

1. Consider the data obtained for the length of an object as measured by three students. The length is known to be 14.54 cm. Which of the conclusions summarizes the data?

	trial 1	trial 2	trial 3	trial 4	trial 5
Student A	14.8	14.1	14.5	14.6	14.2
Student B	14.7	14.2	14.6	14.5	14.8
Student C	14.3	14.4	14.5	14.3	14.5

accuracy
vs.
precision

- a) student B has done the most precise work and student C the most accurate
 b) ~~student B has done the most precise work and student A the most accurate~~
 c) * student C has done the most precise work and student B the most accurate
 d) student C has done the most precise work and student A the most accurate
 e) student A has done the most precise work and student C the most accurate

2. Calculate the following to the correct number of significant figures.

$$\frac{87.45 \times 3.024}{(5.15 + 82.3) \times (0.024 + 3.000)} = \frac{264.4488}{3 \text{ s.f.}}$$

- a) * 264 b) 264.3 c) 264.30 d) 298 e) 2.6×10^2

3. The radius of a baseball is 3.6 cm and it has a mass of 145 g. What is the density of a baseball in g/cm^3 ? (The volume of a sphere is $(4\pi r^3)/3$ where r is the radius.)

- a) 0.58 b) * 0.74 c) 1.3 d) 1.5 e) 1.7

$$\rho = \frac{m}{V} = \frac{145 \text{ g}}{\frac{4\pi(3.6 \text{ cm})^3}{3}}$$

$$\rho = 0.74232 \text{ g/cm}^3$$

4. Select the combination of statements which are correct.

- ✓ A. The mass number of an atom is the sum of the number of neutrons and protons in the nucleus. T ← protons
 ✗ B. The number of neutrons in atom is its atomic number. F
 ✗ C. Isotopes of an element differ only in the number of protons. F ← neutrons
 ✓ D. The volume occupied by the nucleus is a small percentage of the total volume of the atom. T
 ✓ E. The number of electrons and protons in a neutral atom are equal. T

- a) * A, D, E b) B, C c) A, B, C d) A, C, D e) D, E

$$\text{Br: } 35 p^+ \quad -1 \text{ charge} = 36 e^-$$

$$79 = p^+ + n^0$$

$$n^0 = 44$$

5. The ion ${}^{79}_{35}\text{Br}^-$ contains:

- a) 35 protons, 44 neutrons, 35 electrons.
- b) 35 protons, 44 neutrons, 34 electrons.
- c) 44 protons, 35 neutrons, 36 electrons.
- d)* 35 protons, 44 neutrons, 36 electrons.

6. How many iron atoms are present in a stainless steel ball bearing having a radius of 0.254 cm? The stainless steel contains 85.6% Fe by mass, and has a density of 7.75 g/cm³. (The volume of a sphere is $(4\pi r^3)/3$ where r is the radius. Atomic weight: Fe = 55.85)

$$d = \frac{m}{V} = 7.75 \frac{\text{g}}{\text{cm}^3}$$

- a) 1.47×10^{22}
- b)* 4.90×10^{21}
- c) 5.74×10^{21}
- d) 1.72×10^{22}
- e) 1.17×10^{21}

