Energy Changes in Chemical and Nuclear Reactions

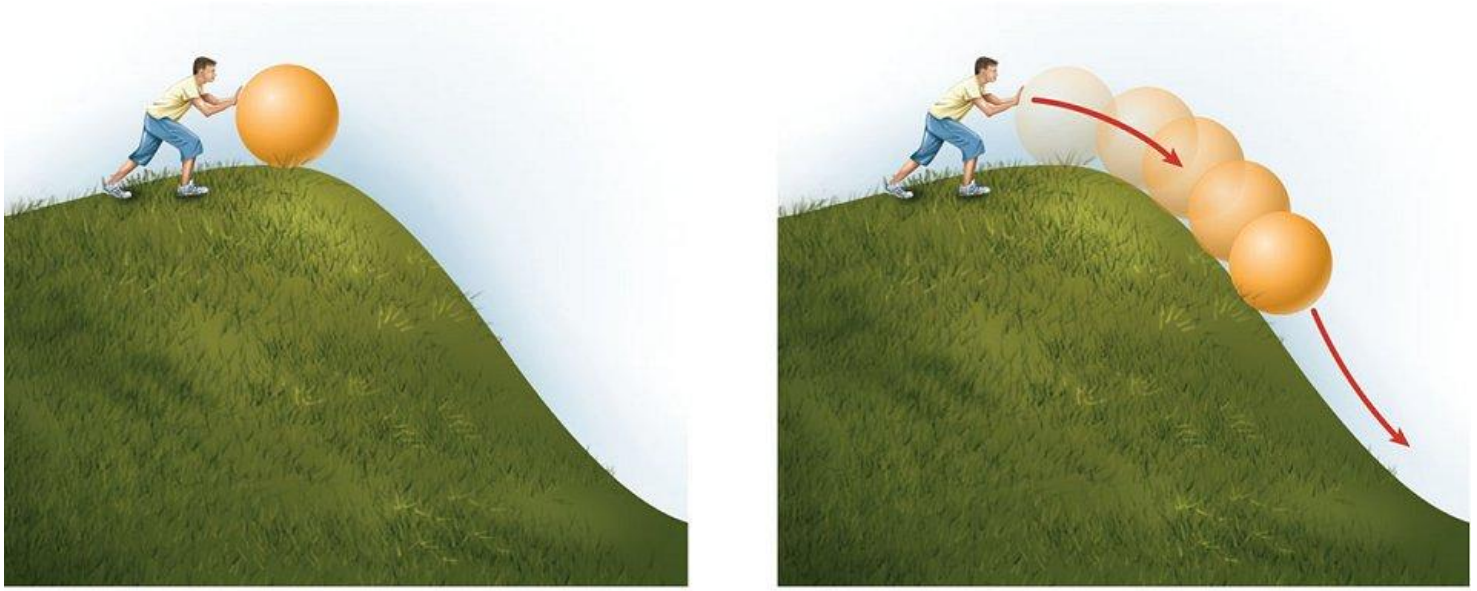
Chapter 5.1

Thermochemistry

- **Thermochemistry** is the study of the energy changes that accompany physical or chemical changes in matter
- **Energy** is the ability to do work, measured in joules (J)
- **Work** is the amount of energy transferred by a force over a distance, also measured in joules (J)

Types of Energy

- **Potential Energy** is the energy of a body or a system due to its position or composition
- **Kinetic Energy** is the energy of an object due to its motion

