Answers to Exercise 7.5
More Stoichiometry Practice

1.	$CaCO_3(s)$	+	$2\ H^+(aq)$	→	$Ca^{2+}(aq)$	+	$H_2O(l)$	+	$CO_2(g)$
M	100.087 g/mol		1.0079 g/mol		40.078 g/mol		18.0152 g/mol		44.0098 g/mol
$c_{initial}$			1.65 mol/L						
$V_{initial}$			225 mL						
m_{inital}	25.5 g								
P									92.7 kPa
T									293.65 K
$n_{initial}$	0.255 mol		0.371 mol						0 mol
n_{change}	-0.186 mol		-0.371 mol						+0.186 mol
n_{final}	0.069 mol		0 mol						0.186 mol
V_{final}									0.00489 m^3 = 4.89 L

Step 1: Write a balanced chemical equation for the reaction

see above

Step 2: Organize all known information

see above; values in grey are not necessary for this calculation

Step 3: Calculate moles of $CaCO_3$ and H^+ ($n_{initial}$)

$$n_{CaCO_3-initial} = 25.5g \times \frac{1mol}{100.087g} = 0.255mol$$

$$n_{H^+-initial} = 225mL \times \frac{1L}{1000mL} \times \frac{1.65mol}{1L} = 0.371mol$$

Step 4: Identify the limiting reagent

2(0.255 mol) = 0.510 mol H^+ are required to react with 0.255 mol $CaCO_3$. Since there is less H^+ than this, the H^+ will run out before the $CaCO_3$. H^+ is therefore the limiting reagent.

Step 5: Use mole ratio to calculate moles of CO_2 produced (n_{final})

$$n_{CO_2} = 0.371\ mol\ H^+ \times \frac{1\ mol\ CO_2}{2\ mol\ H^+} = 0.186\ mol\ CO_2$$

Step 6: Calculate volume of CO_2 produced in m^3 (V_{final})

$$PV = nRT$$

$$V_{CO_2-final} = \frac{nRT}{P} = \frac{(0.186mol)\left(8.3145\frac{Pa\cdot m^3}{mol\cdot K}\right)(293.65K)}{(92.7kPa)} \times \frac{1kPa}{1000Pa} = 0.00489m^3$$

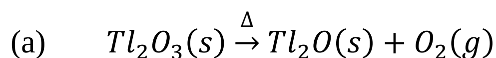
Step 7: Calculate volume of CO_2 produced in L (V_{final})

$$V_{CO_2-final} = 0.00489m^3 \times \frac{1000L}{1m^3} = 4.89L$$

Step 8: Check your work

Does your answer seem reasonable? Are sig. fig. correct?

2.



(a) $Tl_2O_3(s) \xrightarrow{\Delta} Tl_2O(s) + O_2(g)$

(b)	$Tl_2O_3(s)$	→	$Tl_2O(s)$	+	$O_2(g)$
M	456.764 g/mol		424.765 g/mol		31.9988 g/mol
V_{final}					1.6 L
P					88100 Pa
T					295.65 K
$n_{initial}$	0.057 mol		0 mol		0 mol
n_{change}	-0.057 mol		+0.057 mol		+0.057 mol
n_{final}	0 mol		0.057 mol		0.057 mol
$m_{initial}$	26 g				

Step 1: Write a balanced chemical equation for the reaction

see above

Step 2: Organize all known information

see above; values in grey are not necessary for this calculation

Step 3: Calculate moles of O_2 produced (n_{final})

$PV = nRT$

$$n_{O_2-final} = \frac{PV}{RT} = \frac{(88100Pa)(1.6L)}{\left(8.3145\frac{Pa\cdot m^3}{mol\cdot K}\right)(295.65K)} \times \frac{1m^3}{1000L} = 0.057mol$$

Step 4: Use mole ratio to calculate moles of Tl_2O_3 required for reaction ($n_{initial}$)

$$n_{Tl_2O_3-initial} = 0.057\ mol\ O_2 \times \frac{1\ mol\ Tl_2O_3}{1\ mol\ O_2} = 0.057\ mol\ Tl_2O_3$$

Step 5: Calculate mass of Tl_2O_3 required for reaction ($m_{initial}$)

$$m_{Tl_2O_3-initial} = 0.057\ mol\ Tl_2O_3 \times \frac{456.764g}{1\ mol} = 26\ g\ Tl_2O_3$$

Step 6: Check your work

Does your answer seem reasonable? Are sig. fig. correct?

The answer is less than 65 g (the maximum amount possible of Tl_2O_3 in the sample).