$$m = 7.75 \frac{\text{g}}{\text{cm}^3} \left| \frac{4\pi(0.254)^3}{3} \right|$$

7. Silver "tarnish" is silver(I) sulfide. What is its formula?

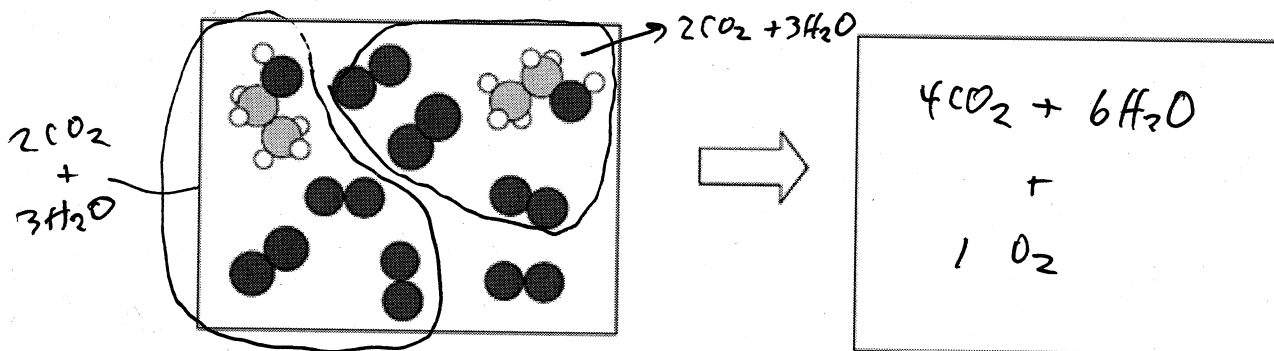
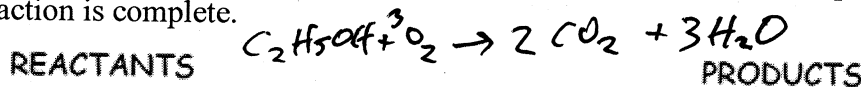
- a) AgS
- b) AgS₂
- c) Ag₂SO₄
- d)* Ag₂S
- e) AgSO₄

$$m = 0.5317 \text{ g}$$

$$g_{\text{Fe}} = 0.5317 \text{ g} (0.856)$$

$$\frac{0.4557 \text{ g Fe} \times N_A}{55.845 \text{ g/mol}} = 4.91 \times 10^{21} \text{ Fe atoms}$$

8. Consider the combustion reaction between 2 ethanol (C₂H₅OH) and 7 oxygen molecules shown below. Which statement below best represents what is present in the product box after the reaction is complete.



- a) 4 CO₂ molecules + 6 H₂O molecules
- b)* 4 CO₂ molecules + 6 H₂O molecules + 1 O₂ molecule
- c) 4 CO₂ molecules + 6 H₂O molecules + 1 C₂H₅OH molecule
- d) 2 CO₂ molecules + 3 H₂O molecules + 1 C₂H₅OH molecule + 4 O₂ molecules
- e) none of the above

$$49.9461(0.0431) + 51.9405(0.8376) + 53.9389(0.0238) = 46.9418$$

$$46.9418 + x(0.0955) = 51.9861 \quad x = 52.9246$$

9. Chromium (atomic weight 51.996) has four naturally-occurring isotopes. Three of these are ^{50}Cr with isotopic weight 49.9461 (abundance 4.31%), ^{52}Cr with isotopic weight 51.9405 (abundance 83.76%) and ^{54}Cr with isotopic weight 53.9389 (abundance 2.38%) Which of the following isotopic weights is the most likely for the fourth isotope?

- a) 48.8211 b) 49.8999 c) 50.9321 **d) * 52.9247** e) 54.9381

10. The mass of one molecule of the anticancer drug cisplatin is 4.99×10^{-22} g. Calculate the molecular weight of cisplatin.

- a) 344 b) 321 c) 279 d) 255 **e) * 301**

$$4.99 \times 10^{-22} \text{ g/molecule} \times 6.022 \times 10^{23} \text{ molecules/mol} = 300.5 \text{ g/mol}$$

11. The mineral zircon contains 49.8% Zr, 15.3% Si and 34.9% O. What is the empirical formula? (Atomic weights: Zr = 91.2, Si = 28.1, O = 16.00) Assume 100g sample

- a) ZrSiO_2 b) ZrSi_2O_4 c) Zr_2SiO_5 **d) * ZrSiO_4** e) ZrSiO_3

$$49.8 \text{ g Zr} \times \frac{1 \text{ mol Zr}}{91.2 \text{ g}} = 0.546 \text{ mol Zr} \quad 15.3 \text{ g Si} \times \frac{1 \text{ mol Si}}{28.1 \text{ g}} = 0.544 \text{ mol Si} \quad 34.9 \text{ g O} \times \frac{1 \text{ mol O}}{16.0 \text{ g}} = 2.18 \text{ mol O}$$

$$\frac{0.546}{0.544} \rightarrow 1 \quad \frac{0.544}{0.544} \rightarrow 1 \quad \frac{2.18}{0.544} \rightarrow 4$$

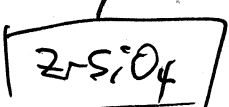
12. A 1.05 g sample of a compound containing only carbon, hydrogen and nitrogen is burned in excess oxygen to form 2.92 g of CO_2 and 0.598 g of H_2O . The approximate molecular weight is 237. What is the molecular formula?

