

## **ALL ABOUT WATER**

THE PROPERTIES OF WATER

THE STEM LITERACY PROJECT

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### **PROPERTIES OF WATER**

- WATER MOLECULES ARE POLAR
- WATER MOLECULES ARE ATTRACTED TO ONE ANOTHER
  - COHESION & ADHESION
- HIGH SPECIFIC HEAT
- DENSITY: GREATEST AT 4° C [ICE IS LESS DENSE THAN LIQUID WATER]
- UNIVERSAL SOLVENT OF LIFE

### THE POLARITY OF WATER

- HAVE YOU OBSERVED EVIDENCE OF THE POLARITY OF WATER?
  - WHAT CHARACTERISTICS OF WATER PROVIDE SUPPORTING EVIDENCE FOR POLARITY?
- WHY DO YOU THINK WATER IS A POLAR MOLECULE?

### **POLARITY OF WATER MOLECULES**

#### • WATER MOLECULES [H<sub>2</sub>O] ARE POLAR

- ELECTRONS ARE NOT SHARED EQUALLY BETWEEN THE TWO HYDROGEN ATOMS AND THE SINGLE OXYGEN ATOM
- THE OXYGEN ATOM IS SLIGHTLY NEGATIVE AND THE HYDROGEN ATOM IS SLIGHTLY POSITIVE
- THE POLARITY OF WATER CAUSES THE MOLECULES OF H<sub>2</sub>O TO BE ATTRACTED TO ONE ANOTHER
  - NOTE THE 'WALTER WICK' IMAGES ON THE RIGHT
  - HYDROGEN BONDS FORM BETWEEN THE + AND REGIONS OF WATER MOLECULES





#### WATER CHEMISTRY

#### • WATER IS A POLAR MOLECULE

- HYDROGEN ATOMS HAVE A SLIGHT + CHARGE
- OXYGEN ATOM HAS A SLIGHT –
  CHARGE
- HYDROGEN BONDS:
  - WEAK ATTRACTIONS BETWEEN THE '+' HYDROGEN ATOMS AND THE '-' OXYGEN ATOMS



http://iweb.langara.bc.ca/biology/mario /Biol1116notes/biol1116chap2.html

#### Each water molecule can form 4 Hydrogen Bonds



http://iweb.langara.bc.ca/biology/mario/Biol1116n otes/biol1116chap2.html

#### **SURFACE TENSION**

- WHAT IS SURFACE TENSION?
  - HOW IS THIS PROPERTY OF WATER RELATED TO THE POLARITY OF THE WATER MOLECULE?
- CAN YOU THINK OF EXAMPLES OF SURFACE TENSION?
  - CHECK THIS OUT: <u>HTTPS://WWW.YOUTUBE.COM/WATCH?V=YNK4VJA-VAQ</u>

### **SURFACE TENSION & WATER**

- HYDROGEN BONDS BETWEEN WATER MOLECULES RESULT IN COHESIVE FORCES
  - SURFACE TENSION IS A CHARACTERISTIC OF WATER
  - INSECTS CAN WALK ON THE SURFACE OF WATER
  - A STEEL PIN CAN FLOAT ON THE SURFACE OF WATER
  - A SLIGHTLY STRONGER BOND EXISTS BETWEEN WATER
    MOLECULES ON THE SURFACE OF WATER
    - THE SURFACE OF WATER HAS AN ELASTIC TRAIT





Wick, W. (1997) A Drop of Water. New York: Scholastic Press

# SURFACE TENSION & ENGINEERING

- HOW DO INSECTS MANAGE TO WALK ON WATER?
  - CHECK THIS OUT: <u>HTTPS://WWW.YOUTUBE.COM/WATCH?V=39DG0WKS254</u>

### MORE ABOUT WATER'S ELASTIC SURFACE

- WALTER WICK'S PHOTOGRAPHS CAPTURE THE ELASTICITY OF WATER
  - IN FRAME 1: A ROUND DROP OF WATER FORMS AS WATER SLOWLY LEAKS FROM THE FAUCET
  - IN FRAME 2: THE DROP BECOMES HEAVIER AND FORMS A PERFECT SPHERE
  - IN FRAME 3: THE DROP BECOMES TOO HEAVY TO REMAIN ATTACHED TO THE STREAM AND FALLS
- THESE PHOTOGRAPHS CAPTURE THE IMPACT OF HYDROGEN BONDING BETWEEN WATER MOLECULES
  - ALL THREE FRAMES CAPTURE COHESIVE NATURE OF
    WATER



Wick, W. (1997). A Drop of Water. New York: Scholastic Press

### **MORE ABOUT SURFACE TENSION**

HOW DOES SURFACE TENSION AFFECT EVERY DAY EVENTS?

