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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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| **Thermal Physics** | Shelving Guide |

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|  | *Data Booklet Equation:*$$Temperature \left(K\right)=Temperature \left(°C\right)+273 $$ |
| 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 |  | $$Q=mc∆T$$ |
| Mass | m | kg |  |
| Specific Heat Capacity | c | J kg-1 K-1 |  | $$Q=mL$$ |
| 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 |  | $$p=\frac{F}{A}$$ |
| 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 | $$\overbar{E}\_{k}$$ | J |  | $$\overbar{E}\_{K}=\frac{3}{2}k\_{B}T=\frac{3}{2} \frac{R}{N\_{A}}T$$ |
| Absolute Temperature | T | K |  |
| Boltzmann’s Constant | kb | J K-1 |  | $k\_{B}$ = 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 |  | $$pV=nRT$$ | $R$ = 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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