Energy And Temperature Introduction

Energy

Thermochemistry studies the heat changes associated with chemical or physical changes

Conservation of Energy – energy is converted from one form to another but is not created nor destroyed

Two general types of energy:

Potential Energy – associated with position (ex. energy stored in chemical bonds)

Kinetic Energy – associated with motion (ex. heat from burning, combustion)

Specific types of energy:

Types of Energy	Examples
Mechanical	Machine with moving parts
Electrical	Moving electrons
Radiant Energy	Light or other electromagnetic radiation
Chemical Energy	Energy in bonds converted to heat or light
Heat Energy	Fire (characterized by random motion)
Nuclear Energy	Stored in the internal structure of atoms, the interconversion mass to energy

Energy meaning and measurement units

Acceleration= increase in velocity per time (m/s^2) Earth's gravity acceleration=9.8 ms^{-2})

Force = (mass)(acceleration) = Newton (N) = (kg)(m/s^2)

Work = (force)(distance)= Joule (J) = (N) (m) = kg m^2/s^2

Energy = capacity to do work = Joule (J) = kg m^2/s^2

Can measure energy in:

J	joules	
kJ	kilojoules	1 kJ = 1000J
cal	calories	1 cal = 4.184 J
kcal	kilocalories	1 kcal = 1000 cal
Cal	dietary calories	1 Cal = 1 kcal

Example
What is the energy required to lift a body with a mass of 100.0 kilogram (about 220 pounds) to a height of 427 meters? The acceleration due to gravity on earth is $9.80 ms^{-2}$.

$F = m\ a = (100.0 kg)\ (9.80 ms^{-2}) = 9.8\ kg\ m\ s^{-2} = 980\ N$

$E = work = F\ d = (980N)\ (427m) = 418{,}400 Nm = 4.18 \times 10^5\ J$

$E = 418{,}400 Nm = 4.18 \times 10^5\ J$

or in dietary Calories

? Cal = 4.184×10^5 J (1cal/4.184J) (1kcal/1000cal) (1 Cal/ 1kcal)

= 100 Cal

In other words, if you weigh 220 pounds, then 100 Calories of food gives you about enough energy to climb up 427 meters.

<u>Temperature</u>

Temperature – measure of degree of hotness

We have direct experience (hot, warm, cool, cold) but need quantitative scale with numbers.

Thermometer – based on expansion of Mercury (Hg) or other liquid with temperature

Scale	**Freezing**	**Boiling**
Celsius (^oC)	0	100
Fahrenheit (^oF)	32	212
Kelvin (K)	273.15	373.15

Temperature related to motion of atoms at coldest temperature.

There is no motion of nuclei of atoms at "Absolute Zero" 0.000 K = -273.15 ^{o}C.

Temperature conversions

Use formulas below to change among temperature scales

$T_C = (T_F - 32.0)/1.80$ or $T_F = T_C\,(1.80) + 32.0$

$T_K = T_C + 273.15$

Any equation that uses ΔT can be in ^{o}C or K (they will have same amount of change)

Any equation that uses T must be in K
(need correct absolute value with no negative possible).

Ex. Normal body temp is 98.6^{o}C convert to ^{o}C and K

$T_F = 98.6^{o}F$

$T_C = (98.6 - 32)/\ 1.8 = 37.0^{o}C$ (32 and 1.8 are exact numbers)

$T_K = 37.0^{o}C + 273.15 = 310.2$ K

Ex. Person with fever had temperature increase from 37.0^{o}C to 41^{o}C – what is ΔT

$\Delta T = T_{final} - T_{initial} = 41.2\ ^{o}C - 37.0\ ^{o}C = 4.2\ ^{o}C$

$\Delta T = 314.35K - 310.15K = 4.2$ K

Note that if you change $\Delta T = 4.2^{o}$C to K as $\Delta T = 4.2 + 273.15 = 277.35$K that is WRONG
because conversion formulas are for T values not ΔT values.

Heat

Heat is a form of energy and chemical reactions can be exothermic or endothermic

Exothermic – gives off heat and feels warm
Endothermic – takes in heat and feels cool