different. The valence electrons in oxygen are much closer to the nucleus, so the nucleus will have a much stronger attraction for additional electrons. This makes oxygen more reactive.

b) **argon has a smaller atomic radius than sodium**

Argon and sodium are both in the third period. Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction increases. This means that the atom's attraction for its valence electrons will increase and it will pull the valence electrons in more closely to the nucleus, so atomic radius decreases moving left to right across a period. Therefore, an argon atom will be smaller because it has a stronger net nuclear attraction (Z*eff*) than sodium.

c) **copper is more electronegative than calcium**

Copper and calcium are both in the fourth period, with copper to the left of calcium. Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction increases. This means that the atom's attraction for the electrons in a bond will increase from left to right (excluding the Noble Gases); therefore, copper has a higher EN than calcium because it has a higher net nuclear attraction (Z*eff*).

d) **it takes more energy to remove an electron from a nitrogen atom than from a phosphorus atom**

Nitrogen and phosphorus are both in Group 15/VA, with phosphorus below nitrogen. Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electrons are further and further from the nucleus, so the valence electrons will be less tightly held by the nucleus. This means that it will require less energy to remove an electron from a phosphorus atom than from a nitrogen atom.

e) **strontium is more reactive than calcium**

Strontium and calcium are both metals in Group 2/IIA. Both will be more stable if they lose 2 electrons. Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electrons in strontium are further from the nucleus than calcium's valence electrons. This means that it will be easier for strontium to lose its valence electrons, making it more reactive than calcium.

24. We have used two chemical indicators in this course, so far: phenolphthalein (phth) and bromothymol blue. Describe what you will see when each is added to the following solutions:

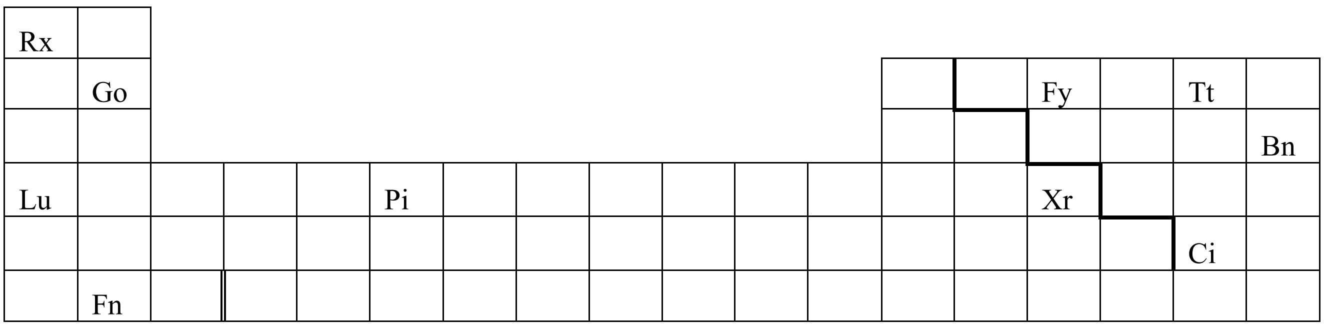
   a) **a metal added to water**: this produces a basic solution. Phth will turn from colourless to pink and bromothymol blue will turn from green to blue.

   b) **a metal oxide in water:** this produces a basic solution. Phth will turn from colourless to pink and bromothymol blue will turn from green to blue.

   c) **a non-metal in water:** this produces an acidic solution. Phth will remain colourless and bromothymol blue will turn from green to yellow.

   d) **a non-metal oxide in water:** this produces an acidic solution. Phth will remain colourless and bromothymol blue will turn from green to yellow.

25. For the following **theoretical** elements on the Periodic Table, answer these questions:



a) Write the electron configurations for Go, Tt and Xr.

Go: $1s^2 2s^2$

Tt: $1s^2 2s^2 2p^5$

Xr: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$

b) Which is more reactive: Fn or Go? Explain.

