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

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			

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			

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			

4 – Kinetic Gas Theory and The Mole

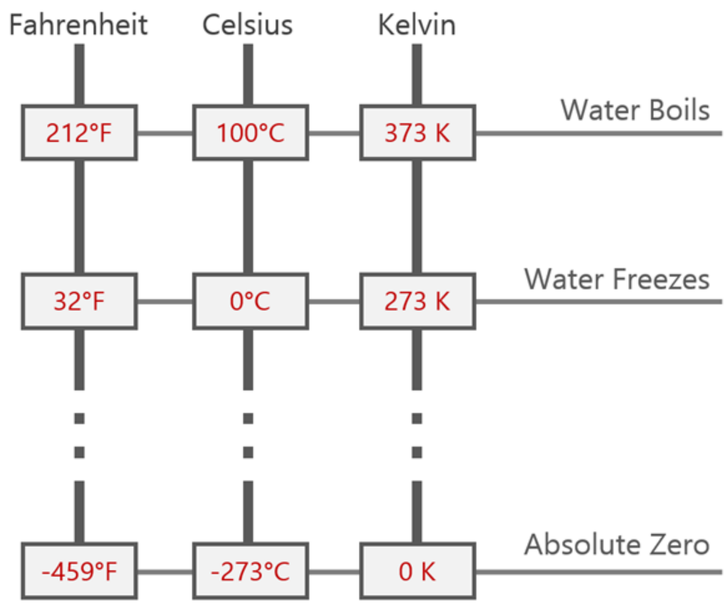
I can describe the conditions necessary for a substance to be considered an ideal gas			
I can define pressure with appropriate fundamental and derived units			
I can relate average molecular kinetic energy with absolute temperature			
I can calculate the average molecule speed for a molecule at a certain 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			

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			

Thermal Physics

Shelving Guide



Data Booklet Equation:

$$\text{Temperature (K)} = \text{Temperature (°C)} + 273$$

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

	Variable Symbol	Unit
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	$J\ kg^{-1}$

Data Booklet Equations:

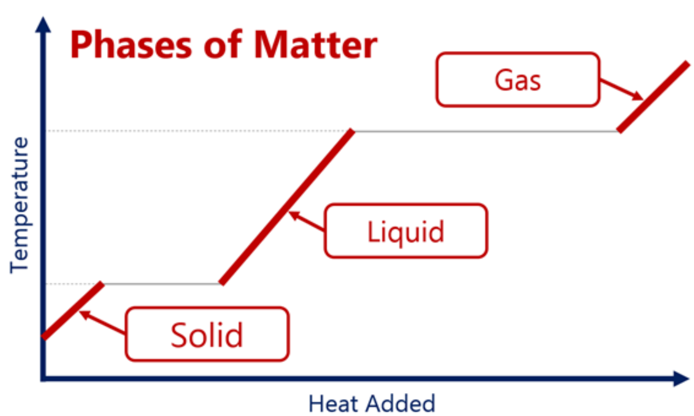
$$Q = mc\Delta T$$

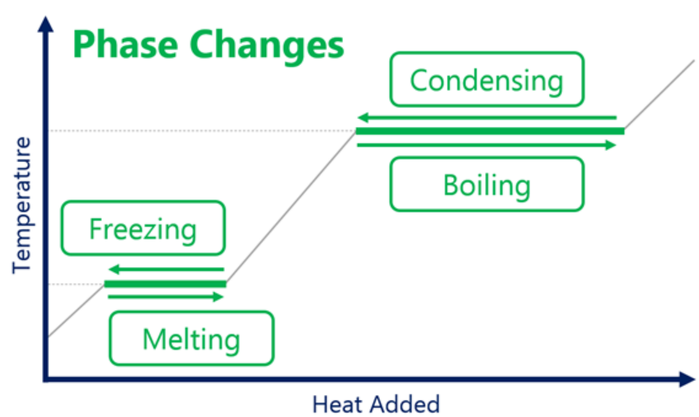
$$Q = mL$$

E_K	Kinetic Energy → Temperature

E_P	Potential Energy → Phase Change

Heating Curves





Pressure

	Variable Symbol	Unit	
Force	F	N	
Area	A	m^2	
Pressure	p	$N\ m^{-2}$	Pa

Data Booklet Equation:

$$p = \frac{F}{A}$$

Kinetic Theory and Temperature

	Variable Symbol	Unit
Average Kinetic Energy	$\bar{E}_k$	J
Absolute Temperature	T	K
Boltzmann's Constant	k_b	$J\ K^{-1}$

Data Booklet Equation:

$$\bar{E}_K = \frac{3}{2}k_B T = \frac{3}{2}\frac{R}{N_A}T$$

$$k_B = 1.38 \times 10^{-23}\ J\ K^{-1}$$

Avogadro's Number	N_A	6.02×10^{23}

Ideal Gas Law

	Variable Symbol	Unit
Pressure	p	Pa
Volume	V	m^{-3}
Number of Molecules	n	mol
Gas Constant	R	$J\ K^{-1}\ mol^{-1}$
Temperature	T	K

Data Booklet Equations:

$pV = nRT$ | $R = 8.31\ J\ K^{-1}\ mol^{-1}$

Conditions for Ideal Gases:

Ideal Gas Relationships