CHECK THIS OUT: <u>HTTPS://WWW.YOUTUBE.COM/WATCH?V=1Q78H0BDDRO</u>

### **COHESION & ADHESION**

- COHESION:
  - WATER MOLECULES ADHERE TO ONE ANOTHER
- ADHESION:
  - WATER MOLECULES ARE ATTRACTED TO OTHER SURFACES



### **COHESION & ADHESION**

- COHESION AND ADHESION CAN BE EASILY OBSERVED, CAN YOU THINK OF EVERY DAY EVENTS WHICH DEMONSTRATE THESE PROPERTIES OF WATER?
  - CHECK THIS OUT: <u>HTTPS://WWW.YOUTUBE.COM/WATCH?V=7-KEJUFRFOO</u>

### WATER & CAPILLARY ACTION

- WATER MOLECULES FLOW UPWARD IN THE GLASS TUBES – THIS IS KNOWN AS 'CAPILLARY ACTION'
  - ADHESION: WATER IS ATTRACTED TO THE SIDES OF THE GLASS TUBES
    - THE HEIGHT OF THE WATER IS A FUNCTION OF THE DIAMETER OF THE GLASS TUBE



Wick, W. (1997). A Drop of Water. New York: Scholastic Press

### **CAPILLARY ACTION**

- HOW DO YOU THINK COHESION AND ADHESION ARE RELATED TO CAPILLARY ACTION?
- WHAT IS THE DIFFERENCE BETWEEN THESE TWO PROPERTIES OF WATER?
  - COHESION:
  - ADHESION:
- CHECK THESE OUT:
  - <u>HTTPS://WWW.YOUTUBE.COM/WATCH?V=NCV8FM5HUX8</u>
  - <u>HTTPS://WWW.YOUTUBE.COM/WATCH?V=D4PJRI3IWVI</u>

#### WATER & SOAP BUBBLES

- SOAP BUBBLES ARE:
  - A LAYER OF SOAP FILM CONSISTING OF A THIN SHEET OF WATER SANDWICHED BETWEEN TWO LAYERS OF SOAP
    - THE LAYERS OF SOAP AND WATER FORM A SPHERE
      AND TRAP AIR WITHIN THE BUBBLE
  - THE SOAP FUNCTIONS TO DECREASE THE SURFACE TENSION WITHIN THE WATER – RESULT: BUBBLES FORM



Wick, W. (1997). A Drop of Water. New York: Scholastic Press

www.webexhibits.org

### **MOLECULES IN MOTION**

- MOLECULES ARE IN CONSTANT MOTION
  - NOTE THE CHANGES THAT OCCUR WHEN DROPS OF FOOD DYE ARE ADDED TO WATER
- EQUILIBRIUM IS ACHIEVED WHEN THE MIXTURE OF WATER AND DYE IS THE SAME THROUGHOUT THE SOLUTION



### **MOLECULES IN MOTION**

- NOTE THE IMAGES TO THE RIGHT:
  - THE BLUE DYE IS DIFFUSING INTO THE WATER
  - THE DYE IS MOVING FROM REGIONS OF HIGHER
    TO LOWER CONCENTRATIONS
- EQUILIBRIUM IS ACHIEVED WHEN THE DYE AND WATER ARE EQUALLY MIXED SO THAT ALL AREAS OF THE MIXTURE LOOK THE SAME



Wick, W. (1997). A Drop of Water. New York: Scholastic Press

#### **MOLECULAR MOTION**

HOW CAN YOUR STUDENTS DEMONSTRATE MOLECULAR MOTION?

- THIS IS A CHALLENGE BECAUSE WE CANNOT SEE MOLECULES
- CHECK THESE OUT:
  - <u>HTTPS://WWW.YOUTUBE.COM/WATCH?V=CXY02TCGIBY</u>
  - <u>HTTPS://WWW.YOUTUBE.COM/WATCH?V=CXY02TCGIBY</u>

#### **PHASES OF WATER**

• WATER CAN EXIST IN THREE DIFFERENT PHASES OR STATES:

- GASEOUS PHASE: WATER VAPOR OR STEAM
- LIQUID PHASE: LIQUID WATER
- SOLID PHASE: FROZEN WATER OR ICE

### SOLIDS, LIQUIDS, & GASES

#### Properties of solids:

- have a definite shape
- do not flow
- virtually impossible to compress
- expand if heated, but usually less than liquids and gases.



