Unit 1 Resources – Introduction to Chemistry, Measurements

1.1 – Metric Prefixes & Conversions Resource		
Prefix	**Symbol**	**Comparable Size:**
giga	G	1 gigaunit = 1 billion (1 E 9) base units
mega	M	1 megaunit = 1 million (1 E 6) base units
kilo	k	1 kilounit = 1,000 (1 E 3) base units
Base Quantity = grams, seconds, meters, liters, moles, etc.		1 base unit = 1 base unit
centi	c	100 centiunits = 1 base unit
milli	m	1,000 (1 E 3) milliunits = 1 base unit
micro	μ	1 million (1 E 6) microunits = 1 base unit
nano	n	1 billion (1 E 9) nanounits = 1 base unit

Process

1. Write down the value you want to convert.
2. Multiply it by a conversion factor such that the unit you want to end up with is in the numerator (top value), and the one you are converting from is in the denominator (bottom value).
3. For multiple step conversions, add in more conversion factors, making sure that the undesired units cancel out.

Examples

145 ng → g.

$$145\ \text{ng} \times \frac{1\ \text{g}}{1\text{ E } 9\ \text{ng}} = 1.45\ \text{E} - 7\ \text{g}$$

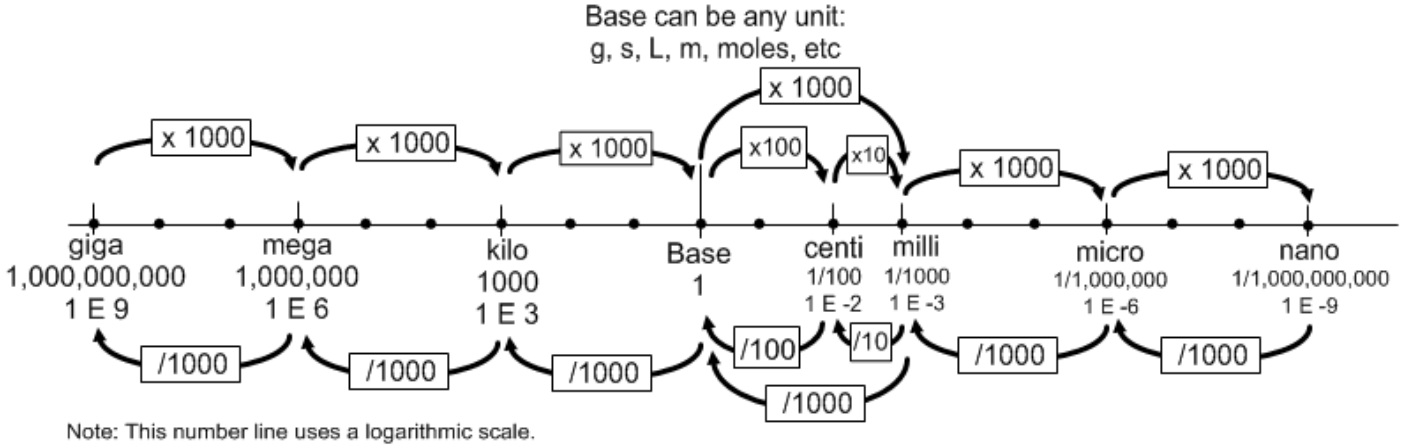
9.40 cm/min → m/s

$$\frac{9.40\ \text{cm}}{1\ \text{min}} \times \frac{1\ \text{m}}{100\ \text{cm}} \times \frac{1\ \text{min}}{60\ \text{s}} = 1.57\ \text{E - } 3\ \text{m/s}$$

2.14 km → mm.

$$2.14\ \text{km} \times \frac{1000\ \text{m}}{1\ \text{km}} \times \frac{1000\ \text{mm}}{1\ \text{m}} = 2.14\ \text{E } 6\text{mm}$$

Visual Guide:



1.2 – Temperature Conversions Resource

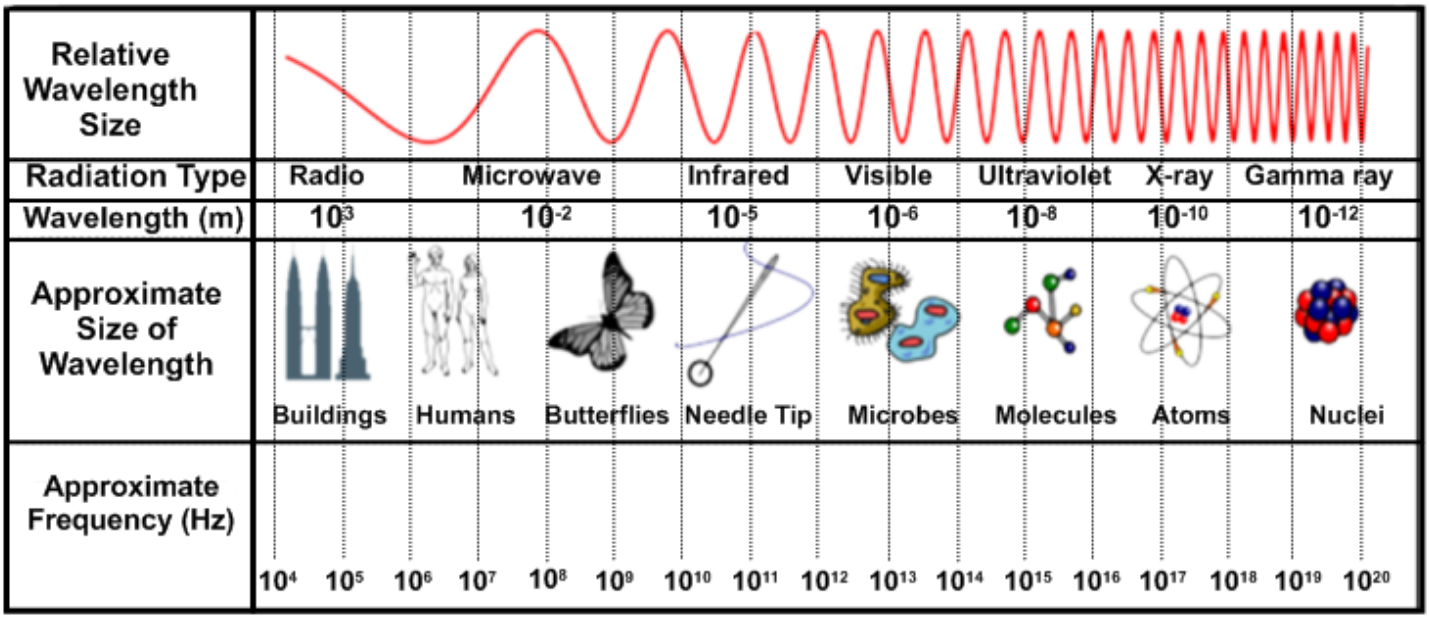
°F to °C: $^{\circ}C = \dfrac{^{\circ}F - 32}{1.8}$ **°C to °F:** $^{\circ}F = 1.8\left(^{\circ}C\right) + 32$

