Chapter C11: Energy in Bonds

C11.1: Potential Energy Diagrams

- The Force experienced by the small object is related to the slope of the potential energy graph:

$$F_x = -\frac{\Delta V}{\Delta x} \ . \tag{1}$$

- This equation is important, because it helps us interpret these potential energy diagrams.
- The main point of this, and the next section, is that a potential energy diagram tells us lots of qualitative information about how the object will move.

C11.2: Bonds

The key picture:

Key ideas:

- Turning points
- Forbidden regions
- Bonds

C11.3: Latent "Heat"

The latent of transformation is the extra internal energy that must be absorbed (or removed) for one kilogram of a substance to undergo the transformation.

$$\Delta U^{\text{th}} = |mL| \, . \tag{2}$$

As with specific "heat", minus signs require some care.

C11.4: Chemical and Nuclear Energy

Useful info:

- Burning a kg of gasoline releases roughly 46 MJ of internal energy.
- Burning a kg of natural gas releases roughly 55 MJ of internal energy.
- For chemical reactions, the energy released per kg ranges between 10 and 100 MJ.
- For nuclear reactions, the energy released per kg ranges between 50 and 500 TJ. (1TJ = 1×10^{12}J.)

Examples

1. How much internal energy must be removed from 500 g of water at 0^0 in order to freeze it?
2. How much ice must be placed in 700 g of water to cool it from room temperature to 0 C?
3. On a glacier research expedition you plan on drinking water obtained by melting the glacier. You'll melt this water with your gasoline camp stove. If you drink 2 kg of water a day, what is the minimum amount of fuel you should bring for each day?

Practice:

1. If you climb up a 400 meter mountain, what is the minimum amount of food calories you need for this task?
2. In a workout you sweat and evaporate half a kilogram of water. What is the minimum amount of food calories you must have "burned"?
3. How much energy is needed to melt 3 kg of copper that is already at its melting point?
4. How much fuel will be needed to bring a Nalgene bottle full of water from 20°C to 100°C?