1. Suppose someone released a blob of a tracer such as sulfur hexafluoride in the thermocline in a region about as big as a ship (i.e. not a big patch).

(a) What would the blob do?
(b) Compute the time it would take for the blob to diffuse horizontally to a width of 1000 km, assuming a standard ocean horizontal eddy diffusivity of $1 \times 10^4 \text{cm}^2/\text{sec} = 1 \text{m}^2/\text{sec}$.
(You can approximate this by looking at the dimensions of diffusivity; see lecture notes.)
(c) How long would it take if all diffusivity were molecular?
(d) Using the time that you calculated in (b), and now considering vertical diffusion, how far vertically would the blob diffuse with a standard vertical eddy diffusivity of $1 \text{cm}^2/\text{sec} = 1 \times 10^{-4} \text{m}^2/\text{sec}$?

2. What do inertial oscillations look like at the north pole (90°N), 45°N, the equator, 45°S and the south pole (90°S) (if there were water there!)? What is their period?

3. In the atmosphere, estimate the adiabatic temperature change from the Earth’s surface up to 5 km height. (Very simple – use information from lecture). Compare this with the adiabatic temperature change in the ocean from the surface to 5 km depth. (You may use various plots that were shown in class to estimate this.) What is the reason for the large difference?

4. The figure shows summer winds off the west coast of N. America.

(a) On the figure show where upwelling is likely to occur. There are two separate regimes of (and reasons for) upwelling. Be sure to show both of them.
(b) Explain the source of the two types of upwelling in (a).
(c) How does the strength of upwelling along this coast vary through the year? (Refer to the text or other sources)

(d) Simplify the above system for the following calculation. Assume that the winds are exactly alongshore, and do not vary with offshore distance. Assume that the alongshore wind stress is $\tau = 0.1 \text{ N/m}^2$. Assume that it extends a distance of 1000 km along the coast. Calculate the offshore Ekman transport; express it in Sverdrups.

(e) If this transport all arises from a coastal strip that is 10 km across (perpendicular to the coast) (and still 1000 km alongshore), calculate the vertical Ekman velocity into the surface layer in this strip.