Determination of the Relative Atomic Mass of Lithium

Results

	Reacting Lithium with water
Mass of Lithium reacted	0.08g
Volume of Hydrogen collected	$131cm^3$

	Titration		
	Rough	**1**	**2**
Volume of LiOH	$25cm^3$	$25cm^3$	$25cm^3$
Volume of HCl required	$25.6cm^3$	$25.4cm^3$	$25.4cm^3$

Analysis

1.

$$2Li_{(s)} + 2H_20_{(l)} \longrightarrow 2LiOH_{(aq)} + H_{2(g)}$$

a) Finding the number of moles of Hydrogen:

To find the number of moles of Hydrogen, we use the values we have collected and place them into the ideal gas equation:

n = ?
$P = 1.01 \times 10^5$ Pa = 101 000 Pa
$V = 131cm^3 = 131 \times 10^{-6} m^3 = 0.000131m^3$
$R = 8.31\ J\ mol^{-1}\ K^{-1}$
T = 18°C = 291K

$$n = \frac{PV}{RT} = \frac{101\ 000 \times 0.000131}{8.31 \times 291} = \frac{13.231}{2418.21} = 0.00547 \text{ mol (3 s.f)}$$

b) Finding the number of moles of Lithium:

To find the number of moles of Lithium, we use the mole ratio found in the equation above:

Mole ratio Li : H_2 = 2 : 1

Therefore, n_{LiOH} = 2 x 0.00547 = 0.0109 mol

c) Finding the relative atomic mass of Lithium:

n = 0.0109 mol
m = 0.08g
A_r = ?

$n = \frac{m}{A_r}$ therefore $A_r = \frac{m}{n} = \frac{0.08}{0.0109} = 7.34$ (3 s.f.)

2.

a) $LiOH_{(aq)} + HCl_{(aq)} \longrightarrow LiCl_{(aq)} + H_2O_{(l)}$

b) Finding the number of moles of HCl:

To find the number of moles of HCl used in the titration, we use the values we have collected, and place them into the following equation:

$C = \frac{n}{V}$ therefore $n = CV$

C = 0.1M
$V = \frac{25.6 + 25.4 + 25.4}{3} = 25.47cm^3$ (2 d.p) = $0.02547dm^3$
n = ?

n = CV = 0.1 x 0.2547 = 0.002547 mol

c) Finding the number of moles of LiOH:

To find the number of moles of HCl, we use the mole ratio found in the equation above:

Mole ratio LiOH : HCl = 1 : 1

Therefore the number of moles of LiOH = 0.002547 mol

d) Finding the number of moles of LiOH in $100cm^3$:

In $25cm^3$ there are 0.002547 moles of LiOH. Therefore in $100cm^3$ there will be 0.002547 x 4 mol = 0.0102 mol (3 s.f)

e) Finding the relative atomic mass of Lithium:

To find the relative atomic mass of Lithium, we return to the original equation we used:

$$2Li_{(s)} + 2H_20_{(l)} \longrightarrow 2LiOH_{(aq)} + H_{2(g)}$$

By using the mole ratio Li : LiOH = 1 : 1, we determine that the number of moles of Li used is 0.0102 mol.

To find the relative atomic mass of Lithium, we use this value and the mass we have already collected and place them into the following equation:

$$n = \frac{m}{A_r} \quad \text{therefore} \quad A_r = \frac{m}{n} = \frac{0.08}{0.0102} = 7.84 \text{ (3 s.f)}$$

3. Estimating the percentage error:

Burette in method 1: maximum amount of distilled water used: 50.15 + 50.15 = 100.3
minimum amount of distilled water used: 49.85 + 49.85 = 99.7

Therefore maximum percentage error for the burette in method 1 = 3%

Balance in method 1 : maximum mass of lithium used: 0.09g
minimum mass of lithium used: 0.07g

Therefore maximum percentage error for the balance in method 1 = $\frac{0.01}{0.08} \times 100 = 12.5\%$

$250cm^3$ measuring cylinder in method 1: maximum amount of gas collected: $136cm^3$
minimum amount of gas collected: $126cm^3$

Therefore maximum percentage error for the measuring cylinder in method 1 = $\frac{5}{131} \times 100$
$= 3.8\%$

Pipette in method 2: maximum amount of LiOH used: $25.05cm^3$
minimum amount of LiOH used: $24.95cm^3$

Therefore maximum percentage error for the pipette in method 2 = $\frac{0.05}{25} \times 100 = 0.2\%$

Burette in method 2: maximum amount of HCl used: $\frac{25.75 + 25.55 + 25.55}{3} = 25.62$
Minimum amount of HCl used: $\frac{25.45 + 25.25 + 25.25}{3} = 25.32$

Therefore maximum percentage error of the Burette in method 2 = $\frac{0.15}{25.47} \times 100 = 0.59\%$

Balance from method 1 for method 2: 12.5%

Total maximum percentage error for method 1 = 3 + 12.5 + 3.8 = 19.3%

Total maximum percentage error for method 2 = 0.2 + 0.59 + 12.5 = 13.29%

Evaluation

1. Consistency of Titration results:

   All three of my titration results were consistent, and there were no anomalous results, with a difference of 0.2 between my rough titration and the other two experiments, which were the same.

   To calculate the average titre, I used all three of the results, including the rough titration and the two other titrations. No titres were ignored, as all of my results were concordant, and there were no anomalies.

2. Difference between results and accepted value:

   Method 1: Result = 7.34
   Accepted Value = 6.9
   Difference = 0.44

   Method 2: Result = 7.84
   Accepted Value = 6.9
   Difference = 0.94

   Differences as a percentage of the accepted value:

Method 1: $\frac{0.44}{6.9} \times 100 = 6.38\%$

Method 2: $\frac{0.94}{6.9} \times 100 = 13.62\%$

3. Magnitude of difference between accepted value and calculated value:

   For method 1, my result is 6.38% out from the accepted value. As the maximum percentage error for method 1 is calculated to be 19.3%, my result is within the boundaries of percentage error, and therefore we can say that it is fairly accurate, taking into account the error of the apparatus.

   For method 2, my result is 13.62% out from the accepted value. As the maximum percentage error for method 2 is calculated to be 13.29%, my result is just out of the boundary for percentage error. Therefore we can say that the method was fairly accurate, but was less accurate than method 1.

4. Looking at method and error:

   Although my method for both 1 and 2 were fairly accurate, there were errors that could have taken place. When filling the measuring cylinder with water, and inverting it into the water bath, a small 'bubble' of air appeared at the top. Although I took this into account when calculating the volume of gas collected, there could have been error, both from my reading and from the cylinder percentage.
   When using the burette, it was difficult to fill it exactly to the 'zero' mark, and so my measurements from the burette may have been slightly wrong. This is added to by the width of the meniscus, and the difficulty in having an accurate reading. Another possibly source of error is the time taken after adding the lithium to the water to replace the bung. Although I tried to limit this time, some lithium could have reacted and produced hydrogen gas before I managed to replace the bung. However, my method was very accurate, which is shown by the accuracy of my results.

5. Improvements to minimise sources of error:

   To minimise the error from using the measuring cylinder, I could use a gas syringe instead, which is more accurate, and would allow me to calculate a more accurate result for the volume of hydrogen produced. This would also discard the error involved with inverting the cylinder of water into the water bath, resulting in the bubble of air forming.
   It is difficult to minimise the sources of human error, such as the readings from the burette, or the time between adding the lithium and replacing the bung. However, by ensuring that I carry out the experiment as accurately and replacing the bung as swiftly as possible helps to minimise these errors.