Appendix 2: National 5 and Higher Simulated Peer-Assessment Activities

National 5 Chemistry Mole Calculations Activity

Students often find chemistry calculations one of the most difficult areas of the curriculum to master due to their complexity; similarly, teachers and exam markers often find them challenging to mark because student's solutions are rarely clear and easy to follow.

Instructions

In the following pages you will find a series of questions, along with a solution to each; however, the solution is incorrect. In your pairs, you are to read through the solution, locate the error(s), discuss how the error as occurred and then re-write the correct solution in your own way. Whilst you do this it is important that you discuss the good and bad features of each solution, such as how clear the layout is or how easy it is to follow the working, and try to improve your own solutions accordingly. Remember to ask your teacher for their opinions and to check your solutions.

Hopefully, by the end of the activity you will have increased your understanding of how to perform chemistry calculations and be able to write an easy to follow solution.

Q1 Calculate the mass of 2 moles of sodium chloride.

Formula: Na (1) Cl (1)

$$\text{Mass} = \frac{\text{GFM}}{\text{Moles}}$$

NaCl

Relative formula mass = 58.5

Gram FM = 58.5g

$$= \frac{58.5}{2} = 29.25\text{g}$$

Q2 Calculate the mass of 4 moles of CH_4.

RFM

element	C	H
number	1	4
relative atomic mass	12	1
total relative mass of each	12	4

RFM of CH_4 = 16

Sol

1 ⟷ 16 (÷4)

0.25 ⟷ 4 (÷4)

0.25g

Q3 Calculate the mass of 0.5 moles of calcium chloride.

$CaCl_2$ GFM of $CaCl_2$ is $40+35.5$

$= 75.5\,g$

1 mole $CaCl_2$ $\Leftrightarrow$ $75.5\,g$

0.5 moles $CaCl_2$ $\Leftrightarrow$ $\underline{\underline{15.1\,g}}$

Q4 Calculate the number of moles in 108 g of water.

Formula H_2O

GFM $18\,g$

1 mole $\longleftrightarrow$ $18\,g$

18 moles $\longleftrightarrow$ $1\,g$

$\underline{\underline{1944 \text{ moles}}}$ $\longleftrightarrow$ $108\,g$

Q5 Calculate the number of moles in 14 g of nitrogen.

RFM of nitrogen is 14

so GFM is 14g

therefore 1 mole is 14g

so answer is 1 mole.

Q6 Calculate the number of moles in 13.2 g of ammonium sulfate.

Formula NH_4SO_4

RFM is $[(14+1)\times4]+[(32+16)\times4]$

$= 60 + 196$

$= 156$

GFM is 156g

$48 \times 4 = 196$

so moles $= \frac{\text{GFM}}{\text{mass}}$

$= \frac{13.2}{156}$

$= 0.084$ moles

Q7 Calculate the mass of water produced upon burning 11.6 g of butane completely in oxygen. The balanced equation is provided below.

$$C_4H_{10} + \frac{13}{2} O_2 \rightarrow 4\ CO_2 + 5\ H_2O$$

1 mole C_4H_{10} $\longleftrightarrow$ 5 moles H_2O

11.6g $\longleftrightarrow$ 5×11.6g

= 58g

Q8 Lithium carbonate reacts with excess hydrochloric acid to form lithium chloride, carbon dioxide and water. If 10 g of lithium carbonate is produced, how much lithium carbonate was required? The balanced equation is provided below.

$$Li_2CO_3 + 2\ HCl \rightarrow 2\ LiCl + CO_2 + H_2O$$

$Li_2CO_3 + 2HCl \longrightarrow 2\ LiCl + CO_2 + H_2O$

mass ? 10 g

$$\text{moles} = \frac{\text{mass}}{F.M}$$

$$= \frac{10}{42.4}$$

$$= 0.24 \text{ moles}$$

1 mole $\longrightarrow$ 2 moles

0.24 moles $\longrightarrow$ 0.48 moles

$$\text{mass} = \text{moles} \times F.M$$

$$= 0.48 \times 73.8$$

$$= 35.4 \text{ g}$$

Q9 Butadiene is a molecule which contains two double bonds, this means it can participate in two addition reactions. The equation for the reaction of butadiene with hydrogen chloride is outlined below. What mass of butadiene is necessary to react with 3 moles of hydrogen chloride?

$$C_4H_6 + 2\,HCl \rightarrow C_4H_8Cl_2$$

C_4H_6 + 2 HCl ⟶ $C_4H_8Cl_2$

Mass? 3 moles

Mass = n × FM

= 3 × 36.5

= 109.5 g

1 ⟵ 2

54.75 ⟵ ÷2 109.5 g

Higher Chemistry Calculations Activity

Students often find chemistry calculations one of the most difficult areas of the curriculum to master due to their complexity; similarly, teachers and exam markers often find them challenging to mark because student's solutions are rarely clear and easy to follow.

Instructions

In the following pages you will find a series of questions, along with a solution to each; however, the solution is incorrect. In your pairs, you are to read through the solution, locate the error(s), discuss how the error as occurred and then re-write the correct solution in your own way. Whilst you do this it is important that you discuss the good and bad features of each solution, such as how clear the layout is or how easy it is to follow the working, and try to improve your own solutions accordingly. Remember to ask your teacher for their opinions and to check your solutions.

