Atomic Structure

1.

Symbol	Atomic Mass	Atomic Number	Number of Protons	Number of Neutrons	Number of Electrons	Full Atomic Symbol
Ar	36	18	18	18	18	$^{36}_{18}Ar$
Ag	108	47	47	61	47	$^{108}_{47}Ag$
Al	27	13	13	14	13	$^{27}_{13}Al$
As	75	33	33	42	33	$^{75}_{33}As$
At	210	85	85	125	85	$^{210}_{85}At$
Au	197	79	79	118	79	$^{197}_{79}Au$
X^{2+} = Ac	227	89	89	138	87	$^{227}_{89}Ac^{2+}$
X^{3+} = Am	243	95	95	148	92	$^{243}_{95}Am^{3+}$

Atomic mass, Isotope

1.) Number of protons

a) Be — 4
b) U — 92
c) Mn — 25

2.) Number of electrons in a neutral atom

a) C — 6
b) Fe — 26
c) Ar — 18

3.) Number of electrons in ions

a) Na^{+} — 10
b) Mg^{2+} — 10
c) V^{3+} — 20
d) O^{2-} — 10
e) Cl^{-} — 18
f) Al^{3+} — 10
g) Sb^{3-} — 54
h) Fe^{2+} — 24
i) H^{-} — 2
j) As^{3+} — 30

4.) Ion produced

a) S^{2-}
b) Ca^{2+}
c) Cl^{-}
d) Al^{3+}

e) Cr^{2+}
f) Mn^{4+}
g) V^{5+}
h) Sb^{3-}

5.) Nuclear charge (same as atomic number)
a) Mg — +12
b) Ne — +10
c) K^{+} — +19
d) S^{2-} — +16

6.) Average atomic masses
a) Ga — 69.8 g
b) Ag — 108.0 g
c) Ge — 72.7 g
d) Zn — 65.5 g

Periodic Table

1.) Predict the properties of the unknown element using the properties of its neighbours and whatever mathematical methods seem appropriate. If Mendel could do it, so can you!

Atomic mass Density $\left(\frac{g}{mL}\right)$ Density of oxide $\left(\frac{g}{mL}\right)$ Formula of chloride Density of chloride $\left(\frac{g}{mL}\right)$ Colour Lustre	**Al** 27.1 2.70 3.97 $AlCl_3$ 2.44 Silvery white metallic	**Si** 28.1 2.33 2.65 $SiCl_4$ 1.48 Grey metallic	**P** 31.0 1.82 2.14 $PCl_{3\,(l)}$, $PCl_{5\,(g)}$ 1.57 (liquid) Pale yellow waxy
Atomic mass Density $\left(\frac{g}{mL}\right)$ Density of oxide $\left(\frac{g}{mL}\right)$ Formula of chloride Density of chloride $\left(\frac{g}{mL}\right)$ Colour Lustre	**Ga** 69.7 5.90 5.88 $GaCl_3$ 2.47 Silvery metallic	**Ge** 72.6 5.35 4.23 $GeCl_4$ 1.84 Greyish white metallic	**As** 74.9 5.73 3.87 $AsCl_3$ 2.16 Steel grey Dull metallic
Atomic mass Density $\left(\frac{g}{mL}\right)$ Density of oxide $\left(\frac{g}{mL}\right)$ Formula of chloride Density of chloride $\left(\frac{g}{mL}\right)$ Colour Lustre	**In** 114.8 7.31 7.18 $InCl_3$ 3.46 Silvery white metallic	**Sn** 118.6 7.28 6.95 $SnCl_2$, $SnCl_4$ 3.95, 2.23 Silvery white metallic	**Sb** 121.8 6.69 5.67 $SbCl_3$, $SbCl_5$ 3.14, 2.34 Bluish-white metallic

2.) State the chemical family or group to which each of the following elements belongs.

a.) radon
Noble gas

c.) iodine
Halogen

e.) calcium
Alkaline earth

g.) zinc
Transition met

b.) iron
Transition met

d.) lithium
Alkali met

f.) cesium
Alkali met

h.) chlorine
Halogen

3.) Give the symbol for the two other elements in the same family as the following.

a.) Na Li, K, Rb, Cs, Fr b.) Ar He, Ne, Kr, Xe, Rn c.) Mg Be, Ca, Sr, Ba, Ra d.) Br F, Cl, I, At

