



Theme B

The Particular Nature of Matter

#	Physical Quantity	Definition
B.1 Thermal Energy		
1	The Internal Energy	" of a substance is the total of inter-particle potential energy and the random kinetic energy of all particles in the substance."
2	Temperature	" Is a measure of the average random kinetic energy of the particles in a substance."
3	Heat (Thermal Energy)	" Is the thermal energy transferred from one body to another as a result of difference in temperature."
4	Density	" of a homogeneous substance is a measure of how much mass it has per unit volume, measured in $\text{kg}\cdot\text{m}^{-3}$."
5	The Absolute Temperature	" Is the Zero Kelvin (-273.15 deg.C) and it is the temperature at which the average kinetic energy of the matter reaches zero."
6	The Triple Point	" Is the temperature at which matter coexist as solid, liquid and vapor in thermal equilibrium. The triple point of water is 273.16 K @ 611.66 Pa."
7	Phase	" A phase of matter is a definite region of space in which all the physical and chemical properties of the substance contained in that space are uniform."
8	Specific Latent Heat of Fusion	" Is the energy required to change the phase of 1 Kg of substance from solid into a liquid at constant temperature and pressure."
9	Specific Latent Heat of Vaporization	" Is the energy required to change the phase of 1 Kg of substance from liquid into a gas at constant temperature and pressure."
10	Refrigerant	" Is a fluid used in the refrigeration cycle of refrigerators, air conditioners and heat pumps."
11	Conduction	" Is thermal energy transfer in a solid by means of microscopic atomic and molecular vibrations within a solid material, without macroscopic motion of the whole body."
12	Convection	" Is thermal energy transfer in a fluid (liquid or gas) by the macroscopic motion of warmer fluid regions that carry them away from the heat source. The warmer, lower-density fluid regions move up and transport their energy."
13	Radiation	" Is thermal energy transfer through the emission of electromagnetic waves that transport energy away from the emitting object. No material medium is required for radiation transmission."
14	Specific Heat Capacity (Thermal Inertia)	" Is the amount of energy transferred to 1 Kg of the substance causing its temperature to increase by one Kelvin."
15	Thermal (Heat) Capacity, C	" Is the heat energy transferred to the substance causing its temperature to increase by one Kelvin."
16	Thermal Conductivity, k	" Is a constant that represents the ability of a substance to conduct thermal energy. Its unit: $\text{w}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$."
17	Thermal Insulator	" Is a material that significantly reduces the flow of thermal energy, e.g. plastics, wood, air, foam and fibreglass."
18	A Black Body	" Is a theoretical object or system that absorbs all the wavelengths of electromagnetic radiation that fall on it and re-radiates that in the form of a spectrum on intensity vs. wavelength, also known as the Plank curve, that is a function of its temperature only."
19	Wien's Displacement Law	" States that for a black body, the wavelength of peak radiation emission, λ_{max} , is inversely proportional to the absolute temperature of the black body."
20	Luminosity, L	" The luminosity of a star is the rate at which it radiates energy. It is thus the power of the star, usually given in units of watts (W) and depends only on the characteristic intrinsic of the star."
21	Apparent Brightness, b	" It is the power of the star's radiation received by an observer per unit area, usually measured in watts per square meter ($\text{w}\cdot\text{m}^{-2}$).
22	Cepheid Variable (Standard Candle)	" Is a star of variable luminosity: The luminosity increases sharply and falls off gently with a well-defined period. The period is related to the absolute luminosity of the star and so can be used to estimate the distance to the star."
23	A Light Year, ly	" Is the distance travelled in a vacuum by light in one year. Thus $1 \text{ ly} = 9.46 \times 10^{15} \text{ m}$."

