

Chem 1A

Answers - Exam 1 - Review Problems

1



a. $(5.0 \text{ mol AlCl}_3) \left(\frac{3 \text{ mol Mg}}{2 \text{ mol AlCl}_3} \right) = 7.5 \text{ mol Mg}$

b. $(50.0 \text{ mg Mg}) \left(\frac{1 \text{ g Mg}}{1000 \text{ mg}} \right) \left(\frac{1 \text{ mol Mg}}{24.31 \text{ g Mg}} \right) \left(\frac{2 \text{ mol Al}}{3 \text{ mol Mg}} \right) = 0.00137 \text{ mol Al}$
 or $1.37 \times 10^{-3} \text{ mol Al}$

c. $(3.00 \text{ g AlCl}_3) \left(\frac{1 \text{ mol AlCl}_3}{133.33 \text{ g AlCl}_3} \right) \left(\frac{3 \text{ mol Mg}}{2 \text{ mol AlCl}_3} \right) \left(\frac{24.31 \text{ g Mg}}{1 \text{ mol Mg}} \right) = 0.820 \text{ g Mg}$

d. $(5.0 \times 10^{24} \text{ atoms Al}) \left(\frac{1 \text{ mol Al}}{6.022 \times 10^{23} \text{ atoms}} \right) \left(\frac{3 \text{ mol Mg}}{2 \text{ mol Al}} \right) \left(\frac{24.31 \text{ g Mg}}{1 \text{ mol Mg}} \right) \left(\frac{1 \text{ cm}^3}{1.738 \text{ g}} \right) =$
 $= \frac{174 \text{ cm}^3 \text{ Mg}}{1.7 \times 10^2 \text{ cm}^3}$

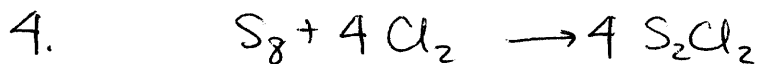
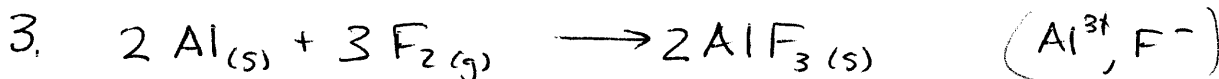
2. $\% \text{Fe} = \frac{\text{g Fe}}{\text{g total}} \times 100$

$\text{MM} = 2(55.85) + 6(12.01) + 12(16.00) = 375.76 \text{ g/mol}$

$\% \text{Fe} = \frac{2(55.85) \text{ g Fe}}{375.76 \text{ g total}} \times 100 = 29.73 \% \text{ Fe}$

$\% \text{C} = \frac{6(12.01) \text{ g C}}{375.76 \text{ g total}} \times 100 = 19.18 \% \text{ C}$

$\% \text{O} = \frac{12(16.00) \text{ g O}}{375.76 \text{ g total}} \times 100 = 51.096 \rightarrow 51.10 \% \text{ O}$



a) LR problem

$(20.0 \text{ g S}_8) \left(\frac{1 \text{ mol S}_8}{256.56 \text{ g S}_8} \right) = 0.07795 \text{ mol S}_8$

2

$$(10.0 \text{ g Cl}_2) \left(\frac{1 \text{ mol Cl}_2}{70.90 \text{ g}} \right) = 0.1410 \text{ mol Cl}_2$$

need: $\frac{4 \text{ Cl}_2}{1 \text{ S}_8}$ have $\frac{0.1410 \text{ mol Cl}_2}{0.07795 \text{ mol S}_8} = \frac{1.809 \text{ mol Cl}_2}{1 \text{ mol S}_8}$
 not enough Cl₂. so Cl₂ is LR.

$$(0.1410 \text{ mol Cl}_2) \left(\frac{4 \text{ mol S}_2\text{Cl}_2}{4 \text{ mol Cl}_2} \right) \left(\frac{135.04 \text{ g S}_2\text{Cl}_2}{1 \text{ mol S}_2\text{Cl}_2} \right) = 19.0 \text{ g S}_2\text{Cl}_2$$

$$4.b. (85.0 \text{ kg S}_2\text{Cl}_2) \left(\frac{1000 \text{ g S}_2\text{Cl}_2}{1 \text{ kg}} \right) \left(\frac{1 \text{ mol S}_2\text{Cl}_2}{135.04 \text{ g S}_2\text{Cl}_2} \right) \left(\frac{4 \text{ mol Cl}_2}{4 \text{ mol S}_2\text{Cl}_2} \right)$$

$$\rightarrow \times \left(\frac{70.90 \text{ g Cl}_2}{1 \text{ mol Cl}_2} \right) = 44627.5 \text{ g Cl}_2 \div 1000$$

$$\Rightarrow 44.6 \text{ kg Cl}_2$$

4c. $\frac{86.5 \text{ g actual}}{100 \text{ g theoretical}}$

we want to actually get 25.0g S₂Cl₂.

so $(25.0 \text{ g S}_2\text{Cl}_2 \text{ actual}) \left(\frac{100 \text{ g theoretical}}{86.5 \text{ g actual}} \right) = 28.9 \text{ g theoretical S}_2\text{Cl}_2$

$$(28.9 \text{ g S}_2\text{Cl}_2) \left(\frac{1 \text{ mol S}_2\text{Cl}_2}{135.04 \text{ g S}_2\text{Cl}_2} \right) \left(\frac{1 \text{ mol S}_8}{4 \text{ mol S}_2\text{Cl}_2} \right) \left(\frac{256.56 \text{ g S}_8}{1 \text{ mol S}_8} \right) = 13.7 \text{ g S}_8$$

5. We have atomic mass on per table = 85.49 amu
 closer to 85 than 87. ⁸⁵Rb is more abundant.

$$6. (2.0 \text{ ng C}_5\text{H}_{12}) \left(\frac{1 \text{ g}}{10^9 \text{ ng}} \right) \left(\frac{1 \text{ mol C}_5\text{H}_{12}}{72.146 \text{ g}} \right) \left(\frac{12 \text{ mol H}}{1 \text{ mol C}_5\text{H}_{12}} \right) \left(\frac{6.022 \times 10^{23} \text{ atoms H}}{1 \text{ mol H}} \right)$$

$$= 2.0 \times 10^{15} \text{ H atoms}$$

3

$$7. (6.111 \text{ g CO}_2) \left(\frac{1 \text{ mol CO}_2}{44.01 \text{ g CO}_2} \right) \left(\frac{1 \text{ mol C}}{1 \text{ mol CO}_2} \right) \left(\frac{12.01 \text{ g C}}{1 \text{ mol C}} \right) = 1.6676 \text{ g C}$$

$$(1.390 \text{ g H}_2\text{O}) \left(\frac{1 \text{ mol H}_2\text{O}}{18.016 \text{ g H}_2\text{O}} \right) \left(\frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} \right) \left(\frac{1.008 \text{ g H}}{1 \text{ mol H}} \right) = 0.15554 \text{ g H}$$

$$2.317 \text{ g comp.} - 1.6676 \text{ g C} - 0.15554 \text{ g H} = 0.49386 \text{ g O}$$

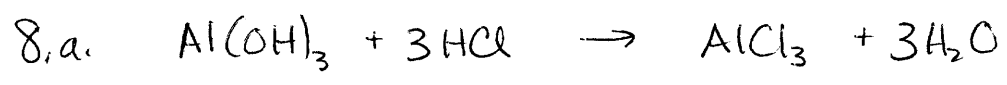
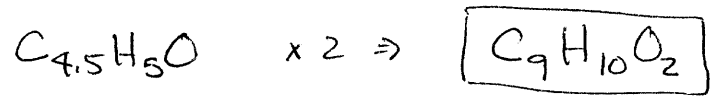
$$(1.6676 \text{ g C}) \left(\frac{1 \text{ mol C}}{12.01 \text{ g C}} \right) = 0.13885 \text{ mol C}$$

$$(0.15554 \text{ g H}) \left(\frac{1 \text{ mol H}}{1.008 \text{ g H}} \right) = 0.1543 \text{ mol H}$$

$$(0.49386 \text{ g O}) \left(\frac{1 \text{ mol O}}{16.00 \text{ g O}} \right) = 0.03087 \text{ mol O}$$

$$\frac{0.13885 \text{ mol C}}{0.03087 \text{ mol O}} = \frac{4.5 \text{ C}}{1 \text{ O}}$$

$$\frac{0.1543 \text{ mol H}}{0.03087 \text{ mol O}} = \frac{5 \text{ H}}{1 \text{ O}}$$



b. LR problem.

$$(5.00 \text{ g Al(OH)}_3) \left(\frac{1 \text{ mol Al(OH)}_3}{78.004 \text{ g}} \right) = 0.064099 \text{ mol Al(OH)}_3$$

$$(8.00 \text{ g HCl}) \left(\frac{1 \text{ mol HCl}}{36.458 \text{ g HCl}} \right) = 0.21943 \text{ mol HCl}$$

needed: $\frac{3 \text{ mol HCl}}{1 \text{ mol Al(OH)}_3}$ have: $\frac{0.21943 \text{ mol HCl}}{0.064099 \text{ mol Al(OH)}_3} = 3.42 \frac{\text{HCl}}{\text{Al(OH)}_3}$

have extra HCl, so Al(OH)₃ is LR.

$$(0.064099 \text{ mol Al(OH)}_3) \left(\frac{3 \text{ mol H}_2\text{O}}{1 \text{ mol Al(OH)}_3} \right) \left(\frac{18.016 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} \right) = \boxed{3.46 \text{ g H}_2\text{O}}$$

4

© how much HCl used?

$$(0.064099 \text{ mol Al(OH)}_3) \left(\frac{3 \text{ mol HCl}}{1 \text{ mol Al(OH)}_3} \right) \left(\frac{36.458 \text{ g HCl}}{1 \text{ mol HCl}} \right) = 7.01 \text{ g HCl used}$$

$$8.00 \text{ g HCl} - 7.01 \text{ g used} = \underline{0.99 \text{ g HCl left over}}$$



$$(50.0 \text{ g C}_8\text{H}_{18}) \left(\frac{1 \text{ mol C}_8\text{H}_{18}}{114.224 \text{ g}} \right) \left(\frac{16 \text{ mol CO}_2}{2 \text{ mol C}_8\text{H}_{18}} \right) \left(\frac{44.01 \text{ g CO}_2}{1 \text{ mol CO}_2} \right) = 154 \text{ g CO}_2$$

$$(50.0 \text{ g C}_8\text{H}_{18}) \left(\frac{1 \text{ mol C}_8\text{H}_{18}}{114.224 \text{ g}} \right) \left(\frac{18 \text{ mol H}_2\text{O}}{2 \text{ mol C}_8\text{H}_{18}} \right) \left(\frac{18.016 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} \right) = 71.0 \text{ g H}_2\text{O}$$

10. $\frac{1.80 \text{ g CO}_2}{1 \text{ L}}$ want: $\frac{\# \text{ molecules}}{\text{in}^3}$

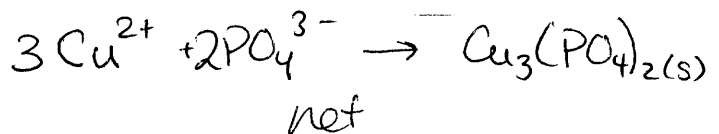
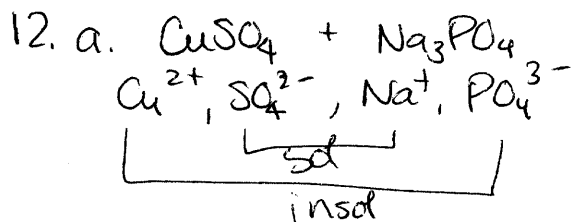
$$\left(\frac{1.80 \text{ g CO}_2}{1 \text{ L}} \right) \left(\frac{1 \text{ mol CO}_2}{44.01 \text{ g CO}_2} \right) \left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol CO}_2} \right) \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{1 \text{ mL}}{1 \text{ cm}^3} \right) \left(\frac{2.54 \text{ cm}}{1 \text{ in}} \right)^3$$

$$= \frac{4.04 \times 10^{20} \text{ molecules CO}_2}{\text{in}^3}$$

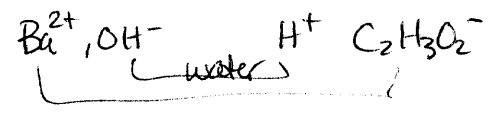
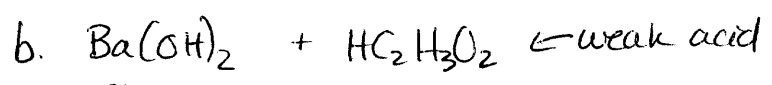
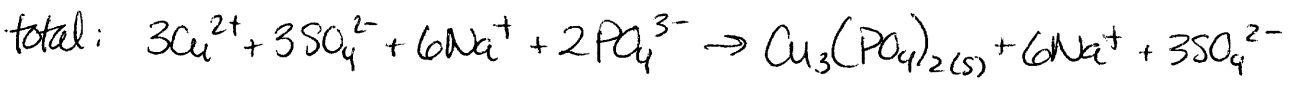
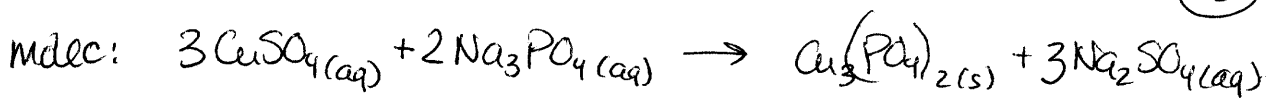
$$11. \text{ wt}_{\text{ave mass}} = (0.9223)(27.97693 \text{ amu}) + (0.0467)(28.97649) + (0.0310)(29.97376)$$

$$= 25.803 \text{ amu} + 1.3532 \text{ amu} + 0.92919 \text{ amu}$$

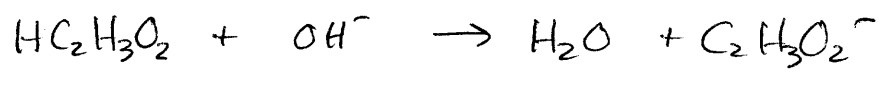
$$= 28.08539 \Rightarrow \underline{28.09 \text{ amu}}$$



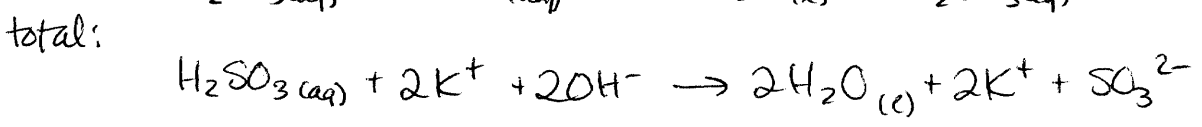
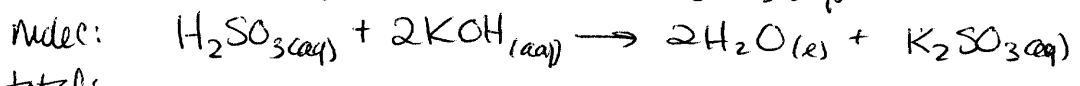
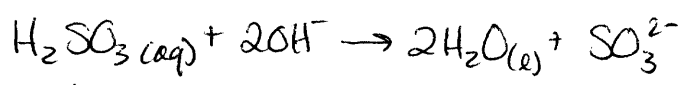
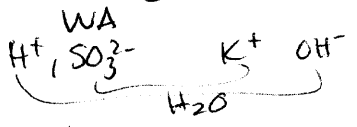
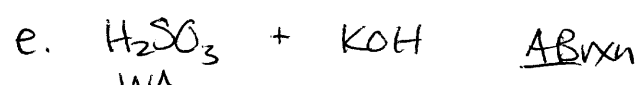
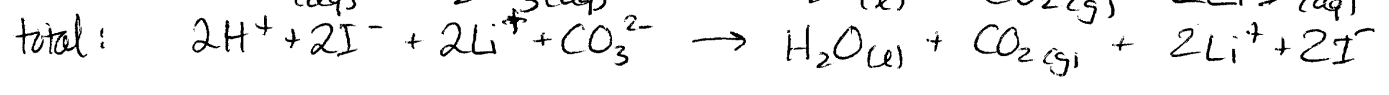
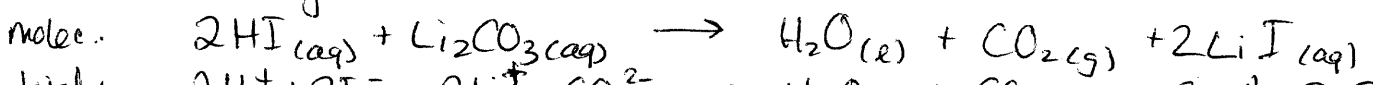
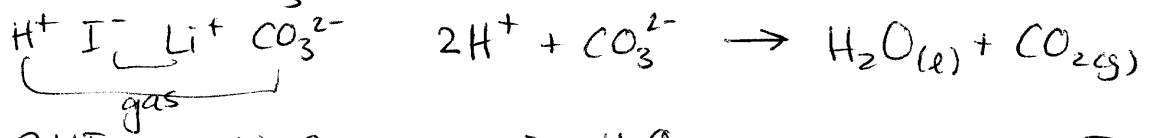
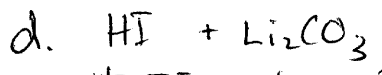
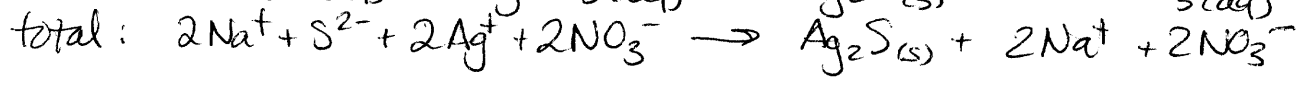
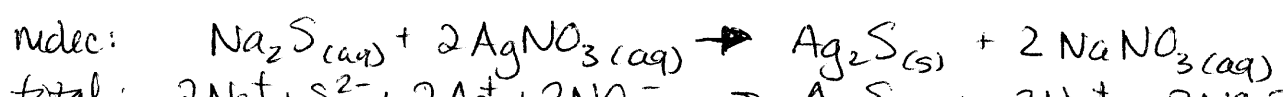
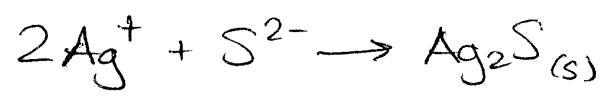
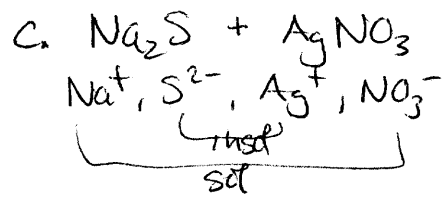
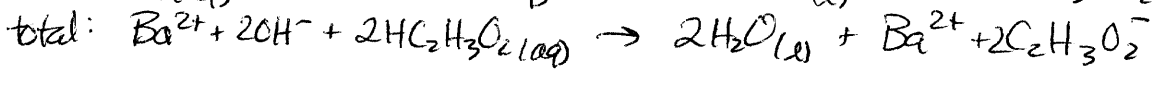
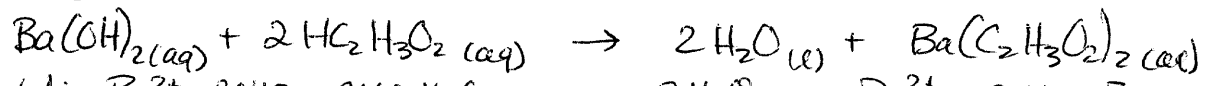
5



net:



molec



6

assume a 100g sample

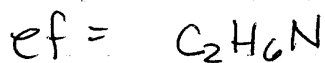
$$13. (54.5 \text{ g C}) \left(\frac{1 \text{ mol C}}{12.01 \text{ g C}} \right) = 4.538 \text{ mol C}$$

$$(13.7 \text{ g H}) \left(\frac{1 \text{ mol H}}{1.008 \text{ g H}} \right) = 13.59 \text{ mol H}$$

$$(31.8 \text{ g N}) \left(\frac{1 \text{ mol N}}{14.01 \text{ g N}} \right) = 2.2698 \text{ mol N}$$

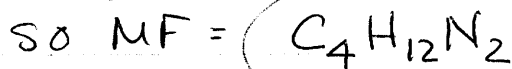
$$\frac{4.538 \text{ mol C}}{2.2698 \text{ mol N}} = \frac{2 \text{ C}}{1 \text{ N}}$$

$$\frac{13.59 \text{ mol H}}{2.2698 \text{ mol N}} = \frac{6 \text{ H}}{1 \text{ N}}$$

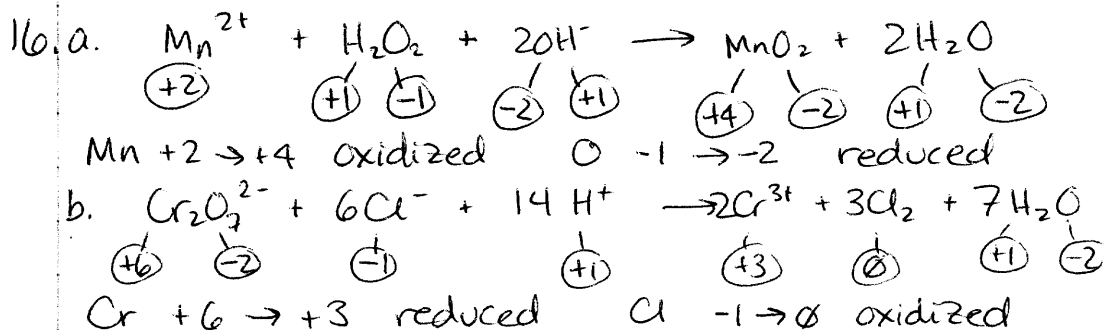


$$\text{mf} \quad \dots \quad \text{molar mass of ef} = 2(12.01) + 6(1.008) + 14.01 \\ = 44.078 \text{ g/mol}$$

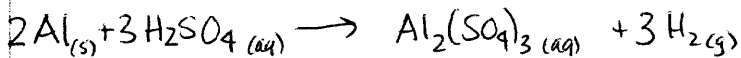
$$\frac{\text{MM}}{\text{EFM}} = \frac{90 \text{ g/mol}}{44.078 \text{ g/mol}} = 2.04 \Rightarrow 2$$



15. a. H_2SO_4 MM = 98.086 g/mol
 $(50.0 \text{ mL}) \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{6.0 \text{ mol H}_2\text{SO}_4}{1 \text{ L solution}} \right) \left(\frac{98.086 \text{ g H}_2\text{SO}_4}{1 \text{ mol H}_2\text{SO}_4} \right) = 29.4 \text{ g H}_2\text{SO}_4$
 $\frac{29.4 \text{ g H}_2\text{SO}_4}{24 \text{ g H}_2\text{SO}_4}$
- b. NaOH MM = 39.998 g/mol
 $(5.00 \text{ g NaOH}) \left(\frac{1 \text{ mol NaOH}}{39.998 \text{ g}} \right) \left(\frac{1 \text{ L solution}}{2.35 \text{ mol NaOH}} \right) = 0.0532 \text{ L}$ or 53.2 mL solution
- c. Na_2SO_4 MM = 142.05 g/mol
 $(35.0 \text{ g Na}_2\text{SO}_4) \left(\frac{1 \text{ mol}}{142.05 \text{ g}} \right) = 0.24639 \text{ mol Na}_2\text{SO}_4$
 $\frac{0.24639 \text{ mol Na}_2\text{SO}_4}{0.253 \text{ L soln.}} = 0.974 \text{ M Na}_2\text{SO}_4$



17. a. Al is more active than H, so Al will replace H.



b. lead is less active than tin, so it won't replace tin. NR.

