Chapter 1 – Kinetic Molecular Theory

Kinetic Molecular Theory (KMT) → states that all matter is made up of tiny particles that are in constant, random motion

States of Matter

a. Solid
   - Fixed shape → according to the KMT, solids have fixed shape due to their molecules having so little kinetic energy that they can only vibrate and rotate in place, and also because they are held together by very strong intermolecular forces (IMF).
   - Fixed volume
   - Cannot be compressed → because its particles are already very close together (also why they have fixed volume)

b. Liquid
   - No fixed shape → the IMF between the molecules of liquid are weaker than solid which is why the molecules of liquid have enough kinetic energy to slide over one another
   - Fixed volume
   - Cannot be compressed

c. Gas
   - No fixed shape → the IMF between gas molecules are so weak that they are close to nonexistent and they have sooooo much kinetic energy which is why they move about rapidly in all directions
   - No fixed volume
   - Can be compressed → since gas molecules have a lot more spaces between them than liquids and solids, they are easily compressed if you apply pressure

Changes of State

- What causes this?
  - Heat and cooling
- Effect of Heat on Molecules
  - When an object is heated, the molecules that they are made up of get more kinetic energy and end up overcoming the IMF. Ex. Ice turns to water when heated
  - What happens when you place a balloon in hot water?
    - ➔ It will expand because of the heat from outside is absorbed by the gas inside the balloon, and the hotter an object, the more kinetic energy it gets, so the gas molecules will move around a lot faster making the balloon bigger
    - ➔ Hot air expands, but is less dense
  - Is it possible to make a balloon smaller or deflate it without taking out its air?
    - ➔ Yes, if you stick it in a freezer, the heat will leave the gas inside the balloon since it is a property of heat that heat will always go where it's cold, and since the heat escapes, so does the kinetic energy, therefore, the balloon will contract due to the kinetic energy of the gas molecules becoming a whole lot weaker
    - ➔ Cold air contracts, but is more dense
    - ➔ NOTE: THE AMOUNT OF AIR **WILL NOT** CHANGE, only the amount of kinetic energy
  - NOTE: No heat = no kinetic energy
  - What do you think will happen to the density of gas when you heat it? Explain how it happened
    - ➔ Because of hot air, molecules are more spread out because they have more kinetic energy, so there will be less molecules in a given area making hot air less dense
      - ■ Bottom line: More KE, more spread out, less molecules in a given space
- Melting

  Step 1: energy is absorbed by particles in the solid and is converted into kinetic energy causing the particles to vibrate faster in their fixed positions

  Step 2: when the temperature is high enough, the vibrations of the particles will become strong enough to overcome the IMF and break away from their bonds

  Step 3: the particles start to slide over one another meaning that it has now become a liquid
  - Melting point – the temperature at which a solid becomes a liquid
  - Why is it that in the graph of temperature against time, there will be a part of the graph that is a straight line meaning that the temperature stays constant?

    A: At that point, the temperature remains constant because all the energy is taken in by the particles so that it could melt; this long line is the melting point
  - Heating curve – shows how the temperature of a solid changes as it is heated to its melting point
  - STUDY GRAPH ON PAGE 9

- Freezing
  Step 1: heat is given off from the particles causing them to lose kinetic energy
  Step 2: when the temperature gets low enough, the particles no longer have enough kinetic energy to move and some even settle into fixed positions
  Step 3: all particles settle and can only vibrate and rotate in their fixed positions meaning that the object is now a solid
  - Freezing point – temperature at which the liquid freezes into a solid
  - Why is it that in the graph of temperature against time, there will be a part of the graph that is a straight line meaning that the temperature stays constant?
    A: because the heat energy is released by the particles as they get attracted closer to one another
  - Cooling curve – shows how the temperature of a pure liquid changes as it is cooled into its freezing point
  - STUDY GRAPH ON PAGE 10
- Boiling
  - Liquid to gas