Hopefully, by the end of the activity you will have increased your understanding of how to perform chemistry calculations and be able to write an easy to follow solution.

Q1 2.7 g Aluminium reacts with 200 cm^3 of 2 $moll^{-1}$ hydrochloric acid according to the equation below. What mass of $AlCl_3$ would be produced?

$$Al + 3\ HCl \rightarrow AlCl_3 + \frac{3}{2} H_2$$

moles $= \frac{2.7}{27}$

$= 0.1$ moles

$n = cv$

$= 2 \times 0.1$

$= 0.2$ moles

3 moles give 1 mole $AlCl_3$

so 0.2 moles gives 0.067 moles $AlCl_3$

mass $= 0.067 \times 133.5$

$= 8.94g$

Q2 Calculate the mass of water produced upon reacting 0.6 g of calcium carbonate with 24 cm^3 of 0.5 $moll^{-1}$ hydrochloric acid.

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$$

0.6g	$24cm^3$
	$0.5 moll^{-1}$
$n = \frac{0.6}{100}$	$n = CV$
	$= 0.5 \times \frac{24}{1000}$
$= 0.006$ moles	$= 0.012$ moles

neither in XS

2 moles HCl $\longleftrightarrow$ 1 mole H_2O

1 mole HCl $\longleftrightarrow$ 2 moles H_2O

0.012 moles HCl $\longleftrightarrow$ 0.024 moles H_2O

Mass H_2O = n × FM

$= 0.024 \times 18$

$= 0.432g$

Q3 What mass of ammonia is needed in the reaction with sulfuric acid to produce 132 g of ammonium sulfate? The equation is provided below.

$$2\ NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

FM of ammonia is 17 g/mol

FM of $(NH_4)_2SO_4$ is $14 + (4 \times 2) + 32 + (4 \times 16)$

$= 118$ g/mol

17 g $\longleftrightarrow$ 118 g

$\frac{17}{118}$ g $\longleftrightarrow$ 1 g

$\frac{17}{118} \times 132$ g $\longleftrightarrow$ 132 g

~19 g $\longleftrightarrow$ 132 g

Q4 At a certain temperature and pressure, the molar volume of hydrogen is 22.4 $lmol^{-1}$. Calculate the volume of 0.04 moles of hydrogen.

1 mole is 22·4 L

4 moles is 5·6 L

0·04 moles is 0·056 L

Q5 100 cm^3 of ethane was combusted with 300 cm^3 of oxygen. Calculate the volume of carbon dioxide produced. The equation is provided below.

$$C_2H_6 + \frac{7}{2} O_2 \rightarrow 2\ CO_2 + 3\ H_2O$$

If $100cm^3$ then $350\ cm^3$

so use $300cm^3$

$\frac{7}{2} \longleftrightarrow 2$ | $\div 2$

$7 \longleftrightarrow 1$ | $\div 7$

$1 \longleftrightarrow \frac{1}{7}$ | $\times 300$

$300 \longleftrightarrow \frac{300}{7}$

so $42.9\ cm^3$

Q6 An excess mass of zinc was added to 100 cm^3 of 0.3 $moll^{-1}$ hydrochloric acid. What volume of hydrogen was produced, given that the molar volume of hydrogen is 24 $lmol^{-1}$. The equation is provided below.

$$Zn + 2\,HCl \rightarrow ZnCl_2 + H_2$$

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

xs $100cm^3$ $0.3\ moll^{-1}$ vol?

$n = cv$

$= 0.3 \times 0.1$

$= 0.03$ moles

2 moles $\longleftrightarrow$ 1 mole

1 mole $\longleftrightarrow$ 0.5 moles

0.03 moles $\longleftrightarrow$ 0.015 moles

24 moles $\longleftrightarrow$ 1 L

1 mole $\longleftrightarrow \frac{1}{24}$ L $\quad \div 0.015$

0.015 moles $\longleftrightarrow$ 2.78 L

Q7 How many positive ions are present in 2 g of $(Mg^{2+})_3(PO_4^{3-})_2$?

MW is 200

1 mole contains L $\{(Mg^{2+})_3(PO_4^{3-})_2\}$ units

1 mole is 200g

200g contains 200L +ve ions

2g contains L +ve ions

so 6.02×10^{23} +ve ions

Q8 How many sodium atoms are found in 46 g of sodium?

$\text{moles} = \frac{46}{23} = 2 \text{ moles}$ 1 mole $\leftrightarrow$ 23L

2 moles $\leftrightarrow$ 46 L

So $46 \times 6.02 \times 10^{23}$

$\doteq 2.77 \times 10^{25}$ atoms

Q9 Calculate the mass of glucose, $C_6H_{12}O_6$, which contains 1.204 x10^{24} atoms.

1 mole of glucose contains L atoms

2 moles of glucose contains 2L atoms

$$\text{Mass} = 2 \times \left((12\times6)+(12\times1)+(6\times16)\right)$$

$$= \underline{\underline{360\text{g}}}$$