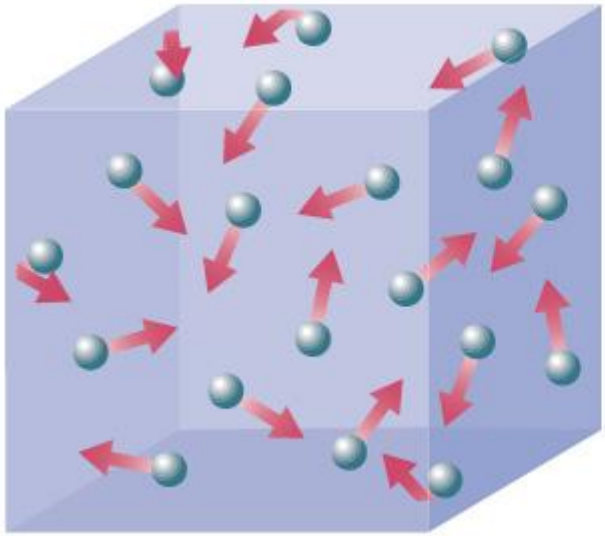


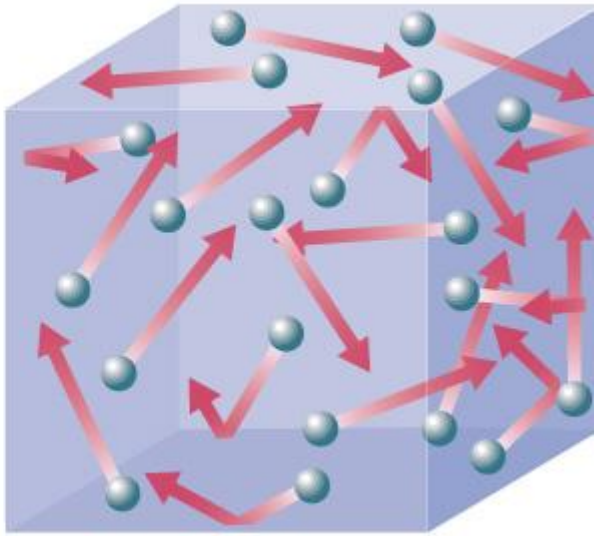
a) Potential energy

(b) Kinetic energy

Thermal Energy

- **Thermal energy** is the total quantity of kinetic and potential energy in a substance
- This depends on how fast its particles are moving
- When a substance absorbs thermal energy, its particles move at a greater speed and it warms up

