Name Key

Block ____ Date _____

Limiting Reagent Scenarios
Threat Level: Midnight

1) Oh no! Two tanker trucks just crashed head-on on I-90! One was carrying 1575kg of hydrochloric acid (HCl), while the other contained 3045 kg of fluorine. The city government needs to know how many grams of chlorine (mustard gas) the Madison area may be exposed to, stat!

$$2HCl(aq) + F_2(g) \rightarrow 2HF(aq) + Cl_2(g)$$

$1,575,000\ g\ HCl \left(\frac{1\ mol\ HCl}{36.46\ g}\right) = 43198\ mol\ HCl$ ★ Limiting

$3,045,000\ g\ F_2 \left(\frac{1\ mol\ F_2}{38.00\ g}\right) = 80132\ mol\ F_2$

HAVE

$43198\ mol\ HCl \left(\frac{1\ mol\ F_2}{2\ mol\ HCl}\right) = 21599\ mol\ F_2$

NEED

$43198\ mol\ HCl \left(\frac{1\ mol\ Cl_2}{2\ mol\ HCl}\right)\left(\frac{70.90\ g}{1\ mol\ Cl_2}\right) = 1,531,000\ g\ Cl_2$

2) Someone is trying to poison the local water supply! An anonymous phone call from the criminal revealed she dropped 1350 kg of sodium into the 5000.0 kg water supply. Lead researchers say the combination of sodium and water produces a violent explosion, along with a strong base sodium hydroxide! Toxic levels will be reached if 2500.0 kg of sodium hydroxide are created...are we safe?!?

$$2Na(s) + 2H_2O(\ell) \longrightarrow 2NaOH(aq) + H_2(g)$$

$1{,}350{,}000\ g\ Na \left(\frac{1\ mol\ Na}{22.98\ mol}\right) = 58{,}747\ mol\ Na$ ← limiting

$58747\ mol\ Na \left(\frac{2\ mol\ H_2O}{2\ mol\ Na}\right) = 58747\ mol\ H_2O$ NEED

$5{,}000{,}000\ g\ H_2O \left(\frac{1\ mol\ H_2O}{18.02\ g}\right) = 277{,}469\ mol\ H_2O$ HAVE

$58747\ mol\ Na \left(\frac{2\ mol\ NaOH}{2\ mol\ Na}\right)\left(\frac{40.00\ g}{1\ mol\ NaOH}\right) = 2{,}349{,}880\ g\ NaOH$

$2{,}349{,}880\ g\ NaOH \left(\frac{1\ kg}{1000\ g}\right) = 2349.88\ kg\ NaOH$

SAFE!

3) Quick MacGyver, an explosion at a local research facility has ruptured a tank containing 7500.0 g of sulfuric acid (H_2SO_4), which is now leaking and eating its way through the floor where 75 people are trapped in the level below. Scientists on site tried to neutralize the spill by reacting the acid with 14000.0 g of sodium hydroxide. By their calculations, the acid will be neutralized to a safe level if less than 300.0 g of H_2SO_4 remain…did they save the trapped researchers?

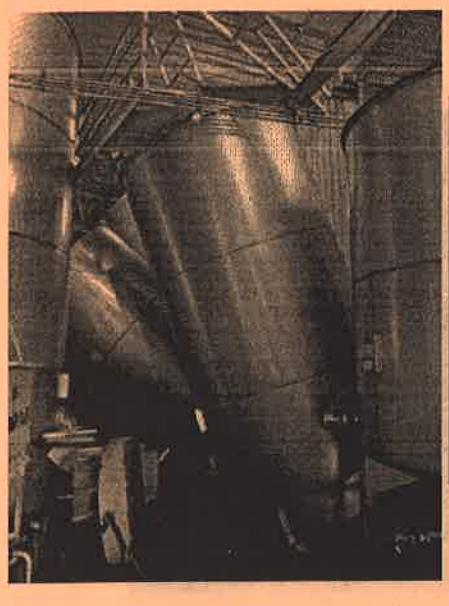
$$H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$$

$7500.0\ g\ H_2SO_4 \left(\frac{1\ mol\ H_2SO_4}{98.09\ g}\right) = 76.464\ mol\ H_2SO_4$ (#Limiting)

$76.464\ mol\ H_2SO_4 \left(\frac{2\ mol\ NaOH}{1\ mol\ H_2SO_4}\right) = 152.93\ mol\ NaOH$ NEED

$14000.0\ g\ NaOH \left(\frac{1\ mol\ NaOH}{40.00\ g}\right) = 350.00\ mol\ NaOH$ HAVE

H_2SO_4 was limiting & therefore all of it was used up (neutralized)



N	1	2
H	3	6
Na	1	1
Cl	1	1
O	1	1

4) Dad just tried to help out with the chores and while trying to make the "ultimate cleaning solution" as he put it, decided to mix 13.5g of ammonia cleaner and 14.9 g of bleach. Little did he know that ammonia (NH_3) and bleach (sodium hypochlorite) react to form water (whew...), sodium chloride (no problem...) and toxic/explosive hydrazine (N_2H_4) (CRIPES!). Hydrazine exposure is deadly if the equivalent of 12.0 g is inhaled...will Pops make it?

$$2NH_3(g) + NaClO(aq) \longrightarrow H_2O(l) + NaCl(aq) + N_2H_4(g)$$

$13.5\ g\ NH_3 \left(\frac{1\ mol\ NH_3}{17.03\ g}\right) = 0.793\ mol\ NH_3$

$14.9\ g\ NaClO \left(\frac{1\ mol\ NaClO}{74.44\ g}\right) = 0.200\ mol\ NaClO$ ← Limiting

HAVE

$0.793\ mol\ NH_3 \left(\frac{1\ mol\ NaClO}{2\ mol\ NH_3}\right) = 0.397\ mol\ NaClO$

NEED

$0.200\ mol\ NaClO \left(\frac{1\ mol\ N_2H_4}{1\ mol\ NaClO}\right)\left(\frac{32.05\ g}{1\ mol\ N_2H_4}\right) = 6.41\ g\ N_2H_4$

SAFE!