Fn and Go are both metals, in the same group (column). The more easily they can lose electrons, the more reactive they will be. Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electrons are further and further from the nucleus, so the valence electrons for Fn will be less tightly held by the nucleus and they will be easier to lose. So, Fn is more reactive than Go.

c) Which is the largest atom: Lu, Pi or Xr? Explain.

Lu, Pi and Xr are all in the third period. Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction increases. This means that the atom's attraction for its valence electrons will increase and it will pull the valence electrons in more closely to the nucleus. Because Xr is the furthest to the right, it will have the smallest atomic radius.

d) Which is more reactive: Tt, Ci or Bn? Explain.

Tt, Ci and Bn are all non-metals. Bn is a Noble Gas, so it will be the least reactive. Tt and Ci both need to gain one electron.

Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electrons are further and further from the nucleus, so the valence electrons will be less tightly held by the nucleus. The nucleus of Ci will have a weaker attraction for new electrons, so Tt is the most reactive.

e) Which element has the lowest ionization energy: Go, Fy or Tt? Explain.

Go, Fy and Tt are all in the second period. Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction increases. This means that the atom's attraction for its valence electrons will increase and it will require more energy to remove an electron from an atom. Because Go is the furthest to the left, it will have the lowest net nuclear attraction (NNA or Zeff) and therefore the lowest ionization energy.

f) Which element will tend to lose electrons most easily: Lu, Pi or Xr? Explain.

Lu, Pi and Xr are all in the fourth period. Moving across a period, left to right (→), the shielding effect is constant (so it has no effect), but the net nuclear attraction increases. This means that the atom's attraction for its valence electrons will increase and it will require more energy to remove an electron from an atom. Because Lu is furthest to the left, it will have the lowest ionization energy and it will lose an electron most easily.

g) Which element will have the strongest attraction for a new electron: Fy, Xr, Tt, Ci or Bn? Explain.

The attraction for a new electron increases moving up a column and to the right, except for the Noble Gases (Bn). Tt has the strongest electronegativity and the smallest shielding effect- both of which will increase its attraction for a new electron.

h) What gas is produced when Fn reacts with water?

Fn is a metal, so it will produce hydrogen gas when it reacts with water.

i) When Fn reacts with water, will the resulting solution be acidic, basic or neutral? Explain.

Fn is a metal, so when it reacts with water, it will produce a basic solution.

j) What ion will Tt tend to form during chemical reactions?

Tt will gain one electron, forming a Tt^{1-} ion
Lu will lose one electron, forming a Lu^{1+} ion
Go will lose two electrons, forming a Go^{2+} ion

k) Write the chemical formula of the metal oxide that will be produced when Lu reacts with oxygen.

Lu will form a 1+ ion, and oxygen forms a 2- ion. Using the criss-cross rule, the metal oxide that will form when is Lu_2O

l) How many valence electrons does the neutral atom of these elements have?

Fn has 2 valence electrons (Group IIA)
Tt has 7 valence electrons (Group VIIB)
Pi has 6 valence electrons (Group VIA)

m) Which two elements could be metalloids?

Xr and Ci are the closest to the staircase line, so they could be metalloids.

Random Questions:

1. How many valence electrons do nitrogen and phosphorus have? **<u>both have 5 (Group VA)</u>**
2. How many elements are there in the fourth period of the Periodic Table? **<u>18</u>**
3. The atomic number of a mythical element called "Tassium" (Ts) is 117.
   a) What is the probable electron configuration of Tassium?

      $1s^22s^22p^63s^23p^64s^23d^{10}4p^65s^24d^{10}5p^66s^24f^{14}5d^{10}6p^67s^25f^{14}6d^{10}7p^5$

   b) In which family (group) will Tassium be found? **<u>Group VIIB</u>** (it has $7s^27p^5$) in its valence shell
   c) In which period will Tassium be found? The **<u>7th period</u>** (its last s term is $7s^2$)

4. Metals tend to **<u>lose</u>** electrons, while non-metals tend to **<u>gain</u>** electrons.

5. The elements whose electron configurations end in s^2p^6 belong to which group on the P.T.? **<u>Group VIIIA</u>**

6. Identify the most metallic element on the Periodic Table. To which family does it belong?
   The most metallic element is Francium. It is a Group IA (Alkali Metal) element.

