The equilibrium partial pressure of species i is equal to vapor pressure equilibrium constant at T.

**Adsorption**- surface uptake **Absorption**- distributed uptake **Sorption**- either one or both

sorption isotherms

Equations you need for the dissociation of weak acid HA

|  |  |  |
| --- | --- | --- |
|  | |  |
| carbon dioxide gas dissolved carbon dioxide calcium carbonate  carbonic acid bicarbonate ion carbonate ion | | |
| pH of water in a limestone aquifer | pH of pristine rainwater | |

Dissolution of ammonium chloride involving a phase change

**Oxidation states**

|  |  |  |  |
| --- | --- | --- | --- |
| Sulfur (S) | Oxygen (O) | Carbon | Hydrogen |
| 0 in elemental form  -2 in sulfide  +6 in sulfate or sulfur trioxide  +4 in sulfur dioxide | -2 in all except  -1 in peroxide  0 in elemental form | -4 in all organic compounds  0 in elemental form  +2 in CO  +4 in CO2 | 0 in elemental form  +1 in proton  -1 in hydride |
| Nitrogen (N) | Chlorine (Cl) | | |
| 0 in elemental form  -3 in ammonia/ammonium  +2 in NO  +4 in NO2  +5 in nitrate and N2O5  +3 in nitrite | 0 in elemental form  -1 in chloride  +1 in HOCl (hypochlorous acid)  +7 in HClO4 (perchloric acid) | | |

|  |  |
| --- | --- |
| Photosynthesis  Nitrification | Aerobic respiration  Methane formation |

Nitrogen fixation

Denitrification

Sulfate reduction

S- limiting substrate concentration (mg/L), km- the maximum substrate degradation rate (mg S/mgX/d)s

Ks- half saturation degradation rate (mg S/L), Y- cell-yield coefficient (mg S/mg X)

If 1st order If 0th order

|  |  |
| --- | --- |
| BOD + OD -> oxidized products   1. Measure the initial DO content of water, call DO(0) 2. Fill a 300 mL glass bottle with a sample of the water, seal it. 3. Incubate in dark at 20 degrees for 5 days 4. Measure DO content on day 5, DO5 5. Compute BOD5=DO(0) - DO5 |  |

Dispersion is concentrations spread out in space. Diffusivity: big species ↓, small species ↑, water ↓, air ↑, low T ↓, high T ↑

|  |  |  |
| --- | --- | --- |
| Molecular diffusion: D [=] m2/s | Turbulent diffusion: [=] m2/s | Advection: |

Two properties of a fluid that contribute to drag: viscosity, density. Particles reach terminal velocity quickly, Fnet = 0

Drag on particles

|  |  |
| --- | --- |
|  |  |
| 0.3~1000 |  |
| 1000~35000 |  |

Gravitational settling

is the speed of the particle relative to the fluid

|  |  |
| --- | --- |
|  | C = bulk Cs = equilibrium with bulk Ci = interface  If liquid film resistance dominates  If gas film resistance dominates |

|  |  |  |  |
| --- | --- | --- | --- |
| Batch reactor | Zeroth order | First order | Second order |
| CMFR | Zeroth order | First order | Second order |
| PFR | Zeroth order | First order | Second order |

Ci, Q into CMFR 🡪 C1, Q into PFR 🡪 C2,Q (both first order)

|  |  |
| --- | --- |
|  |  |
|  |  |