This exercise will consolidate the different calculations you could be asked to carry out within the National 5 Chemistry exam.

1. Calculating the gram formula mass of a compound is an extremely important skill that you will need to do more challenging calculations. For the compounds below, calculate the gram formula mass. 

   You may wish to use page 18 of your Unit 1 Summary notes to help you.

   (a) Carbon dioxide
   (b) Lithium hydroxide
   (c) Calcium carbonate
   (d) Copper (II) chloride

2. In chemistry, calculation the number of moles of a substance you are using is a skill you will need to be able to use individually or as part of a calculation from a balanced chemical equation.

   (a) Write the formula triangles used for calculating the number of moles of a substance used.

   You may wish to use pages 19-21 of your Unit 1 Summary notes to help you.

   (b) (i) Calculate the mass of 5 moles of sodium chloride
   (ii) Calculate the mass of 0.5 moles of magnesium nitrate
   (iii) Calculate the mass of 2.5 moles of ammonium phosphate
   (iv) An experiment requires 100g of lithium oxide. Calculate the number of moles of lithium oxide required.
   (v) 300g of ethane was burned to release energy. Calculate the number of mole of ethane burned.
   (vi) 10g of magnesium hydroxide was dissolved in water to create an alkaline solution. Calculate the number of moles of magnesium hydroxide used.

   You may wish to use pages 19-21 of your Unit 1 Summary notes to help you.

   (c) (i) 10cm$^3$ of 0.5 moll$^{-1}$ sodium hydroxide was used to neutralise a sample of hydrochloric acid. Calculate the number of moles of sodium hydroxide used.
   (ii) 16cm$^3$ of 2 moll$^{-1}$ nitric acid was used in a neutralisation reaction. Calculate the number of moles of nitric acid used.
   (iii) Calculate the concentration of the solution formed when 1.5 moles of potassium carbonate was dissolved in 300cm$^3$ of water.
   (iv) Calculate the concentration of the solution formed when 0.5 moles of lithium hydroxide was dissolved in 150cm$^3$ of water.
A student used 0.1 moles of hydrochloric acid to create a 0.05 molar solution. Calculate the volume of water required.

A student used 1 mole of calcium hydroxide to create a 0.8 molar solution. Calculate the volume of water required.

3. (a) (i) The equation for the combustion of methane is given below. Balance this equation.

\[ \text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]

(ii) From your balanced equation, write the molar ratio for the comparison of propane and carbon dioxide.

(b) (i) Ethanol can be a suitable replacement for fossil fuels as a source of energy. The equation of the combustion of ethanol is shown below. Balance this equation.

\[ \text{C}_2\text{H}_6\text{O} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]

(ii) From your balanced equation, write the molar ratio for the comparison of ethanol and oxygen.

(c) (i) The equation for the neutralisation of hydrochloric acid with magnesium hydroxide is shown below. Balance this neutralisation equation.

\[ \text{HCl} + \text{Mg(OH)}_2 \rightarrow \text{MgCl}_2 + \text{H}_2\text{O} \]

(ii) From your balanced equation, write the molar ratio for the comparison of magnesium hydroxide and magnesium chloride.

(d) (i) The equation for the neutralisation of nitric acid with potassium carbonate is shown below. Balance this neutralisation equation.

\[ \text{HNO}_3 + \text{K}_2\text{CO}_3 \rightarrow \text{KNO}_3 + \text{CO}_2 + \text{H}_2\text{O} \]

(ii) From your balanced chemical equation, write the molar ratio for the comparison of nitric acid and potassium carbonate.

4. All of the skills you have been working through can be used in a calculation from equation type question.

(a) The equation for the combustion of methane is shown below.

\[ \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \]

Calculate the mass, in g, of carbon dioxide produced when 100g of methane is burned.

(b) The equation for the combustion of butane is shown below.

\[ \text{C}_4\text{H}_{10} + 9\text{O}_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O} \]

Calculate the mass, in g, of oxygen required to completely combust 250g of butane.
(c) The equation for the neutralisation of hydrochloric acid with sodium hydroxide is shown below.

\[ \text{HCl + NaOH} \rightarrow \text{NaCl + H}_2\text{O} \]

A student found that 25 cm\(^3\) of 0.1 mol\(\cdot\)l\(^{-1}\) sodium hydroxide was required to neutralise 15 cm\(^3\) of the acid. Calculate the concentration of the hydrochloric acid.

(d) The equation for the neutralisation of sulfuric acid with lithium hydroxide is shown below.

\[ \text{H}_2\text{SO}_4 + 2\text{LiOH} \rightarrow \text{Li}_2\text{SO}_4 + 2\text{H}_2\text{O} \]

A student found that 16 cm\(^3\) of 0.5 mol\(\cdot\)l\(^{-1}\) lithium hydroxide was required to neutralise 20 cm\(^3\) of the acid. Calculate the concentration of the sulfuric acid.

(e) The equation for the neutralisation of nitric acid with calcium hydroxide is shown below.

\[ 2\text{HNO}_3 + \text{Ca(OH)}_2 \rightarrow \text{Ca(NO}_3)_2 + 2\text{H}_2\text{O} \]

When 30 cm\(^3\) of 2 mol\(\cdot\)l\(^{-1}\) nitric acid was used, 20 cm\(^3\) of calcium hydroxide was required to create a neutral solution. Calculate the concentration of the calcium hydroxide solution used.