  Step 1: energy is absorbed by particles of liquid and they start to move faster as it gets hotter
  Step 2: soon, the particles of the liquid have enough energy to break free from their bonds and become gas
  - Boiling point – temperature at which liquid turns to gas
  - Graph is different from the 2 previous graphs
  - Why does the temperature remain constant?
    A: because the particles use the heat to overcome the IMF, so the line will remain constant until all the liquid turns into gas
  - STUDY GRAPH ON PAGE 11
  - When you boil something, the bubbles that you see consist of lots of different gasses that dissolve into the liquid that rise to escape into the air
- Evaporation
  - Liquid to gas, but below boiling point temperature
  - Liquid escapes from surface, not from bottom
  - Volatile liquids – liquids that evaporate quickly
- BOILING VS EVAPORATION
  - Boiling – only occurs at boiling point, occurs throughout the liquid and occurs quickly
  - Evaporation – occurs below boiling point, occurs only on surface and occurs slowly
- Condensation
  - Gas to liquid when cooled
    Ex. When water vapor touches a cold surface, it turns into water
  - Reverse of boiling
  - Heat energy is given out during condensation causing the gas to lose kinetic energy, slowing the movement and eventually making it turn back into gas
- Sublimation
  - Solid to gas without going through liquid
  - When dry ice is exposed to temperatures higher than -78°C, it turns into CO_2
  - Occurs when particles at the surface of a solid have enough energy to break away from the solid
  - Gas to solid is also called condensation

Chapter 2 – Measurement and Experimental Techniques

Measuring…

- … time – use stopwatch; SI unit: seconds (s)
- … temperature – use mercury thermometer; SI unit: Kelvin (K)
- … mass – use beam balance or electronic balance (has accuracy of 0.01); SI unit: kilogram (kg)
- … volume – use measuring cylinder (more accurate than beakers, but doesn't measure the decimals, only exact measurements), beaker (Used to estimate volume), pipette (measures fixed volumes. Ex. 20cm^3 then 25cm^3), and burette (measures up to 0.1); SI unit: cubic meter (m^3)
  - Meniscus – the curve of the surface of the water; the lower one is used to read the volume of liquid
- … distance – use ruler, measuring tape, etc.; SI unit: meters (m)
- … gas – use gas syringe to measure gas; 3 methods: Water displacement (gas that is insoluble in water), Downward Delivery (gas that is denser than air and soluble in water), Upward delivery (Gas that is less dense than air and soluble in water)

Chapter 4 – Elements, Mixtures and Compounds

- Elements → pure substance that cannot be split up into simpler substances by chemical reactions or electricity
  - Chemical Symbols → used to represent elements
  - 2 major groups:

METALS	NON-METALS
Shiny	Dull (when solid)
Solid (at room temp and pressure) (except mercury)	Either gases, volatile liquids or solids with low melting point (at room temp and pressure)
Malleable, Sonorous, and Ductile	Brittle (if solid)
High melting and boiling point	Low melting and boiling points (except carbon and silicon)
Good conductors of heat and electricity	Poor conductors of heat and electricity (except carbon and graphite)

