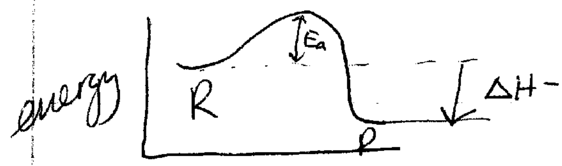
Chem 30A

Review Questions for Final - part 2

1. exothermic — endothermic



2. exo: products are more stable (lower E)
3. a. OH^- will react with the acid component of the buffer $\underline{H_2PO_4^-}$ (conj. acid), $\underline{HPO_4^{2-}}$ (conj base)

   $OH^- + H_2PO_4^- \longrightarrow H_2O + HPO_4^{-2}$

   b. H_3O^+ will react with the base component of the buffer.

   $H_3O^+ + HPO_4^{2-} \longrightarrow H_2O + H_2PO_4^-$
4. Higher heat capacity means it needs more energy to change the temperature by a certain amount. (more resistant to temperature changes)
   Assuming the Fe and Au have the <u>same mass</u>, Au will reach body temp first, as it has the lower heat capacity. (changes T easier, faster)
5. $V = l \times w \times h = (4.12\ cm)(1.0\ cm)(0.51\ cm) = 2.1012\ cm^3$

   $(2.1012\ cm^3)\left(\frac{2.70g}{1\ cm^3}\right) = 5.673\ g \Rightarrow$ (5.7 g Al)
6. ^{35}Cl, because the weighted-average atomic mass of Cl is 35.45. This is closer to 35 than 37, so ^{35}Cl must be more abundant.
7. Cl $1s^2 2s^2 2p^6 3s^2 3p^5$

   Mn $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
8. Cl ⇅ ⇅ ↑ (3p)

   Mn ↑ ↑ ↑ ↑ ↑ (3d)

part 2

9. In any chemical rxn, mass is conserved
total mass reactants = total mass of products

10.

ionic	molecular
Solids at room temp	s, l, or g at room temp
very high mp	low mp
conduct electricity (when dissolved)	Don't conduct electricity
consists of ions	consists of molecules

11. ionic solids - very high mp, conduct if dissolved or melted
held together by ionic bonds
molecular solids - low mp, don't conduct, held together molecules
by intermolecular forces
network covalent solids - large molecule in an
"infinite" network - held together by
covalent bonds. Very high mp.
metallic solids - metals - conduct electricity
held together by a "sea" of outer e^-
that can move

12. Acids - low pH, turn litmus red, react w/ bases,
produce H_3O^+ in water (or H^+)
Base - high pH, turn litmus blue, react w/ acids
produce OH^- in water

13. a. alkali metals - very reactive, form +1 ions, react w/ H_2O
b. halogens - very reactive, diatomic, form -1 ions
c. noble gases - very unreactive atoms
d. metals - conduct heat + electricity, malleable, shiny
e. metalloids - intermediate properties between metal + non
conduct electricity poorly
f. brittle, don't conduct

14. $2\,Al + 6\,HCl \rightarrow 2\,AlCl_3 + 3H_2$

$PV = nRT \qquad n = \frac{PV}{RT} = \frac{(1.00\,atm)(0.100\,L)}{(0.08206\,\frac{L\cdot atm}{K\cdot mol})(298\,K)} = 0.0040893\ mol\ H_2$

14. continued

$(0.0040\bar{8}93 \text{ mol } H_2)\left(\frac{2 \text{ mol Al}}{3 \text{ mol } H_2}\right)\left(\frac{26.98 \text{ g Al}}{1 \text{ mol Al}}\right) = 0.073\bar{5}5 \text{ g Al} = 0.0736 \text{ g Al}$

$(0.0040\bar{8}93 \text{ mol } H_2)\left(\frac{6 \text{ mol HCl}}{3 \text{ mol } H_2}\right)\left(\frac{1 \text{ L}}{0.500 \text{ mol HCl}}\right) = 0.016\bar{3}572 \text{ L}$ or 16.4 mL HCl

