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# CHEMISTRY MODULE 3

## 1. CHEMICAL REACTIONS

**Inquiry Question:** What are the products of a chemical reaction?

A. Investigate a variety of reactions to identify possible indicators of a chemical change

i. A significant temperature change
ii. Formation of a solid in a solution
iii. Production of an odor
iv. Production of a gas

B. Use modelling to demonstrate:

i. The arrangement of atoms to form new substances
   1. *$2\ Mg + O_2 \rightarrow 2MgO$*
ii. the conservation of atoms in a chemical reaction
   1. *"As the number of atoms is unchanged, the mass of the products must equal the mass of the reactants". Balancing equations adjusts the ratio of each substance until the number of reactant atoms equals the number of product atoms.*

C. Conduct investigations to predict and identify the products of a range of reactions, for example:

i. Synthesis:
   1. *$A + B \rightarrow AB$, a compound is formed from elements or from other, usually smaller compounds*
ii. Decomposition:
   1. *$AB \rightarrow A + B$, a single reactant breaks down to form two or more products*
iii. Combustion:
   1. *$A + O_2 \rightarrow AO_x$, the reactant combines with oxygen to produce oxides, which releases energy.*
iv. Precipitation:
   1. *$AB_{(aq)} + CD_{(aq)} \rightarrow AD_{(aq)} + BC_{(s)}$, two solutions are mixed and a solid is formed.*
v. Acid/Base Reactions and Acid/Carbonate Reactions:
   1. *Acid + reactive metal → salt + hydrogen, acid + metal hydroxide → salt + water, acid + metal carbonate → salt + water + carbon dioxide, acid + metal hydrogen carbonate → salt + water + carbon dioxide*

D. Investigate the chemical processes that occur when Aboriginal and Torres Strait Islander Peoples detoxify poisonous food items

i. Use heat to kill germs, destroy toxin or improve texture

ii. Used water to leach (toxins are soluble and so are washed out when soaked in water) out soluble toxins from food

iii. Ground food to facilitate the removal of impurities

iv. Grated vegetables on rough bark to remove the skin

E. Construct balanced equations to represent chemical reactions

i. *In workbooks and note scaffolds. Practice these.*

## 2. PREDICTING REACTIONS OF METALS

**Inquiry Question:** How is the reactivity of various metals predicted?

A. Conduct practical investigations to compare the reactivity of a variety of metals in:

i. Water

| *METAL* | *REACTIVITY WITH WATER* |
|---|---|
| *Potassium, sodium, calcium* | *React with cold water to produce hydrogen and hydroxide ions* |
| *Magnesium* | *Reacts with hot water to produce hydrogen and hydroxide ions* |
| *Aluminium, zinc, iron* | *Reacts with steam to produce hydrogen and the metal oxide* |

ii. Dilute acid

| *METALS* | *REACTIVITY WITH DILUTE HCl ACID* |
|---|---|
| *Potassium, sodium, calcium* | *Not tested.* |
| *Magnesium* | *Reacts vigorously in cold acid, producing magnesium ions and hydrogen gas* |
| *Aluminium* | *Reacts slowly at first, then vigorously, producing aluminium ions and hydrogen gas* |
| *Zinc* | *Reacts less vigorously than magnesium, producing zinc ions and hydrogen gas* |
| *Iron* | *Reacts slowly in cold acid, producing Iron II ions and hydrogen gas* |
| *Tin, Lead* | *Reacts very slowly in warm acid, producing ions and hydrogen gas* |
| *Copper, Silver* | *No reaction with either cold or warm acid.* |

iii. Oxygen

| *METAL* | *REACTIVITY WITH OXYGEN* |
|---|---|
| *Potassium, sodium, calcium, magnesium* | *React readily with oxygen* |
| *Aluminium, zinc, iron* | *React readily with oxygen if in powdered form* |
| *Tin, lead, copper* | *React slowly when heated in oxygen* |
| *Silver* | *Does not react with oxygen* |

iv. Other metal ions in solution

| *METALS* | *REACTIVITY WITH METAL IONS IN SOLUTION* |
|---|---|
| *Zinc* | *No reaction with Zinc 2, brown deposit with Copper 2 and black deposit with Silver.* |
| *Copper* | *No reaction with Zinc 2 and Copper 2, and black deposit with Silver.* |
| *Silver* | *No reaction with any three.* |

B. Construct a metal activity series using the data obtained from practical investigations and compare this series with that obtained from standard secondary-sourced information

   i. Magnesium > Zinc > Iron > Tin > Lead > Copper > Silver

   ii. Note: the more reactive a metal is, the less reactive its ion is.

C. Analyse patterns in metal activity on the periodic table and explain why they correlate with, for example:

   i. Ionisation energy

      1. *Decreases down a group, increases across a group*

   ii. Atomic radius

      1. *Increases down a group, decreases across a group*

   iii. Electronegativity

      1. *Decreases down a group, increases across a group*

D. Apply the definitions of oxidation and reduction in terms of electron transfer and oxidation numbers to a range of reduction and oxidation (redox) reactions

   i. A reactant which has lost oxygen is a reduction, a reactant which has gained oxygen is an oxidation, and so they work together.

   ii. EXAMPLE: $FE_2O_3 + 2CO \rightarrow 2Fe + 3CO_2$. Fe has been reduced, carbon monoxide has been oxidized.

E. Conduct investigations to measure and compare the reduction potential of galvanic half-cells

   i. A current flows in a galvanic cell because one half-cell has a greater tendency to push electrons into the external circuit than the other half-cell. This is known as a potential difference. They are measured in 1 bar and 1 mol/L. It is given the symbol $E^o$.

   ii. The reduction potential is measured by assigning a standard half-cell potential to each half-cell by connecting them to a standard reference half-cell and measuring the voltage produced.

F. Construct relevant half-equations and balanced overall equations to represent a range of redox reactions.

   i. *In workbook and note scaffolds.*

G. Predict the reaction of metals in solutions using the table of standard reduction potentials.

i. A reduction reaction (positive electrode) will occur in the half-cell with the most positive $E^o$ value, and an oxidation (negative electrode) will occur in the half-cell with the most negative $E^o$ value.

H. Predict the spontaneity of redox reactions using the value of cell potentials

i. Energy would be released as heat rather than electrical energy. The lower half-reaction in the table of standard reduction potentials occurs in the forward direction and the higher half-reaction occurs in the reverse direction.

ii. Look for substances that are arranged in a bottom-left, top-right position.

## 3. RATES OF REACTION

**Inquiry Question:** What effects the rate of a chemical reaction?

A. Conduct a practical investigation, using appropriate tools to collect data, analyse and report on how the rate of a chemical reaction can be affected by a range of factors, including but not limited to:

i. Temperature:

1. *Temperature increases frequency of collisions due to rapid movements of particles (collision theory) but the energy of their collisions (kinetic energy – movement).*

ii. Surface area of reactants:

1. *The greater the number of exposed particles, the frequency of collisions between these particles and other react particles increases (collision theory).*

iii. Concentration of reactants:

1. *Higher concentrations lead to increased reaction rates due to more particles being available to react with (collision theory).*

iv. Catalysts:

1. *All of the above act as catalysts – something that has an affect on rate of reaction without being a reactant or product.*

B. Investigate the role of activation energy, collisions and molecular orientation in collision theory

i. You can increase reaction rate through increasing the proportion of successful collisions through:

1. *Increasing the frequency of successful collisions by increasing the number of collisions that can occur during a given time*
2. *Increasing the proportion of collisions that have energy greater than or equal to the activation energy.*

C. Explain a change in reaction rate using collision theory

i. As above in (A.)