- Atoms and elements
  - Smallest parts of an element that have the chemical properties of that element
  - 88 are natural while 30 are synthesized
  - Monatomic elements (example: Helium = He)
    - ➔ Means that atoms are not joined together chemically
    - ➔ Means that the element is made up of only one atom
  - Diatomic elements (example: Oxygen = O_2)
    - ➔ Formed by a combination of two atoms
  - Triatomic elements (example: Ozone = O_3) → not sure if this exists… gulo ng book ehh.
    - ➔ Formed by a combination of three atoms
  - Polyatomic elements (example: Sulfur = S_8)
    - ➔ Four or more elements
- Compounds
  - A substance that contains two or more elements that are chemically combined
  - Molecules = the smallest parts of a compound that can exist independently
  - Represented by a chemical formula
  - Naming compounds:
    - ➔ 2 elements = *-ide* (example: Sodium chlor*ide* = sodium + chlorine)
    - ➔ With hydroxide ions(OH^-) = *hydroxide* (example: Potassium hydroxide = potassium + hydroxide ions)
    - ➔ With negatively charged polyatomic atoms = *-ate* (example: sodium nitrate = 3 oxygen atoms + 1 nitrate ion)
    - ➔ Covalent (2 nonmetals) = use prefixes (mono, dia, tri, tetra, penta, etc)
    - ➔ Ionic (metal and nonmetal) = polyatomic; no prefixes
  - Molecule = smallest particle of a compound
  - Chemical formula = represents a compound
  - Naming Chemical Formula
    - ➔ Metal and non-metal = metal first (example: calcium oxide = CaO)
    - ➔ Number of atom (diatomic, monatomic) = written as subscript (example: H_2O not HO_2)
    - ➔ DO NOT WRITE THE SUBSRCIPT IF IT IS ONE!
    - ➔ Oxygen atom is written last (example: H_2**O**)
  - Writing Formula of ionic compounds
    - ➔ Step 1: write the ions and their charges
    - ➔ Step 2: balance out changes so they become neutral
    - ➔ Step 3: write chemical formula
    - ➔ NOTE: Shortcut is to cross multiply the charges
  - List of polyatomic atoms:

BrO_3^- = bromate
CO_3^{-2} = carbonate
CN^- = cyanide
ClO_4^- = perchlorate
ClO_3^- = chlorate
ClO_2^- = chlorite
ClO^- = hypochlorite
CrO_4^{-2} = chromate
$Cr_2O_7^{-2}$ = dichromate
HCO_3^- = bicarbonate
MnO_4^- = permanganate
NH_4^+ = ammonium
NO_3^- = nitrate
NO_2^- = nitrite
OH^- = hydroxide
O_2^{-2} = peroxide
PO_4^{-3} = phosphate
PO_3^{-3} = phosphite

SO_4^{-2} = sulfate SiO_3^{-2} = silicate
SO_3^{-2} = sulfite

- Example of writing the chemical formula of covalent ions:
  SO_2 = Sulfur **di**oxide
  N_2F_4 = **bi**nitrogen **tetra**fluorine
- Example of writing the formula of ionic compounds:
  Magnesium Chloride =
  Step 1: Mg^{2+} and Cl^-
  Step 2: Mg^{2+} and two Cl^- are needed to make them neutral
  Step 3: $MgCl_2$
  Lead Chromate = $PbCrO_4$
  Aluminum Hydroxide = $Al(OH)_3$
  Sodium Nitrite = Na_3N

- Mixtures → 2 substances are added together without chemical bonds being formed
  - Types of mixtures:
    - ➔ Homogeneous
      - Means same → you cannot see the different phases (example, when you put salt in water, it just diffuses into the water and you can no longer see the salt
      - Solutions → homogenous mixtures that combine solute with solvent
        - Solute is the thing that is dissolved while the solvent is the one that dissolves the solute
        - Solubility → how easily a solute will dissolve in a solvent
          - High solubility →easily gets dissolved (example: salt and water)
          - Low solubility → doesn't get dissolved easily (example: sand and water)
        - Dilute → solution with small amount of solute
        - Concentrated → solution with large amount of solute
        - Saturated solution → when solution can no longer hold any more solute at a certain temperature
        - Super-saturated solution → when the solution is saturated, you can heat it so that it can take more solute. When you do that, the solution becomes super-saturated
    - ➔ Heterogeneous
      - Means different → you can see the different phases of the mixture (example, when you put sand in water, you can see the solid phase, the sand, and the liquid phase, the water)
      - 2 types:
        - Suspension → settles at the bottom
        - Colloids → look like homogenous mixtures
          - Internal Phase (dispersion phase) → the mixed particles
          - External phase (dispersion medium) → the suspending mediumm

TABLES GIVEN IN THE POWERPOINTS:

	Properties	**Suspension**	**Colloid**	**Solution**
1.	Particle size	>100nm	1-100nm	<1nm
2.	Separation 1)ordinary filtration 2) ultra filtration	possible possible	not possible possible	not possible not possible
3.	Settling	Settles under gravity	Settles on Centrifugation	Does not Settle
4.	Appearance	opaque	Generally clear	Clear
5.	Diffusion	Not possible	Diffuses slowly	Diffuses rapidly
6.	Brownian motion	shows	shows	Not observable
7.	Tyndall effect	shows	shows	Not observable

