Note: 1 mole of any gas = 22.4 L of Volume at STP

IN THE FOLLOWING PROBLEMS DETERMINE THE FOLLOWING:
- BALANCE REACTION
- ANSWER ? IN CORRECT UNITS
- DETERMINE LIMITING REAGENTS
- DETERMINE AMOUNT OF EXCESS

*Convert to moles to use ISE

Balance first →

① Convert to moles - fill in ISE

$30g/mol$ $32g/mol$ $44g/mol$ $18g/mol$

1. $2\,C_2H_6(aq) + 7\,O_2(g) \rightarrow 4\,CO_2(g) + 6\,H_2O(g)$
   12.5g   38.9g   ?
                        LITERS

$12.5g\,C_2H_6 \dfrac{1\,mol}{30g} = 0.42\,mol\,C_2H_6$

$38.9g\,O_2 \dfrac{1\,mol}{32g} = 1.2\,mol\,O_2$

			put in ISE
I	0.42	1.2	
S	-0.34	-1.2	+0.69
E	0.08	0	0.69

LR ↓

② Find LR
$\dfrac{0.42\,mol\,C_2H_6}{} \dfrac{4\,CO_2}{2\,C_2H_6} = 0.84\,mol\,CO_2$

$\dfrac{1.2\,mol\,O_2}{} \dfrac{4\,CO_2}{7\,O_2} = 0.69\,mol\,CO_2$ put in ISE
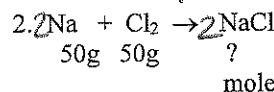
③ Find excess (based on LR)
$\dfrac{1.2\,mol\,O_2}{} \dfrac{2\,C_2H_6}{7\,O_2} = 0.34\,mol\,C_2H_6$

Excess $0.08\,C_2H_6$

④ Find L of CO_2
$\dfrac{0.69\,mol\,CO_2}{} \dfrac{22.4\,L}{1\,mol\,CO_2} = 15.4\,L\,CO_2$

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2. $2\,Na + Cl_2 \rightarrow 2\,NaCl$
   50g   50g   ?
                  moles

$\dfrac{50g\,Na}{} \dfrac{1\,mol}{23g} = 2.2\,mol\,Na$

$\dfrac{50g\,Cl_2}{} \dfrac{1\,mol}{71g} = 0.70\,g\,Cl_2$

I	2.2	0.70
S	-1.4	-0.7	+1.4
E	0.8	0	1.4

↑ excess
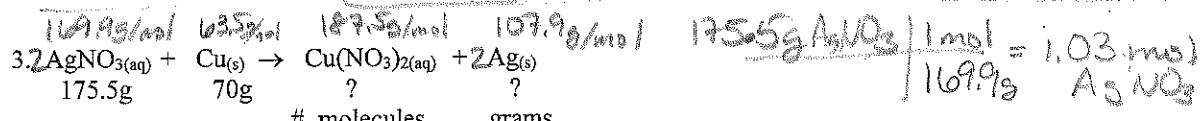
$\dfrac{2.2\,mol\,Na}{} \dfrac{2\,NaCl}{2\,Na} = 2.2\,mol\,NaCl$

$\dfrac{0.7\,mol\,Cl_2}{} \dfrac{2\,NaCl}{1\,Cl_2} = 1.4\,mol\,NaCl$ LR   put in ISE

$\dfrac{0.8\,mol\,Na}{} \dfrac{23g}{1\,mol} = 18.4g\,Na$ excess

Cl_2 is LR

product? 1.4 mol NaCl

$169g/mol$ $63.5g/mol$ $187.5g/mol$ $107.9g/mol$

3. $2\,AgNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + 2\,Ag(s)$
   175.5g   70g   ?   ?
                         # molecules   grams

$\dfrac{175.5g\,AgNO_3}{} \dfrac{1\,mol}{169.9g} = 1.03\,mol\,AgNO_3$

I	1.03	1.10		
S	-1.03	-0.52	+0.52	+1.03
E	0	0.58	0.52	1.03

EXCESS 0.58 mol Cu
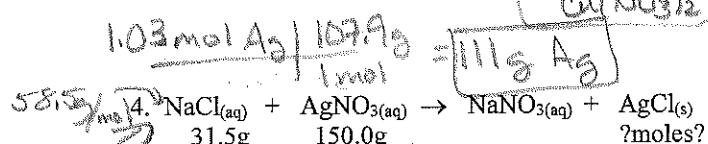
$\dfrac{70g\,Cu}{} \dfrac{1\,mol}{63.5g} = 1.10\,mol\,Cu$ LR

$\dfrac{1.03\,mol\,AgNO_3}{} \dfrac{1\,Cu(NO_3)_2}{2\,AgNO_3} = 0.52\,mol\,Cu(NO_3)_2$ ↑ put in ISE

$\dfrac{0.52\,mol\,Cu(NO_3)_2}{} \dfrac{6.022\times10^{23}}{1\,mol} = 3.1E23$ molecules $Cu(NO_3)_2$

$\dfrac{1.10\,mol\,Cu}{} \dfrac{1\,Cu(NO_3)_2}{1\,Cu} = 1.10\,mol\,Cu(NO_3)_2$

$\dfrac{1.03\,mol\,Ag}{} \dfrac{107.9g}{1\,mol} = 111g\,Ag$

$58.5g/mol$

4. $NaCl(aq) + AgNO_3(aq) \rightarrow NaNO_3(aq) + AgCl(s)$
   31.5g   150.0g   ?moles?