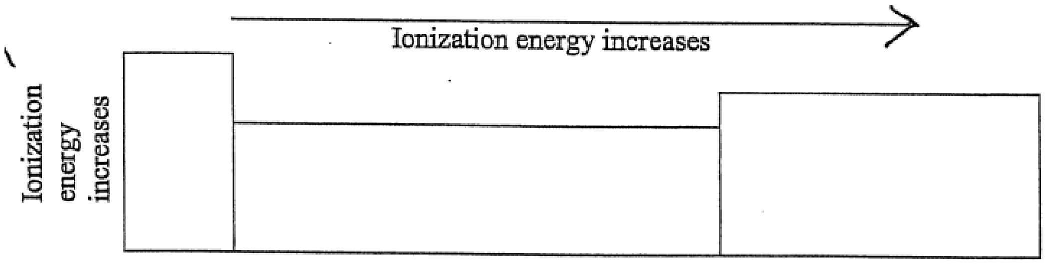
4.) Give the symbols for the two other elements in the same period as the following.

a.) C Li, Be, B, N, O, Ne b.) S Na, Mg, Al, Si, P, S, Cl, Ar

Periodic Trends

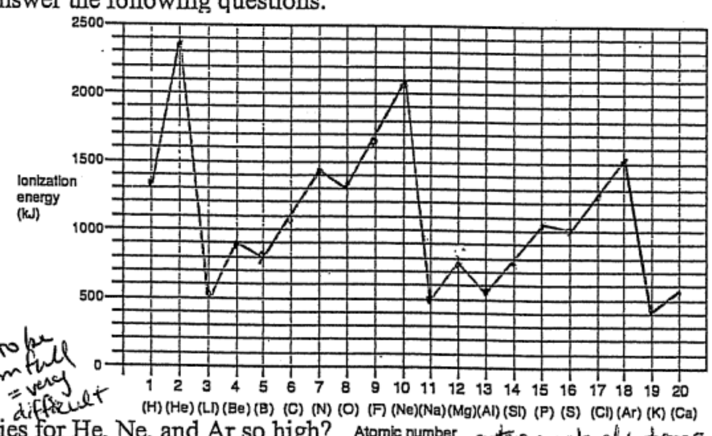
1. Attract or repel? a. positive and positive R b. negative and negative R c. positive and negative A

2. Place arrowheads in the correct direction on the horizontal and vertical lines below.



3. Which member of each of the following pairs should have a greater ionization energy?
   a) Br or Cl b) Al or Cl c) Ne or Xe d) Mg or Ba e) F or Ne f) Rb or I

Plot the ionization energy versus atomic number on the following graph and connect each point to the next with a straight line. Then answer the following questions.



electrons have to be removed from full shells = very difficult

a) Why are the ionization energies for He, Ne, and Ar so high?
b) Why do the ionization energies decrease going from He to Ne to Ar? outer most electrons are further from nucleus, attraction smaller, easy to remove
c) Why is there a general increase in ionization energy going from Li to Ne? electrons closer to nucleus, increased attraction
d) "Filled subshells and half-filled subshells have a special stability which requires extra energy to be applied before electron removal can occur". This general statement is supported by the existence of the electron configuration exceptions found for Cu and Cr. What experimental evidence exists in the graph "ionization energy versus atomic number"?

half-filled N & P have half-filled p → IE higher than elements around them | Be + Mg, He, Ne, & Ar have filled shells (s, p) IE higher than elements around them.

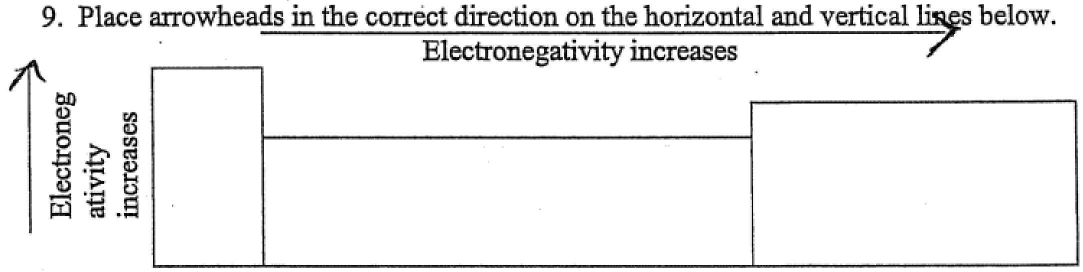
5. Consider two atoms: O and Te.
    a) Which atom has the larger atomic radius? Te
    b) Which atom has the larger ionization energy? O
    c) Which atom has more shells? Te
    d) How many valence electrons does Te have? 6
    e) What is the valence of Te? 2
    f) Which atom has a greater electrostatic attraction between its nucleus and outermost electrons? O

