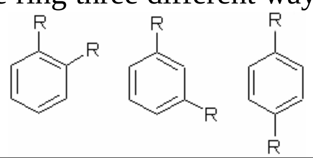
NChO 2005

ANNOTATED ANSWERS

1.	**D** acid + carbonate → $CO_2(g)$ Know the gases that form on your "Stuff I Should Know for AP" sheet.
2.	**B** $I_2(s)$ sublimes. Notice bottle of $I_2(s) \leftrightarrows I_2(g)$ in classroom. Purple vapor.
3.	**A** A mixture melts at a lower temperature (and boils at a higher temperature)… colligative properties
4.	**A** You can make a barometer out of water, but it will need to be 33 feet tall!
5.	**B** This is part of a series of labs called "qualitative analysis". Just remember this fact.
6.	**D** Heat the top of the liquid so if a bubble forms, it will not push all of the contents out of the tube.
7.	**C** 1 molecule H_2O x $\frac{1\text{ mole } H_2O}{6.02 \times 10^{23}\text{ molecules}}$ x $\frac{18.02\text{ g } H_2O}{1\text{ mole } H_2O}$ = 3 x 10^{-23} g (no calculator needed)
8.	**D** Balance equation: $N_2 + 2O_2 \rightarrow 2\ NO_2$ This is a limiting reactant. N_2 is L.R. making 8 NO_2's.
9.	**C** Calculate mass of FeS that formed the H_2S gas. ♥ is 1:1 FeS:H_2S Notice this is at STP. 448 mL H_2S x $\frac{1\text{ L}}{1000\text{ mL}}$ x $\frac{1\text{ mol } H_2S}{22.4\text{ L}}$ x $\frac{1\text{ mol FeS}}{1\text{ mol } H_2S}$ x $\frac{87.92\text{ g FeS}}{1\text{ mol FeS}}$ = 1.76 g FeS $\frac{1.76\text{ g FeS}}{3.15\text{ g}}$ = **55.8%**
10.	**D** If 50/50, the atomic mass would be 204.0. Must be a little *more* Ti-205 \ **70.0%** (no calc needed)
11.	**C** This is a limiting reactant problem. Work it out twice and take the smaller answer. 15.5 g N_2O_4 x $\frac{1\text{ mol } N_2O_4}{92.0\text{ g } N_2O_4}$ x $\frac{6\text{ mol NO}}{2\text{ mol } N_2O_4}$ x $\frac{30.0\text{ g NO}}{1\text{ mol NO}}$ = **15.16 g NO** 4.68 g N_2H_4 x $\frac{1\text{ mol } N_2H_4}{32.0\text{ g } N_2H_4}$ x $\frac{6\text{ mol NO}}{1\text{ mol } N_2O_4}$ x $\frac{30.0\text{ g NO}}{1\text{ mol NO}}$ = 26 g NO
12.	**A** Balanced equation: $2\ KOH + H_2SO_4 \rightarrow 2\ H_2O + K_2SO_4$ ♥ is 2:1 KOH:H_2SO_4 25.0 mL x $\frac{0.145\text{ mol KOH}}{1000\text{ mL KOH}}$ x $\frac{1\text{ mol } H_2SO_4}{2\text{ mol KOH}}$ x $\frac{1000\text{ mL}}{0.108\text{ mol } H_2SO_4}$ = **16.78 mL H_2SO_4**
13.	**D** lightest particle (H_2) is the fastest. "< H_2" is enough to tell you the answer must be **D**.
14.	**A** molar mass = $\frac{\text{grams}}{\text{moles}}$ The mass is 1052.4 g = 1050.0 g = 2.4 g. Calculate the moles. P = 800 mmHg x $\frac{1\text{ atm}}{760\text{ mmHg}}$ = 1.05 atm T = 273 + 25.0 = 298 K PV = nRT ∴ n = $\frac{PV}{RT} = \frac{(1.05\text{ atm})(2.0\text{ L})}{(0.0821\frac{L\cdot atm}{mol\cdot K})(298\text{ K})}$ =0.0860 mol molar mass = $\frac{2.4\text{ g}}{0.086\text{ mol}}$ = **27.9 g/mol**
15.	**B** The pressure inside the tube (750 mmHg) is caused by N_2, O_2, & H_2O. We know P_{H_2O} = 22 mmHg The N_2 & O_2 are causing (750-22) = 728 mmHg. Since $\frac{2}{3}$ of the gas is O_2, $P_{O_2} = \frac{2}{3}(728)$ = **485 mmHg.**
16.	**B** "does not conduct" eliminates the metal, Pt. "insoluble in water" eliminates ionic CsCl. The high MP eliminates the molecular substance, $C_{10}H_{22}$. They are describing a "covalent network solid."
