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| **Thermal Physics** | IB Physics Content Guide |

# Big Ideas

* The macroscopic effects of volume, pressure, and temperature can be understood with a microscopic model
* Kinetic Energy on a molecular level is observed as temperature and heat
* The heat required to change the temperature or phase of a material is a property of the material itself
* The properties of an ideal gas are proportional to each other and can be calculated under certain conditions

# Content Objectives

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| 1 – Heat vs Temperature |  | | | |
| I can explain the relationship between temperature and molecular kinetic energy | |  |  |  |
| I can describe the energies present in an object’s total internal energy | |  |  |  |
| I can convert between Celsius and Kelvin | |  |  |  |
| I can describe the nature of molecules when at a temperature of absolute zero | |  |  |  |
| I can compare temperature (average KE) and heat (total KE) | |  |  |  |
| I can describe the molecular process that allows heat to flow | |  |  |  |

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| 2 – Specific Heat |  | | | |
| I can define specific heat capacity with proper units | |  |  |  |
| I can describe the effect of larger or smaller specific heat values | |  |  |  |
| I can relate specific heat capacity to the heat energy and temperature change | |  |  |  |
| I can describe how a calorimeter uses the conservation of heat to study a material’s specific heat | |  |  |  |
| I can experimentally determine the specific heat capacity of a material | |  |  |  |

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| 3 – Latent Heat |  | | | |
| I can identify key features in a material’s heating curve | |  |  |  |
| I can describe why a heating curve plateaus during phase changes | |  |  |  |
| I can describe the different ways that the heat added to a system can become internal energy | |  |  |  |
| I can define specific latent heat with proper units | |  |  |  |
| I can calculate the heat required to cause a certain amount of a substance to change phases | |  |  |  |
| I can compare the processes of evaporation and boiling | |  |  |  |

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| 4 – Kinetic Gas Theory and The Mole |  | | | |
| I can describe the conditions necessary for a substance to be considered an ideal gas | |  |  |  |
| I can define pressure with appropriate fundamental and derived units | |  |  |  |
| I can relate average molecular kinetic energy with absolute temperature | |  |  |  |
| I can calculate the average molecule speed for a molecule at a certain temperature | |  |  |  |
| I can discuss how the mass of a molecule changes its overall speed at a given temperature | |  |  |  |
| I can describe the importance of having a large quantity like the “mole” defined | |  |  |  |
| I can identify the difference between different isotopes of an element | |  |  |  |
| I can calculate an atom’s mass number when given the number of protons and neutrons | |  |  |  |
| I can use the average atomic weight of an element to convert between mass and moles | |  |  |  |

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| 5 – Gas Laws |  | | | |
| I can identify conditions when a substance is no longer considered an ideal gas | |  |  |  |
| I can describe the relationship between volume and pressure for an ideal gas (Boyle’s Law) | |  |  |  |
| I can describe the relationship between temperature and pressure for an ideal gas (Pressure Law) | |  |  |  |
| I can describe the relationship between temperature and volume for an ideal gas (Charles’s Law) | |  |  |  |
| I can use the Ideal Gas Law to solve for pressure, volume, amount, or temperature | |  |  |  |
| I can use the Ideal Gas Law to describe how changing one or more variable(s) would affect another | |  |  |  |

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|  | *Data Booklet Equation:* |
| Conditions for Absolute Zero:  Molecules stop moving. This is the coldest possible temperature.  Absolute Zero = 0 K = -273 K |

## Specific Heat Capacity and Specific Latent Heat

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| --- | --- | --- | --- | --- |
|  | Variable Symbol | Unit |  | *Data Booklet Equations:* |
| Heat Energy | Q | J |  |  |
| Mass | m | kg |  |
| Specific Heat Capacity | c | J kg-1 K-1 |  |  |
| Change in Temperature | ΔT | K |  |
| Specific Latent Heat | L | J kg-1 |  |  |

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| EK | Kinetic Energy 🡪 Temperature |  | EP | Potential Energy 🡪 Phase Change |

# Heating Curves

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|  | | |  | | | | |
| Pressure | Variable Symbol | Unit | | |  | *Data Booklet Equation:* | | |
| Force | F | N | | |  |  | | |
| Area | A | m2 | | |  |
| Pressure | p | N m-2 | | Pa |  | |  | |

## Kinetic Theory and Temperature

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| --- | --- | --- | --- | --- |
|  | Variable Symbol | Unit |  | *Data Booklet Equation:* |
| Average Kinetic Energy |  | J |  |  |
| Absolute Temperature | T | K |  |
| Boltzmann’s Constant | kb | J K-1 |  | = 1.38 × 10-23 J K-1 |

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| --- | --- | --- |
| Avogadro’s Number | NA | 6.02 × 1023 |

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| --- | --- | --- | --- | --- | --- |
| Ideal Gas Law | Variable Symbol | Unit |  | *Data Booklet Equations:* | |
| Pressure | p | Pa |  |  | = 8.31 J K-1 mol-1 |
| Volume | V | m-3 |  | Conditions for Ideal Gases: | |
| Number of Molecules | n | mol |  |
| Gas Constant | R | J K-1 mol-1 |  |
| Temperature | T | K |  |

## Ideal Gas Relationships

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