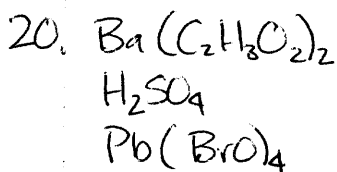
c. tin is more active than lead. It will replace lead.



18. wt. ave mass Ag (from per table in back) = 107.8682 amu
 let abundance of $^{107}\text{Ag} = x$ abundance of $^{109}\text{Ag} = 1-x$ ← this is exact by definition.
- $$107.8682 \text{ amu} = x(106.90509 \text{ amu}) + (1-x)(108.9047 \text{ amu})$$
- $$107.8682 = 106.90509x + 108.9047 - 108.9047x$$
- $$-108.9047 = -1.99961x$$
- $$\frac{-1.0365}{-1.99961} = \frac{-1.99961x}{-1.99961}$$
- $x = 0.51835$ 5sf $1-x = 0.48165$
- ^{107}Ag 51.835% ^{109}Ag 48.165%

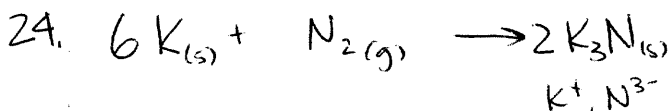
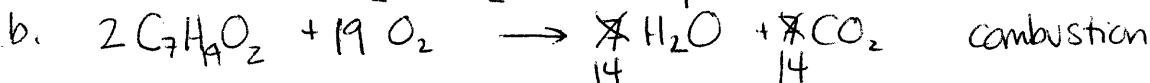
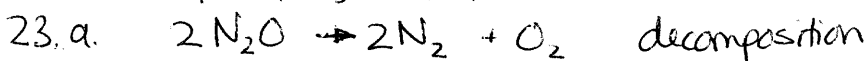
19. ammonium sulfite
tin (II) chloride
oxalic acid

- phosphorus triiodide
gold (I) periodate
copper (I) chromate
~~Ag₂O~~ CS₂
Ag₂O
Al₂(CO₃)₂



21. 47p⁺, 47n⁰ 109-47 = 62 n⁰

22. a. Ce, Pr, Nd, Th, Pa, U etc
b. F, Cl, Br, I
c. Rb, Sr, Y, Zr, Sn, Sb, I etc.
d. H, Li, Mg, Al, P, O etc



25. (2.00 kg) ($\frac{1000g}{1kg}$) ($\frac{1cm^3}{4.51g}$) ($\frac{1inch}{2.54cm}$)³ = 27.1 in³



a. (0.500 g Al) ($\frac{1 mol Al}{26.98 g Al}$) ($\frac{6 mol HBr}{2 mol Al}$) ($\frac{80.908 g HBr}{1 mol HBr}$) = 4.4982 g HBr
4.50 g HBr

b. (0.500 g Al) ($\frac{1 mol Al}{26.98 g Al}$) ($\frac{3 mol H_2}{2 mol Al}$) ($\frac{6.022 \times 10^{23} molecules H_2}{1 mol H_2}$) = 1.67 × 10²² H₂ molecules



a. (50.0 g Fe) ($\frac{1 mol Fe}{55.85 g Fe}$) = 0.89526 mol Fe

need $\frac{4H_2O}{3Fe} = \frac{1.33 H_2O}{1 Fe}$

(30.0 g H₂O) ($\frac{1 mol H_2O}{18.016 g H_2O}$) = 1.665 mol H₂O

have $\frac{1.665 H_2O}{0.89526 Fe} = \frac{1.85 H_2O}{1 Fe}$

have more than enough H₂O, so Fe is LR.

(0.89526 mol Fe) ($\frac{1 mol Fe_3O_4}{3 mol Fe}$) ($\frac{231.55 g Fe_3O_4}{1 mol Fe_3O_4}$) = 69.1 g Fe₃O₄

c. % yield = $\frac{60.2 g actual}{69.099 g theor.} \times 100 = 87.1\% yield.$

b. (0.89526 mol Fe) ($\frac{4 mol H_2O}{3 mol Fe}$) ($\frac{18.016 g H_2O}{1 mol H_2O}$) = 21.5 g H₂O used

30.0g start
- 21.5g used
8.5g H₂O left