6. Consider two atoms: Ga and Br.
    a) Which atom has a larger atomic radius? Ga
    b) Which atom has the larger ionization energy? Br
    c) Which atom has more shells? Same
    d) How many valence electrons does each atom have? Ga = 3 Br = 7
    e) What is the valence of each atom? 3 = Ga 1 = Br
    f) Which atom has a greater electrostatic attraction between its nucleus and outermost electrons? Br

7. Consider two atoms: Li and F.
    a) Which atom is larger? Li
    b) Which atom has the stronger attraction to the outer electrons on a neighbouring atom, based only on the atomic radius? F
    c) Which atom has the greater nuclear charge? F
    d) Which atom can attract electrons from an adjacent atom most strongly, based on both size and nuclear charge? F
    e) Fill in the blanks: In general, when going from left to right across the periodic table the electronegativity of the atoms will increase.

8. Consider two atoms: F and I.
    a) Which atom is larger? I
    b) Which atom has a stronger attraction to the outer elelctrons of another atoms? F
    c) Fill in the blanks: In general, when going down a family of the periodic table the electronegativity of the atoms will decrease.

9. Place arrowheads in the correct direction on the horizontal and vertical lines below.



10. a) Ignoring the noble gases, which atom is the most electronegative? F
b) Ignoring the noble gases, which atom is the least electronegative? Fr
c) Which is more electronegative, K or Be? Be
d) Which is more electronegative, Pb or S? S

Periodic Table Trends

1) Electronegativity is an atom's ability to attract electrons in a bond; ionization energy is the energy needed to remove an electron from an atom.

2) Fluorine has a smaller atomic radius and its valence electrons are closer to the nucleus, so more energy is required to remove one.

3) Because they have the same number of valence electrons, which determines chemical behavior.

4) Flerovium (man-made) or Lead (non-man made) elements

5) Fluorine (F)

6) Xenon

7) Oxygen < Carbon < Aluminium < Potassium

8) Neon < Aluminium < Sulphur < Oxygen

9) Na > Mg > Al > P > Cl

10)
a) N^{3-}
b) Ca^{2+}
c) Fe^{2+}

11)
a) Mg
b) O^{2-}
c) Cl^{-}
d) P^{3-}

12)
a) Li
b) Ar
c) Br

d) Ne
e) B

13)
a) Ba
b) S^{2-}
c) Cu
d) H
e) Na

14)
a) N
b) S
c) S^{2-}

15)
a) $K^- > S^{2-} > Cl^- > Ar$
b) Al > Si > C > F
c) Na > Mg >P > Ar
d) $Cs^+ > Ba^{2+} > I^- > F^-$

16)
a) F < C < Li
b) Li < Na < K
c) O < P < Ge
d) N < C < Al
e) Cl < Al < Ga

17)
a) $Mg^{2+} < S^{2-} < Si^{4-}$
b) $Mg^{2+} < Ca^{2+} < Ba^{2+}$
c) $F^- < Cl^- < Br^-$
d) $Cu^{2+} < Zn^+ < Ba^{2+}$
e) $O^{2-} < P^{3-} < Si^{4-}$

18)
a) Mg < Si < S
b) Ba < Ca < Mg
c) Br < Cl < F
d) Ba < Cu < Ne
e) Si < P < He

19)
a) Li < C < N
b) Ne < C < O

c) Si < P < O
d) K < Mg < P
e) He < S < F

Electron configuration

1. Write the electron configurations for the following.

a) P (15)	$1s^2 2s^2 2p^6 3s^2 3p^3$
b) Ti (22)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
c) Co (27)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$
d) Br (35)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$
e) Sr (38)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2$
f) Ar (18)	$1s^2 2s^2 2p^6 3s^2 3p^6$
g) K (19)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
h) Cd (48)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10}$
i) Ca (20)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
j) Xe (54)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$
k) Cs (55)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^1$
l) Pb (82)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^2$
m) Ga (31)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$
n) Mn (25)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
o) Zr (40)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^2$