B.2 Greenhouse Effect

24	The Greenhouse Effect	" Is the warming of the Earth caused by infrared radiation emitted by the Earth's surface, which is absorbed by various gases in the atmosphere and then partly re-radiated ultraviolet radiation towards the Earth's surface."
25	Enhanced Greenhouse Effect (Anthropogenic Climate Change)	" Is the reduction in radiation emitted into space from Earth due to an increasing concentration of greenhouse gases in the atmosphere caused by human activities."
26	Anthropogenic Climate Change	" Are changes in the climate due to human activities. Also called global warming or Enhanced Greenhouse Effect."
27	The Solar Constant	" Is the mean solar radiation power received by one square meter placed normally to the path of the incoming solar rays arriving at the top of the atmosphere of the Earth. The accepted average value is $1.36 \times 10^3 \text{ W m}^{-2}$."
28	Albedo	" Is defined as the ratio of the power of radiation reflected or scattered from the body to the total power incident on the body's surface. A perfect black body would have an albedo of zero."
29	Scattering	" Is defined as the unpredictable and irregular reflections of waves or particles from their original path by interactions with matter."
30	Emissivity, e - Def.1	" Is the ratio of the power per unit area radiated by an object to that of a black body of the same temperature."
31	Emissivity, e - Def.2	" Is the ratio of the power radiated by an object to that of a black body of the same surface area and temperature."
32	Greenhouse Gases	" Are the gases that are responsible for the greenhouse effect: water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)."
33	Resonance	" Is the transfer of energy into an oscillating system at its natural frequency. For example if the atoms in a molecule vibrate at the same frequency as the infrared radiation passing through the greenhouse gas, then energy can be absorbed."
34	Fuel	" A fuel is a store of chemical or nuclear energy that can be used to do useful work."
35	Fossil Fuels	" Are naturally occurring fuels that have been produced by the effects of high pressure and temperature on dead organisms over a period of millions of years. Coal, crude oil and natural gas are all fossil fuels."
36	Renewable Energy	" Is the energy resource for which the rate of consumption is less than the rate of replacement by natural processes and will not be used up or depleted for a very long time."

B.3 Gas Laws

37	The Mole - Def.1	" Is the amount of substance that contains as many elementary entities as the number of atoms in 12 grams of the isotope Carbon-12. Elementary entities could be atoms, molecules, ions, electrons, or formula units."
38	The Mole - Def.2	" Is the amount of substance that contains a number of particles equal to the Avogadro's constant and whose mass in grams is equal to the molar mass of the substance."
39	Avogadro Constant, N_A	" Is the number of particles (atoms, molecules, ions and electrons) in 1 mol of a substance."
40	Molar Mass, M	" The molar mass of a substance is its relative molecular mass or relative atomic mass expressed in grams. Unit: g mol^{-1} "
41	Pressure	" Is defined as the normal (perpendicular) force applied per unit area. Unit: N m^{-2} (Pa)"
42	Atmospheric Pressure	" Is the pressure due to the weight of the air above an area of one square meter. It acts equally in all directions. 1 atm = 101,325 Pa at sea level."
43	Ideal Gas	" Is a theoretical model of a gas that obeys perfectly the ideal gas laws and the Equation of State under all conditions."
44	Gas Laws	" Are laws of physics relating the pressure, volume and temperature of a fixed amount of a gas."
45	Boyle's Law	" States that for a fixed mass of gas, the pressure is inversely proportional to the volume at constant temperature."
46	Charles' Law	" States that for a fixed mass of gas, the volume is directly proportional to the absolute temperature at constant pressure."
47	The Third Gas (Gay-Lussac's) Law	" States that for a fixed mass of gas, the pressure is directly proportional to the absolute temperature at constant volume."
48	Equation of State for an Ideal Gas (EOS)	" Describes the macroscopic behavior of ideal gases: $PV = nRT$."
49	Avogadro's Law	" The number of particles in a gas is directly proportional to the volume of gas at constant temperature and pressure."

