Groundwater Systems

1) Importance of Groundwater
    a) Only 3% of the Earth's water is fresh & potable.
    b) Although groundwater is only 0.6% of the Earth's water it is 14% of the fresh water.
    c) Excluding glaciers, groundwater is 94% of the available freshwater.
    d) Groundwater usage
        i) Drinking water for > 50% of the population
        ii) Accounts for 40% of the Irrigation water
        iii) Provides 25% of industry's needs

2) Water infiltrates in recharge areas – areas at the Earth's surface that allows water to move through it

3) Where is groundwater stored?
    a) Porosity
        i) Percentage of total volume of rock or sediment that consists of voids (pores)
        ii) Function of
            (1) Size and shape of the grains
            (2) The packing of the grains
            (3) Sorting of the grains
    b) Permeability
        i) Ability of a material to transmit a fluid (water)
        ii) The interconnectedness of the pores
        iii) Shales have a low permeability
        iv) Sandstones have a high permeability

4) Is groundwater an underground river?

5) Groundwater occurs everywhere
    a) Saturated Zone– all the pore space is filled with water
    b) But not all the ground is saturated
    c) Unsaturated Zone– pores are filled with air and water
    d) Water Table – upper surface of the zone of saturation
    e) Groundwater is not stagnant, it responds to climatic changes
        i) i.e. the water moves up wet periods & moves down during dry periods
        ii) Effluent (gaining) Stream
            (1) Groundwater discharges into a stream – provides water to the stream
            (2) Generally associated with Permanent Streams
        iii) Influent Streams
            (1) Stream water infiltrates into the groundwater – stream recharges groundwater
            (2) Generally associated with Ephemeral Streams

6) Groundwater movement
    a) Groundwater is moving, but slowing
    b) Energy Drives Water Movement
        i) Groundwater moves from high "energy" to low "energy"
        ii) Groundwater has two types of energy
        iii) Potential (stored) energy – controlled by elevation – how far can the water drop

iv) Kinetic (in motion) energy – controlled by pressure and velocity (very small can be ignored)

c) Total of potential and kinetic energy is hydraulic head

7) Aquifer
   a) Permeable rock or sediment that transmit groundwater freely
   b) Example: sand, gravels, sandstones
   c) Unconfined Aquifer – top of the aquifer is exposed to the atmosphere
   d) Confined Aquifer – an aquifer lying between two aquitards, water is under pressure
8) Aquitard-Confining Unit
   a) Impermeable layer of rock or sediment that hinders groundwater movement
   b) Examples: clays, shales, mudstone, non-fractured igneous or metamorphic rocks
9) Artesian Conditions
   a) Artesian is applied to any situation where the groundwater in a well rises above the level where it is initially encountered.
   b) Associated with confined aquifers – due to excess pressure from overlying material