Total 40
1. (a) Chemical formula: CO₂
   \[ \text{GFM} = (C \times 1) + (O \times 2) = (12 \times 1) + (16 \times 2) = 44 \text{g} \]

   Mark: 1
   Notes: Units must be provided

(b) Chemical formula: LiOH
   \[ \text{GFM} = (Li \times 1) + (O \times 1) + (H \times 1) = (7 \times 1) + (16 \times 1) + (1 \times 1) = 24 \text{g} \]

   Mark: 1
   Notes: Units must be provided

(c) Chemical formula: CaCO₃
   \[ \text{GFM} = (Ca \times 1) + (C \times 1) + (O \times 3) = (40 \times 1) + (12 \times 1) + (16 \times 3) = 100 \text{g} \]

   Mark: 1
   Notes: Units must be provided

(d) Chemical formula: CuCl₂
   \[ \text{GFM} = (Cu \times 1) + (Cl \times 2) = (63.5 \times 1) + (35.5 \times 2) = 134.5 \text{g} \]

   Mark: 1
   Notes: Units must be provided

2. (a) 1 mark for both correct triangles

(b) (i) \[ m = n \times \text{GFM} = 5 \times 58.5 = 292.5 \text{g} \]
    Formula: NaCl

   Mark: 1
   Notes: 1 mark for final answer with units

(ii) \[ m = n \times \text{GFM} = 0.5 \times 148.5 = 74.25 \text{g} \]
    Formula: Mg(NO₃)₂

   Mark: 1
   Notes: 1 mark for final answer with units

(iii) \[ m = n \times \text{GFM} = 2.5 \times 149 = 372.5 \text{g} \]
    Formula: (NH₄)₃PO₄

   Mark: 1
   Notes: 1 mark for final answer with units

(iv) \[ n = m / \text{GFM} = 100 / 30 = 3.3 \text{ moles} \]
    Formula: Li₂O

   Mark: 1
   Notes: 1 mark for final answer with units

(v) \[ n = m / \text{GFM} = 300 / 30 = 10 \text{ moles} \]
    Formula: C₂H₆

   Mark: 1
   Notes: 1 mark for final answer with units

(vi) \[ n = m / \text{GFM} = 10 / 58.5 = 0.17 \text{ moles} \]
    Formula: Mg(OH)₂

   Mark: 1
   Notes: 1 mark for final answer with units

(c) (i) \[ n = cv \]
   \[ v = 10 \text{cm}^3 = 0.01 \text{l} \]

   Mark: 1
   Notes: 1 mark for final answer with units

(ii) \[ n = cv \]
   \[ v = 16 \text{cm}^3 = 0.016 \text{l} \]

   Mark: 1
   Notes: 1 mark for final answer with units

(iii) \[ c = n / v \]
   \[ v = 300 \text{cm}^3 = 0.3 \text{l} \]

   Mark: 1
   Notes: 1 mark for final answer with units

(iv) \[ c = n / v \]
   \[ v = 150 \text{cm}^3 = 0.15 \text{l} \]

   Mark: 1
   Notes: 1 mark for final answer with units

(v) \[ v = n / c \]
   \[ v = 0.1 / 0.05 = 2 \text{l} \]

   Mark: 1
   Notes: 1 mark for final answer with units

(vi) \[ v = n / c \]
   \[ v = 1 / 0.8 = 1.25 \text{l} \]

   Mark: 1
   Notes: 1 mark for final answer with units
### 3.

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<td>(a)</td>
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<td>(ii)</td>
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<td>(b)</td>
<td>(i)</td>
<td>(\text{C}_2\text{H}_6\text{O} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O})</td>
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<td>(c)</td>
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<td>(d)</td>
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### 4.

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| (a) | n of methane = \(\frac{m}{\text{GFM}} = \frac{100}{16} = 6.25\) moles  
molar ratio 1 : 1 = 6.25 moles of carbon dioxide  
m of carbon dioxide = \(n \times \text{GFM} = 6.25 \times 44 = 275\)g |
| (b) | n of butane = \(\frac{m}{\text{GFM}} = \frac{250}{58} = 4.31\) moles  
molar ratio 1 : 9 = 38.8 moles of oxygen  
m of oxygen = \(n \times \text{GFM} = 38.8 \times 32 = 1241\)g |
| (c) | n of sodium hydroxide = \(cv = 0.1 \times 0.025 = 0.0025\) moles  
molar ratio 1 :1 = 0.0025 moles of hydrochloric acid  
c of hydrochloric acid = \(n / v = 0.0025 / 0.015 = 0.17\)mol\(^{-1}\) |
| (d) | n of lithium hydroxide = \(cv = 0.5 \times 0.016 = 0.008\) moles  
molar ratio 1 :2 = 0.004 moles of sulfuric acid  
c of sulfuric acid = \(n / v = 0.004 / 0.02 = 0.2\)mol\(^{-1}\) |
(e)  

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<td>n of nitric acid = cv = 2 x 0.03 = 0.06 moles</td>
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<td>Allow follow through (max 2 marks available)</td>
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<td>1 mark for mass of calcium hydroxide</td>
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