Critical Concepts: Oceanography is not just about facts and figures. Below are some fundamental concepts that form the core of the science that you must learn in order to understand the basic processes operating in the oceans. These concepts ***by no means cover everything*** that you are expected to learn, but rather form a foundation of fundamental principles and ideas. Some of these concepts will probably be familiar to you, but perhaps their application to oceanography will be new. You will find that many of the concepts are applicable to multiple aspects of oceanography, and will appear repeatedly during the course. Dates indicate the first major appearance of each topic.

Density stratification (1/17): Explain the layering of the Earth's interior as a function of composition, temperature, and pressure. Describe the behavior of neutrally buoyant material.

Isostatic equilibrium (1/17): Predict how surface topography would vary with crustal density and thickness. Explain how isostatic equilibrium accounts for the existence of ocean basins.

Convection (1/22): Describe the conditions necessary for the development of a convection cell. Identify the driving forces behind convection of the mantle and the atmosphere.

Sediment transport (1/29): Explain what variables control the settling rate of a spherical particle according to Stokes Law. Describe the sediment sizes and modes of transportation for terrigenous particles reaching the deep sea.

Heat and temperature (1/31): Distinguish between temperature and heat. Explain why water has a high heat capacity. Appraise the importance of water's high latent heats of fusion and vaporization in moderating Earth's temperature.

Seawater density (1/31): Predict how the density of seawater would change with temperature, salinity, and pressure. Contrast the influence of temperature on pure vs. salty water. Compare the relative influence of salinity in warm vs. cold seawater.

Steady state and residence time (2/5): Describe the conditions that must be met under the assumption of steady state for a given substance. Predict how residence time would vary with input/output rate and concentration.

Biogeochemical cycling (2/12): Describe the role of electron transfer in photosynthesis and respiration. Explain the importance of nutrient cycling through seawater, biota, and sediments.

Coriolis effect (2/19): Illustrate why Coriolis deflection is said to depend on the frame of reference. Describe how the direction and magnitude of the Coriolis effect vary with latitude and velocity.

Geostrophic flow (2/21): Draw vectors to illustrate the balance of the pressure gradient force and Coriolis, including the resulting geostrophic flow, around a pressure high or low. Use the latitudinal variation of Coriolis to explain why western boundary currents are more intense than eastern boundary currents.

Thermohaline flow (2/28): Explain why (and what) energy is ultimately required to drive the thermohaline circulation, and under what surface conditions deep waters may form.

Deep vs. shallow water waves (3/4): Distinguish between deep water and shallow water waves on the basis of wavelength and water depth. Name the variable that the velocity of each wave type depends on.

Limitations on productivity (4/1): Identify specific nutrients and other factors which may limit marine photosynthesis. Predict where and when these factors may become limiting.

Food chain efficiency (4/3): Explain why mass transfer across increasing trophic levels is inefficient. Estimate the percent biomass transferred from algae to a given trophic level.

Chemosynthesis (4/17): Compare and contrast between photosynthesis and chemosynthesis. Explain how energy may be extracted from certain inorganic compounds, and give an example.

Maximum sustainable yield (4/22): Summarize the basic population dynamics that allow for a healthy fishery. Explain why harvesting older fish has both benefits and risks.

Toxicity (4/24): Explain why the acceptable concentration for a particular chemical is difficult to define. Give an example of an element that is required at low concentrations but toxic at high concentrations.