#### Properties of liquids:

- no definite shape
- can flow to take the shape of the bottom of a container
- very difficult to compress (virtually incompressible).



#### Particles in liquids:

Particles in solids:

· strongly bonded to each other

to liquids and gases

vibrate faster when heated.

· vibrate a little, but not much compared

- · weakly bonded to each other
- · break their bonds easily
- · vibrate and move more than those in a solid
- · move faster when heated.

#### Properties of gases:

- no fixed shape
- gases spread (or diffuse) to completely fill a container
- · gases are easily compressed.



#### Gas particles:

- · are 'free', having no bonds between them
- · have much more energy than those of a solid or liquid
- fly around, bouncing off each other and the walls of their container.



academyoferudition.com

#### **FROZEN WATER**

- WHEN WATER FREEZES IT FORMS A CRYSTALLINE STRUCTURE BASED ON THE PROPERTIES OF THE WATER MOLECULE
  - WHEN WATER FREEZES, EACH MOLECULE IS BONDED TO 4 OTHER MOLECULES FORMING A LATTICE STRUCTURE
  - ICE IS LESS DENSE THAN WATER AND FLOATS IN WATER
    - THERE IS MORE SPACE BETWEEN WATER
      MOLECULES IN ICE MAKING IT LESS DENSE THAN
      LIQUID WATER



Wick, W. (1997). A Drop of Water. New York: Scholastic Press



www.its.Caltech.edu

### WATER IN THE ATMOSPHERE

- CLOUDS FORM WHEN WATER VAPOR IN THE AIR
  CONDENSES INTO TINY DROPLETS OF WATER
  - WATER VAPOR CONDENSES ON DUST PARTICLES OR OTHER
    PARTICULATE MATTER IN THE AIR
  - CLOUDS FORM WHEN:
    - THE AMOUNT OF WATER IN THE AIR HAS INCREASED THROUGH EVAPORATION/TRANSPIRATION AND THE AIR IS SATURATED
    - THE AIR IS COOLED TO THE DEW POINT WHERE CONDENSATION
      WILL OCCUR BECAUSE AT THAT TEMPERATURE, THE AIR IS
      SATURATED



http://www.metoffice.gov.uk/learning/clouds/what-are-clouds

# **EVAPORATION & CONDENSATION**

#### • EVAPORATION:

- WHEN LIQUID WATER IS WARMED OR WHEN THE PRESSURE IS DECREASED – THE ATTRACTION BETWEEN WATER MOLECULES DECREASES
- WATER MOLECULES MOVE FROM A LIQUID STATE TO A GASEOUS STATE
- WATER EVAPORATES FROM SURFACE WATER
  INTO THE ATMOSPHERE
- WATER EVAPORATES FROM PLANT LEAVES INTO THE ATMOSPHERE [TRANSPIRATION]



Wick, W. (1997). A Drop of Water. New York: Scholastic Press

# **EVAPORATION & CONDENSATION**

#### <u>CONDENSATION:</u>

- WATER VAPOR IN THE ATMOSPHERE CONDENSES OR FORMS A LIQUID ON COOL SURFACES
- NOTE THE FORMATION OF DROPLETS OF WATER ON THE SURFACE OF THE GLASS OF ICE WATER



Wick, W. (1997). A Drop of Water. New York: Scholastic Press



#### WATER & LIGHT

#### VISIBLE LIGHT IS PART OF THE ELECTROMAGNETIC SPECTRUM AND IS COMPOSED OF MULTIPLE WAVELENGTHS

- EACH WAVELENGTH WITHIN THE VISIBLE SPECTRUM IS
  ASSOCIATED WITH A DISTINCT COLOR
- DROPLETS OF WATER IN THE ATMOSPHERE ACT LIKE TINY PRISMS AND DISPERSES THE LIGHT AND REFLECTS THE LIGHT BACK TO YOUR EYES
  - THE RESULT: YOU SEE THE COLORS OF THE RAINBOW
  - ROYGBIV: RED, ORANGE, YELLOW, GREEN, BLUE, INDIGO, VIOLET



www.ecouterre.com

#### THE WATER CYCLE



- THE WATER CYCLE IS ALSO
  KNOWN AS THE HYDROLOGIC
  CYCLE
- WATER MOVES FROM THE EARTH INTO THE ATMOSPHERE THROUGH:
  - EVAPOTRANSPIRATION
  - EVAPORATION
  - SUBLIMATION
- WATER MOVES FROM THE
  - ATMOSPHERE TO THE EARTH:
    - CONDENSATION
    - PRECIPITATION

### THE ELECTROMAGNETIC SPECTRUM & VISIBLE LIGHT

