N28 - Limiting Reagents → when you run out of one reactant too soon, and have some of the other reactant left over.

Limiting Reagent	Excess Reagent
(LR) the one you run out of too soon	(XS) the one you have left over

ALL ABOUT MOLE RATIOS! "THE KEY TO STOICHIOMETRY!"

Suggestions

① Label EVERYTHING!
- Formulas, units, "@ start", "made", "have", "need", "left"

② use lots of space!

③ moles, moles, moles... the key!

④ one part of the Q at the time... don't get overwhelmed

STEPS

① grams to moles for reactants

② check mole ratios
(NEEDED (coefficients in balanced eq.)) v.s (ACTUAL (answers to step #1))

③ Identify LR & XS
(look @ Answer to step #2)

④ Finding amount of product made
(Dimensional Analysis using moles of LR)

⑤ Finding amount of XS left over
- 1ST Find moles of XS used
  mol LR @ start + mol ratio $\frac{XS}{LR}$
- 2ND Subtract
  mol XS @ start − mol XS used = mol XS left

⑥ convert answer to step #5 to desired unit if not moles (grams is common)

Summary

- FINDING LIMITING } STEPS 1, 2, 3
- AMOUNT PRODUCT MADE } STEP 4
- AMOUNT XS LEFT OVER } STEPS 5, 6

$2Cu + Cl_2 \rightarrow 2CuCl$

150g 50g

QS

(A) Which is XS, which is LR
(B) How many g of product(s) made
(C) How many mol XS left?
(D) How many g XS left?

(A) STEP (1)

$$\frac{150\text{g Cu} \mid 1\text{ mol Cu}}{63.55\text{g Cu}} = 2.36\text{ mol Cu @ START}$$

$$\frac{50\text{g Cl}_2 \mid 1\text{mol Cl}_2}{70.91\text{g Cl}_2} = 0.71\text{ mol Cl}_2\text{ @ START}$$

STEP (2)

TRICK: $\frac{\text{Big Coefficient}}{\text{small Coefficient}} \rightarrow$ Reduce to $\frac{X\text{ mol}}{1\text{ mol}}$ (1 mol on bottom) (Just use calculator)

NEED: $\frac{2\text{ mol Cu}}{1\text{ mol Cl}_2}$ HAVE: $\frac{2.36\text{ mol Cu}}{0.71\text{ mol Cl}_2}$

$$\frac{2.36\text{ mol Cu}}{0.71\text{ mol Cl}_2} \rightarrow \frac{3.32\text{ mol Cu}}{1\text{ mol Cl}_2}$$

STEP (3) Top # is bigger! We have extra! **Cu = XS, Cl_2 = LR**

(B) STEP (4) USE LR AS KNOWN VALUE!

$$\frac{0.71\text{ mol Cl}_2 \mid 2\text{ mol CuCl} \mid 99\text{ g CuCl}}{1\text{ mol Cl}_2 \mid 1\text{ mol CuCl}} = 140.58\text{ g CuCl MADE}$$

(C) STEP (5) 1ST find XS used 2ND subtract

$$\frac{0.71\text{ mol Cl}_2 \mid 2\text{ mol Cu}}{1\text{ mol Cl}_2} = 1.42\text{ mol Cu USED}$$

2.36 mol @ START
− 1.42 mol used
0.94 mol Cu LEFT

(D) STEP (6)

$$\frac{0.94\text{ mol Cu} \mid 63.55\text{g Cu}}{1\text{mol Cu}} = 59.74\text{ g Cu LEFT}$$

(IF it only asked for grams of XS left over & not moles, you can combine step 5 & 6 into one dimensional analysis set up)

$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

2.32g 6.34g

Step ①

$$\frac{2.32\text{ g Fe}}{55.85\text{ g Fe}} \left| \frac{1\text{ mol Fe}}{} \right. = 0.0415 \text{ mol Fe @ START}$$

$$\frac{6.34\text{ g } O_2}{32\text{ g } O_2} \left| \frac{1\text{ mol } O_2}{} \right. = 0.198 \text{ mol } O_2 \text{ @ START}$$

Step ② NEED:

$$\frac{4\text{ mol Fe}}{3\text{ mol } O_2} \rightarrow \frac{1.33\text{ mol Fe}}{1\text{ mol } O_2}$$

HAVE:

$$\frac{0.0415\text{ mol Fe}}{0.198\text{ mol } O_2} \rightarrow \frac{0.21\text{ mol Fe}}{1\text{ mol } O_2}$$

Step ③ Top is too small! We dont have enough!

$Fe = LR$

$O_2 = XS$

Step ④

$$\frac{0.0415\text{ mol Fe}}{4\text{ mol Fe}} \left| \frac{2\text{ mol } Fe_2O_3}{1\text{ mol } Fe_2O_3} \right| \frac{159.7\text{ g } Fe_2O_3}{} = 3.314\text{ g } Fe_2O_3 \text{ made}$$

Step ⑤

$$\frac{0.0415\text{ mol Fe}}{4\text{ mol Fe}} \left| \frac{3\text{ mol } O_2}{} \right. = 0.0311 \text{ mol } O_2 \text{ USED}$$

$0.198\text{ mol } O_2$ @ START

$- 0.0311\text{ mol } O_2$ USED

$0.167\text{ mol } O_2$ LEFT

Step ⑥

$$\frac{0.167\text{ mol } O_2}{1\text{ mol } O_2} \left| \frac{32\text{ g } O_2}{} \right. = 5.34\text{ g } O_2 \text{ LEFT}$$