°C to K: $K = ^{\circ}C + 273$ **K to °C:** $^{\circ}C = K - 273$

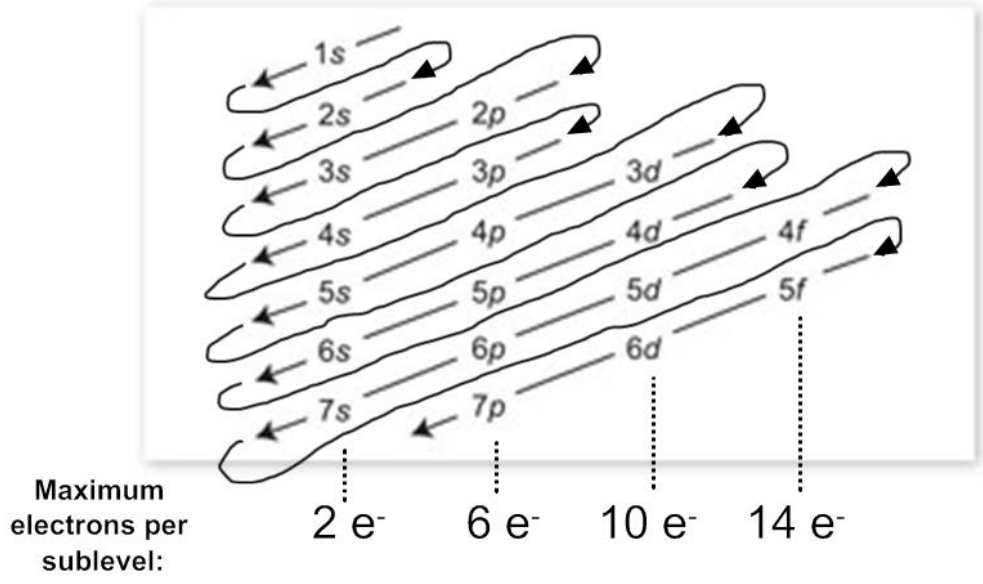
Unit 4 Resources – Electrons and The Periodic Table

4.1 – Electromagnetic Spectrum Resource:

This graph shows in rough detail the different types of EM radiation the approximate size of their wavelengths, and ranges of frequencies.



4.2 Aufbau Diagram:



Unit 4 – Table of Ions Resource

Cations

1+

Ammonium, NH_4^+
Cesium, Cs^+
Copper (I), Cu^+
Hydrogen, H^+
Lithium, Li^+
Potassium, K^+
Silver, Ag^+
Sodium, Na^+

2+

Barium, Ba^{2+}
Beryllium, Be^{2+}
Cadmium, Cd^{2+}
Calcium, Ca^{2+}
Chromium (II), Cr^{2+}
Cobalt (II), Co^{2+}
Copper (II), Cu^{2+}
Iron (II), Fe^{2+}
Lead (II), Pb^{2+}
Magnesium, Mg^{2+}
Manganese (II), Mn^{2+}
Nickel (II), Ni^{2+}
Strontium, Sr^{2+}
Tin (II), Sn^{2+}
Zinc, Zn^{2+}

3+

Aluminum, Al^{3+}
Chromium (III), Cr^{3+}
Cobalt (III), Co^{3+}
Iron (III), Fe^{3+}
Manganese (III), Mn^{3+}
Nickel (III), Ni^{3+}

4+

Chromium (IV), Cr^{4+}
Cobalt (IV), Co^{4+}
Lead (IV), Pb^{4+}
Manganese (IV), Mn^{4+}
Tin (IV), Sn^{4+}

Anions

1-

Acetate, $C_2H_3O_2^-$
Bromide, Br^-
Bromate, BrO_3^-
Chlorate, ClO_3^-
Chlorite, ClO_2^-
Chloride, Cl^-
Cyanide, CN^-
Dihydrogen Phosphate, $H_2PO_4^-$
Fluoride, F^-
Bicarbonate, HCO_3^-
Hydrogen Sulfate, HSO_4^-
Hydroxide, OH-
Hypochlorite, ClO^-
Iodide, I^-
Iodate, IO_3^-
Nitrate, NO_3^-
Nitrite, NO_2^-
Permanganate, MnO_4^-
Perchlorate, ClO_4^-
Periodate, IO_4^-

2-

Carbonate, CO_3^{2-}
Chromate, CrO_4^{2-}
Dichromate, $Cr_2O_7^{2-}$
Hydrogen Phosphate, HPO_4^{2-}
Manganate, MnO_4^{2-}
Oxide, O^{2-}
Oxalate, $C_2O_4^{2-}$
Peroxide, O_2^{2-}
Selenide, Se^{2-}
Sulfate, SO_4^{2-}
Sulfide, S^{2-}
Sulfite, SO_3^{2-}
Tartrate, $C_4H_4O_6^{2-}$
Thiosulfate, $S_2O_3^{2-}$