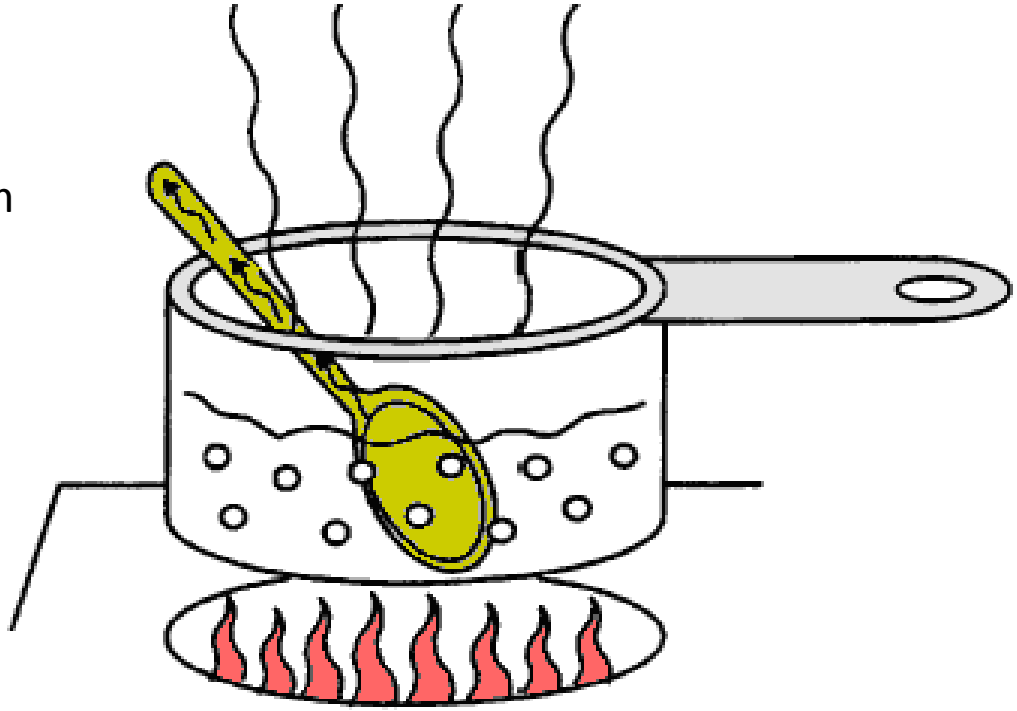




Heat

- **Heat** is the transfer of thermal energy from a warm object to a cooler object (it is a verb)

As we *heat* the water, we are *transferring thermal energy* from the stove burner to the water



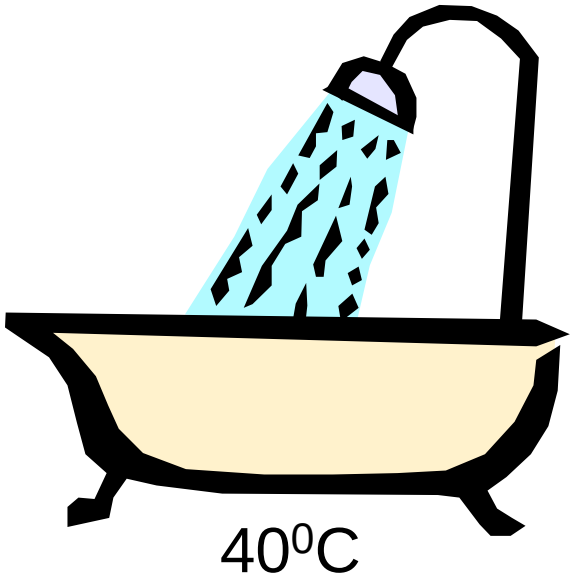
Temperature

- **Temperature** is a measure of the average kinetic energy of entities in a substance
  - As a substance is warmed, some of its particles move faster
  - The average kinetic energy of the substances particles increases and so does the temperature of the substance

Temperature ≠ Thermal Energy

90^0C

- The cup of water has the **higher temperature** because the average water molecule is moving faster
- The total quantity of **thermal energy is lower** in the cup because there are fewer water molecules in total

