Topic 5 - Energy

Vocabulary

Condensation – the change of state from a vapor to a liquid.

Conduction – transfer of heat by vibrations from atom to atom. The pan on the stove is hot by touching a heat source.

Convection – energy is transferred by circulating of hot low density rises over heat source and cool dense sinks away from heat source. Happens in atmosphere, bodies of water and Earth's mantle.

Crystallization – a type of solidification where molten material cools forming crystals.

Electromagnetic energy – energy given of in the form of waves from any object that is not at absolute zero (0 Kelvin), such examples include visible light, radio waves, infra-red, ultra violet, and gamma. Also known as electromagnetic radiation.

Electromagnetic spectrum – chart used to illustrate the full range of electromagnetic energy from short wavelength to longest wavelength (pg. 14 ESRT)

Energy – the ability to do work

Heat energy – energy that is transferred from one body to another body as a result of differences in temperature, flows from high energy to low energy.

Joules – a unit of energy used to measure energy in a system. Metric form.

Radiation – energy moving place to place by electromagnetic waves.

Solidification – the process which a solid turns to a solid.

Temperature – a measure of the kinetic energy is matter; how hot or cold something is.

Texture – the roughness of a material.

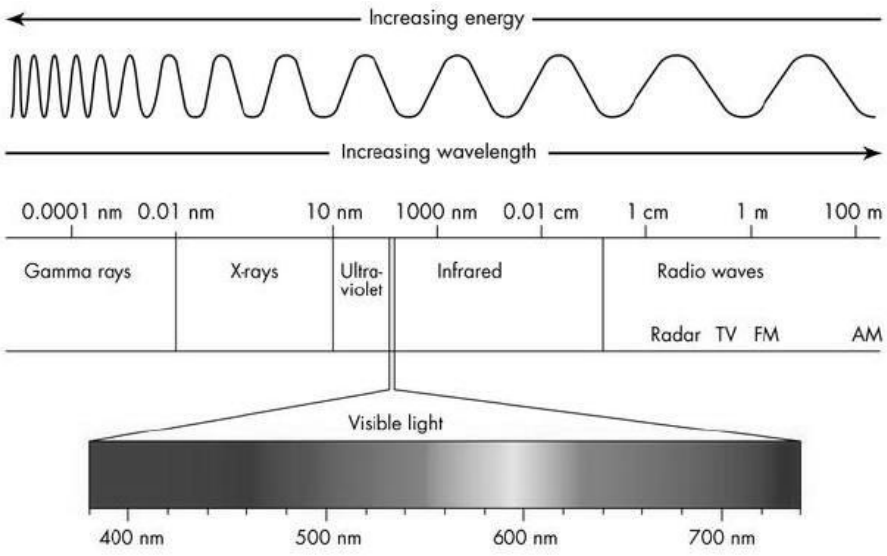
Vaporization – evaporation when a substance changes states from a liquid to a gas.

Wavelength – the distance between a point on a wave to the point on the next consecutive wave.

Overview of Topic

I. Electromagnetic Energy (E.M.)
- In the solar system the Sun is the source

a. Characteristics of E.M.