(Atomic weights: C = 12.01, O = 16.00, H = 1.008, N = 14.01)

- a) $\text{C}_{13}\text{H}_{11}\text{N}_5$ b) $\text{C}_{15}\text{H}_{17}\text{N}_2$ c) $\text{C}_{14}\text{H}_{29}\text{N}_2$ d) $\text{C}_{14}\text{H}_{13}\text{N}_4$ **e) * $\text{C}_{15}\text{H}_{15}\text{N}_3$**

$$2.92 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.01 \text{ g}} \times \frac{1 \text{ mol C}}{1 \text{ mol CO}_2} = 0.0663 \text{ mol C} \times \frac{12.01 \text{ g}}{1 \text{ mol C}} = 0.796 \text{ g C}$$

$$0.598 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g}} \times \frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} = 0.0664 \text{ mol H} \times \frac{1.01 \text{ g}}{1 \text{ mol H}} = 0.0671 \text{ g H}$$



$$1.05 \text{ g} - 0.796 \text{ g} - 0.0671 \text{ g} = 0.187 \text{ g N}$$

13. A 0.1965 g sample of a mixture of KI and KNO_3 is dissolved in water, and all of the iodide present is precipitated as 0.2213 g of AgI. What is the percent by mass of KI in the mixture?

(Atomic weights: K = 39.10, I = 126.90, Ag = 107.87)

- a) 56.44 b) 59.03 c) 69.88 **d) * 79.63** e) 84.33

$$0.2213 \text{ g AgI} \times \frac{167.882}{234.7682} = 0.16168 \text{ g Ag}$$

$$0.187 \text{ g N} \times \frac{1 \text{ mol N}}{14.01 \text{ g}} = 0.0133 \text{ mol N}$$

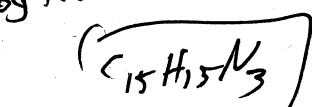
$$\frac{0.0663 \text{ mol C}}{0.0133} = 5$$

$$\frac{0.0664 \text{ mol H}}{0.0133} = 5$$

$$\frac{237}{79} = 3 \quad \text{C}_5\text{H}_{15}\text{N}_3 = (12.5 + 1.5 + 14) = 79$$

$$0.16168 \text{ g Ag} \times \frac{1 \text{ mol Ag}}{107.87 \text{ g}} + \frac{1 \text{ mol I}^-}{1 \text{ mol Ag}} + \frac{1 \text{ mol KI}}{1 \text{ mol I}^-} \times \frac{165.9 \text{ g}}{1 \text{ mol KI}} = 2.1556 \text{ g KI}$$

$$\frac{0.1556 \text{ g KI}}{0.1965 \text{ g}} \times 100\% = 79.32\%$$



14. A fatal concentration of carbon monoxide (CO) exists if 2.48 g is released in a garage having a volume of $1.50 \times 10^3 \text{ ft}^3$. How many molecules are there per ft^3 under these conditions? (Atomic weights: C = 12.01, O = 16.00)

a)* 3.55×10^{19} b) 3.53×10^{17} c) 5.30×10^{22} d) 5.30×10^{20} e) 5.30×10^{26}

$$2.48 \text{ g CO} \times \frac{1 \text{ mol CO}}{28.0 \text{ g}} = 0.08857 \text{ mol CO} \times \frac{6.022 \times 10^{23} \text{ molec.}}{1 \text{ mol CO}} = \frac{5.334 \times 10^{22} \text{ molec.}}{1.50 \times 10^3 \text{ ft}^3} = \frac{x}{1 \text{ ft}^3}$$

15. Balance the following equation. What is the sum of the coefficients of the reactants and products?

$$\underline{1} \text{ C}_7\text{H}_{16} + \underline{11} \text{ O}_2 \rightarrow \underline{7} \text{ CO}_2 + \underline{8} \text{ H}_2\text{O}$$

a)* 27 b) 24 c) 21 d) 18 e) 15

$x = 3.55 \times 10^{19}$
molecules

16. The net ionic equation for the reaction between aqueous sulfuric acid and aqueous sodium hydroxide is _____.

$$\text{H}_2\text{SO}_4(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{Na}_2\text{SO}_4(\text{aq})$$

$$2\text{H}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l})$$

a) * $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$

b) $\text{H}^+(\text{aq}) + \text{HSO}_4^-(\text{aq}) + 2\text{Na}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{Na}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$

c) $2\text{H}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{Na}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$

d) $\text{SO}_4^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq}) \rightarrow 2\text{Na}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$

e) $\text{H}^+(\text{aq}) + \text{HSO}_4^-(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{SO}_4^{2-}(\text{aq})$

