Worksheet 5.2: Solutions
Gas calculations

No.	Question	Answer
1	$m(H_2SO_4)$ = x 19.56 = 19.2 g $n(H_2SO_4) = \frac{m}{M} = \frac{19.2}{98.076} = 0.196$ mol $n(NH_3) = 2 \times n(H_2SO_4) = 2 \times 0.196 = 0.392$ mol $\therefore V(NH_3) = \frac{nRT}{P} = \frac{0.392 \times 8.314 \times 360.1}{310} = 3.8$ L	
2	At constant temperature and pressure, the mole ratio becomes a volume ratio. $\therefore$ 150 mL CO reacts with 75 mL of oxygen to produce 150 mL of CO_2. 75 mL of O_2 remains unreacted. No CO remains.	
3	$n(NaCl) = 500$ mol $n(Cl_2) = \frac{1}{2} \times n(NaCl) = 250$ mol $\therefore V(Cl_2) = n \times V_M = 250 \times 24.5 = 6.12 \times 10^3$ L	
4	$n(MgO) = \frac{m}{M} = \frac{100}{40.31} = 2.481$ mol $n(CO_2) = n(MgO) = 2.481$ mol $\therefore V(CO_2) = n \times V_M = 2.481 \times 22.41 = 55.6$ L	
5	**a** Lethal dose is 0.300 g of HCN in 1000 g of air $d(\text{air}) = 0.001\,18$ g mL$^{-1} = \frac{m(\text{air})}{V(\text{air})}$ V(1000 g of air) = $= 8.475 \times 10^5$ mL mass of HCN in 1 mL = $\frac{0.300}{8.475 \times 10^5} = 3.54 \times 10^{-7}$ g	
	b $n(NaCN) = \frac{m}{M} = \frac{8.80}{49.01} = 0.1796$ mol $n(H_2SO_4) = c \times V = 0.475 \times 0.100 = 0.04750$ mol 0.1796 mol of NaCN will react with 0.08980 mol of H_2SO_4; however, we only have 0.047 50 mol $\therefore H_2SO_4$ is the limiting reagent. $n(HCN) = 2 \times n(H_2SO_4) = 2 \times 0.047\,50 = 0.095\,00$ mol $V(HCN) = \frac{nRT}{P} = \frac{0.09500 \times 8.314 \times 293.1}{100} = 2.31$ L	
6	$d = \frac{PM}{RT} = \frac{750 \times 101.3 \times 28.02}{760 \times 8.314 \times 293.1} = 1.15$ g L^{-1}	
7	$M = \frac{mRT}{PV} = \frac{2.04 \times 8.314 \times 298.1}{101.3 \times 1.56} = 32.0$ g mol^{-1}	

8	$d = \frac{PM}{RT} = \frac{400 \times 28.01}{8.314 \times 289.1} = 4.7 \text{ g L}^{-1}$
9	$M = \frac{dRT}{P} = \frac{1.22 \times 8.314 \times 298.1}{101.3} = 29.8 \text{ g mol}^{-1}$ MF = C_nH_{2n+2} $\therefore 12n + 2n + 2 = 29.8$ $\therefore n = 2$ $\therefore$ MF = C_2H_6
10	N : H $= \frac{87.4}{14.01} : \frac{12.6}{1.008} = 6.238 : 12.50 \approx 1 : 2$ $\therefore$ EF is NH_2 $M = \frac{dRT}{P} = \frac{0.977 \times 8.314 \times 373.1}{0.93 \times 101.3} = 32.2 \text{ g mol}^{-1}$ Mass of EF = $14.0 + (2 \times 1.0) = 16$ Mass of MF = $32.2 \approx 16 \times 2$ $\therefore$ MF = $(NH_2)_2 = N_2H_4$