

## ESS 130 - Study guide for final exam

What you need to know:

- 1 Geometry and bottom topography of the oceans
- 2 Sound propagation, sound channel
- 3 Wave refraction (Snell's law)
- 4 Light transmission, absorption and scattering
- 5 Horizontal distribution of sea surface temperature and salinity
- 6 Vertical profiles of temperature and salinity. Mixed layer. Thermocline.
- 7 Potential temperature.
- 8 Density: dependence on temperature, salinity, pressure.
- 9 Stratification. Static stability.
- 10 Surface gravity waves. Propagation of shallow and deep water waves. Wave energy. Internal waves and Brunt Vaisala frequency.
- 11 Equations of motion:
  - concept of total derivative,
  - Coriolis force, Coriolis parameter
  - gravitational force,
  - pressure gradient force,
  - friction force, molecular and eddy viscosity, wind stress.
- 12 Conservation of mass: continuity equation.
  - Divergence/convergence.
  - Upwelling/downwelling.
- 13 Ekman currents. Ekman pumping.
- 14 Inertia currents.
- 15 Hydrostatic pressure.
- 16 Geostrophic approximation. Rossby number. Surface geostrophic flow. Geostrophic flow below the surface.
- 17 Barotropic/baroclinic conditions.
- 18 Sverdrup transport.

- 19 Vorticity (relative, planetary, absolute, potential). Conservation of potential vorticity. Topographic stirring.
- 20 Western boundary current intensification. Gulf stream and Kuroshio current examples.
- 21 General picture of the wind driven circulation:
  - large scale wind patterns over the Earth
  - Ekman transport and pumping via conservation of mass
  - Sverdrup transport (conservation of potential vorticity)
  - gyre formation and western boundary current intensification
- 22 Long waves:
  - Kelvin waves (coastal and equatorial) and their propagation
  - Rossby waves (westward propagation, not present at the equator)
- 23 El Nino Southern Oscillation:
  - description
  - delayed oscillator model with Kelvin and Rossby wave propagation
- 24 Tides:
  - tidal generating force as difference between centrifugal force and gravitational attraction to the Moon and the Sun
  - periodicity
  - propagation as Kelvin waves
  - amphidromic points and cotidal maps
- 25 Water masses:
  - conservative tracers (T, S) and processes that modify them at the surface
  - non conservative tracers (dissolved oxygen, radiocarbon, tritium)
  - water mass types and names of the most important ones
  - water mass generation (deep and shallow convection and distribution of water formation sites over the globe)
  - water mass age
- 26 Abyssal circulation:
  - Stommel-Aarons theory
  - Thermohaline circulation

Also, make sure that you know how to do the homework!!!

Final is closed book, closed notes. However, I won't ask you to remember how to write complicated equations such as the equations of motion. I might provide them and ask you to manipulate them and to know their physical meaning.

You can use a calculator. Bring it if you want it. Good luck!