2. Write the electron configurations for the following using core notation.

a) P	[Ne] $3s^2 3p^3$
b) Ti	[Ar] $4s^2 3d^2$
c) Co	[Ar] $4s^2 3d^7$
d) Br	[Ar] $4s^2 3d^{10} 4p^5$
e) Sr	[Kr] $5s^2$
f) Ar	[Ne] $3s^2 3p^6$

3. Write the electron configurations for the following ions, using core notation.

a) H^-	$1s^1 + 1e = 1s^2$
b) Sr^{2+}	$[Kr]\ 5s^2 = 2e^- + [Kr]$ or $[Ar]\ 4s^2 3d^{10} 4p^6$
c) Br^-	$[Ar]\ 4s^2 3d^{10} 4p^5 + 1e^- = [Ar]\ 4s^2 3d^{10} 4p^6$
d) N^{3+}	$[He]\ 2s^2 2p^3 = 3e^- + [He]\ 2s^2$
e) Ti^{2+}	$[Ar]\ 4s^2 3d^2 = 2e^- + [Ar]\ 3d^2$
f) N^{2-}	$[He]\ 2s^2 2p^3 + 2e^- = [He]\ 2s^2 2p^5$
g) Mn^{2+}	$[Ar]\ 4s^2 3d^5 = 2e^- + [Ar]\ 3d^5$
h) Ge^{4+}	$[Ar]\ 4s^2 3d^{10} 4p^2 = 4e^- + [Ar]\ 3d^{10}$
i) Fe^{3+}	$[Ar]\ 4s^2 3d^6 = 3e^- + [Ar]\ 3d^5$
j) Ge^{2+}	$[Ar]\ 4s^2 3d^{10} 4p^2 = 2e^- + [Ar]\ 4s^2 3d^{10}$
k) Ru^{3+}	$[Kr]\ 5s^2 4d^6 = 3e^- + [Kr]\ 4d^5$
l) Sb^{3+}	$[Kr]\ 5s^2 4d^{10} 5p^3 = 3e^- + [Kr]\ 5s^2 4d^{10}$

4. Write the electron configurations for the following. How many valence electrons does each one contain?

a) O	$1s^2 2s^2 2p^4 = [He]\ 2s^2 2p^4$	6
b) P	$1s^2 2s^2 2p^6 3s^2 3p^3 = [Ne]\ 3s^2 3p^3$	5
c) V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3 = [Ar]\ 4s^2 3d^3$	5
d) Ca	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 = [Ar]\ 4s^2$	2
e) Xe	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$	0
f) Hg	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} = [Xe] +$	2
g) Te	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^4 = [Kr]\ 5s^2 4d^{10} 5p^4$	6
h) Cl^-	$[Ne] 3s^2 3p^5 + 1e^- = [Ne]\ 3s^2 3p^6$	0
i) I^{5+}	$[Kr] 5s^2 4d^{10} 5p^5 - 5e^- = [Kr] 5s^2 4d^{10}$	2
j) Xe^{2+}	$[Kr]\ 5s^2 4d^{10} 5p^6 - 2e^- = [Kr]\ 5s^2 4d^{10} 5p^4$	6
k) Zn^{2+}	$[Ar]\ 4s^2 3d^{10} - 2e^-\ [Ar]\ 3d^{10}$	0
l) Ge^{4+}	$[Ar]\ 4s^2 3d^{10} 4p^2 - 4e^- = [Ar]\ 3d^{10}$	0
m) Tc^{4+}	$[Kr]\ 5s^2 4d^5 - 4e^- = [Kr]\ 4d^3$	3
n) Sb^{3+}	$[Kr]\ 5s^2 4d^{10} 5p^3 - 3e^- = [Kr] 5s^2 4d^{10}$	2
o) O^-	$[He]\ 2s^2 2p^4 + 1e^- = [He]\ 2s^2 2p^5$	7
p) Nb^{3+}	$[Kr]\ 5s^2 4d^3 - 3e^- = [Kr]\ 4d^2$	2