Chapter 10: Energy

These Notes are to SUPPLIMENT the Text, They do NOT Replace reading the Text Material. Additional material that is in the Text will be on your tests!

To get the most information, READ THE CHAPTER prior to the Lecture, bring in these lecture notes and make comments on these notes. These notes alone are NOT enough to pass any test!

Energy is the ability to do work or produce heat

Potential energy is energy due to position – water above a waterfalls

Kinetic energy is energy due to motion

$E_k = \frac{1}{2} mv^2$ m = mass, v = velocity

Law of Conservation of energy: energy can be converted from one form to another, but cannot be created nor destroyed.

EXAMPLE of 2 balls going down a hill and up a slight incline

Work: Force acting over a distance.

State Function is a property of a system that changes independently of it's pathway.

EXAMPLE: Going up a hill directly or by going around the hill

Temperature is a measure of the random motion of the components of a substance

EXAMPLE: Two attached containers one with 90^o C water and one with 10^o C water.

Heat is the flow of energy due to a temperature difference.

ΔT is the change in temperature. Above example $\Delta T = 90^o C - 10^o C = 80^o C$

Chemical Reactions

Exothermic: evolution of heat
In an exothermic reaction, some of the potential energy stored in chemical bonds is converted to thermal energy

Endothermic: absorbs energy

Thermodynamics

First Law of Thermo: The energy of the universe is constant

Internal Energy, E is the sum of the kinetic and potential energy of the system

The change in Internal Energy is $\Delta E = q + w$ q = heat, w = work

For an Exothermic evolution of heat reaction, q is NEGATIVE to indicate the systems energy is decreasing

For an Endothermic absorption of heat reaction, q is POSITIVE

q is measured in **calories** or **joules**. **1 calorie = 4.184 joules** **1 cal = 1 J**

DO SOME ENERGY CONVERSIONS

Another definition of a **calorie is the amount of energy required to heat 1 g of water 1^o C**

WORK SOME PROBLEMS FOR HEATING WATER

How much energy in joules is required to heat 100. g of water from 0^o C to 100^o C?

Specific Heat Capacity is the amount of energy required to change the temperature of 1 gram of a substance 1^{o}C.

Substance	**Specific Heat Capacity in J/g ^{o}C**
Water	4.184
Aluminum	0.89
Iron	0.45
Mercury	0.14
Carbon	0.71
Silver	0.24
Gold	0.13

Example 10.3 How much energy is required to heat 1.3 g of iron from 25^o C to 46^o C?

Q = s * m * Δt s = Specific Heat, m = mass, Δt = change in temperature

Q = 0.45 J/g ^{o}C * 1.3 g * (46^o C - 25^o C) = 12.285 J = 12 J [Note 2 SigFig]

Exercise 10.3 How much energy is required to heat 5.63 g of gold from 21 ^{o}C to 32 ^{o}C?

Example 10.4 A 1.6 g sample of a metal requires 5.8 J to change it's temperature from 23 to 41 ^{o}C. Is the metal gold?

Hint: Solve the above equation for "s"

Exercise 10.4 a 2.8 g of metal requires 10.1 J of energy to heat it from 21 to 36 ^{o}C. What is the metal?

Enthalpy: how much energy is produced or absorbed in a chemical reaction.

Enthalpy is H, but we measure the **change in enthalpy = ΔH** At **q_p = ΔH**

Example 10.5 1 mol of methane (CH_4) is burned at P_K and 890 kJ of energy is released. What is the ΔH?

ΔH = Energy / m = -890 kJ / 1 mol = - 890 kJ/mol

How much energy is given off by burning 5.8 g of methane?

Exercise 10.5 How much energy is given off by reacting 1.00 g of Fe with excess oxygen

$4 Fe + 3 O_2 \rightarrow 2 Fe_2O_3$ ΔH = -1652 kJ

Hess's Law: in going from a particular set of reactants to a particular set of products, the change in enthalpy is the same whether the reaction takes place in one step or in a series of steps.

DO EXAMPLE OF PROPANE

Quality of Energy

Heat Death: all of the energy of the universe is spread evenly throughout the universe and everything is at the same temperature. At this point it will not be possible to do work.

Energy and out World

Fossil fuels: Plants have stored energy via photosynthesis and then decay to become fossil fuels

Petroleum: a thick dark liquid composed mostly of hydrocarbons [C & H containing compounds]

Natural Gas: a mixture mostly of methane [CH_4], with traces of ethane [$H_3C\text{-}CH_3$] and propane [$H_3C\text{-}CH_2\text{-}CH_3$] and butane [$H_3C\text{-}CH_2\text{-}CH_2\text{-}CH_3$].

Gasoline	$C_5 – C_{10}$ fractions
Kerosene	$C_{10} – C_{18}$ fractions
Diesel Fuel	$C_{15} – C_{25}$ fractions
Asphalt	$> C_{25}$

Pyrolytic cracking: heating kerosene to 700 ^oC go break it into smaller molecules

Engine Knocking is caused by uneven burning of gasoline vapours in the car engine. Adding **Tetraethyl Lead ($(C_2H_5)_4$ Pb** would stop knocking. But Lead vapours started to build up in our atmosphere which was not a good thing!

Coal: a complex organic material with an empirical formula of CH_2O and a molecular weight around 500,000 g/mole.

Coal Type	**% Carbon**	**% Sulfur**
Lignite	71	1
Subbituminous	77	1
Bituminous	80	**5**
Anthracite	92	1

The more carbon, the more energy you can get from burning coal

Greenhouse Effect

Sun → **Visible Radiation** → **EARTH** absorbs the light

Earth converts light to heat and **radiates the heat out** → heat or Infra-Red Radiation

CO_2 in the atmosphere **absorbs the IR** and eventually **re-radiates it out**

It radiates it half out to outer space and half back to earth.

The **half reflected back to earth** is called the **Blanket Effect.**

Where does CO_2 come from?

Entropy

Second law of Thermodynamics: The entropy of the universe is always increasing

Entropy is also known as the randomness of something

Burning of a wood log to generate CO2, H2O, ashes and energy

Log [Carbon] + O_2 → CO_2 + H_2O + ashes and energy

You never see carbon dioxide water and ashes and energy forming a log, do you?

Put two flasks together, one filled with a gas one with a vacuum. Open the valve between the flasks, the gas will now fill both flasks. Have you ever seen the reaction to go the other way?

Energy Spread: Light a Bunsen burner. Methane burns to form CO_2 + H_2O + energy
The energy, or heat and light spreads out. Have you ever seen it go the other way?

These all describe Entropy. Entropy (S) is a measure of disorder or randomness, as these increase, S increases.