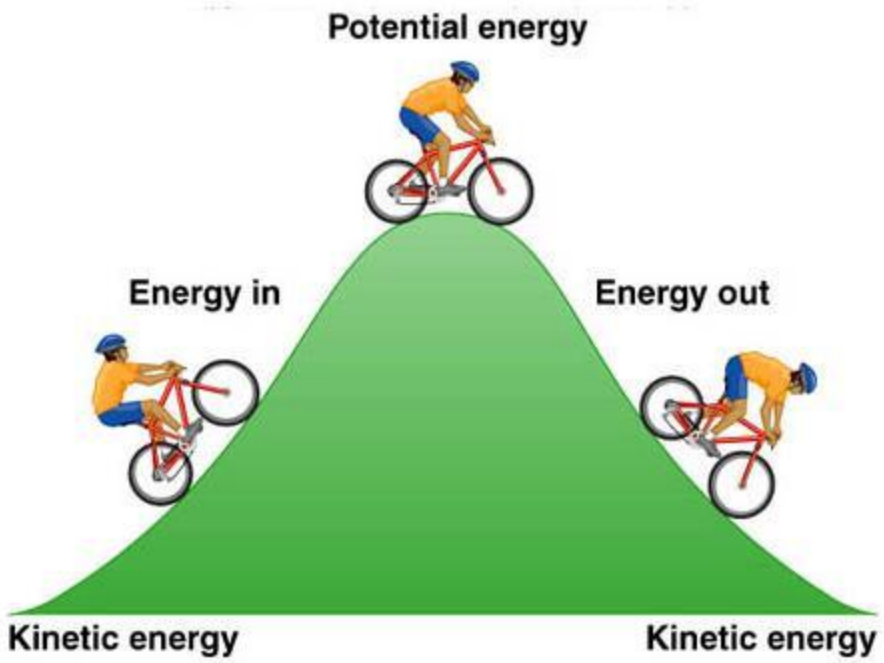


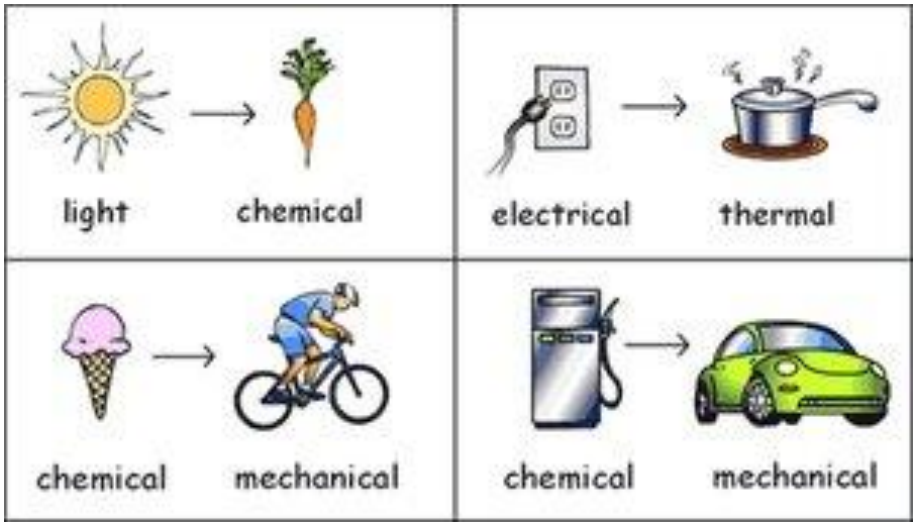
40^0C

- The bathtub of water has the **lower temperature** because the average water molecule is moving slower
- The total quantity of **thermal energy is higher** in the bathtub because there are more water molecules in total

Law of Conservation of Energy

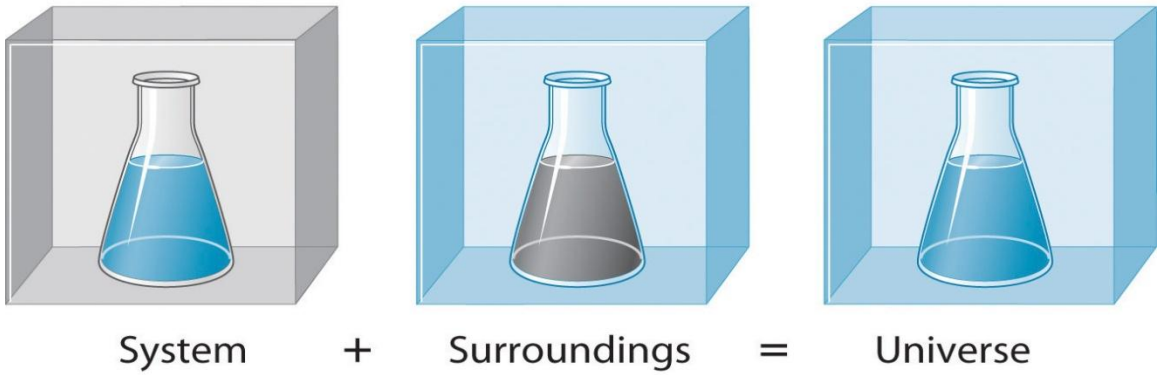
- The **Law of Conservation of Energy** states that energy cannot be created or destroyed, it can only be converted from one form into another





