

Part 1. Multiple Choice. Circle the one alternative that best completes the statement or answers the question.

1. Which of the following is soluble in water? (2 pts.)

- a) BaSO₄ b) AgCl ***c) KOH** d) Fe(OH)₃ e) PbSO₄ f) PbBr₂

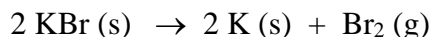
2. Which of the following is insoluble in water? (2 pts.)

- a) Fe(NO₃)₃ b) BaCl₂ c) Ba(OH)₂ ***d) CaCO₃** e) Li₂S f) NaBr

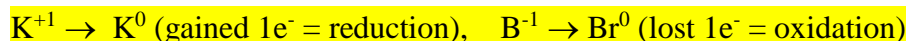
3. Reduction is defined as: (2 pts.)

- a) loss of electrons ***b) gain of electrons** c) loss of H d) gain of H e) loss of O

4. Is the following an Oxidation-Reduction reaction, and if so, what element is oxidized? (2 pts.)



- a) K ***b) Br** c) Br₂ d) KBr e) This is not an oxidation-reduction reaction.



PART 2. FILL IN THE BLANK or Short Answer or Calculations (MUST SHOW ALL WORK with units and correct significant figures).

5. What is the mass of 0.348 moles of calcium? (3 pts.)

$$0.348 \text{ mol Ca} \left(\frac{40.078 \text{ g}}{1 \text{ mole Ca}} \right) = 13.9 \text{ g}$$

6. How many moles of zinc are in 43.0 g of zinc? (3 pts.)

$$43.0 \text{ g Zn} \left(\frac{1 \text{ mole Zn}}{65.39 \text{ g}} \right) = 0.658 \text{ mol Zn}$$

7. How many copper atoms are in 8.79 moles of copper? (2 pts.)

$$8.79 \text{ mole Cu} \left(\frac{6.022 \times 10^{23} \text{ Cu atoms}}{1 \text{ mole Cu}} \right) = 5.29 \times 10^{24} \text{ Cu atoms}$$

8. How many copper atoms are in 34.9 g of copper? (4 pts.)

$$34.9 \text{ g Cu} \left(\frac{1 \text{ mol Cu}}{63.546 \text{ g}} \right) \left(\frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mole Cu}} \right) = 3.31 \times 10^{23} \text{ Cu atoms}$$

9. What is the molar mass of magnesium nitrate, $\text{Mg}(\text{NO}_3)_2$? Report answer to 5 significant figures. (4 pts.)

$$= 1(\text{Mg atom}) + 2(\text{N atoms}) + 6(\text{O atoms}) = 24.3050 \text{ g/mol} + 2(14.0067 \text{ g/mol}) + 6(15.9994 \text{ g/mol}) =$$

$$148.3148 = 148.31 \text{ g/mole}$$

10. What is the mass of 0.477 moles of magnesium nitrate? (4 pts.)

$$0.477 \text{ mol} \left(\frac{148.3148 \text{ g}}{1 \text{ mol}} \right) = 70.7 \text{ g} \quad \text{molar mass from problem \#9 above}$$

11. What is the percent by mass composition of oxygen in magnesium nitrate? Report answer to 4 significant figures. (4 pts.)

$$\frac{6(\text{molar mass of O})}{\text{molar mass of Mg}(\text{NO}_3)_2} \times 100 = \frac{6(15.9994 \text{ g/mol})}{148.3148 \text{ g/mol}} \times 100 = 64.72\%$$

Molar mass of magnesium nitrate from problem #9 above.

12. How many moles of iron (III) chlorate, $\text{Fe}(\text{ClO}_3)_3$, are in 273 g of iron (III) chlorate? (4 pts.)

$$\begin{aligned} \text{Molar mass of compound} &= 1(\text{Fe atom}) + 3(\text{Cl atoms}) + 9(\text{O atoms}) = \\ &= 55.845\text{g/mol} + 3(35.453\text{g/mol}) + 9(15.9994\text{g/mol}) = 306.1986 \text{ g/mole} \end{aligned}$$

$$273 \text{ g} \left(\frac{1 \text{ mole Fe}(\text{ClO}_3)_3}{306.1986 \text{ g}} \right) = 0.892 \text{ mole}$$

13. How many moles of carbon are in 3.28 moles of C_3H_8 ? (2 pts.)

$$3.28 \text{ mol C}_3\text{H}_8 \left(\frac{3 \text{ mol C}}{1 \text{ mole C}_3\text{H}_8} \right) = 9.84 \text{ mol C}$$

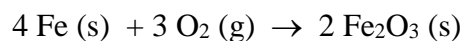
14. How many carbon atoms are in 3.28 moles of C_3H_8 ? (4 pts.)