15. $\frac{25 \text{ g Pb}}{1{,}000{,}000 \text{ mL } H_2O}$ $(2.00 \text{ L})\left(\frac{1000 \text{ mL}}{1 \text{ L}}\right)\left(\frac{25 \text{ g}}{10^6 \text{ mL}}\right) = 0.050 \text{ g } Pb^{2+}$

16. $(10.0 \text{ mL})\left(\frac{1.00 \text{ g}}{1 \text{ mL}}\right)\left(\frac{1 \text{ mol}}{18.016 \text{ g}}\right)\left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}}\right) = 3.34 \times 10^{23}$ molecules

17. $2HCl + Ba(OH)_2 \rightarrow 2H_2O + BaCl_2$

$(0.0400 \text{ L})\left(\frac{0.100 \text{ mol } Ba(OH)_2}{\text{L}}\right)\left(\frac{2 \text{ mol HCl}}{1 \text{ mol } Ba(OH)_2}\right)\left(\frac{1 \text{ L}}{0.300 \text{ mol HCl}}\right) = 0.0266667 \text{ L}$ 26.7 mL

18. $H_3PO_4 + 3NaOH \rightarrow 3H_2O + Na_3PO_4$

$(0.02500 \text{ L})\left(\frac{0.2051 \text{ mol NaOH}}{\text{L}}\right)\left(\frac{1 \text{ mol } H_3PO_4}{3 \text{ mol NaOH}}\right) = 0.0017\bar{0}9 \text{ mol } H_3PO_4$

$\frac{0.0017\bar{0}9 \text{ mol } H_3PO_4}{0.02566 \text{ L } H_3PO_4} = 0.0666 \text{ M } H_3PO_4$

19. 30.0% v/v means $\frac{30.0 \text{ mL solute}}{100 \text{ mL total solution}}$

$(70.0 \text{ mL solution})\left(\frac{30.0 \text{ mL iso.}}{100 \text{ mL solution}}\right) =$ 21.0 mL isopropyl alcohol

20. $(50.0 \text{ mL isopropyl alcohol})\left(\frac{100 \text{ mL solution}}{30.0 \text{ mL iso}}\right) =$ 167 mL solution

21. $\frac{25.0 \text{ g suc}}{100 \text{ mL solution}}$

$(1.00 \text{ L solution})\left(\frac{1000 \text{ mL}}{1 \text{ L}}\right)\left(\frac{25.0 \text{ g suc}}{100 \text{ mL solution}}\right)\left(\frac{1 \text{ mol sucrose}}{342.296 \text{ g}}\right) =$ 0.730 mol sucrose

22. $\frac{22.0 \text{ g } H_2SO_4}{100 \text{ mL solution}}$ $2NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$

$(25.0 \text{ mL soln})\left(\frac{22.0 \text{ g } H_2SO_4}{100 \text{ mL soln}}\right)\left(\frac{1 \text{ mol } H_2SO_4}{98.076 \text{ g}}\right)\left(\frac{2 \text{ mol NaOH}}{1 \text{ mol } H_2SO_4}\right)\left(\frac{1 \text{ L}}{0.500 \text{ mol NaOH}}\right) = 0.224 \text{ L}$ 224 mL

23. $C_1V_1 = C_2V_2$ $C_2 = \frac{C_1V_1}{V_2} = \frac{(2.00\%)(50.0mL)}{(80.0mL)} = $ (1.25% (m/V) NaOH)

$V_2 = V_1 + V_{water} = 80.0mL$

24. $C_1V_1 = C_2V_2$ $C_2 = \frac{C_1V_1}{V_2} = \frac{(2.00\%)(50.0mL)}{(150.0mL)} = $ (0.6666% (m/V) NaOH)

25. $C_1V_1 = C_2V_2$ $V_2 = \frac{C_1V_1}{C_2} = \frac{(50.0\%)(40.0mL)}{(10.0\%)} = 200. mL = V_{total}$

$V_{water} = 200mL$ total $- 40.0mL$ initial $=$ (160. mL H_2O to add)

26. $(250.\ mL\ soln)\left(\frac{1L}{1000mL}\right)\left(\frac{0.050Eq}{L}\right)\left(\frac{1\ mol\ Al^{3+}}{3\ Eq}\right)\left(\frac{26.98g\ Al^{3+}}{1\ mol}\right) = 0.112\ g\ Al^{3+}$ (0.11g Al^{3+})

27. pH = 2.43 so $[H_3O^+] = 10^{-2.43} = $ (3.7×10^{-3} M H_3O^+)

$K_w = [H_3O^+][OH^-]$ so $[OH^-] = \frac{K_w}{[H_3O^+]} = \frac{1.0 \times 10^{-14}}{3.7 \times 10^{-3}} = $ (2.7×10^{-12} M OH^-)

acidic

28. Yes - if pressure is lower than 1 atm (external P)
A liquid will boil when its vapor pressure = atmospheric pressure
In lab - demo - water boiled at ~25-40°C (not hot!)
If atmospheric/external P is lowered, then vp = external p at a low temp.

29. 1. Increase the temperature
2. Increase concentrations of reactants
3. Add a catalyst (if possible)

30. They have similar e⁻ configurations.
Same # of valence e⁻.

31. $(15\ g\ protein)\left(\frac{4.0\ kcal}{1g\ pro}\right) = 60.\ kcal$

$(1\ g\ fat)\left(\frac{9.0\ kcal}{1\ g\ fat}\right) = 9\ kcal$

$(42\ g\ carb)\left(\frac{4.0\ kcal}{1\ g\ carb}\right) = 168\ kcal$

237 kcal total

32. RBC (0.30 osM) ← → ↓ 0.36 osM outside: 0.12 M $MgCl_2$ ($Mg^{2+} + 2Cl^-$) × 3 ⇒ 0.36 osM
H_2O flows out
cell shrinks

33. 1 Pb 207.2 — 207.2 g Pb

2 S 2×32.07 — 64.14 g S

8 O 8×16.00 — 128.00 g O

399.34 g total

$\frac{128.00\,g\,O}{399.34} \times 100 = 32.05\%\,O$

$\frac{207.2\,g\,Pb}{399.94\,g\,total} \times 100 = 51.89\%\,Pb$ $\frac{64.14\,g\,S}{399.34\,g\,total} \times 100 = 16.06\%\,S$

add %'s = adds up to 100%

34. $(56.33\,g\,Sn)\left(\frac{1\,mol\,Sn}{118.7\,g}\right) = 0.4743\,mol\,Sn$ ← smallest # moles - divide all by this #.

$(13.30\,g\,N)\left(\frac{1\,mol\,N}{14.01\,g\,N}\right) = 0.9493\,mol\,N$

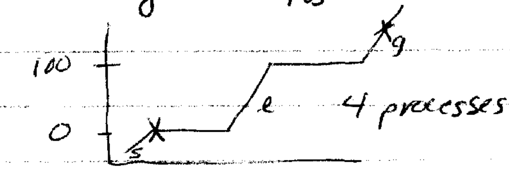
$(30.37\,g\,O)\left(\frac{1\,mol\,O}{16.00\,g\,O}\right) = 1.898\,mol\,O$

$\frac{0.9493\,mol\,N}{0.4743\,mol\,Sn} = \frac{2\,N}{1\,Sn}$ $\frac{1.898\,mol\,O}{0.4743\,mol\,Sn} = \frac{4\,O}{1\,Sn}$

empirical formula: SnN_2O_4

35. ① ice 0°C → water 0°C (phase change - melting use ΔH_{fus})

$(250.\,g)\left(\frac{80\,cal}{g}\right) = 2\bar{0}000\,cal$



② water 0°C → water 100°C

$q = sm\Delta T = (1.00\,cal/g°C)(250\,g)(100°C) = 25\bar{0}00\,cal$

③ water vaporizing use ΔH_{vap}

$(250\,g)\left(\frac{540\,cal}{g}\right) = 13\bar{5}000\,cal$

④ steam 100°C → 180°C T change

$q = sm\Delta T = \left(0.48\,\frac{cal}{g°C}\right)(250.\,g)(80.°C) = 9\bar{6}00\,cal$

add $2\bar{0}000 + 25\bar{0}00 + 13\bar{5}000 + 9\bar{6}00 = 18\bar{9}600\,cal$

±1000 ±100 ±1000 ±100 answer ±1000

$= 1.90 \times 10^5\,cal$ or 190. kcal

36 a. $CaCl_2 \rightarrow Ca + Cl_2$

+2 −1 0 0

Ca +2 → 0 charge decreasing - reduced

Cl: −1 → 0 charge is increasing - oxidized.

37. $2C_7H_{16}O + 21\,O_2 \rightarrow 14\,CO_2 + 16\,H_2O$

38. a. $2Al + 3Br_2 \rightarrow 2AlBr_3$ combination
b. $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ combustion
c. $Mg + 2AgNO_3 \rightarrow 2Ag + Mg(NO_3)_2$ single replacement
d. $2AgNO_3 + MgBr_2 \rightarrow 2AgBr + Mg(NO_3)_2$ double displacement
e. $CaCO_3 \rightarrow CaO + CO_2$ decomposition

39. a. $HCN + NO_2^- \rightleftharpoons HNO_2 + CN^-$
A B A B
conjugates

b. $HCO_3^- + HPO_4^{2-} \rightleftharpoons PO_4^{3-} + H_2CO_3$
B A B A
conjugates

40. a. $Zn_{(s)} + 2HNO_{3\,(aq)} \rightarrow H_{2\,(g)} + Zn(NO_3)_{2\,(aq)}$ (single replacement)
b. $LiHCO_{3\,(s)} + HI_{(aq)} \rightarrow LiI_{(aq)} + H_2O + CO_{2\,(g)}$
c. $3K_2CO_{3\,(aq)} + 2Al(NO_3)_{3\,(aq)} \rightarrow Al_2(CO_3)_{3\,(s)} + 6KNO_3$ ppt. (double displacement)
K^+ CO_3^{2-} Al^{3+} NO_3^-
d. $Ca(OH)_{2\,(s)} + 2HNO_{3\,(aq)} \rightarrow 2H_2O_{(l)} + Ca(NO_3)_{2\,(aq)}$ (acid-base)
e. $Cu_{(s)} + 2AgNO_{3\,(aq)} \rightarrow 2Ag_{(s)} + Cu(NO_3)_{2\,(aq)}$
f. $Ag + Cu(NO_3)_2 \rightarrow$ no reaction (since Ag is less active than Cu)
g. $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

41. Rutherford shot α particles, which are ⊕ charged, through thin metal foil. He <u>thought</u> that in atoms, the positive charged was evenly spread out in the whole atom, so the alpha particles should go straight through the foil. What actually happened was that most of the α particles went straight through but some of them were deflected at large angles or bounced back. This meant that the α particles were bouncing off of something. The conclusion was that the ⊕ charge in atoms was concentrated into a small space instead of being spread out. Also, most of the mass of the atom was concentrated into a small space. Rutherford's experiment led to the discovery of the <u>nucleus</u>. (small, dense, ⊕ charged center of atom - contains all of the ⊕ charge and most of the mass.)