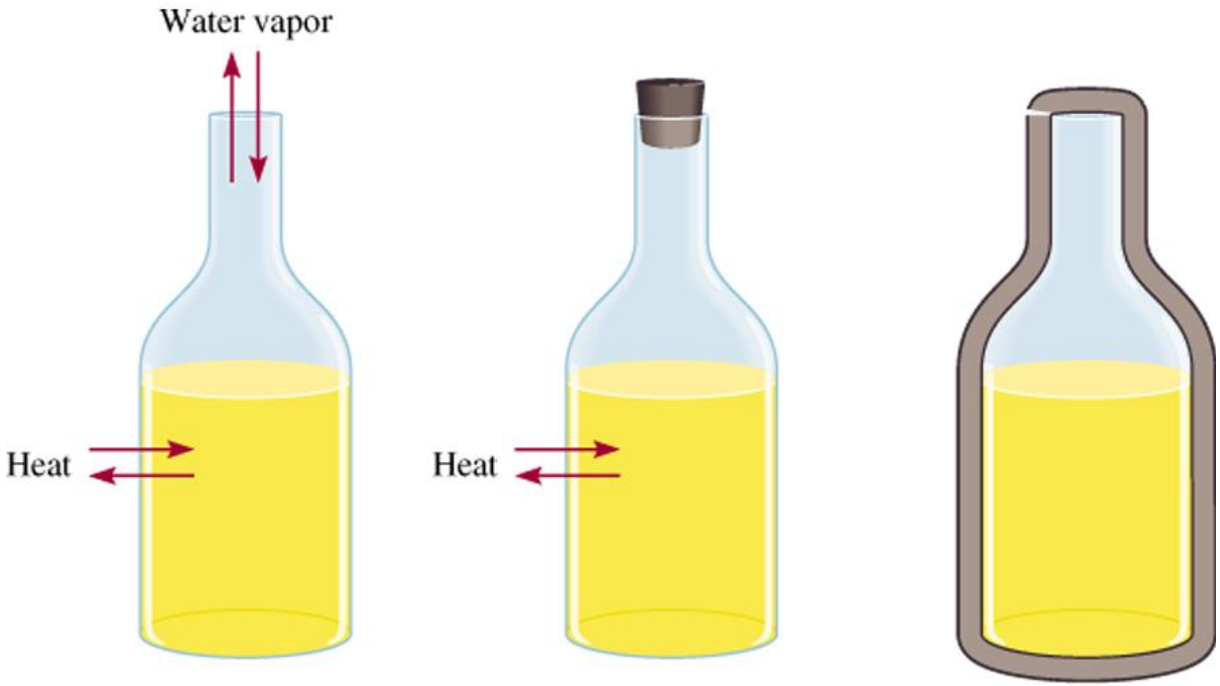
Divisions of the Universe

- A **chemical system** is a group of reactants and products being studied
- The **surroundings** are all the matter that is not part of the system



Types of Systems

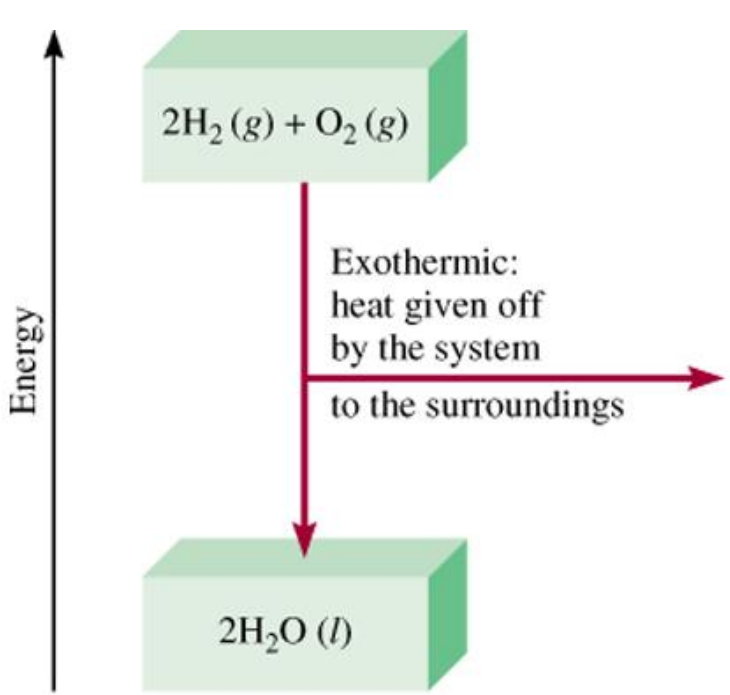
- An **open system** is a system in which both matter and energy are free to enter and leave the system (ex: barbecue)
- A **closed system** is a system in which energy can enter and leave the system, but matter cannot (ex: glow stick)
- An **isolated system** is an ideal system in which neither matter nor energy can move in or out (it is impossible to set up a completely isolated system)