Dispersion Medium	Dispersed phase	Type of colloid	Example
Gas	Liquid	Aerosol	Fog, clouds
Gas	Solid	Aerosol	Smoke
Liquid	Gas	Foam	Whipped cream, soda water
Liquid	Liquid	Emulsion	Milk, hair cream
Liquid	Solid	Sol	Paints, cell fluids
Solid	Gas	Foam	Pumice, plastic foams
Solid	Liquid	Gel	Jelly, cheese
Solid	Solid	Solid Sol	Ruby glass

Chapter 5 – Atomic Structure

What are Atoms made up of?

- Protons – positive charge, relative mass of one, represented by symbol p
- Electrons – negative charge, relative mass of 1/1840, represented by symbol e
- Neutron – no charge, relative mass of one, represented by symbol n

Proton number and Nucleon number

- Proton number
  - Also known as Atomic number
  - Represented by symbol z
  - Indicates the number of protons in an atom, and also the number of electrons
    Example: atomic number of nitrogen is seven, so it has 7 protons and 7 electrons
  - Each atom has a different atomic or proton number
- Nucleon number
  - Also known as Mass number
  - Represented by letter A
  - Indicates the total number of protons and neutrons
  - How to write chemical symbols:
    ➔ Mass number on top left side of the symbol of the element
    ➔ Atomic number on bottom left side of the symbol of the element
    Example: $^{23}_{11}Na$

Isotopes

- Atoms of the same element with the same number of protons, but different number of neutrons

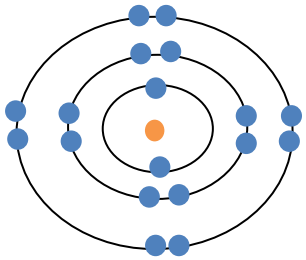
Arranging Electrons

- Electrons shells – where the electrons are found
  - First shell can hold 2 electrons
  - The rest of the shells can hold 8 electrons
  - Valence electrons – last or outer shell
- Periodic table
  - Groups (column) – indicate the number of electrons on valence electrons
  - Periods (row) – indicates the number of shells
- Electronic configuration

Example: Given – Argon $^{40}_{18}Ar$, located on the third row, eighth column of the periodic table

We can conclude that Argon has 18 electrons (based on proton number), three shells (third row), and 8 valence electrons (eighth column), so it'll look like this:

Argon
(Ar) 2, 8, 8



The Atomic Theory Timeline!

1. Democritus – said that everything is composed of atoms and that atoms are indivisible
2. John Dalton – produced the first useful atomic theory of matter (1803)
3. Eugen Goldstein – discovered that atoms have positive charge
4. JJ Thomson – discovered electrons and made the raisin bread model (He declined Dalton's model)
5. Ernest Rutherford – suggested a new model = positive charge must be focused in the center (nucleus)
6. Niels Bohr – electrons orbit around nucleus randomly
7. Erwin Schrödinger – developed a mathematical description about the way the electrons would orbit the nucleus; developed the Wave Mechanical Formula, the basic model of today's atomic theory
8. James Chadwick – discovered that nucleus contained neutral particles

http://www.youtube.com/watch?v=WSY5H1k3TVU

Structure of the Atom!

