Electron Configuration Worksheet

1. Maximum number of electrons: (a) $2e^-$ (b) $8e^-$ (c) $18e^-$ (d) $32e^-$

2.

Orbitals and Electrons in *s, p, d,* and *f* Sublevels				
Sublevel	**Symbol**	**Value of *l***	**Number of orbitals**	**Max # of electrons**
(a)	*s*	0	1	2
(b)	*p*	1	4	8
(c)	*d*	2	9	18
(d)	*f*	3	16	32

3. The aufbau principle states that electrons occupy lower energy orbitals first. Either a diagonal orbital diagram or the periodic table can be used to determine this order of occupancy.

4. If four electrons are to be placed into a *p* subshell, the aufbau principle states that all lower energy levels must already be full, and Hund's rule states that each of the three *p* orbitals must already have one occupying electron before the fourth is placed in any one of the orbitals.

5(a)

beryllium atom, Be:
2*s* ↑↓
1*s* ↑↓

magnesium atom, Mg:
3*s* ↑↓
2*p* ↑↓ ↑↓ ↑↓
2*s* ↑↓
1*s* ↑↓

calcium atom, Ca:
4*s* ↑↓
3*p* ↑↓ ↑↓ ↑↓
3*s* ↑↓
2*p* ↑↓ ↑↓ ↑↓
2*s* ↑↓
1*s* ↑↓

5(b) (b) These diagrams all show two *s* electrons in the highest energy orbital.

6.
(a) *s*
(b) *d*
(c) *p*
(d) *f*

7.
(a) The halide ions have a charge of negative one, −1.
(b) The electron configuration of each halogen shows one less electron than a full *p* orbital energy level; for example, fluorine is $1s^2\ 2s^2\ 2p^5$, chlorine is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$, bromine is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^5$, and so on. We explain the ion charge by assuming that halogens strongly attract one extra electron to occupy the unfilled *p* orbital in the highest orbital energy level.

8.
(a) A sodium ion, Na^+, has a configuration of $1s^2\ 2s^2\ 2p^6$, the same as that of a neon atom, Ne.
(b) These two chemical entities are both chemically very stable, and have the same electron configuration; but sodium ions are positively charged and strongly attract negative ions to form ionic solid compounds, while neutral neon atoms have extremely weak attractive forces, and form a noble gas at room conditions.

9. The electron configuration for Sb^{3+} is [Kr] $5s^2\ 4d^{10}$. The electron configuration for Sb^{5+} is [Kr]$4d^{10}$.

10. The electron configuration for a gallium atom, Ga, is [Ar] $4s^2\ 3d^{10}\ 4p^1$. The Ga^{3+} ion has most probably lost three electrons from the fourth shell, and so should have a configuration of [Ar] $3d^{10}$.

11. Copper has an electron configuration of [Ar] $4s^1\ 3d^{10}$ and therefore has an unpaired electron ($4s^1$). Zinc has an electron configuration of [Ar] $4s^2\ 3d^{10}$ and has no unpaired electrons.

12. A gold atom should have an electron configuration of [Xe] $6s^2\ 4f^{14}\ 5d^9$, if we use the aufbau principle. However, a filled *d* suborbital creates extra stability, especially in large atoms, so [Xe] $6s^1\ 4f^{14}\ 5d^{10}$ is the normal configuration.

13.
(a) Sc^{3+} has a probable configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$, or [Ar].
(b) Ag^+ has a probable configuration of [Kr] $4d^{10}$.
(c) Fe^{3+} has a probable configuration of [Ar] $3d^5$.
Fe^{2+} has a probable configuration of [Ar] $4s^1\ 3d^5$.
(d) Th^+ has a probable configuration of [Rn] $7s^2\ 5f^1$.
Th^{3+} has a probable configuration of [Rn] $5f^1$.

15.
(a) The result predicted by classical theory is that the atoms should hit a target to form a solid pattern because the atoms should hit the photographic plate randomly within the beam. The result predicted by quantum theory is that the pattern should be two distinct lines.
(b) Silver has an electron configuration of [Kr] $5s^1\ 4d^{10}$, with a single unpaired *s* valence electron. If all silver atoms were identical, any magnetic moment caused by the external field should move the atoms in random directions, since it could be oriented in any direction as the atoms enter the field. The two distinct lines indicate that a silver atom must have one of two distinct and opposite magnetic moments. This was later interpreted to be due to the valence (unpaired) electron having one of only two possible (and opposite) "spins."