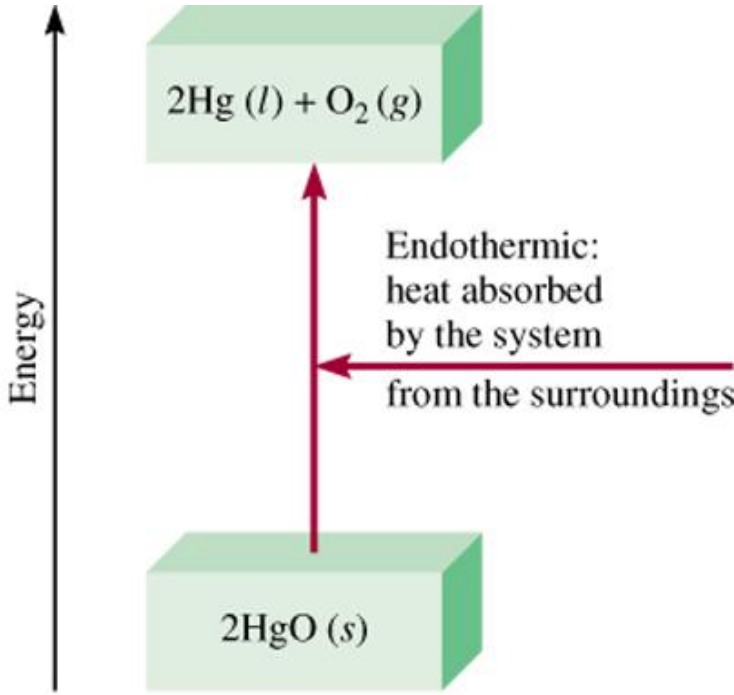
Endothermic and Exothermic Reactions

- An **exothermic** chemical reaction is one in which energy is released from the system to the surroundings
- An **endothermic** chemical reaction is one in which energy is absorbed by the system from the surroundings

$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(l)} + \text{energy}$

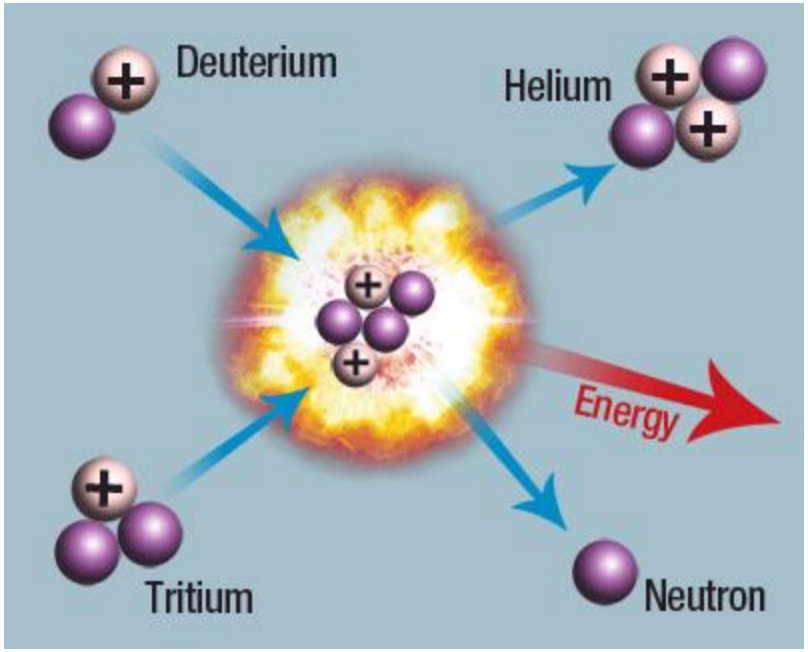


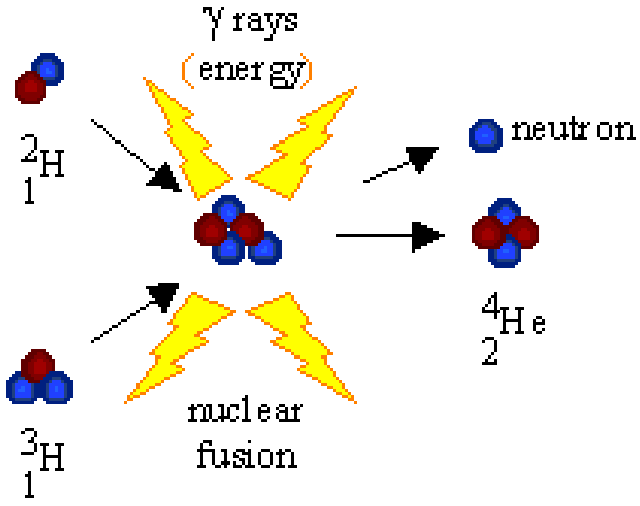
$2HgO_{(s)} + \text{energy} \longrightarrow 2Hg_{(l)} + O_{2(g)}$



Nuclear Energy

- A **fusion** reaction is the process of combining two or more nuclei of low atomic mass to form a heavier nucleus





Nuclear Energy

- A **fission** reaction is the process of using a neutron to split a nucleus of high atomic mass into two nuclei with smaller masses