3-

Arsenate, AsO_4^{3-}
Arsenide, As^{3-}
Borate, BO_3^{3-}
Nitride, N^{3-}
Phosphate, PO_4^{3-}
Phosphite, PO_3^{3-}
Phosphide, P^{3-}

Diatomic Elements

H_2
N_2
O_2
F_2
Cl_2
Br_2
I_2

Unit 6 Resources – Covalent Compounds

6.1 – Common Acid Names and Formulas Resource

The three acids in **boldface** are the most common acids.

Binary Acids

Hydrobromic acid	HBr	Hydrofluoric acid	HF
Hydrochloric acid	**HCl**	Hydroiotic acid	HI
Hydrocyanic acid	HCN	Hydrosulfuric	H_2S

Oxyacids

Acetic acid (vinegar)	$HC_2H_3O_2$	or:	CH_3COOH (organic acid)
Carbonic acid	H_2CO_3		
Chloric acid	$HClO_3$		
Chlorous acid	$HClO_2$		
Nitric acid	**HNO_3**		
Nitrous acid	HNO_2		
Phosphoric acid	H_3PO_4		
Sulfuric acid	**H_2SO_4**		
Sulfurous acid	H_2SO_3		

6.2 – Molecular Prefixes Resource

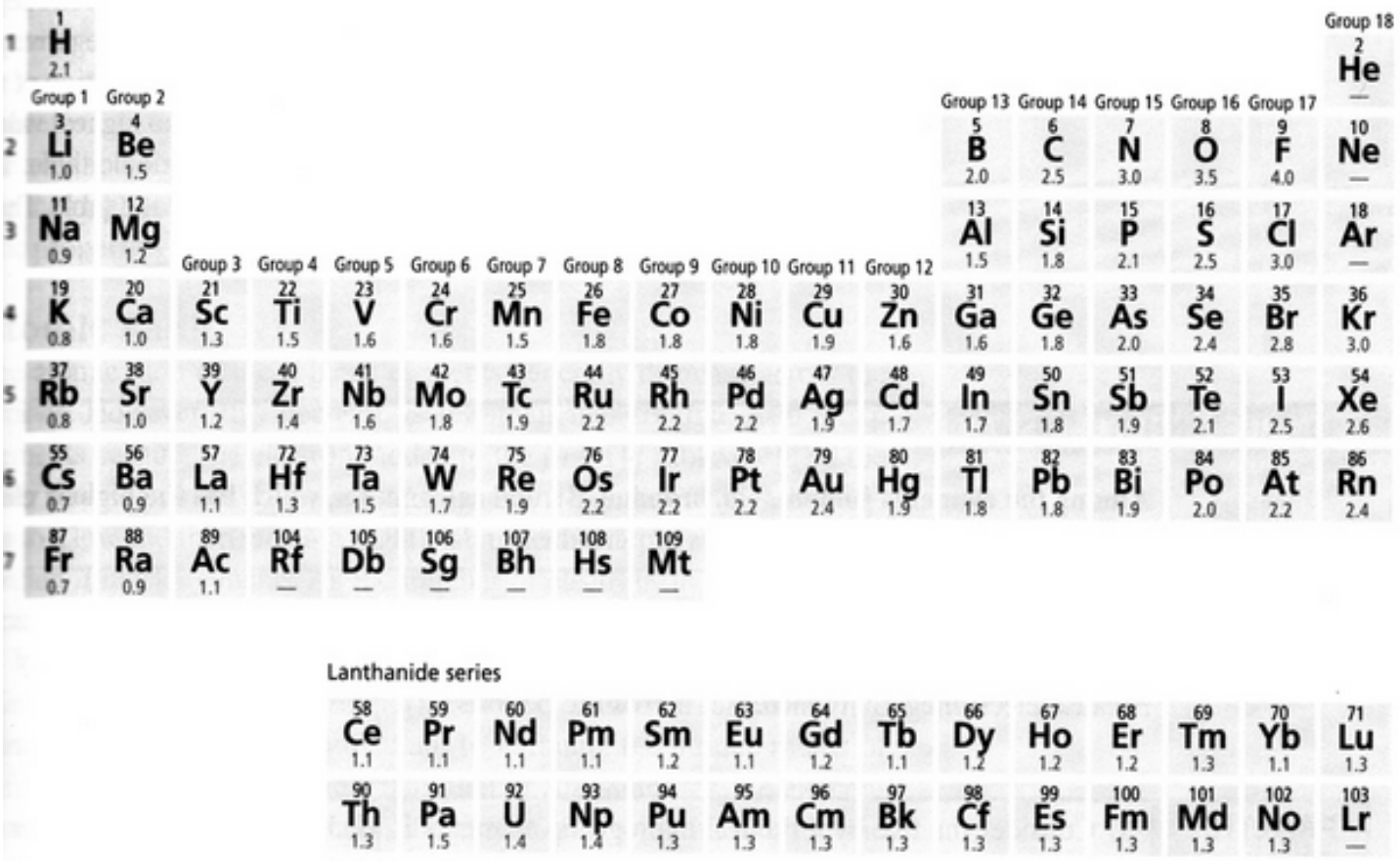
Number of Atoms	Prefix	Number of Atoms	Prefix
1	mono-	6	hexa-
2	di-	7	hepta-
3	tri-	8	octa-
4	tetra-	9	nona-
5	penta-	10	deca-

