CHEM131 NOTES

ENERGY is the *capacity to do work*.

- Such capacity is *transferred* to another object for **WORK** to exist. Therefore, work is the act of *transferring* energy.
- Work may also be done while *converting* energy within the system as it is or isn't retained within it.

PHYSICAL CHANGES occurs…

- When a system *absorbs* (endo-) or *releases* (exo-) *thermal energy*.
- By **CHEMICAL REACTION** or **PHASE CHANGE**.
- In *chemistry*, the **SOLUTION** itself is the **THERMODYNAMIC SYSTEM**.

***THERMAL* ENERGY** is denoted by q or Q.

- $q > 0$ implies that process is **ENDOTHERMIC**.
- $q < 0$ implies that process is **EXOTHERMIC**.
- Examples of exothermic processes: Oxidation, Neutralization
- Example of endothermic process: Thermal Decomposition
- Uses the unit, $\mathrm{J} = \frac{\mathrm{kg \cdot m^2}}{\mathrm{s^2}}$, or $\mathrm{cal.}$ $1\ \mathrm{cal.} = 4.184\ \mathrm{J}$.
- In nutrition, $\mathrm{cal.}$, is treated as kcal.

POTENTIAL ENERGY: $E_p = mgh,\ g = 9.81\frac{\mathrm{m}}{\mathrm{s^2}}$ **KINETIC ENERGY**: $E_k = \frac{1}{2}mv^2$

IONIZING RADIATION starts at $1 \cdot 10^{16}\mathrm{Hz}$.

FUEL VALUE is *energy released* when $1\mathrm{g}$ of substance is *metabolized* (cellular respiration). It's also measured via calorimetry.

Carbohydrates are converted to glucose, $\mathrm{C_6H_{12}O_6}$, upon breakdown. Fats are literally broken down into $\_\mathrm{CO_2} + \_\mathrm{H_2O}$ upon contact with $\mathrm{O_2}$.

FUEL EFFICIENCY is *nearly complete conversion of energy* to another form. (lossless conversion) It is denoted by $\mathrm{kJ/kg}$. Gravimetric energy density, in *foods*, *share* the same *unit* as well.

Gravimetric energy density of general component of foods:
FAT: $9.3\ \mathrm{kcal/g}$, **CARBOHYDRATES**: $4.1\ \mathrm{kcal/g}$, **PROTEIN**: $32.9\ \mathrm{kcal/g}$

FUEL is a *transportable combustible material* used to *produce thermal energy*. They are captured via *a* **HEAT ENGINE**, which converts thermal energy to mechanical energy.

Types of Fuel:

- **SOLID**: Easy storage, large waste, low prod cost, high handling cost.
- **LIQUID**: Energy-dense, costs more than solid, fossil-derived. **PETROL** and **LPG** are examples. LPG contains *ethyl mercaptan* to *detect leakages*.
- **GASEOUS**: Naturally-occurring, requires storage tank, prone to leaks, derived from solid or liquid fuel. **SYNGAS**, a gaseous fuel, is made by *coal gasification*. H has potential energy value of $142\ \mathrm{kJ/kg}$.

$$q_{reaction} = -q_{calorimeter}$$
$$q_{calorimeter} = mC_p\Delta T$$

C_p is the **SPECIFIC HEAT CAPACITY** of the substance with its unit, $\frac{\text{J}}{\text{g}\cdot^{\circ}\text{K}}$.
$\gg C_p$, *higher boiling point.* $\ll C_p$, *higher conductivity.*

ΔH is heat of enthalpy.
Its value determines if the chemical reaction is endothermic or exothermic.

Coffee-cup calorimeter:

- Isobaric. $\Delta P = 0$.
- Closed System. $\Delta V = 0$.
- For solids and liquids only

Recall: Thermodynamic Systems

OPEN: $\Delta m \neq 0,\ \Delta E \neq 0$

CLOSED: $\Delta m \neq 0,\ \Delta E = 0$

ISOLATED: $\Delta m = 0,\ \Delta E = 0$