1. Democritus
   - All existence is made up 2 things
     a. Atoms
        - From "atomos" meaning "indivisible"
        - Concept of Atomism
     b. The Void
   - Atomism
     - Disapproved by Aristotle, Plato, and the early Church
   - Alchemy
     - Fake chemistry
     - Transmutation – metals into silver or gold
     - Gave us the Scientific method (Observation and Experimentation)
   - Elizabeth I
     - During her reign, experimentation became ok
     - William Gilbert I
        - Magnetism
        - Rubbed things can attract small bits of matter
     - Niccolo Codeo
        - Discovered repulsion
2. Benjamin Franklin
   - Kite flying experiment
     - Proved that lightning was electricity
3. Charles Coulomb
   - Coulomb's law → force of repulsion grows stronger as distance between 2 objects intensify
4. Lavoisier
   - Combined hydrogen and oxygen to get water using an electric spark
   - Sum of reactants = mass of products
   - Matter was concrete and measurable

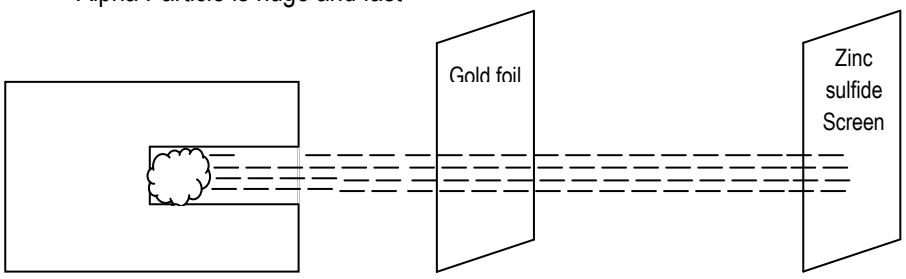
5. Joseph Proust
   - Made the concept of elements being the building blocks of matter

http://www.youtube.com/watch?v=BhWgv0STLZs

6. John Dalton
   - Why does water absorb more of one kind of gas than another?
     - Concluded that when water absorbs a gas, a particle of the gas must fit between the particles of water
     - Some gas was light, so few would squeeze through water
     - Others were heavy, so the particles would sink between matter
   - Conclusions:
     - Implied that matter was made up of individual particles with spaces in between them
     - Elements of matter consist of characteristic types of particles
     - Particles of the same element have the same characteristics
     - Atoms are indivisible
     - There are as many atoms as there are elements
     - Atoms of one element cannot be converted into atoms of another element
     - Atoms in chemical reactions are only rearranged not destroyed
   - Dalton's observations explained Proust's law of definite proportion
     - If each element is a particular kind of atom, then the atoms combine to form a compound atom
     - Compound atoms can be formed by combining two basic elements
       - Simplest is one atom of each kind
7. JJ Thompson
   - Designed a special cathode ray tube
     - Cathode rays were attracted to positive charge
     - Cathode rays consist of negatively charges magnets
     - Electromagnets could deflect the cathode rays
   - Calculated the charged : mass ratio
   - Came up with electrons
   - Made the raisin bun model

http://www.youtube.com/watch?v=30gBsa849VU&feature=related

8. Earnest Rutherford
   - Proved that atoms are made up mostly of empty space
   - He stuck polonium (element with radiation) in a lead box and slit a hole in that box then placed a screen on top
   - A strong magnetic field bent one set of rays in one direction and the other in another
     - Indicated that the particles (alpha and beta) have charge and mass
   - Alpha Particle is huge and fast



   - The setup shows that the most of the alpha particles passed through the gold foil with not change of direction
   - Sometimes, a particle would be deflected or the particle would bounce back
     - This shows that the gold foil must be mostly empty space
     - The alpha particle would probably collide with some substance in the empty space which causes the bounce back
     - The positively charged alpha particles could, possible, be charging head-on into a nucleus
   - Discovered the nucleus
   - Discovered the distance of closest approach
   - Made the Rutherford model
     - A solar system with the nucleus being the sun and the electrons being the planets