6.3 – Polarity Resource

Electronegativity Difference	Bond Character
> 1.7	Mostly Ionic
0.4 – 1.7	Polar Covalent
<0.4	Mostly Covalent
0	Nonpolar Covalent

6.4 – Electronegativity Resource

Electronegativities are listed below the elements' symbols.



6.5 – Molecular Shapes Resource

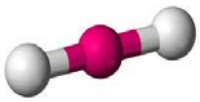
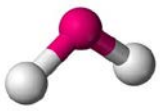
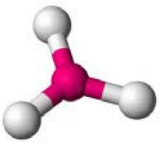
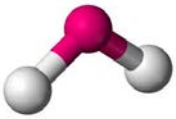
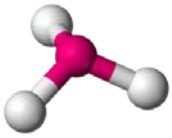
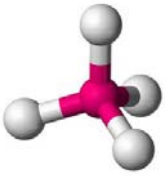
How to use:

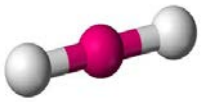
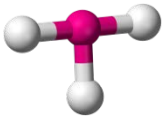
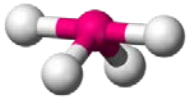
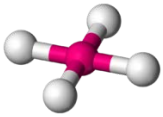
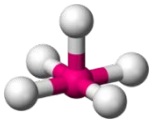
1. Draw the Lewis Structure of your molecule.
2. Locate the central atom and count how many lone pairs and terminal atoms it has.
3. Determine the central atom's hybridization from this chart:

Hybridization Chart

1 = s	2 = sp	3 = sp^2
4 = sp^3	5 = sp^3d	6 = sp^3d^2

4. Use the following chart to determine the shape, applying the number of total sets of electrons, bond count, and lone pairs to find a matching molecular appearance.