7. Identify the most non-metallic element on the Periodic Table. To which family does it belong?
   The most non-metallic element is He. It is a Noble Gas.

8. In a family of metals, where are the most reactive elements located?
   The most reactive metals are at the bottom of each group (family)

9. Which group contains the elements that have the highest ionization energy? The lowest ionization energy?
   The Noble Gases (Group VIII) have the highest ionization energy.
   The Alkali Metals (Group IA) have the lowest ionization energy.

10. Which element in each group has the largest atomic radius? a) B, **<u>Li</u>**, or F b) **<u>K</u>**, Li or Na
11. Which element in each group has the lowest ionization energy? a) B, **<u>Li</u>**, or F b) **<u>K</u>**, Li or Na
12. What ion will each of the following elements most likely form? Mg, Cl, N, Ar, Al, S, Na
    Mg^{2+} Cl^{1-} $N^{3=}$ Ar (will not ionize) Al^{3+} S^{2-} Na^{1+}
13. When calcium reacts with water, the solution produced is (acidic, **<u>basic</u>**).
14. The gas produced when lithium reacts with water is **<u>hydrogen</u>**.
15. Magnesium oxide solution turns bromothymol blue what colour? **<u>blue (basic)</u>**
16. The element in Group II with the highest ionization energy is **<u>beryllium</u>**.
17. The most reactive halogen is **<u>fluorine</u>**.
18. A solution of bromine in water is (**<u>acidic</u>**, basic). Bromothymol blue will turn **<u>yellow</u>**.
19. Non-metals generally form (positive, **<u>negative</u>**) ions.
20. The most stable electron configurations are found for Group **<u>VIIIA</u>** (the Noble Gases).

21. Cesium is more reactive than lithium. Explain this in terms of their electron arrangements.

    Cesium and lithium are both metals in Group IA. Both will be more stable if they can lose 1 electron. Moving down a group (↓), the net nuclear attraction is constant (so it has no effect), but the shielding effect increases. This means that the valence electron in cesium is further from the nucleus than lithium's valence electron. This means that it will be easier for cesium to lose its valence electron, making it more reactive than lithium.

22. Fluorine is more reactive than chlorine. Explain this in terms of their electron arrangements.

Fluorine and chlorine are non-metals and both tend to gain one electron to obtain a stable octet. They have the same net nuclear attraction, so it has no effect. Fluorine has a smaller shielding effect, so its valence electrons are closer to its nucleus than chlorine's, which has a larger shielding effect. This means that fluorine will have a stronger attraction for new electrons, so it will be more able to gain electrons and is therefore, more reactive than chlorine

23. In which energy level are the valence electrons of each of the following elements found? I, Ca, Ga, F, Fr.

Iodine's valence electrons are in the fifth energy level (n = 5, or the 5^{th} period)

Calcium's valence electrons are in the fourth energy level (n = 4, or the 4^{th} period)

Gallium's valence electrons are in the fourth energy level (n = 4, or the 4^{th} period)

Fluorine's valence electrons are in the second energy level (n = 2, or the 2^{nd} period)

Francium's valence electrons are in the seventh energy level (n = 7, or the 7^{th} period)

24. Li, Na and K all react similarly because of their similar **electron configurations**. All have s^1 as their last term.

Atomic Theory and Periodic Table Review (cont.)

1. Complete this chart:

Quantum Level (Principal Energy Level)	Maximum Number of Electrons that can fit in this Quantum Level	Total Number of Orbitals in this Quantum Level	How Many Types of Orbitals are there in this Quantum Level	Names of the Orbitals in this Quantum Level
1	2	1	1	s
2	8	4	2	s,p
3	18	9	3	s, p, d
4	32	16	4	s, p, d, f
5	50	25	5	s, p, d, f, g
n	$2n^2$	n_2	n	s, p, d, f, g, h, i etc.