17.	**A** Vapor pressure certainly increases with increased temperature because more particles can escape. Surface tension (due to IMF's) would be weakened if the particles had greater kinetic energy.
18.	**D** When the line between solid & liquid has a positive slope, you can compress a liquid into the more dense solid. [Note: Water is different (negative slope)… compressing a solid turns it into a liquid.]
19.	**D** Definition of ΔH_f -- 1 mole of $B_5H_9(g)$ is formed from its elements under standard conditions.
20.	**D** Hess's Law. The equation for vaporization is: $H_2O(l) \rightarrow H_2O(g)$ ΔH = + 44.0 kJ/mol To combine with the given equation, multiply by 3 and reverse the equation. So, ΔH = -132.0 kJ Adding the enthalpies give you: -1427.7 + (-132.0) = **-1559.7 kJ**

21.	**A** Calorimetry using equation: $q = mc\Delta T$; heat lost by ring = heat gained by water; x = final temp (3.81 g)(0.129)(84-x) = (50 g)(4.18)(x-22.1) Solve for x. **x = 22.2°C** [Note: Water has a large specific heat compared to gold, so very little heating is done by the hot ring!]
22.	**B** Notice this is at STP. 11.2 L = .50 moles, so the answer is ½ of 241.8 kJ/mol = **120.6 kJ**
23.	**B** liquid → gas is the greatest increase in entropy of the given examples. "A" and "D" are decreases in entropy. "C" has very little change in entropy.
24.	**A** ΔH –; ΔS + (liquid → gases); so this will be product-favored at all temperatures. Both driving forces are driving this reaction.
25.	**B** "A" and "C" increase rate. "D" would decrease the rate. "B" would not affect the rate, but it would drive the equilibrium toward the products. Don't confuse Rates (kinetics) with the equilibrium state.
26.	**C** Use ♥ of the problem. $3.0\ mol\cdot L\cdot s^{-1}\ N_2 \times \frac{3\ mol\ O_2}{2\ mol\ N_2} = \mathbf{4.5\ mol\cdot L\cdot s^{-1}\ O_2}$
27.	**C** Rate = $k[A]^2$; $\therefore k = \frac{Rate}{[A]^2} = \frac{mol\cdot L^{-1}\cdot s^{-1}}{mol^2\cdot L^{-2}} = mol^{-1}\cdot L1\cdot s^{-1} = \mathbf{L\cdot mol^{-1}s^{-1}}$
28.	**D** Changing $[OH^-]$ has no effect ∴ zero order. halving $[(CH_3)_3CBr]$ halves the rate ∴ 1st order.
29.	**D** The activation energy barrier is lowered because a alternative mechanism is used.
30.	**A** This is an equation we used in the Kinetics chapter (3rd equation given on Page 2 of this exam) and we also solved this problem graphically by plotting ln k vs. 1/T; slope = $-E_a/R$
31.	**B** Heat appears as a product. Look for changes that shift the equilibrium to the right. "I" shifts to the left and "III" doesn't change the equilibrium state.
32.	**B** leave out the solids. Products over reactants.