42. $(2.5\,m^2)\left(\frac{100\,cm}{1\,m}\right)^2 = 2.5\times10^4\,cm^3$

43. $(35\,in^3)\left(\frac{2.54\,cm}{1\,in}\right)^3 = 573.55\,cm^3$ ~~52~~ $570\,cm^3$

44. wt. ave mass = (abundance of A)(mass of A) + (abundance of B)(mass of B)
wt. ave mass = (0.0750)(6.015121 amu) + (0.9250)(7.016003 amu)
= 0.451134 amu + 6.4898 amu
wt ave mass = 6.940936 = (6.941 amu)

45. HNO_2 nitrous acid — H_3PO_4 phosphoric acid
HBr hydrobromic acid — H_2CO_3 carbonic acid
H_2SO_4 sulfuric acid — HI hydroiodic acid
H_2SO_3 sulfurous acid — $HC_2H_3O_2$ acetic acid

46. HF, HNO_3, $HClO_3$, $HClO_2$, HClO.

47. a. chemical b. chemical c. physical d. physical

48. $(85.6\,g\,C)\left(\frac{1\,mol\,C}{12.01\,g\,C}\right) = 7.127\,mol\,C$

$(14.4\,g\,H)\left(\frac{1\,mol\,H}{1.008\,g\,H}\right) = 14.2857\,mol\,H$

$\frac{14.2857\,mol\,H}{7.127\,mol\,C} = \frac{2\,H}{1\,C}$

empirical formula = CH_2

$\frac{MM}{EFM} = \frac{85\,g/mol}{12.01+2(1.008)} = \frac{85}{14.026} = 6.06$ so MF = EF × 6 (C_6H_{12})

49. $2Al + 3Br_2 \rightarrow 2AlBr_3$ LR problem -

$(25.0\,g\,Al)\left(\frac{1\,mol\,Al}{26.98\,g\,Al}\right)\left(\frac{2\,mol\,AlBr_3}{2\,mol\,Al}\right)\left(\frac{266.68\,g\,AlBr_3}{1\,mol\,AlBr_3}\right) = 247\,g\,AlBr_3$

$(100.\,g\,Br_2)\left(\frac{1\,mol\,Br_2}{159.8\,g\,Br_2}\right)\left(\frac{2\,mol\,AlBr_3}{3\,mol\,Br_2}\right)\left(\frac{266.68\,g\,AlBr_3}{1\,mol\,AlBr_3}\right) = (111\,g\,AlBr_3)$ 111.256 g — smallest amt.

↑ Br_2 is LR

% yield = $\frac{\text{actual y.}}{\text{theoretical y.}} \times 100 = \frac{64.2\,g\,AlBr_3\text{ actual}}{111.256\,g\,AlBr_3\text{ theoretical}} \times 100 =$ (57.7 % yield)

50. $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$ LR prob

$$(50.0\,g\,HCl)\left(\frac{1\,mol\,HCl}{36.458\,g\,HCl}\right)\left(\frac{2\,mol\,AlCl_3}{6\,mol\,HCl}\right)\left(\frac{133.33\,g\,AlCl_3}{1\,mol\,AlCl_3}\right) = 60.9\bar{5}7\,g\,AlCl_3$$

smallest

$$(20.0\,g\,Al)\left(\frac{1\,mol\,Al}{26.98\,g\,Al}\right)\left(\frac{2\,mol\,AlCl_3}{2\,mol\,Al}\right)\left(\frac{133.33\,g\,AlCl_3}{1\,mol\,AlCl_3}\right) = 98.\bar{8}4\,g\,AlCl_3$$

LR = HCl amt $AlCl_3$ formed = 61.0 g

amt excess left — first calc amt of Al that reacted with the LR

$$(50.0\,g\,HCl)\left(\frac{1\,mol\,HCl}{36.458\,g\,HCl}\right)\left(\frac{2\,mol\,Al}{6\,mol\,HCl}\right)\left(\frac{26.98\,g\,Al}{1\,mol\,Al}\right) = 12.\bar{3}34\,g\,Al$$

used up

20.0 g Al (start) − 12.$\bar{3}$34 g Al (used) = 7.$\bar{6}$66 g Al left over

7.7 g Al left