Molecular Shape	Ex.	Terminal Atoms	Lone Pairs	Hybrid-ization	Angles	Molecular Appearance
Linear Diatomic (2 atoms)	HCl	1	NA	s	NA	
Linear	CO_2	2	0	sp	180º	
Bent	O_3	2	1	sp^2	120º	
Trigonal Planar	BH_3	3	0	sp^2	120º	
Bent	H_2O	2	2	sp^3	104.5º	
Trigonal Pyramidal	PH_3	3	1	sp^3	107.3º	
Tetrahedral	CH_4	4	0	sp^3	109.5º	

Molecular Shape	Ex.	Terminal Atoms	Lone Pairs	Hybrid-ization	Angles	Molecular Appearance
Linear	XeF_2	2	3	sp^3d	180º	
T – Shaped	ClF_3	3	2	sp^3d	180º 90º	
Seesaw	SF_4	4	1	sp^3d	180º 120º 90º	
Trigonal Bipyramidal	TeF_5	5	0	sp^3d	120º 90º	
Square Planar	XeF_4	4	2	sp^3d^2	180º 90º	
Square Pyramidal	BrF_5	5	1	sp^3d^2	180º 90º	
Octahedral	SF_6	6	0	sp^3d^2	90º	

Answers to Selected Homework Problems

Use the following to help guide your homework assignments. Remember: you **MUST** show your work to get credit for problems.

Unit 1 – Intro. To Chemistry & Data Analysis

1.2 – Units

3. 1.0 g/mL
4. 3.0 mL

1.4 – Uncertainty in Data

6. 1.79 %

Unit 2 – Properties of Matter

2.2 – Changes in Matter

4. 70.91 g
5. 264 g

2.4 – Elements and Compounds

2. 6.0 g H_2, 316 g H_2
5. 60 g O_2

Unit 3 – Atomic Structure

3.4 – Radioactive Decay

6. 125 g, 62.5 g, 7.8 g

Unit 4 – Electrons & The Periodic Table

4.1 – Light and Energy

7. 4.42 E 8 Hz
8. 9,070 s (151 minutes)

Fall Chemistry Terms Extra Credit Bingo Review

Put words from the following list into the grid. Although you will have more words than spaces, don't use words more than once!

All students will have at least 5 E. C. points added to your semester final category; winners will have their points added to that.

Review List 1

Chemistry
Data
Base Unit
Pure Research
Quantitative Data
Control
Precision
Density
Hypothesis
Conclusion
Dependent Variable
Weight
Substance
Mass
Qualitative Data
Experiment
Independent Variable
Applied Research
Derived Unit
Standard Unit
Scientific Notation
Accuracy
Error
Extrapolation
Interpolation
Metric Prefixes
States of Matter
Chemical Change
Physical Change
Hybridization
Oxyacid
Lewis Structure
Delocalized Electron

Bingo Grid 1

		Free!		

Review List 2

Put words from the following list into the grid. Although you will have more words than spaces, don't use words more than once!

Product
Phase Change
Reactant
Alloy
Element
Atom
Crystallization
Sublimation
Filtration
Monatomic
Octet Rule
Binary Compound
Anion
Greek Elements
Aristotle
John Dalton
Electron
Radiation
Alpha Particle
Nuclear Model
Isotope
Atomic Number
Nucleus
Proton
Neutron
Cation
Covalent Bond
Metallic Bond
Polar Covalent Bond
Actinide Series
Inner Transition Metal
Alkaline Earth Metal

Bingo Grid 2

		Free!		

Review List 3

Put words from the following list into the grid. Although you will have more words than spaces, don't use words more than once!

Vapor
Molecule
Formula Unit
Resonance
Valence Electron
Wavelength
Ground State
Photon
Energy Level
Frequency
Polyatomic Ion
Monatomic Ion
Noble Gas
Halogen
Metal
Transition Metal
Electronegativity
Hund's Rule
Aufbau Principle
Pauli Exclusion Principle
Electron Dot Structure
Atomic Orbital
Metalloid
Alkali Metal
Group
Period
Exothermic Reaction
Endothermic Reaction

Bingo Grid 3

		Free!		

Points Possible:	**25**
Late/Inc. Fee:	**-5**
Final Score:	**/ 25**
Extra Credit:	

Chemistry Fall Semester Review

This is test preparation for the final exam, due the last day of regular classes. Students **must** do at least 25 problems, beyond that, extra credit is earned at the rate of one point per four extra problems, applied to your final exam. A solution set will be available after extra credit has been assessed.

Unit 1 – Introduction to Chemistry

1. Define an independent variable in an experiment. Explain the term with respect to the solubility of salt at different temperatures.

2. A student records the temperature of a mixture of ice and rubbing alcohol as -3.8 K. Is this a valid measurement? Explain your answer.

3. Evaluate this dimensional analysis setup. A paperclip is 3.2 cm long. How many paperclips would fit in a football field (100.0 yards) if 1 inch = 2.54 cm?

4. The data for two different measurements are shown below. Which measurement was more accurate? Find the percent error to determine your answer.

Sample	Measured value	Accepted value
Distance	54,700 m	57,900 m
Mass	61.3 g	65.7 g

5. Convert 18.2 L to mL, and 850 mg to grams.

6. How many significant digits are there in
   a. 6.023 E 10^{23} molecules b. 0.0023 g c. 1.5020 L d. 160 kg

Unit 2 – Properties of Matter

7. Explain the difference between a *gas* and a *vapor*.

8. Describe both a *physical change* and a *chemical change* that could be done to a piece of paper.

9. A vessel contains 31 mL of water. A sample of 54.0 g of copper metal is dropped into this vessel, raising the level of water in it to 37 mL. What is the density of the copper sample?

10. If 19.9 grams of copper are burned in air to produce 25.0 grams of copper (II) oxide, what is the mass of oxygen from the air that is needed?

11. Describe how you might perform the following separations:
    a. separating carbon dioxide, sugar, and water from a soda.

    b. Separating iron filings, salt, and glass fragments from a mixture.

Unit 3 – Atomic Structure

12. What is the average atomic mass of this element?

Isotope	Mass (amu)	Percent Abundance
Silver-105	105	48%
Silver-108	108	43%
Silver-109	109	9%

13. Complete the following nuclear reactions:

    a. $^{64}_{31}Ga \rightarrow {}^{60}_{29}Cu + \_\_\_\_\_$

    b. $\_\_\_\_\_ \rightarrow {}^{101}_{46}Pd + {}^{0}_{-1}e$

    c. $^{122}_{57}La^{*} \rightarrow \_\_\_\_\_ + \gamma$

14. Write the entire nuclear reaction to describe the alpha decay of $^{243}_{95}Am$.

15. Write the isotopic notation for the following isotopes:
    a. uranium with an mass number of 238. b. cobalt with 37 neutrons.

16. What were the main flaws in Dalton's atomic theory? Which aspects hold true?

17. Complete the following table:

Element	Number of protons	Number of electrons	Number of neutrons	Atomic number	Mass number
Sodium		11	12		
Phosphorus	15				31
Cobalt	27		32		
Bromine		35			80
Silver			61	47	

Unit 4 – Electrons & Periodic Table

18. Predict how the wavelength and frequency of a wave would change if the amount of energy it carried were increased.

19. A radio station broadcasts a program at 122.9 MHz. Calculate the wavelength of the radio wave at this frequency.

20. Write the ground state electron configurations for the following, using the noble gas shortcut if you want. Also, provide electron dot diagrams to show how many valence electrons each has.
    a. Barium
    b. Chlorine
    c. Selenium
    d. Phosphorus

21. Explain what is wrong with this electron dot diagram for the element Nitrogen (N), and what principle is being violated:

22. Define a photon. What is the energy associated with a photon with a frequency of 1.23 E 15 Hz?

23. How is atomic emission spectra used in chemistry?

24. What were the contributions of the following scientists to the modern periodic table?
    a. Antoine Lavoisier
    b. John Newlands
    c. Dmitri Mendeleev
    d. Henry Moseley

25. Why do elements in the same group have similar properties?

26. The second ionization energy of sodium is very high as compared to the first ionization energy. Explain this phenomenon.

27. Why is the size of a sodium ion (Na^+) less than that of a sodium atom (Na)?

28. Rank the following atoms in terms of *increasing* size: Ba, Mg, Na, F, Rn, Fe, He

Unit 5 – Ionic Compounds

29. Make four compounds from the four ions shown, listing them with their names and formulas.

Fe^{2+}	PO_3^{-3}
Fe^{3+}	PO_4^{-3}

30. Write the formulas of the following:
    a. beryllium nitrite
    b. lead (IV) sulfate
    c. manganese (III) chloride
    d. ammonium dichromate

31. Fix the following formulas or names of compounds:
    a. $NaCl_2$
    b. K_2NO_3
    c. $(Na)_2SO_4$
    d. $H_2(SO_3)$
    e. cobalt oxide
    f. sodium (II) bromide
    g. iodine potassium

Unit 6 – Covalent Compounds

32. What are the names of the following molecules:
    a. SO_3
    b. P_4O_{10}
    c. N_2O_4

33. Write the formula, draw the Lewis structure, determine hybridization of the central atom, report the geometry, and tell whether the following are polar:
    a. silicon dioxide
    b. chlorine trifluoride

34. For each of the bonds listed, indicate which atom is more negatively charged:
    a. C-H
    b. C-S
    c. C-N
    d. C-O

The Periodic Table of the Elements

1	2											3	4	5	6	7	8
1	1 **H** Hydrogen 1.00794																2 **He** Helium 4.003
2	3 **Li** Lithium 6.941	4 **Be** Beryllium 9.012182											5 **B** Boron 10.811	6 **C** Carbon 12.0107	7 **N** Nitrogen 14.00674	8 **O** Oxygen 15.9994	9 **F** Fluorine 18.9984032	10 **Ne** Neon 20.1797
3	11 **Na** Sodium 22.989770	12 **Mg** Magnesium 24.3050											13 **Al** Aluminum 26.981538	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.973761	16 **S** Sulfur 32.066	17 **Cl** Chlorine 35.4527	18 **Ar** Argon 39.948
4	19 **K** Potassium 39.0983	20 **Ca** Calcium 40.078	21 **Sc** Scandium 44.955910	22 **Ti** Titanium 47.867	23 **V** Vanadium 50.9415	24 **Cr** Chromium 51.9961	25 **Mn** Manganese 54.938049	26 **Fe** Iron 55.845	27 **Co** Cobalt 58.933200	28 **Ni** Nickel 58.6934	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.723	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92160	34 **Se** Selenium 78.96	35 **Br** Bromine 79.904	36 **Kr** Krypton 83.80
5	37 **Rb** Rubidium 85.4678	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.90585	40 **Zr** Zirconium 91.224	41 **Nb** Niobium 92.90638	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.90550	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.8682	48 **Cd** Cadmium 112.411	49 **In** Indium 114.818	50 **Sn** Tin 118.710	51 **Sb** Antimony 121.760	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90447	54 **Xe** Xenon 131.29
6	55 **Cs** Cesium 132.90545	56 **Ba** Barium 137.327	57 **La** Lanthanum 138.9055	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.207	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.217	78 **Pt** Platinum 195.078	79 **Au** Gold 196.96655	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.3833	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98038	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
7	87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

	58 **Ce** Cerium 140.116	59 **Pr** Praseodymium 140.90765	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.964	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.92534	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93032	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93421	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.967
	90 **Th** Thorium 232.0381	91 **Pa** Protactinium 231.03588	92 **U** Uranium 238.0289	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

The Periodic Table of the Elements

1	2											3	4	5	6	7	8
1 H Hydrogen 1.00794																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938049	26 Fe Iron 55.845	27 Co Cobalt 58.933200	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90545	56 Ba Barium 137.327	57 La Lanthanum 138.9055	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.078	79 Au Gold 196.96655	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98038	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
90 Th Thorium 232.0381	91 Pa Protactinium 231.03588	92 U Uranium 238.0289	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)