$$3.28 \text{ mol C}_3\text{H}_8 \left(\frac{3 \text{ mol C}}{1 \text{ mol C}_3\text{H}_8} \right) \left(\frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol C}} \right) = 5.93 \times 10^{24} \text{ C atoms}$$

15. How many carbon atoms are in 47.2 g of C_3H_8 ? (5 pts.)

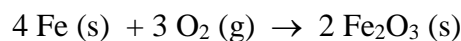
$$47.2 \text{ g C}_3\text{H}_8 \left(\frac{1 \text{ mol C}_3\text{H}_8}{44.09652 \text{ g}} \right) \left(\frac{3 \text{ mol C}}{1 \text{ mol C}_3\text{H}_8} \right) \left(\frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol C}} \right) = 1.93 \times 10^{24} \text{ C atoms}$$

16. How many moles of O₂ react with 6.21 moles of iron? (2 pts.)



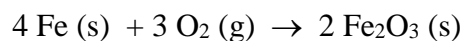
$$6.21 \text{ mol Fe} \left(\frac{3 \text{ mol O}_2}{4 \text{ mol Fe}} \right) = 4.66 \text{ mol O}_2$$

17. How many moles of Fe₂O₃ are produced when 6.21 moles of iron react? (2 pts.)



$$6.21 \text{ mol Fe} \left(\frac{2 \text{ mol Fe}_2\text{O}_3}{4 \text{ mol Fe}} \right) = 3.11 \text{ mol Fe}_2\text{O}_3$$

18. How many moles of Fe₂O₃ are produced when 39.7 g of iron react? (4 pts.)



$$39.7 \text{ g Fe} \left(\frac{1 \text{ mol Fe}}{55.845 \text{ g}} \right) \left(\frac{2 \text{ mol Fe}_2\text{O}_3}{4 \text{ mol Fe}} \right) = 0.355 \text{ mol Fe}_2\text{O}_3$$

19. A compound with the empirical formula CH₂ was found to have a molar mass of approximately 84 g/mole. What is the molecular formula of the compound? (5 pts.)

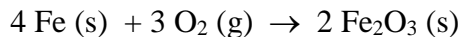
one method:

another method:

$\frac{\text{actual molar mass}}{\text{molar mass of empirical formula}} = X$	possible chemical formulas	molar mass
$\frac{84 \text{ g/mole}}{14.02688 \text{ g/mole}} = 5.9885 \cong 6 = X$	CH ₂	14.1 g/mol
	emp.for. *2 = C ₂ H ₄	28.2 "
	" *3 = C ₃ H ₆	42.3 "
	"*4 = C ₄ H ₈	56.4 "
	"*5 = C ₅ H ₁₀	70.5 "
	"*6 = C ₆ H ₁₂	84.6 "
actual chemical formula = X (empirical formula)		
= 6 * (CH ₂) = C ₆ H ₁₂		
	last one matches molar mass, 84.6 ≈ 84, so actual chemical formula is C ₆ H ₁₂	

Please circle answers. (I can't do that in Word.)

20. If we want to produce 73.0 g of iron (III) oxide, (a) how many moles of iron do we need to react, and (b) how many grams of iron do we need to react? (6 pts.)

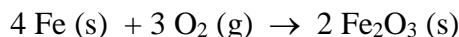


$$(a) \quad 73.0 \text{ g Fe}_2\text{O}_3 \left(\frac{1 \text{ mol Fe}_2\text{O}_3}{159.6882 \text{ g}} \right) \left(\frac{4 \text{ mol Fe}}{2 \text{ mole Fe}_2\text{O}_3} \right) = 0.914 \text{ mol Fe}$$

$$(b) \quad 73.0 \text{ g Fe}_2\text{O}_3 \left(\frac{1 \text{ mol Fe}_2\text{O}_3}{159.6882 \text{ g}} \right) \left(\frac{4 \text{ mol Fe}}{2 \text{ mole Fe}_2\text{O}_3} \right) \left(\frac{55.845 \text{ g}}{1 \text{ mole Fe}} \right) = 51.1 \text{ g Fe}$$

For Part (b), you can just show the answer from Part (a) times the 3rd step above = answer. Just remember to not round the answer from part (a) when you are calculating part (b). When you give the answer to part (a) be sure to give it in the correct number of significant figures.

21. If 15.7 g of iron reacts and 18.3 g of iron (III) oxide are produced in lab, what is the percent yield? (7 pts.)



$$15.7 \text{ g Fe} \left(\frac{1 \text{ mole Fe}}{55.845 \text{ g}} \right) \left(\frac{2 \text{ mole Fe}_2\text{O}_3}{4 \text{ mol Fe}} \right) \left(\frac{159.6882 \text{ g}}{1 \text{ mol Fe}_2\text{O}_3} \right) = 22.44699 \text{ g Fe}_2\text{O}_3 = \text{theoretical yield}$$

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100 = \frac{18.3 \text{ g}}{22.44699 \text{ g}} = 81.5\%$$

22. What is the empirical formula of a compound that contains 82.66% carbon and 17.34% hydrogen by mass? (6 pts.)

1) Assume a 100.0 g sample, so you have 82.66 g and 17.34 g.