- Had problems!!
  - Any accelerating object should release electromagnetic radiation or energy, so the electron should lose energy and should eventually slam into the nucleus causing the atom to collapse, but this doesn't happen

http://www.youtube.com/watch?v=Uock1r-ELDE&feature=related

9. Niels Bohr
   - Proposed the first working model of the hydrogen atom
     - Electron orbits nucleus
     - Inside hydrogen atom, electron only has certain orbits
     - Electrons can only occupy orbits only at certain distances from the nucleus
     - Said that the electron doesn't crash into the nucleus because it just doesn't happen
     - Inside an atom, electrons only radiate energy when they jump from one orbit to another
   - Study the structure thingy by yourselves… I don't get it… T^T

http://www.youtube.com/watch?v=-YYBCNQnYNM&feature=related

10. Werner Heisenberg
    - It is impossible to pinpoint the exact location and momentum of an electron in an atom, but you can predict where they appear
    - Electrons in an atom can only reappear and disappear on their fixed orbits
    - Vertical Particles: particles that can appear in two places for a brief period of time
      - Particle appears where crests are maximum
      - Particle avoids where crests are minimum
      - When wave changes, particle changes
11. Erwin Schrödinger
    - Developed equation that correctly describes behavior and motion of hydrogen atoms and all other atoms and elements in the universe
    - Wave function – description of the real world

http://www.youtube.com/watch?v=7GTCus7KTb0&feature=related

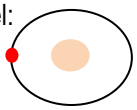
REVIEW (August 4, 2011)

ATOMIC THEORY SCIENTISTS

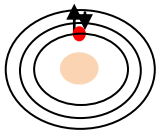
1. Democritus
   - First person **in recorded history** to come up with what matter is made up of
   - Atomos → "indivisible"
   - Stated that "everything is made up of atoms and atoms are indivisible
2. John Dalton
   - People whose works lead to Dalton's contribution:
     a. The alchemists – started the scientific method (observations and experimentation)
     b. Bacon – revived the scientific method: "conclusions based on observations and experimentation"
     c. Gilbert – magnetic nature of matter (electric attraction)
     d. Codeo – repulsion
     e. Coulomb – Coulomb's law: Any two charged objects will create a force on each other. Opposite charges will produce an attractive force while similar charges will produce a repulsive force. The greater the charges, the greater the force. The greater the distance between them, the smaller the force.
     f. Franklin – lightning = electricity
     g. Lavoisier – conservation of matter (mass of reactant = mass of product)
     h. Proust – law of definite proportion – matter is made up of definitely proportionate objects
   - These works lead to the first working atomic theory
     - Matter is made up of indivisible paricles
3. Eugen Goldstein
   - Discovered positive charges using the crux tube
4. J.J. Thomson
   - Discovered electron

- Raisin bread model

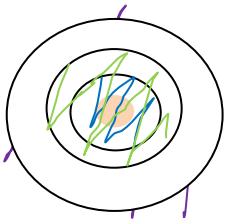
5. Ernest Rutherford
   - Nucleus → positive center that electrons revolve around
   - Alpha Particle Scattering Experiment
   - His model:



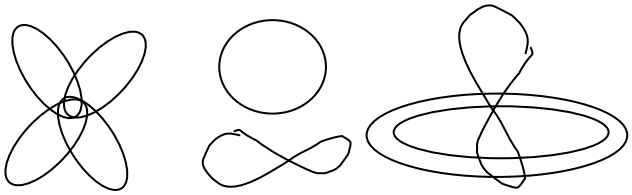
6. Niels Bohr
   - Discovered fixed electron orbits
   - Ground state → the electrons are in their own orbit with little energy
   - Excited State →electron jumps to other orbits and has lots of energy
   - His model:


Electrons can jump!

7. Heisenberg
   - Exact positions of electrons and their momentum cannot be determined
   - Electrons exist in shells or clouds (regions where electrons are most likely found)
   - His model:



8. Erwin Schrödinger
   - Wave functions
   - Determine the location of all electrons in any element or atom
   - Equation how electrons revolve around the nucleus (Wave mechanical formula)
   - His models:



9. James Chadwick
   - Discovered the neutron

IF I FORGOT SOMETHING, THEN PLEASE FORGIVE ME. DON'T FORGET TO STUDY THE TERMS, BECAUSE HE MIGHT MAKE US DEFINE THEM AGAIN. DON'T RELY ONLY ON THIS REVIEWER BECAUSE IT HAS MISTAKES, BECAUSE I DIDN'T CHECK IT… GOD BLESS ON THE QUARTER EXAMS! ☺