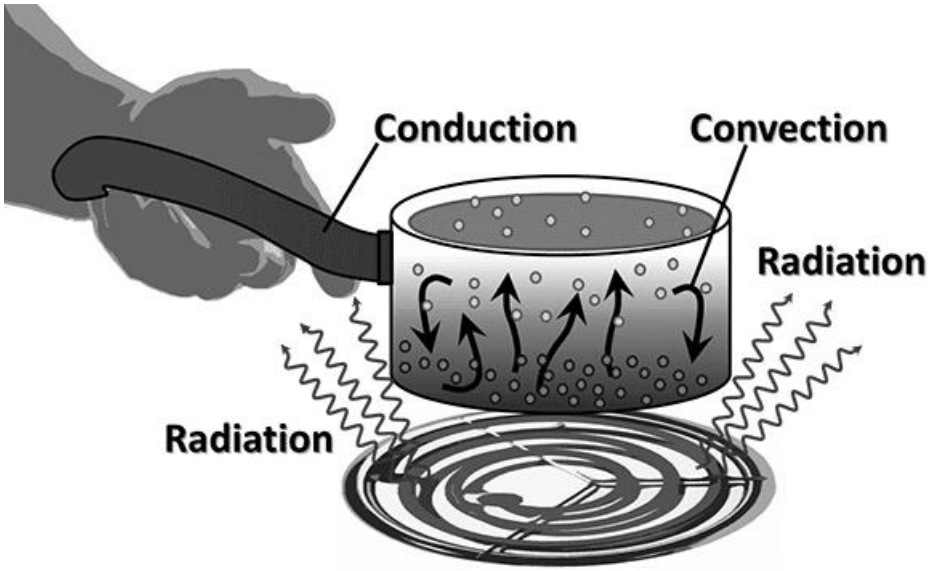


b. Interaction between E.M. and the Environment
- Energy can be
  - Refracted – or bent as it passes through other material
  - Reflected
  - Scattered
  - Transmitted – passed through a material
  - Absorbed

c. Surface interactions with E.M.
- Texture
  - Rough absorbs a lot of energy
  - Dark absorbs a lot of energy
  - Smooth absorbs very little energy
  - Light reflects a lot of energy

II. Transferring Energy

- In the natural world all systems want to achieve a dynamic equilibrium, a balance.



- Conduction – most effective in solids, atom to atom
- Convection – most effective in fluids, rising hot, sinking cool
- Radiation – no medium is needed, sun energy reaches earth

III. Temperature and Heat

- Not the same

a. Temperature measures the average kinetic energy of particles in a substance. In other words how fast the particles are moving
    - Low kinetic energy = slow moving = low temperatures
    - High kinetic energy = fast moving = high temperatures

b. Heat is the thermal energy as a result of the movement of the atoms. Measured in joules.

IV. Specific Heat

- Defined as the amount of thermal energy needed to raise 1 gram of water 1 ° Celsius. It takes 4.18 $\frac{Joules}{g*C^0}$ for liquid water.

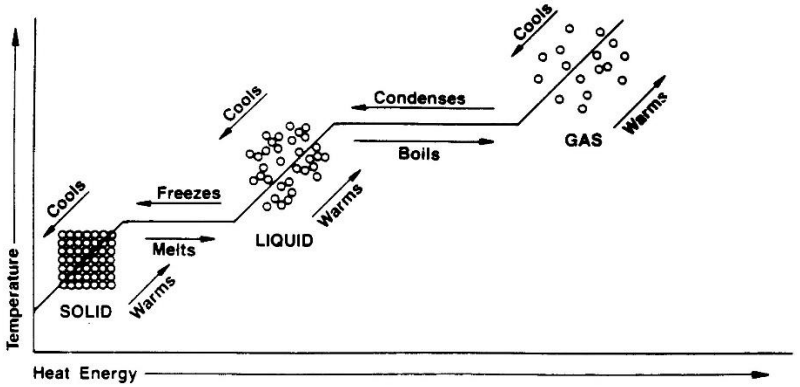
a. Each substance requires a different amount of energy to raise its temperature.
    - Page 1 ESRT
    - Liquid water has the highest specific heat
        - Water resists heat and resists cooling
            - Great insulator
        - Solids have very low specific heat
            - Great conductors

V. Changing States

- Energy is required to change from on state of matter to another state of matter. (pg. 1 ESRT)

a. The phases of matter – the change of state
    - Melting – changing solid to liquid
        - Heat energy gained during melting 334 $\frac{J}{g}$
    - Solidification or freezing – changing liquid to solid
        - Heat energy released during freezing 334 $\frac{J}{g}$
    - Evaporation or vaporization – changing from liquid to vapor.
        - Heat energy gained during vaporization 2260 $\frac{J}{g}$
    - Condensation – changing vapor to a liquid
        - Heat energy released during condensation 2260 $\frac{J}{g}$

b. The heating curve for water



- Water boils at 100 C^o, it also condenses 100 C^o.
- Water freezes at 0 C^o, it also melts at 0 C^o.

Earth Science Reference Table – (ESRT)

Pages from ESRT used in Topic 5 (pg. 1, 13 and 14)

Specific Heat

Specific Heats of Common Materials

MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

More energy required

Less energy required

These values are not used in calculations however they represent how much energy is need to change 1 gram of a substance 1 degree Celsius.

The higher the value the more heat energy is needed to raise the temperature and it represents the resistance to releasing heat energy.

Lead for example will change temperature much faster than liquid water because lead has a very small specific heat.