2) Convert grams to moles.

$$82.66 \text{ g C} \left(\frac{1 \text{ mole C}}{12.011 \text{ g}} \right) = 6.882 \text{ mol C}$$

$$17.34 \text{ g H} \left(\frac{1 \text{ mole H}}{1.00794 \text{ g}} \right) = 17.203 \text{ mol H}$$

3) Divide by the smallest number of moles to get a ratio of moles (and to get larger numbers versus fractions).

$$\frac{17.20 \text{ mol H}}{6.882 \text{ mol C}} = \frac{2.499 \text{ mol H}}{1 \text{ mol C}}$$

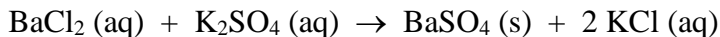
4) Find a whole number ratio (we can't have 2.5 H atoms). Guideline is that you can round to a whole number only if it is within 0.1 of a whole number.

$$\frac{2.499 \text{ mol H}}{1 \text{ mol C}} \times \frac{2}{2} = \frac{4.998}{2} \approx \frac{5 \text{ mol H}}{2 \text{ mol C}}$$

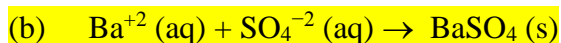
5) Write the empirical formula in proper format.

empirical formula = C_2H_5

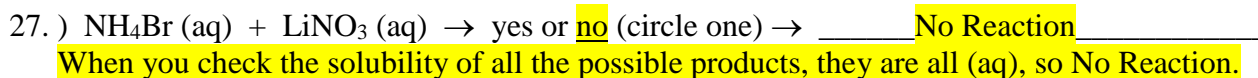
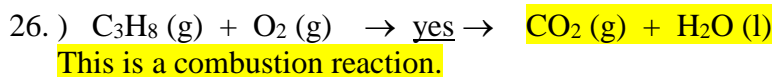
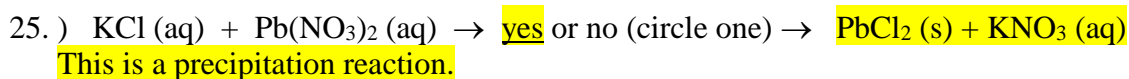
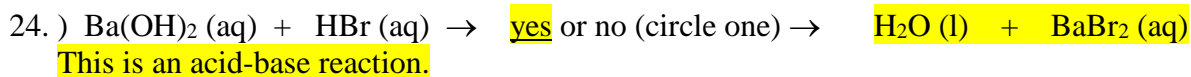
23. For the following reaction, (a) write the balanced, complete ionic equation (5pts.), (b) write the balanced net ionic equation (3 pts.), and (c) list or circle the spectator ions (2 pts.).



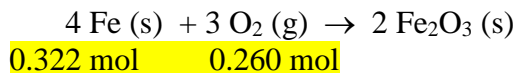
or underline spectator ions



PART 3. Do the following reactions occur, and if so, what are the products? (If you say No Reaction, cross off any products.) [You do NOT need to balance the reactions.] (2-3 pts. each)
I can't circle in Word so I will underline.

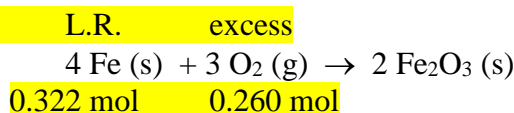


28. If 0.322 moles of iron reacts with 0.260 moles of oxygen gas, (a) what is the limiting reactant? Must show work and explain. (b) How many moles of iron (III) oxide are produced? MUST show work. (9 pts.)



(a) To find the Limiting Reactant, answer the question: If we use all of Reactant #1, how much of Reactant #2 do we need?

$0.322 \text{ mol Fe} \left(\frac{3 \text{ mol O}_2}{4 \text{ mol Fe}} \right) = 0.2415 \text{ mol O}_2$, we only need 0.2415 mol of O_2 to react with all of the Fe. We have more than this, we have 0.260 mol O_2 . So, if we reacted all of the Fe, we would only use 0.2415 mol of O_2 and then we would have some O_2 leftover. There, the O_2 is the excess reactant and Fe is the limiting reactant. I then go back and write L.R. and excess over the appropriate reactant:



(b) Always start a calculation with a number you know. We know that we used all of the Limiting Reactant (by definition).

L.R.

$$0.322 \text{ mol Fe} \left(\frac{2 \text{ mole Fe}_2\text{O}_3}{4 \text{ mol Fe}} \right) = \underline{0.161 \text{ mol Fe}_2\text{O}_3 \text{ are produced}}$$