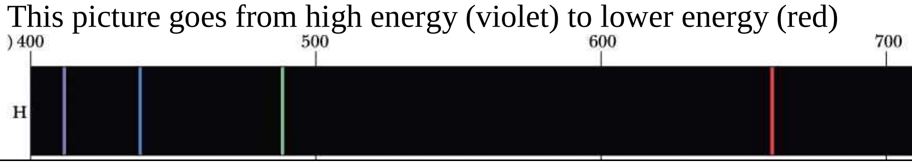
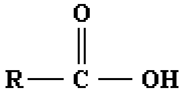
NChO 2004

ANNOTATED ANSWERS

1.	**A** Besides H and the Noble Gases, only O, F, and Cl are gases…memorize them
2.	**D** $\mathbf{SO_2}$ CO_2 and H_2O are combustion products. NO_2 is a component of smog because unreactive N_2 and O_2 can combine under the high temperature and pressure conditions of a car engine. SO_2 is formed from burning coal that may have small amounts of sulfur impurities.
3.	**C** **Sn**, a metal is the best conductor. Ge and Te are semi-metals and Se is a non-metal.
4.	**C** Eliminate A & D because you should not add water to acid. Eliminate B because the volumes will not necessarily be additive. 10 mL acid + 90 mL acid do not necessarily add up to 100 mL solution.
5.	**C** The hottest part of the flame is just above the "inner cone".
6.	**D** Wafting is the proper technique.
7.	**A** The molecular formula, C_6H_5COOH or $C_7H_6O_2$, is not reducible to an empirical formula.
8.	**D** mass = volume x density… $(x\ cm^3)(.66\ g/cm^3) = (80\ cm_3)(1.59\ g/cm^3)$ $x = 193\ cm^3$
9.	**A** $0.10\ g \times \frac{1\,\text{mole}}{249.7\ g} \times \frac{5\,\text{mole}\ H_2O}{1\,\text{mol}\ CuSO_4 \cdot 5H_2O} \times \frac{6.02 \times 10^{23}\,\text{molecules}\ H_2O}{1\,\text{mole}\ H_2O} = 1.2 \times 10^{21}$ molecules H_2O
10.	**C** $C_2H_2 + {}^5/_2\,O_2 \rightarrow 2CO_2 + H_2O$ $\therefore$ Ratio $O_2{:}C_2H_2 = {}^5/_2{:}1$ or **5:2**
11.	**B** $1.00\ g\ Mg(OH)_2 \times \frac{1\,\text{mole}\ Mg(OH)_2}{58.33\ g\ Mg(OH)_2} \times \frac{2\,\text{mole HCl}}{1\,\text{mole}\ Mg(OH)_2} = 0.0343$ moles HCl Note: Stomach acid is HCl; $2HCl + Mg(OH)_2 \rightarrow 2H_2O + MgCl_2$
12.	**D** x = .3047 mL NaOH $V_a\underline{M}_a = V_b\underline{M}_b$ (25 mL)(0.2100 $\underline{M}$) = (17.23 mL) x Note: since the acid is diprotic, the $\underline{M}_a = 2[H_2SO_4] = 2(0.1050M) = 0.2100M$
13.	**C** 44 g/mol Mass O_2 = 125.10 – 124.46 g = 0.64 g Mass Unknown = 125.34 – 124.46 = 0.88 g Note: equal volumes of gas (at the same temp and pressure) contain equal numbers of moles $\therefore$ Ratio of masses = ratio of molar masses $\frac{.64}{.88} = \frac{32\,g\,O_2}{x}$ Remember that oxygen is diatomic, O_2.
14.	**C** Both N_2O and CO_2 have a mass of 44 g/mol. Rate of diffusion at 25°C depends on mass.
15.	**A** Solid only. Memorize the phases of the three regions of the phase diagram.
16.	**A** Slowing down the particles and pushing them closer together will allow IMF's to condense the gas.
17.	**A** Highest vapor pressure = lowest IMF. Eliminate (B) and (D) because they have hydrogen bonding. Smaller nonpolar molecules have weaker London forces than larger nonpolar molecules.
18.	**D** SiO_2 is a network solid held together with strong covalent bonds while the other oxides are molecules held to each other with London Forces and Hydrogen Bonds. Highest MP = Strongest IMF
19.	**A** ΔH°_f implies formation of a compound from its **elements** as they exist at 25°C.
20.	**B** ΔH is always positive for endothermic reactions. ΔG (Gibbs Free Energy) can be + or – for an endothermic reaction, depending on ΔS.
21.	**D** A bomb calorimeter consists of a metal chamber that cannot change **volume**.
22.	**A** +124 kJ $\Delta H = \Delta H_f$ of products - ΔH_f of reactants 3(-54 kJ) – 2(-143 kJ) = +124 kJ
23.	**B** Heat lost by water = heat gained by ice as it melts **and** warms to 5°C ($q = mC\Delta T$) $(200\ g)(4.18\ Jg^{-1}{}^\circ C^{-1})(20.00^\circ C) = x(340\ Jg\text{-}1) + x(4.18\ Jg^{-1}{}^\circ C^{-1})(5.00^\circ C)$ 16720 J = 340 x + 20.9 x = 360.9 x x = 16720/360.9 = **46.3 g**
24.	**A** changing from liquid to gas is an increase in entropy (+ΔS)
25.	**D** remember, this is called the Method of Initial Rates
26.	**C** Rate Law is: Rate = $k[A]^2$ Solve for k's units using $mol \cdot L^{-1}$ for [A] and the given units for Rate.
27.	**A** Since B is not in the rate law, it is not involved in the rate determining step (the slow step) and increasing B's concentration will only speed up a faster step… no change to the overall rate.
28.	**C** First-order reactions have a constant half-life.