2. Complete this chart:

Name of Element	Symbol for Element	Atomic Number	Number of Protons	Number of Electrons	Number of Neutrons	Mass Number	Total Electric Charge
phosphorus	P	15	15	18	23	38	3 -
manganese	Mn	25	25	23	31	56	2 +
magnesium	Mg	12	12	12	14	26	0
fluorine	F – 19	9	9	10	10	19	1 -
argon	Ar	18	18	18	21	39	0
magnesium	Mg - 27	12	12	10	15	27	2 +
scandium	Sc	21	21	18	23	44	3 +
manganese	Mn	25	25	21	32	57	4 +
selenium	Se	34	34	36	45	79	2 -
sulfur	S	16	16	18	19	35	2 -

Trends in the Periodic Table

3. Circle the element from each pair which has the **highest** electronegativity:

- EN increases going across a period (→), because NNA increases so the atom has a stronger attraction for a new electron.
- EN decreases as you go down a group (↓), because shielding effect increases so the valence electrons are further from the nucleus and there is a weaker attraction for a new electron.

a) **lithium** or cesium
b) **fluorine** or bromine
c) calcium or **beryllium**
d) titanium or **cobalt**
e) boron or **nitrogen**
f) potassium or **chlorine**

4. Circle the element from each pair which has the **largest** atomic radius

- atomic radius decreases going across a period (→), because net nuclear attraction (*Zeff*) increases so the atom has a stronger attraction for the valence electrons. The electrons are pulled in tighter to the nucleus so the atom is smaller.
- atomic radius increases going down a group (↓), because the shielding effect increases and there are more full electron shells, so the atoms get larger

a) **calcium** or sulfur
b) **barium** or vanadium
c) neon or **lithium**
d) **strontium** or bromine
e) zinc or **rubidium**
f) **potassium** or scandium

5. Circle the element from each pair which has the **lowest** ionization energy

- ionization energy increases going across a period (→), because net nuclear attraction (Z*eff*) increases so the atom has a stronger hold on its electrons. It takes more energy to remove an electron, so ionization energy increases.
- ionization energy decreases as you go down a group (↓), because shielding effect increases so the valence electrons are further from the nucleus. It takes less energy to remove an electron, so ionization energy decreases.

a) argon	or	**boron**	d) **calcium**	or	iron
b) **barium**	or	magnesium	e) **silicon**	or	chlorine
c) lithium	or	**sodium**	f) chlorine	or	**selenium**

6. Circle the element from each pair which is the **most** reactive

First check to see if you are dealing with metals or non-metals.

- Reactivity of **metals** decreases as you go across a period (→). Metals tend to lose valence electrons. As net nuclear attraction (Z*eff*) increases, the nucleus has a stronger and stronger attraction for its valence electrons, so it is harder and harder for them to lose electrons, so reactivity decreases.
- Reactivity of **metals** increases going down a group (↓), because the shielding effect increases. The valence electrons are further from the nucleus so they are easier to lose and reactivity increases.

- Reactivity of **non-metals** increases as you go across a period (→). Non-metals tend to gain electrons. As net nuclear attraction (Z*eff*) increases, an atom has a stronger and stronger attraction for electrons, so it will be easier to gain, and reactivity increases.
- Reactivity of **non-metals** decreases going down a group (↓), because the shielding effect increases. The valence electrons are further from the nucleus so the atom has a weaker attraction for new electrons. It is harder for them to gain new electrons, and reactivity of non-metals decreases.

a) sodium	or	**potassium**	e) **barium**	or	scandium
b) **scandium**	or	cobalt	f) strontium	or	**cesium**
c) iodine	or	**fluorine**	g) **oxygen**	or	selenium
d) **lead**	or	radon	h) argon	or	**sodium**