33.	**B** HNO_3 is a strong acid ∴ $[H^+] = [HNO_3]$ pH = -log(.0015) = **2.82**
34.	**B** Shortcut: $[H^+] = \sqrt{[HA]\cdot K_a}$; $x^2 = [HA]\cdot K_a$; $[HA] = \frac{x^2}{K_a} = \frac{(2.3 \times 10^{-3})^2}{1.7 \times 10^{-4}} = 3.1 \times 10^{-2}$
35.	**C** First, realize that this is a **<u>buffer</u>**. ***IF*** $[HA] = [A^-]$, then $[H^+] = K_a = 3.0 \times 10^{-6}$. However, $[HA] > [A^-]$ (more of the acid), ∴ $[H^+]$ is a little larger than 3.0×10^{-6}. **Ans: 6.0×10^{-6}**
36.	**D** All compounds are 1:1 ∴ $K_{sp} \propto$ solubility ["∝" means "is proportional to"]; smallest to largest K_{sp}
37.	**C** Oxidation means an increase in oxidation #. $Cr^{3+} \rightarrow CrO_4^{2-}$ is an *increase* from (+3) → (+6)
38.	**B** The "reducing agent" gets oxidized. $2Br^- \rightarrow Br_2$ is an *increase* from (-1) to (0)
39.	**D** The two half-reactions are: $10\ e^- + 12\ H^+ + 2\ ClO_3^- \rightarrow Cl_2 + 6\ H_2O$ $2\ Br^- \rightarrow Br_2 + 2\ e^-$ [to cancel the e^-'s, multiply by 5] ∴ ratio of Br^-/ClO_3^- is 10/2 or **5/1**
40.	**A** First, notice that the E° chart is from *most negative to most positive! The reverse of what is usual.* $E°_{cell} = E°_{reduction} - E°_{oxidation}$ = (-.336 V) – (-.763 V) = **+ 0.427 V.** [Note: when I write $E°_{oxidation}$, I mean the *reduction potential* of the reaction that undergoes oxidation, not the "oxidation potential".]
41.	**A** Instead of "upper left, lower right", we need to do "upper right, lower left". Only "I" fits.
42.	**C** If 3 moles of e^-'s move through the circuit, we will get 3 mol Ag°, 1.5 mol Cu°, & 1 mol Au°.
43.	**C** If *n*=3, *l* cannot be 3… it must be 2 or 1 or 0.
44.	**B** Locate Fe (Z=26) on the periodic table. From its position in the "d-block" it is $3d^6$. ⊗∅∅∅∅
45.	**D** Remember the Hydrogen's line spectrum. The wavelengths of light in the spectrum gave clues of the differences in the energy levels of H's electron. (red, blue-green, blue-violet, & violet)
46.	**A** Cations (+ ions) lose e^-'s and therefore have less e^- - e^- repulsion. Anions gain e^-'s and have more repulsion.
47.	**D** These elements are arranged: Li Be B / Na The largest atoms are lower left, smallest upper right
48.	**B** Recall that beta is ${}^{0}_{-1}e$. Example: ${}^{14}_{6}C \rightarrow {}^{0}_{-1}e + {}^{14}_{7}N$

49.	**D** Practice drawing these! S has 6 valence electrons, 4 are used to bond the F's. That leave one pair. Steric number is 5, arrangement of the electron pairs is trigonal bipyramidal, shape is see-saw.
50.	**C** Practice drawing these! Recall that CO_2 is linear (O=C=O) and BF_3 is trigonal planar () and CS_2 looks like CO_2 (S=C=S)
51.	**A** "I" is a resonance structure. "II" is not. You can't switch the position of atoms, only the electrons.
52.	**B** Draw CS_2. Remember to put the two lone pairs on each S.
53.	**D** You should remember that of the seven diatomic elements, N_2 has a triple bond, O_2 has a double bond, and all the rest have single bonds. Triple is stronger than double, double is stronger than single.
54.	**A** Practice drawing these C_2H_2 is H-C≡C-H; a single is a sigma (σ), a triple is a sigma & two pi's (π)
55.	**D** Review your functional group on the "Stuff I Am Supposed To Know for AP" sheet. 1-butanol is C-C-C-C-O and diethyl ether is C-C-O-C-C
56.	**B** Review your functional groups. "A" is ether, "C" is carboxylic acid, "D" is ester.
57.	**C** You can place two Br's on a benzene ring three different ways… ortho-, meta-, and para- 
58.	**D** Look for the longest chain that contains the double bond. It is five carbons long $\therefore$ "**pentene**"
59.	**D** All three are SN=3, sp^2 hybridization. If these were oxygen or nitrogen atoms, don't forget to draw in the lone pairs.
60.	**B** Proteins are long chains (polymers) of amino acids. Their properties depend on their shape. This shape comes from the order of the amino acids and the way the protein "folds up" as it is formed. Hydrogen bonding plays a huge role in how a protein folds up to give it a shape. When a protein is heated (as when you cook an egg), the clear protein molecules in the egg white unfold (denature) and stick together in a new way as they cool. In cooking, this is a good thing. If it happens to proteins in your bodies (like enzymes or hemoglobin) it is a very bad thing. Changes in temperature and changes in pH can cause proteins to denature.