17. Which statement is false for the balanced equation given below?
(Atomic weights: C = 12.01, Cl = 35.45, H = 1.008)

$$\text{CH}_4 + 4 \text{ Cl}_2 \rightarrow \text{CCl}_4 + 4 \text{ HCl}$$

~~a) The reaction of 70.9 g of Cl_2 will produce 0.250 moles of CCl_4 . T~~ $\frac{1 \text{ mol Cl}_2}{4 \text{ mol Cl}_2} \times \frac{1 \text{ mol CCl}_4}{1 \text{ mol CCl}_4} = 0.250 \text{ mol CCl}_4$

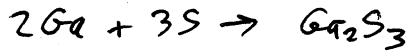
~~b) Two molecules of CH_4 react with eight molecules of Cl_2 . T 1:4 ratio~~

~~c) One mole of CH_4 will produce 153.8 g of CCl_4 . T 1:1 mol ratio~~

~~d) One mole of Cl_2 will produce one mole of HCl . T 1:1 mol ratio~~

e) * 16 g of CH_4 will react fully with 141.8 g of Cl_2 . F

$(1 \text{ mol CH}_4 + 4 \text{ mol Cl}_2)$
need 4 mol to fully react



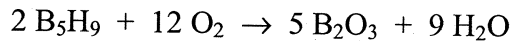
18. Gallium and sulfur react to form Ga_2S_3 . A 4.00 g sample of gallium is reacted with 3.00 g of sulfur. What mass of what substance remains unreacted? (Atomic weights: Ga = 69.729, S = 32.06)

- a) 0.35 g Ga b) 0.64 g Ga c) 1.77 g S **d) * 0.24 g S** e) 1.16 g S

LR \rightarrow $4.00\text{g Ga} \times \frac{1\text{mol Ga}}{69.729\text{g}} \times \frac{1\text{mol Ga}_2\text{S}_3}{2\text{mol Ga}} = 0.0287\text{mol Ga}_2\text{S}_3$ $0.03124\text{mol} \rightarrow 0.0287\text{mol}$

$3.00\text{g S} \times \frac{1\text{mol S}}{32.015} \times \frac{1\text{mol Ga}_2\text{S}_3}{3\text{mol S}} = 0.03124\text{mol Ga}_2\text{S}_3$ $0.0287\text{mol Ga}_2\text{S}_3 \times \frac{3\text{mol S}}{1\text{mol Ga}_2\text{S}_3} \times \frac{32.015\text{g}}{1\text{mol S}} = 2.76\text{g}$

19. The mass of B_2O_3 produced by the reaction of 4.00 g of B_5H_9 and 10.00 g of O_2 is 8.32 g. What is the percent yield? (Atomic weights: B = 10.81, O = 16.00, H = 1.008)



a) * 91.7 b) 92.8 c) 93.5 d) 88.6 e) 87.2

$4.00\text{g B}_5\text{H}_9 \times \frac{1\text{mol B}_5\text{H}_9}{63.05\text{g}} \times \frac{5\text{mol B}_2\text{O}_3}{2\text{mol B}_5\text{H}_9} = 0.1586\text{mol}$ $10.00\text{g O}_2 \times \frac{1\text{mol O}_2}{32.0\text{g O}_2} \times \frac{5\text{mol B}_2\text{O}_3}{12\text{mol O}_2} = 0.1302\text{mol}$

$0.1302\text{mol B}_2\text{O}_3 \times \frac{69.62\text{g}}{1\text{mol B}_2\text{O}_3} = 9.06\text{g}$

$3.00\text{g} - 2.76\text{g} = 0.24\text{g}$

20. Which of the following sets below list only weak electrolytes?

- a) HCl, KCl b) HCl, $\text{HC}_2\text{H}_3\text{O}_2$, NH_3 , and KCl c) $\text{HC}_2\text{H}_3\text{O}_2$ and KCl

- d) * $\text{HC}_2\text{H}_3\text{O}_2$ and NH_3** e) HCl, $\text{HC}_2\text{H}_3\text{O}_2$, and KCl

21. Calculate the molarity of a solution of 2.12 g of KBr in 458 mL of solution. (Atomic weights: K = 39.10, Br = 79.90)

- a) * 3.89×10^{-2} b) 4.25×10^{-2} c) 5.99×10^{-2} d) 3.89×10^{-1} e) 4.25×10^{-1}

$2.12\text{g KBr} \times \frac{1\text{mol KBr}}{119.0\text{g}} = 0.0178\text{mol} / 0.458\text{L} = 3.89 \times 10^{-2}\text{M}$

22. A solution is prepared by dissolving 516.5 mg of oxalic acid ($\text{C}_2\text{H}_2\text{O}_4$) to make 100.0 mL of solution. A 10.00 mL portion is then diluted to 250.0 mL. What is the molarity of the final solution? (Atomic weights: C = 12.01, H = 1.008, O = 16.00)

- a) 5.737×10^{-2} b) 5.737 **c) * 2.295×10^{-3}** d) 2.295 e) 5.738×10^{-2}

$0.5165\text{g C}_2\text{H}_2\text{O}_4 \times \frac{1\text{mol C}_2\text{H}_2\text{O}_4}{90.0\text{g}} = 0.005739\text{mol C}_2\text{H}_2\text{O}_4 / 0.1000\text{L} = 0.05739\text{M/L}$

$0.05739\text{mol/L} \times 0.0100\text{L} = 0.0005739\text{mol} / 0.2500\text{L} = 2.295 \times 10^{-3}\text{M}$

$$0.225 \frac{\text{mol Ni(OH)}_2}{\cancel{\text{L}}} \times 0.075 \text{ L} = 0.0016875 \text{ mol Ni(OH)}_2 \times \frac{2 \text{ mol Ni}^{2+}}{1 \text{ mol Ni(OH)}_2} = 0.003375 \text{ mol Ni}^{2+}$$

23. What volume, in mL, of 0.150 M NaOH is required to precipitate all of the nickel(II) from 75.0 mL of 0.225 M Ni(OH)₂? ~~should be NO₃⁻~~

(Atomic weights: Ni = 58.70, Na = 22.99, O = 16.00, H = 1.008)

We need
0.0016875 x 2 mol
of OH⁻

Full credit given for #23

- a) 150 b) 15.0 c) 500 d) 22.5 e)* 225

0.003375 mol OH⁻

24. Which of the following has the greatest number of oxygen atoms?

a) 152 g Cr₂O₃ 152g/mol 152g Cr₂O₃ x $\frac{1 \text{ mol}}{152 \text{ g}}$ x $\frac{3 \text{ mol O}}{1 \text{ mol Cr}_2\text{O}_3}$ = 3 mol O

b) 152 g SnO₂ 150.7g/mol

c) 25.0 mL of 3.0 M copper(II) nitrate $\frac{3.0 \text{ mol}}{\cancel{\text{L}}} \times 0.025 \text{ L} = 0.075 \text{ mol Cu(NO}_3)_2 \times \frac{7 \text{ mol O}}{1 \text{ mol}}$

d) 25.0 mL of 3.0 M lithium nitrate LiNO₃

$\times \frac{3 \text{ mol O}}{1 \text{ mol NO}_3} = 0.45 \text{ mol O}$

e) both c) and d) have the same number of oxygen atoms

25. Which of the following reactants will be capable of oxidizing copper metal to Cu²⁺ ions?

- a) NaCl solution
b) HCl solution
c) AgNO₃ solution*
d) ZnCl₂ solution
e) Both (b) HCl and (c) AgNO₃ solutions

must be below Cu in activity series

$$2.885 \text{ g M} \times \frac{1 \text{ mol M}}{\cancel{x}} \times \frac{1 \text{ mol M}_2\text{O}_3}{2 \text{ mol M}} \times \frac{(2x + 48)}{1 \text{ mol M}_2\text{O}_3} = 3.365 \text{ g}$$

$$2.885(2x + 48) = 3.365(2x)$$

$$5.77x + 138.48 = 6.73x$$

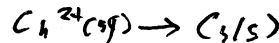
$$138.48 = 0.96x$$

x = 144g

26. A 2.885 g sample of a metal reacts completely with oxygen to yield 3.365 g of a metal oxide M₂O₃. What is the atomic weight of M? (Atomic weight: O = 16.00)

- a) 138.9 b)* 144.2 c) 150.4 d) 158.9 e) 64.1

27. An unknown metal is placed in a solution of copper(II) sulfate and copper is plated onto the surface of the metal according to the reaction: X(s) + CuSO₄(aq) → XSO₄(aq) + Cu(s), but when the same metal is put into a solution of NaCl, nothing happened. Which of the following metals could be "X"?



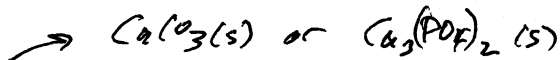
↳ must be above Cu in Activity series

↳ must be below Na in Activity series

- a. cobalt b. calcium c. silver d. potassium e. lithium

a. cobalt

28. If you take an ionic compound, dissolve it into water, and then carry out the following steps:



I. Add 50 mL of 2.0 M $\text{Ca}(\text{NO}_3)_2$ solution. This produces a white precipitate.

II. Next add 50 mL of 2.0 M HCl solution. This causes the precipitate to dissolve and produces a lot of bubbles, but no apparent odor

Which of the following anions (from the original ionic compound) would be consistent with these results.

a) OH^- $\text{Ca}(\text{OH})_2$ soluble

b) SO_4^{2-} CaSO_4 soluble

c) S^{2-} CaS soluble

d) CO_3^{2-} $\text{CaCO}_3(s)$ } add HCl

acid + carbonate \Rightarrow gas formation ✓
acid + phosphate \Rightarrow no gas

e) PO_4^{3-} $\text{Ca}_3(\text{PO}_4)_2(s)$

29. Thiophene contains only the elements, carbon, hydrogen and sulfur. A sample weighing 7.96 g was burned in oxygen to give 16.65 g CO_2 and 3.40 g of H_2O . What is the empirical formula of thiophene?

$16.65 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44 \text{ g CO}_2} \times \frac{1 \text{ mol C}}{1 \text{ mol CO}_2} = 0.378 \text{ mol C} \times \frac{12 \text{ g}}{1 \text{ mol C}} = 4.54 \text{ g}$

$3.40 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18 \text{ g H}_2\text{O}} \times \frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} \times \frac{1 \text{ g}}{1 \text{ mol H}} = 0.378 \text{ mol H} = 0.378 \text{ g H}$

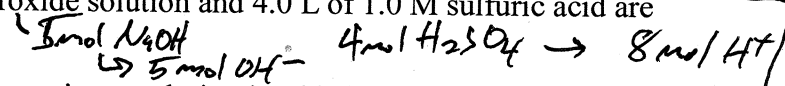
$7.96 \text{ g} - 4.54 \text{ g} - 0.378 \text{ g} = 3.04 \text{ g S}$

$\frac{3.04 \text{ g S}}{32 \text{ g S}} = 0.09506 \text{ mol S}$

$\frac{0.378}{0.09506} = 4$

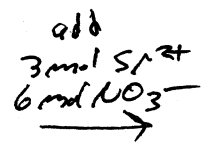
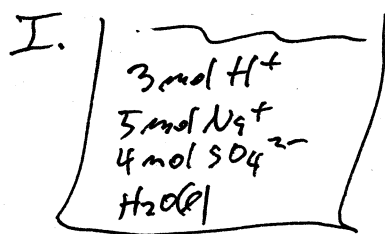
30. What would be the outcome of the following two steps:

I. 5.0 L of 1.0 M sodium hydroxide solution and 4.0 L of 1.0 M sulfuric acid are mixed in beaker A.



II. Next 3.0 L of 1.0 M strontium nitrate solution is added to beaker A.

- a) No precipitate will form and the solution will be acidic
- b) No precipitate will form and the solution will be basic
- c) A precipitate will form and the solution will be acidic
- d) A precipitate will form and the solution will be basic
- e) A precipitate will form and the solution will be neutral



SrSO_4 will form ppt
 H^+ present \rightarrow acidic



$\frac{0.378}{0.09506} = 4$