 Module 2 gas laws

Year 11 chemistry 2018

Duration: 10 hours

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Inquiry question

How does the Ideal Gas Law relate to all other Gas Laws?

Rationale

Students explore problems to determine the relationship between the Ideal Gas Law and; Gay-Lussac’s Law (temperature), Boyle’s Law, Charles’ Law and Avogadro’s Law. Students work together to relate the laws to real life applications.

Outcomes

Working scientifically skills

* CH11-1 Develops and evaluates questions and hypotheses for scientific investigations
* CH11-2 Planning investigations designs and evaluates investigations in order to obtain primary and secondary data and information
* CH11-3 Conducting investigations conducts investigations to collect valid and reliable primary and secondary data and information
* CH11- 4 Processing data and information selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media
* CH11-5 Analysing data and information analyses and evaluates primary and secondary data and information
* CH11-6 Problem solving solves scientific problems using primary and secondary data, critical thinking skills and scientific processes
* CH11-7 Communicates scientific understanding using suitable language and terminology for a specific audience or purpose

Knowledge and understanding

* CH11-9 describes, apply and quantitatively analyse the mole concept and stoichiometric relationships

Depth study

* Derive the ideal gas law using gas equations.
* Plan and conduct an investigation to communicate a deep understanding of quantitative chemistry (PowerPoint presentation resource)

Assessment

* Collaborative task to map laws to real life applications.
* Formative post-quiz at end of learning sequence.

Content

The working scientifically skills mentioned in the outcomes should be embedded throughout the teaching and learning experiences.

CH11-9 describes, apply and quantitatively analyse the mole concept and stoichiometric relationships

Students:

* conduct investigations and solve problems to determine the relationship between the Ideal Gas Law and:
  + Gay-Lussac’s Law (temperature)
  + Boyle’s Law
  + Charles’ Law
  + Avogadro’s Law (ACSCH060) A student:

| Teaching and learning | Evidence of learning |
| --- | --- |
| Define the term ideal gas (qualitatively and quantitatively).  Watch [“The ABC’s of gas: Avogadro, Boyle, Charles”](http://ed.ted.com/lessons/1207-1-a-bennet-brianh264) http://ed.ted.com/lessons/1207-1-a-bennet-brianh264  Watch: [The Ideal Gas Law: Crash Course Chemistry #12](https://www.youtube.com/watch?v=BxUS1K7xu30) https://www.youtube.com/watch?v=BxUS1K7xu30  Watch: [The Gas Laws - The Science Classroom](https://www.youtube.com/watch?v=_EWd0DuN43E) https://www.youtube.com/watch?v=\_EWd0DuN43E  Observe: [Simulation of gas properties](https://phet.colorado.edu/en/simulation/legacy/gas-properties) - https://phet.colorado.edu/en/simulation/legacy/gas-properties | Define the term ideal gas. |
| Define Gay-Lussac’s Law (temperature) that pressure is proportional to temperature (when volume is constant).    Solve problems using Gay-Lussac’s Law (temperature).  Conduct first –hand investigation to observe Gay-Lussac’s Law (temperature).  Examples:   * Place a small amount of liquid in a pneumatic trough or shallow dish, place candles in dish/trough, light candles and place a beaker over the top. Candle flames will go out and the water will rise. [Video of investigation](https://www.youtube.com/watch?v=N6DZRiSIK3s) https://www.youtube.com/watch?v=N6DZRiSIK3s | Define Gay-Lussac’s Law (temperature) that pressure is proportional to temperature (when volume is constant).    Solve problems using Gay-Lussac’s Law (temperature).  Conduct first –hand investigation to observe Gay-Lussac’s Law (temperature). |
| Define Boyle’s Law that equal pressure is inversely proportional to volume (when temperature is constant).  Solve problems using Boyle’s Law.  Conduct first–hand investigation to observe Boyle’s Law.  Examples:   * Marshmallow or shaving cream in a bell jar and a pressure pump as a demonstration for students. Students can replicate this with marshmallows in large plastic syringes. As a build activity, students can create their own demonstrations by using glass jars and hand pumps. * [Balloon in a syringe](https://www.youtube.com/watch?v=eR49g3ubTBg) https://www.youtube.com/watch?v=eR49g3ubTBg * Fill the bulb of a pipette with liquid and secure the end with a clamp, push on bulb and observe the liquid move back and forth. Place pipette next to a ruler and apply pressure using books. Students can measure quantitative data of number of object vs length liquid moves (demonstrates that pressure increases as gas is compressed). This can be graphed. Graph demonstrates that when pressure goes up volume goes down. [Video](https://www.youtube.com/watch?v=vSFVMJQ4J7U) https://www.youtube.com/watch?v=vSFVMJQ4J7U * Cartesian diver demonstration. This is a simple experiment which students can do involving plastic bottles, water and a sachet of ketchup (or plastic dropper). Other variations exist. | Define Boyle’s Law that equal pressure is inversely proportional to volume (when temperature is constant).  Solve problems using Boyle’s Law.  Conduct first–hand investigation to observe Boyle’s Law. |
| Define Charles’ Law that volume is proportional to temperature (when pressure is constant).    Solve problems using Charles’ Law.  Conduct a first–hand investigation to observe Charles’ Law.  Examples:   * Half fill a balloon with helium. Place weights at the bottom (e.g. paperclips). Heat balloon with a hair dryer. * Place a small amount of water in the bottom of a conical flask, place a balloon on the top. Put the flask in a pneumatic trough filled with warm water, observe the balloon expand. Place the conical flask into cold water and observe it contract. * Blow up a balloon. Put boiling water in a beaker (half full) and place balloon in beaker. Place a lid or cover over the top and observe the balloon get bigger. [Video](https://www.youtube.com/watch?v=NplVuTrr59U) https://www.youtube.com/watch?v=NplVuTrr59U | Define Charles’ Law that volume is proportional to temperature (when pressure is constant).  Solve problems using Charles’ Law.  Conduct a first–hand investigation to observe Charles’ Law. |
| Define Avogadro’s Law that equal volumes of all ideal gases (at the same temperature and pressure) contain the same number of molecules.    Solve problems using Avogadro’s Law.  Conduct first–hand investigation to observe Avogadro’s Law.  Example: Reacting different masses (and therefore amounts) of magnesium with excess acid and collecting the volume of hydrogen released by water displacement (e.g. in an upturned burette). You can then relate the volume of hydrogen gas released to the amount of hydrogen produced (calculated from the amount of magnesium consumed). | Define Avogadro’s Law that equal volumes of all ideal gases (at the same temperature and pressure) contain the same number of molecules.  Solve problems using Avogadro’s Law.  Conduct first –hand investigation to observe Avogadro’s Law. |
| Create a summary table/diagram/representation to summarise the gas laws.  Determine the combined gas law using Gay-Lussac’s Law (temperature), Boyle’s Law, Charles’ Law as:    Observe a firsthand investigation to observe the combined gas law.  Example: [Egg in a bottle](https://www.youtube.com/watch?v=kr1V0KtZPGw) https://www.youtube.com/watch?v=kr1V0KtZPGw | Determine the combined gas law using Gay-Lussac’s Law (temperature), Boyle’s Law, Charles’ Law as: |
| Determine/derive the Ideal Gas Law as  Identify all values within the Ideal Gas Law, including R as the Ideal Gas Constant.  Watch:  [Ideal gas equation: Khan Academy](https://www.khanacademy.org/science/chemistry/gases-and-kinetic-molecular-theory/ideal-gas-laws/v/ideal-gas-equation-pv-nrt) https://www.khanacademy.org/science/chemistry/gases-and-kinetic-molecular-theory/ideal-gas-laws/v/ideal-gas-equation-pv-nrt  Solve problems using the Ideal Gas Law. | Determine/derive the Ideal Gas Law as  Solve problems using the Ideal Gas Law. |
| Students map the laws to create a concept map – create conceptual understanding of the laws and how they relate. Students come up with real life applications of where the laws can be observed.  Post-quiz, using [Kahoot!](https://kahoot.com/) https://kahoot.com, Microsoft Forms (access through portal) or Google Forms (access through portal). |  |

Reflection and evaluation: