Lecture 8

April 18, 2012

Specific heat refers to the capacity of a body to
absorb heat, while remaining in a single phase.
However, there are other and more complex possibilities that we now study.

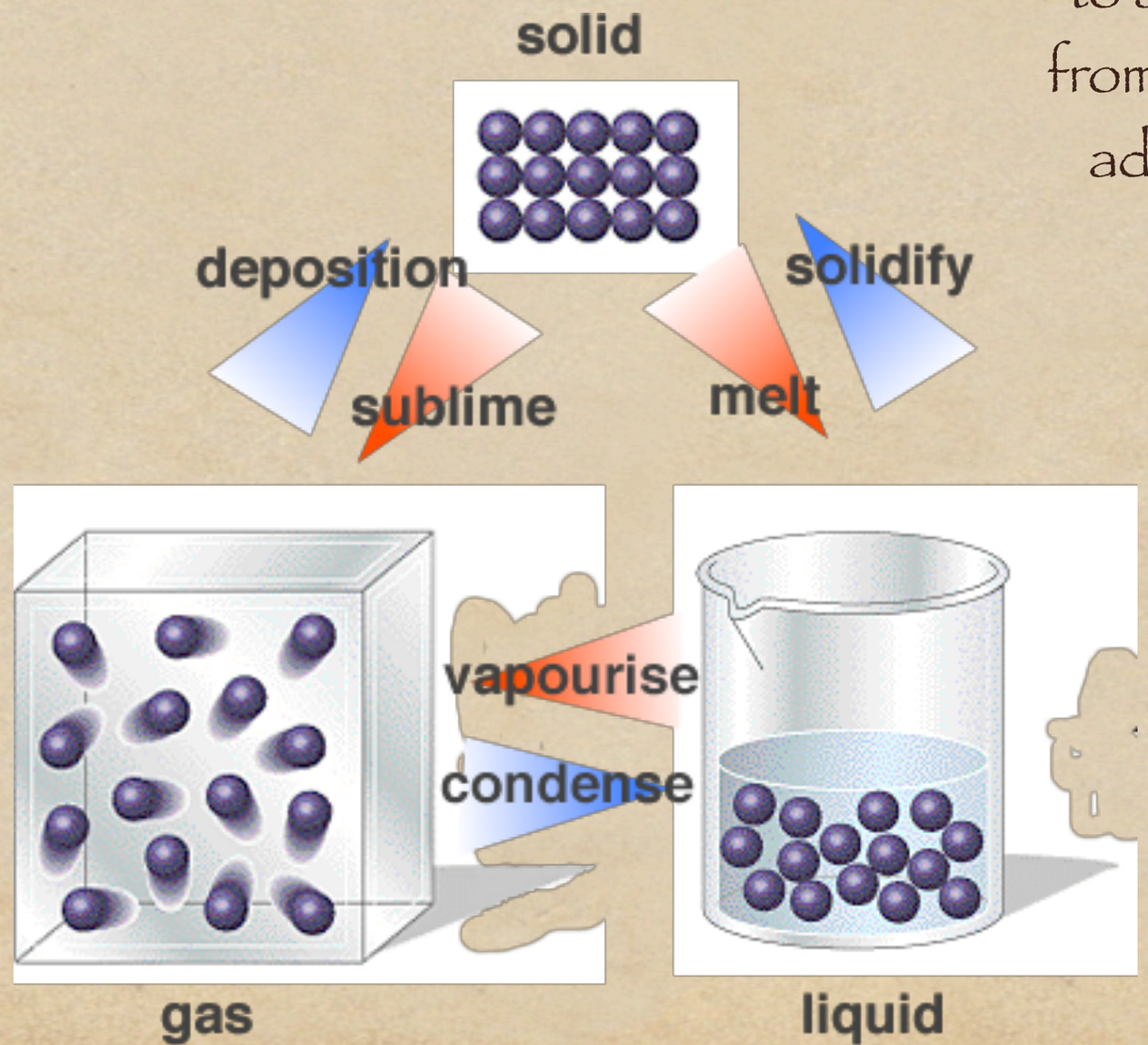
These involve change of "phase",
e.g.

Liquids can freeze to give solids
Liquids can evaporate to give gases
and the reverse of these phenomena are melting and condensation.

Changes of phase and Latent heat

Solid state (ice, rock)
Liquid state (water, lava)
Gas state (vapour, dispersed ash)

The same matter, in different conditions exhibits different phases. Converting from one phase to another either absorbs energy from environment (endothermic) or adds energy to the environment (exothermic).



ice melts	$\Delta Q<0$	Need to supply heat from neighbourhood
water freezes	$\Delta Q>0$	warms the neighbourhood
water evaporates	$\Delta Q<0$	Need to supply heat from neighbourhood
vapour condenses	$\Delta Q>0$	warms the neighbourhood

Reactions and heat of chemical reactions
Exothermic versus endothermic

$$C + O_2 \rightarrow CO_2 + \quad 95 \text{ kcalories per mole}$$

- BASICS OF CHEMICAL REACTIONS
- Mole contains $N_A = 6 \times 10^{23}$ Avogadro's number of atoms
- Atoms have three numbers
  - A=mass number
  - Z=atomic number
  - N= neutron number
  - A=Z+N
- e.g. Carbon has A=12,Z=6,N=6
- Oxygen has A= 16,Z=8,N=8
- One mole of carbon weighs A gms and one mole of oxygen weights 16 gms
- One mole O_2 weighs 32 gms

The reaction per mole may be described as:

12 grams of Carbon + 32 grams of Oxygen combine to give 44 gms of CO2 and 95 kcalories of heat.

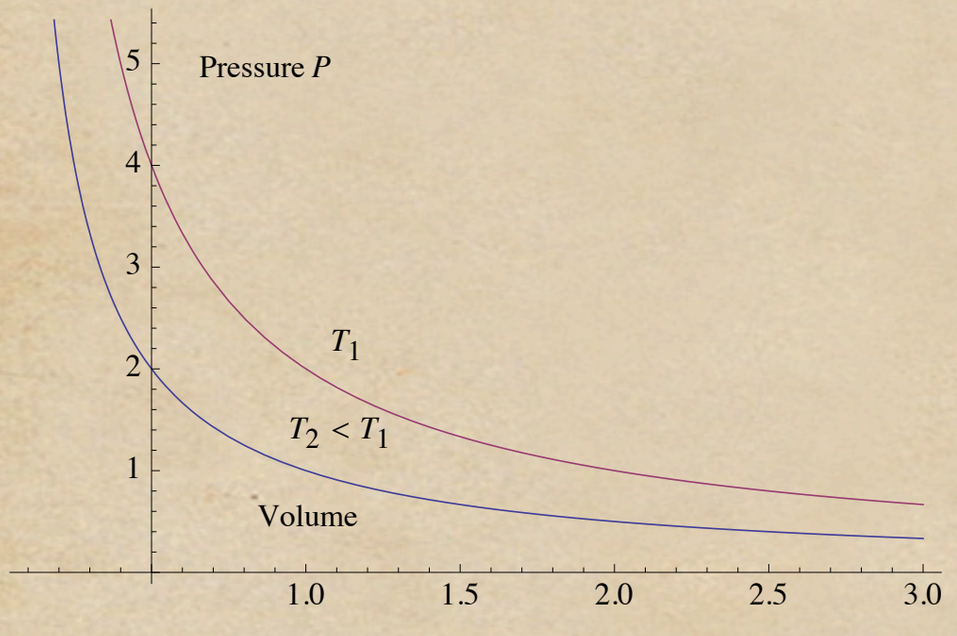
Problem: Calculate the number of Btu of energy obtained by burning one tonne of coal.

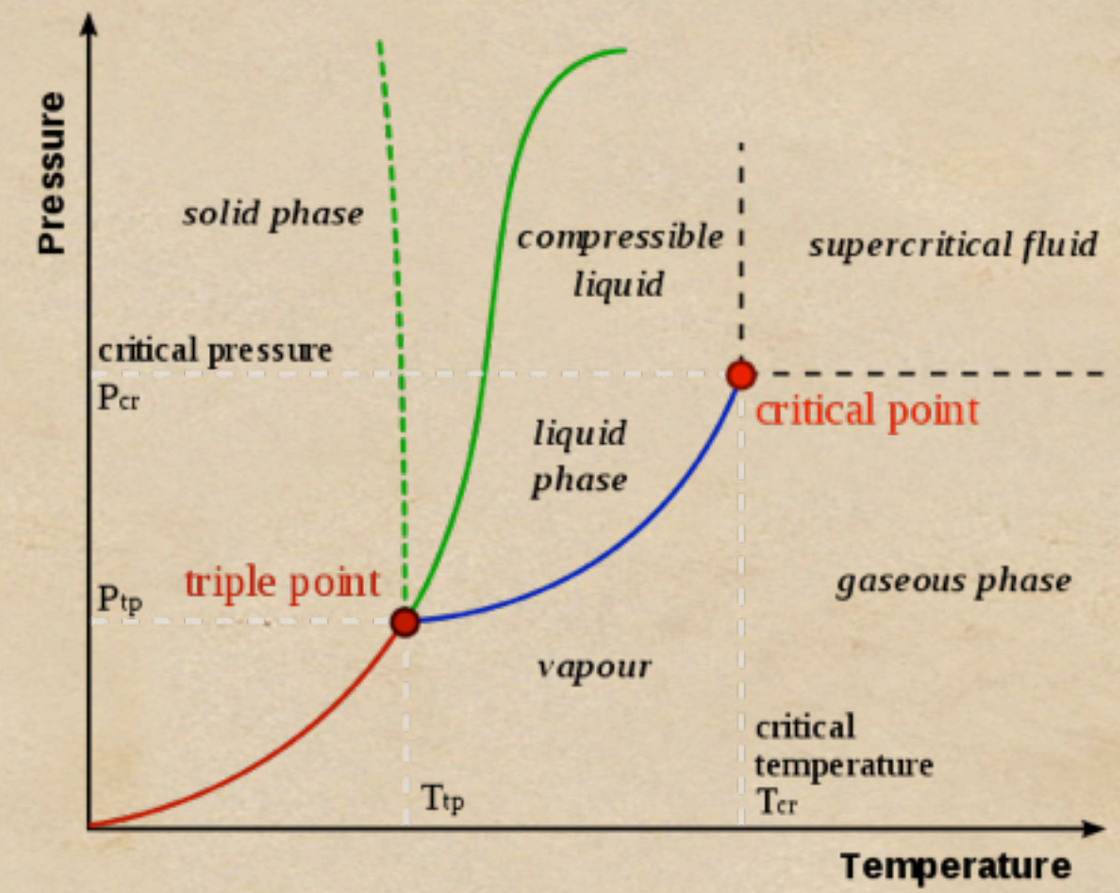
Solution: 32 Million Btu

Phase diagram and latent heat

Gases compress. T also compresses

p V = R T is the "gas law"





When thermal energy is withdrawn from a liquid or solid, the temperature falls. When thermal energy is added to a liquid or solid, the temperature rises. However, at the transition point between solid and liquid (the melting point), extra energy is required (the heat of fusion).

In going from liquid to solid (freezing), the molecules of a substance become arranged in a more ordered state. Since the solid is more ordered, it has a lower energy and the excess energy is released- exothermic in this process.

In going from solid to liquid (melting), the molecules of a substance become arranged in a less ordered state. Heat energy is needed to "break" the solid's crystalline order hence absorbs i.e. endothermic.

In both cases change of state occurs at fixed temperature.

The heat of fusion can be observed by measuring the temperature of water as it freezes. If a closed container of room temperature water at 20 ^{0}C is plunged into a very cold environment (say –20 °C), the temperature will fall steadily until it drops just below the freezing point (0 °C). The temperature then will rebound and hold steady while the water crystallizes. Once the water is completely frozen, its temperature will fall steadily again.