**UNIT 8 – Physical Behavior of Matter - Test April 15, 2016**
Kavanah pp. 57-77 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



# Heating and Cooling Curves

## Phases of Matter – Review

### Solid phase

#### Rigid

#### Definite volume and shape

#### Strong intermolecular forces hold particles in place with only small vibrations

#### Ex. ice, iron, aluminum

### Liquid phase

#### Particles are able to move past each other

#### No definite shape, but liquids have a definite volume

#### Ex. water, ethanol

### Gaseous phase

#### Very small intermolecular forces

#### No definite shape and no definite volume

#### Gases expand to fill the size of a container

#### Ex. nitrogen gas, oxygen, water vapor (vapor is the word used for substances that are liquid or solid under normal conditions)



## Reading the Heating Curve HW Kavanah 60-61

### Solid section

#### Begin with ice in a very cold freezer.

#### What is freezing point of water? 0 Celsius

#### If ice is “supercooled” it is below 0 celsius.

#### Remove from freezer and slowly let it warm up. Measure temp every 15 seconds.

#### The ice will warm up but stay solid until it reaches its melting point. As it warms, the kinetic energy of the particles increases.

#### Kinetic energy – energy of motion. The particles vibrate more as temperature increases..

### Melting (aka fusion)

#### Water molecules vibrate fast enough to break the bonds holding them in the solid phase

#### Even though heat is still added to the ice, the temperature does not increase

#### Phase changes (e.g. melting) occur at constant temperature. Kinetic energy of the particles stays the same.

#### Potential energy increases

#### Water and ice (solid and liquid) are both present

#### Melting is endothermic – heat is absorbed

#### The energy required to melt the ice is called heat of fusion

### Liquid section

#### Now that all the H2O is in liquid form, it can begin to warm up

#### As energy is added to the water, the temperature increases

#### The temperature of a substance is directly proportional to the Kinetic Energy of the particles in degrees Kelvin

#### Therefore, kinetic energy increases

#### Temperature increases until the boiling point is reached

### Boiling (aka vaporization)

#### Boiling begins when some of the particles have enough kinetic energy to break out of the liquid phase into the gas phase

#### During boiling, temperature remains constant.

#### Kinetic energy is constant, but potential energy increases

#### Liquid and vapor are both present

#### Boiling is endothermic

### Gas section

#### Once all the water has turned to steam, and we continue to add energy, the temperature will increase

#### Kinetic energy increases as temperature increases

# Heat Energy

## Do now: Label a cooling curve

### With these words

#### Kinetic energy

#### Potential energy

#### Boiling point

#### Freezing point

#### Solid, liquid, gas

## Temperature HW Kavanah p. 63

### Proportional to average kinetic energy of particles

### Depends only on kin. energy, not on the amount

#### Ex. Which has greater kinetic energy? 10 g of water at 50 Celsius or 500 g of iron at 20 Celsius?

#### Answer: The water, because it is hotter.

### Measured with a thermometer

#### Common thermometers are calibrated using the boiling point and freezing point of water

#### K = C + 273

#### Each degree is the same in Kelvin or Celsius, because there are 100 degrees between boiling and freezing

#### Degrees Fahrenheit are not so easy to convert, because there are 180 degrees between boiling and freezing

## Heat

### Heat and energy are NOT THE SAME

### When 2 bodies have a temperature difference, heat will FLOW until the temperatures are equal

### Heat is ENERGY

### Heat flows from one place to another

### heat is measured in claories or joules, not Kelvin or celsius

### Ex. When requires more energy, melting 1 gram of ice or 10 grams of ice?

### Ans: 10 grams of ice, because heat is energy and it depends on the amount of substance.

## Heat of a temperature change

### Formula is q=mCΔT (formula in Table T)

### q is heat (in joules)

### m is mass of substance (in grams)

### C is specific heat capacity of substance (in Table B)

### ΔT is change in temp. Final temp – initial temp.

### Ex. How many joules are absorbed with 50.0 g of water are heated from 30.0 degrees to 60.0 degrees?Ans: Write the givens.q=(50 g)(4.18 J/ g C)(60-30)=6270 J

## What is a calorimeter?

### A device used by scientists to measure the amount of heat given off by a reaction

### Reaction takes place in an insulated container filled with water.

### Heat given off by exothermic reaction has to go somewhere. Where? Energy can never be created or destroyed.

### Heat goes into the water and the temperature of the water rises.

### You can calculate the amount of heat energy using the equation q=mCΔT

### Calorimeter measure calories (or joules)

###

## Heat of a phase change HW Kavanah p. 65

### Review: what are the phase changes?melting (aka fusion or freezing) and boiling (aka vaporization or condensation)

### Phase changes occur at constant temp so I can’t use q=mCΔT formula

### Use q=mHf for solid🡪liquid or liquid🡪solid phase change

### Use q=mHv for liquid🡪gas or gas🡪liquid phase change

### Ex. How many joules are required to melt 100 grams of ice at 0 celsius?Ans. Write the givensq=100g x 334 J/g = 33400 J = 33.4 kJ

### Melting is endothermic. Heat is absorbed and the potential energy increases.

### Ex. How many joules of energy are required to vaporize 200. grams of water at 100 celsius?Ans. Write the givens.q=mHv = 200 g x 2260 J/g = 452,000 J = 452 kJ

# Gas Laws

## Pressure

### Force divided by area

### Units are atmospheres, mm Hg (aka Torr), pascals, kilopascals, and pounds per square inch

### 1 atm = 760 mm Hg = 101.3 kPa = 14.7 psi

### You can use any unit of pressure as long as you are consistent throughout the problem

### Pressure is the collision of gas particles against the walls of the container

## Boyles Law HW plot pressure vs volume data

### When you push in a piston, pressure increases.

### As you increase the pressure, the volume decreases.

### P1V­1=P2V2

### Pressure and volume are inversely related P↑V↓

### Ex. #47What volume will a 300.0 mL sample of a gas at STP occupy when the pressure is doubled at constant temperature?Same question if the pressure is cut in half?Same question if I change the pressure from 1 atm to 1.5 atm?

## Charles Law HW plot volume vs temperature

### The volume of a gas is directly proportional to temperature when pressure is constant.

### A balloon is at constant atmospheric pressure because the atmosphere is pressing on it

### When you chill a balloon it contracts. When you heat it, it expands

### Internal combustion engines run on Charles Law. The gases expand due to high temperature, pushing the piston down. Watch video.

## Gay-Lussac Law

### Memory crutch for the gas laws

#### Table T combined gas law

#### Move clockwise in alphabetical order

### The pressure of a gas is directly proportional to the temperature when you hold the volume constant.

### Caution: Never throw an aerosol can into the fire!

### Why not? Volume is held constant by the can. Temp causes pressure build up until the can explodes.

## Combined Gas Law

### This is the only law I use. I just cross out the variable that is not being used in in the particular example.

### Combined gas law is in Table T.



## Ideal Gases PV=nRT (extra credit extension topic)

# Kinetic Molecular Theory HW Kavanah p. 66

## Theory

### Review: A theory is a model that is used to explain some aspect of the natural world that is repeatedly tested and confirmed through observation and experimentation.

### Compare to theories of the atom.

### KMT explains the observations about gases that Boyle, Charles, Gay-Lussac, Avogadro, and other scientists have made.

## Major ideas of KMT

### Gases contain particles (atoms like He or molecules like H2) that are in constant, random, straight-line motion. Whiz! Whiz!

### Gas particles collide with each other and with the walls of the container, but no net energy is lost in these collisions. This is called an elastic collision (Physics preview)

### Gas particles are far apart.

### The volume of each gas particle is so small that it is negligible.

### Gas particles do not attract each other (no IMF).

## Ideal vs real gases

### KMT is based on an “ideal” gas with all of the above properties.

### It is a good approximation, but real gases behave slightly differently.

#### There is some attraction between gas particles, ex. water vapor molecules combine to form snow and rain.

#### Gas particles do have some amount of volume

### When do gases look more “ideal”?

#### Low pressure 🡪 gas particles are more spread out so there is less chance of collision and volume of container is much bigger than volume of particles

#### High temperature

#### Low mass 🡪 smaller particles like He and H2 have lower IMF

# Avogadro’s Hypothesis

## When P and T are all the same, an equal number of particles always has the same volume, regardless of the gas.

## Ex. 12 L of nitrogen has the same number of molecules as 12 L of oxygen at STP

## 1 mole of any gas has a volume of 22.4 liters at STP

## 1 mole of any substance contains 6.02 x 1023 particles