B.4 Thermodynamics - HL Only

50	Thermodynamics	" Is the branch of Physics involving transfers of thermal energy to do useful mechanical work, e.g. heat engines."
51	A Thermodynamic System	" Is a quantity of matter (e.g. a fixed mass of gas) or a group of objects under investigation."
52	Surroundings	" Is the region external to the system with which it interacts."
53	The Universe	" Represents everything including the system and the surroundings."
54	Isolated System	" One which cannot exchange thermal energy, work or matter with its surroundings."
55	Open System	" One which can exchange thermal energy, work and matter with its surroundings."
56	Closed System	" One which can exchange thermal energy or work with its surroundings, but not matter."
57	Isothermal Process	" During which, temperature remains constant. This means that internal energy remains constant."
58	Isovolumetric (Isochoric) Process	" During which, volume remains constant. This means that no work is done on or by the gas."
59	Isobaric Process	" During which, pressure remains constant."
60	Adiabatic Process	" During which, no thermal energy (heat) is transferred between a gas and its surroundings. An adiabatic expansion results in cooling while an adiabatic compression results in heating."
61	The First Law of Thermodynamics	" States that the net thermal energy transferred to a system Q equals to the change in its internal energy ΔU plus the net work done on its surroundings W ."
62	Entropy, S	" Is a thermodynamic quantity that relates to the degree of disorder of the particles in a system."
63	Microstate	" refers to a specific molecular configuration or the numerous possible combinations of microscopic properties of a thermodynamic system."
64	Macrostate	" Is a larger-scale, measurable outcome, resulting from the outcome of each of the smaller microstates."
65	Irreversible Process	" In an irreversible process the total entropy of an isolated system always increases. All natural macroscopic processes are irreversible."
66	Reversible Process	" In a reversible process, the total entropy of a system remains unchanged i.e. $\Delta S = 0$."
67	Thermodynamic Cycle	" Is a sequence of processes which in turn vary the pressure, volume and temperature of a gas, but eventually return it to its initial state."
68	Carnot Cycle	" Is an idealized and reversible four-stage process that represents the most efficient thermodynamic cycle."
69	The Second Law of Thermodynamics (The Clausius Version)	" It is impossible for thermal energy to flow from a cold to a hot object without performing work."
70	The Second Law of Thermodynamics (The Kelvin-Planck Statement)	" For a heat engine working in a cyclic process, it is impossible to completely convert thermal energy into mechanical work."
71	The Second Law of Thermodynamics (The Carnot Version)	" No heat engine operating between two reservoirs can be more efficient than a Carnot engine operating between the same two reservoirs."
72	The Second Law of Thermodynamics (The Entropy Version)	" The entropy of an isolated system never decreases. In such a system, entropy increases in realistic irreversible processes and stays the same in theoretical, idealized reversible processes."

B.5 Current and Circuits - Includes HL Section

73	Electricity	" Is the movement (or flow) of mobile charge carriers (electrons) through a material."
74	Electric Current	" Is the rate of flow of charge."
75	Law of Conservation of Charge	" States that the total charge in an isolated system remains constant."
76	Direct Current (DC)	" Is a flow of electric charge that is always in the same direction."



77	Alternating Current (AC)	" Is a flow of electric charge that changes direction periodically."
78	Electric Cell	" Is a device that transfers chemical energy into electric energy carried by an electric current."
79	The Elementary Charge, e	" Is the smallest unit of electric charge that can exist independently in nature, it is the charge of one proton or one electron and has the magnitude of $1.602176634 \times 10^{-19}$ C."
80	Coulomb	" One Coulomb is the quantity of negative charge that is equivalent to the total charge of 6.24×10^{18} electrons."
81	Resistance, R	" Is a measure of the opposition to the flow of current through a component. It is defined as the potential difference across a component per unit current passing through it."
82	Ohm's Law	" The electric potential difference across a conductor is directly proportional to the current flowing through it, at constant temperature."
83	Resistivity, ρ	" Is the resistance of a specimen of a material that has a length of 1 m and cross-sectional area of 1 m^2 ."
84	Electromotive Force (emf) - Def.1	" Is the total electric potential energy supplied to each coulomb of charge flowing through the entire circuit."
85	emf - Def.2	" Is the work done per unit charge taking the charges from the low potential to the high potential."
86	emf - Def.3	" Is the terminal potential difference when no current is supplied i.e. open circuit."
87	emf - Def.4	" Is the power provided by the battery per unit current."
88	The Internal Resistance, r	" Is the electrical resistance of the cell itself, associated with the electrochemical reactions within it."
89	Voltmeter	" Is an instrument used for measuring the voltage across a component by being placed in parallel with the component."
90	Potential Difference (Voltage)	" Is the work done per unit charge on moving a positive charge from one point to the other along the path of the current."
91	An Ideal Voltmeter	" Is one which draws no current from the circuit, so has infinite resistance."
92	Ammeter	" Is an instrument used for measuring the current intensity through a component by being placed in series with the component."
93	An Ideal Ammeter	" Is one which does not affect the current, so has zero resistance."
94	Electrical Power	" Is the amount of work done per second, or the amount of electrical energy transferred per second."
95	Electronvolt	" Is the work done when a charge equal to one electron charge is taken across a potential difference of one volt."
96	The Power Dissipated	" The power dissipated in the resistor is the amount of electrical energy converted to heat per unit time."
97	Kilowatt hour, kWh	" Is the amount of electrical energy transferred by a 1 kW device in 1 hour."
98	Rheostat	" Is a type of variable resistance that is used to control current."