LR

I	0.538	0.883		
S	-0.538	-0.538	+0.538	+0.538
E	0	0.345	0.538	0.538
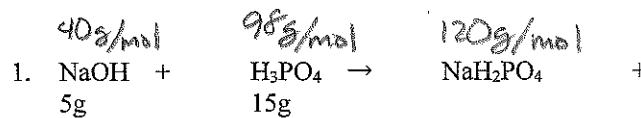
excess 0.345 moles $AgNO_3$

$\dfrac{31.5g\,NaCl}{} \dfrac{1\,mol}{58.5g} = 0.538\,mol\,NaCl$

$\dfrac{150g\,AgNO_3}{} \dfrac{1\,mol}{169.9g} = 0.883\,mol\,AgNO_3$

$0.538\,mol\,AgCl$

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- DETERMINE AMOUNT OF EXCESS IN GRAMS

$$\frac{5g \ NaOH}{} \Big| \frac{1 \, mol}{40g} = 0.13 \ \frac{mol}{NaOH}$$

$$\frac{15g}{} \Big| \frac{1 \, mol}{98g} = 0.15 \ mol \ H_3PO_4$$

1.
40g/mol	98g/mol	120g/mol		18g/mol	
NaOH +	H_3PO_4 →	NaH_2PO_4	+	H_2O (Balanced)	
5g	15g			? Liters	

I	0.13	0.15	0	0
S	-0.13	-0.13	+0.13	+0.13
E	0	0.02	0.13	0.13

LR is NaOH

excess: $\frac{0.02 \, mol \ H_3PO_4}{} \Big| \frac{98g}{1 \, mol} = 1.96g \ H_3PO_4$

$$\frac{0.13 \, mol \ H_2O}{} \Big| \frac{22.4L}{1 \, mol} = \boxed{2.9 \ L \ H_2O}$$

2.
F_2 +	H_2 →	2 HF		
10g	50g	? (grams)		

$$\frac{10g \ F_2}{} \Big| \frac{1 \, mol}{38g} = 0.26 \ mol \ F_2 \qquad \frac{50g \ H_2}{} \Big| \frac{1 \, mol}{2g} = 25 \, mol \ H_2$$

I	0.26	25	0
S	-0.26	-0.26	+0.52
E	0	24.74	0.52

$$\frac{0.52 \, mol \ HF}{} \Big| \frac{20g}{1 \, mol} = \boxed{10.4 \ g \ HF}$$

LR = F_2 excess $\frac{24.74 \, mol \ H_2}{} \Big| \frac{2g}{} = \boxed{49.48g \ H_2 \ \text{excess}}$

3.
CO_2 +	2 NaOH →	CO_3^{2-} +	$H_2O_{(g)}$ +	2 Na^+
10g	10g	?	?	?
			Liters	# of ions

$$\frac{10g \ CO_2}{} \Big| \frac{1 \, mol}{44g} = 0.23 \ \frac{mol}{CO_2}$$

I	0.23	0.25	0	0	0
S	-0.125	-0.125	+0.125	+0.125	+0.25
E	0.105	0	0.125 mol	0.125	0.25

$$\frac{10g \ NaOH}{} \Big| \frac{1 \, mol}{40g} = 0.25 \, mol \ NaOH$$

LR is NaOH

$$\frac{0.105 \, mol \ CO_2}{} \Big| \frac{44g}{1 \, mol} = \boxed{4.62g \ CO_2} \quad \text{excess}$$

$$\frac{0.125 \, mol \ H_2O}{} \Big| \frac{22.4L}{1 \, mol} = \boxed{2.8L \ H_2O}$$

$$\frac{0.25 \, mol \ Na^+}{} \Big| \frac{6.022E23}{1 \, mol} = \boxed{1.5E23 \ Na^+}$$

4.
$NaHCO_3$ +	HCl →	NaCl +	$CO_{2(g)}$ +	H_2O (Balanced)
289.g	300g	?	?	
		Grams	Liters	

I	3.44	8.22	0	0	0
S	-3.44	-3.44	+3.44	+3.44	+3.44
E	0	4.78	3.44	3.44	3.44

$$\frac{289g \ NaHCO_3}{} \Big| \frac{1 \, mol}{84g} = 3.44 \qquad \frac{300g \ HCl}{} \Big| \frac{1 \, mol}{36.5g} = 8.22 \, mol \ HCl$$

LR is $NaHCO_3$

excess $\frac{4.78 \, mol \ HCl}{} \Big| \frac{36.5g}{1 \, mol} = \boxed{174g \ HCl}$

$$\frac{3.44 \, mol \ NaCl}{} \Big| \frac{58.5g}{1 \, mol} = \boxed{201g \ NaCl}$$

$$\frac{3.44 \, mol \ CO_2}{} \Big| \frac{22.4L}{1 \, mol} = \boxed{77.1L \ CO_2}$$