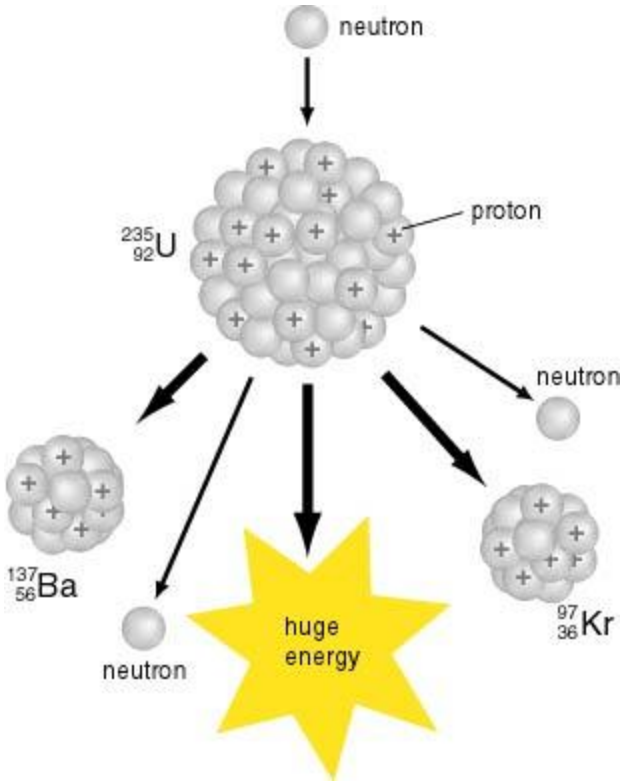
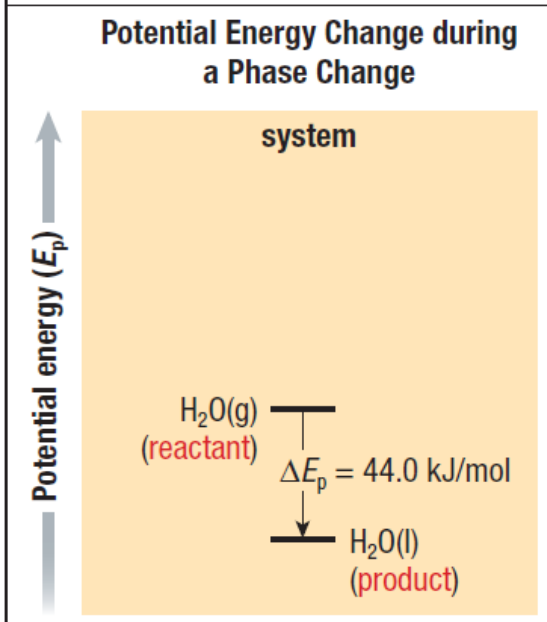
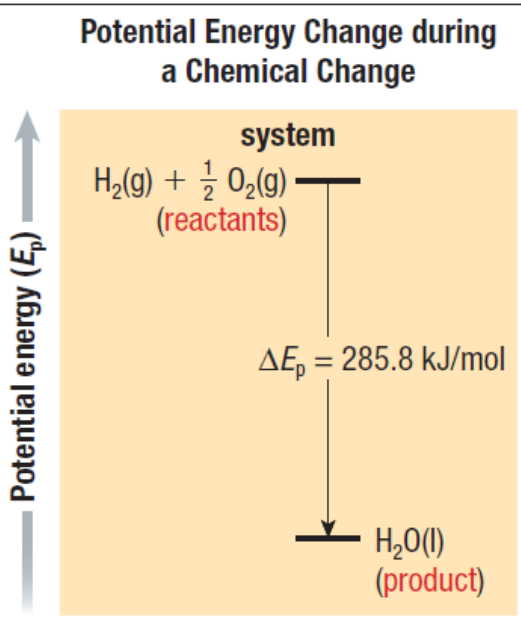
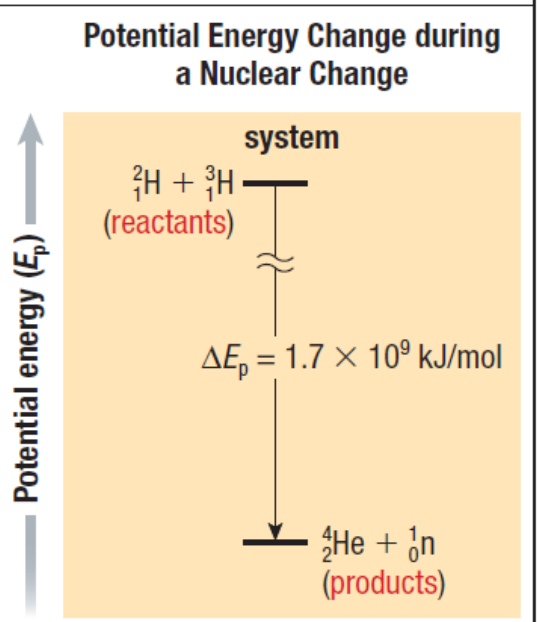


Table 1 Examples of Magnitudes of Potential Energy Changes during a Phase Change, Chemical Change, and Nuclear Change

Phase change	Chemical change	Nuclear change
$H_2O(g) \rightarrow H_2O(l)$	$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$	${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$
		

HOMEWORK

Required Reading:

p. 284-291

(remember to supplement your notes!)

Questions:

p. 291 #1-9