29.	**C** The rate of both exothermic and endothermic reactions increase with an increase in temperature. Students often confuse Rates with whether the reaction will shift to the right or to the left (Equilibrium)
30.	**B** The energy barrier will change. This will change #1 and #3.
31.	**C** This is just the definition of what is equal at equilibrium. Note the incorrect answers well.
32.	**D** The concentrations of solids cannot change and are not included in the equilibrium expression.
33.	**B** $K_a \cdot K_b = K_w$ (for a conjugate acid-base pair), so $K_b = \frac{K_w}{K_a} = \frac{1x10^{-14}}{3.0x10^{-4}} = 3.3x10^{-11}$
34.	**A** Adding a little strong base will make the solution a little more basic, pH increases.
35.	**B** When a strong acid & weak base mix, the resulting salt (the conjugate acid of a weak base) makes the solution somewhat acidic. pH = 5.
36.	**D** AgCl is a 1:1 compound, $\therefore K_{sp} = s^2$, where solubility, s = molarity of the saturated solution = moles (1.9×10^{-4} g / 143.4 $g \cdot mol^{-1}$) / Liters (.100 L) = 1.32×10^{-5} M $K_{sp} = s^2 = (1.32 \times 10^{-5})^2$
37.	**B** Fe^{2+} + 6(CN^-) = charge of 4-; S is +6, N is +3, I don't know what Ni is… must be +4!
38.	**B** Cr changes from +3 to +6… this is oxidation. V in (A) remains +5; S in (C) remains +6; N in (D) is **reduced** from +5 to +3
39.	**D** This is balancing a redox reaction… I used the half-reaction method: $3\ Sn^{2+} \rightarrow 3\ Sn^{4+} + 6\ e^-$ $6\ e^- + 2\ NO_3^- + 8\ H^+ \rightarrow 2\ NO + 4\ H_2O$
40.	**B** Red Cat; An Ox; always!
41.	**A** Implied Info: The standard reduction: $2H^+ + 2e^- \rightarrow H_2(g)$ E° = 0.00 volts Ga^{3+} is not being reduced in this case, it is being oxidized, so it's E° must be lower than 0.00 volts. Since the difference is +0.54 volts, 0.00 – x = +0.54 ∴E° for $Ga^{3+} + 3e^- \rightarrow Ga°$ must be -0.54 volts
42.	**D** Molar mass is not involved. It would be if the question asked for **mass** of metal deposited.
43.	**D** Four lines, Red, and then closer to each other are Blue-Green, Blue-Violet, and Violet. This picture goes from high energy (violet) to lower energy (red) 
44.	**B** From their positions on the periodic table, you can tell the electron configurations: Ge ($4s^2\ 4p^2$)= 2 unpaired; As ($4s^2\ 4p^3$)= 3 unpaired; Se ($4s^2\ 4p^4$)= 2 unpaired; Br ($4s^2\ 4p^5$)= 1 unpaired
45.	**D** The fact that it has 18 electrons makes it isoelectronic with Ar. (The ion would be Ca^{2+})
46.	**B** K, Atoms get larger down a family and to the left of a period. Lowest, most left atom is the answer.
47.	**D** n=3 means three subshells: 3s, 3p, and 3d; a total of 9 orbitals, and ∴18 electrons.
48.	**A** LeO GeR; reducing ability means ability to get oxidized, **donate** electrons and **reduce other atoms**. As you move across the periodic table, there are more protons in the nucleus and the atom is better able to **attract** electrons, but **less able to donate electrons**. The reducing ability **decreases**.
49.	**A** Remember, acids are covalently bonded molecules that only form ions when dissolved in water.
50.	**D** P=5, O=6, valence electrons in P2O74- = 2(5) + 7(6) + 4 from somewhere else = 56 e-
51.	**A** BF_3 is trigonal planar with a bond angle of 120°. The other three are based on tetrahedral (109.5°).
52.	**C** ANY triple bond is 1 sigma and 2 pi bonds.
53.	**C** London dispersion forces hold nonpolar molecules to each other. The fact that the larger atoms have larger London dispersion forces is due to the larger and ∴**more polarizable electron cloud**.
54.	**B** bent SO_2, you gotta do their electron dots (unless you have them memorized, like I do).
55.	**A** butane means four carbons and all single bonds. C_4H_{10}
56.	**D** 1,1-dichoro…, 2,2-dichoro…,1,2-dichoro…,1,3-dichoro…
57.	**B** sp^2, carboxyl group as in carboxylic acid. Steric number = 3 

58.	**A** ester formation… we made wintergreen in class.
59.	**D** also called polytetrafluoroethylene
60.	**D** enzymes are biochemical catalysts