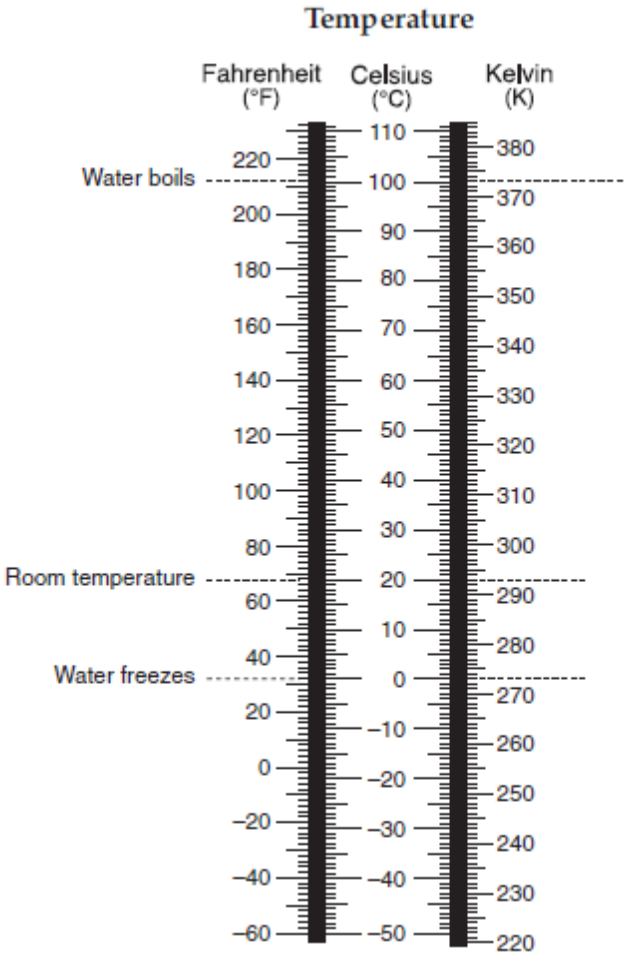
Properties of Water

Properties of Water

Heat energy gained during melting	334 J/g
Heat energy released during freezing	334 J/g
Heat energy gained during vaporization	2260 J/g
Heat energy released during condensation	2260 J/g
Density at 3.98°C	1.0 g/mL

Again you shouldn't have to use these values in calculations, however know that energy is required to change states (phases).

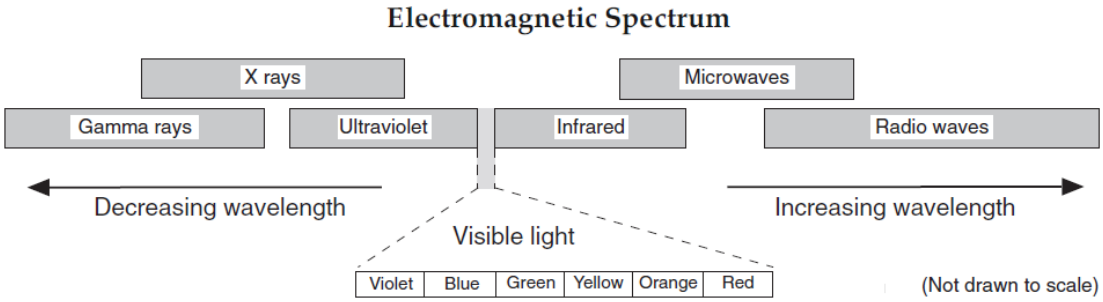
Temperature



Used to convert between the different temperature scales. Pay attention to the scaling on each scale of the minor graduations they are different.

Students may be asked to convert between scales or given a Fahrenheit value but need to report in Celsius or Kelvin. Each graduation of Fahrenheit is 2 degrees and for Celsius and Kelvin it is 1 degree.

Electromagnetic radiation



This diagram can lead to a bit of confusion. It shows the relationship between several wavelengths of the electromagnetic spectrum. Have students draw with a pencil the decreasing wavelength to increasing wavelength. Also indicate the increasing energy to decreasing energy.

Notice that visible light is between Ultra violet and Infrared. Students get confused with the pull out section indicating the colors. A common mistake students make is indicating violet light has a smaller wavelength (higher energy) than ultraviolet or red light has a larger wavelength (lower energy) than infrared. It is not the case; they get confused because they fail to realize it is a pullout section between infrared and ultraviolet.

The Regents exam should ask only about the wavelengths indicated if they have to find them directly.

Below is a diagram of what this table should look like after students make the helpful markings.