1. The attached time series shows the Southern Oscillation Index and an SST anomaly time series, with the graphic taken from the TAO website for ENSO. 
http://www.pmel.noaa.gov/tao/jsdisplay/

(a) Use the internet and find a figure showing a map of the SST anomaly in the Pacific Ocean for some time in the last few months. Insert that map in your homework answers. List your website source.

Describe the SST anomaly map: what about it shows that we are currently in an El Nino phase?

(b) Do the same and find a map of the sea surface height (SSH) anomaly for some time in the last few months. Include in your homework, and list your website source.

Describe the SSH anomaly map: what about it shows that we are currently in an El Nino phase?

(c) Write down the definition of the Southern Oscillation Index (SOI).

Explain how the time series of SOI that is attached shows that we are currently in an El Nino.

(d) Describe the relationship between the SOI and the SSH anomaly map that you found for (b). Why is low SOI associated with the SSH anomaly pattern?
2. On the wind stress map:
(a) Indicate location of the trades and westerly winds.
(b) For the Pacific Ocean, indicate roughly the direction of the Ekman transport in the trade and westerly wind belts in both hemispheres. (Do not worry about the eastern boundary regions.)
(c) Where is there Ekman convergence?
(d) What direction is the Sverdrup transport in these regions of Ekman convergence? Why?
(e) Explain how the western boundary current transport at a given latitude is predicted, given only the wind stress.
3. (a) These are oxygen and salinity sections from the Atlantic, Pacific and Indian Oceans.

Label which column is salinity and which is oxygen.

Label the Atlantic, Pacific and Indian sections. Very briefly explain how you can tell which is which ocean. That is, what about the salinity and oxygen features helps you identify the ocean.
(b) This is an overturning schematic for the global ocean, modified from DPO Fig 14.11. There is a purple path at the top. Describe the significance of this pathway in terms of the global overturning circulation. (Describe what waters are involved and what their role is in the overturn.)

(c) The other pathways are labeled with water mass names. In class we did not talk about all of these but you can find information in Chapters 4 or 14 about them.

For each of the following water masses, very briefly provide the following information.
- How do you recognize the water mass using salinity or oxygen?
- Mark the water mass on the salinity and oxygen sections.
- Where is the water mass formed?
- What is its formation process?

(i) AABW
(ii) AAIW
(iii) PDW

(d) NADW is the most complicated of the water masses in the diagram because it is composed of several different source water masses, which are NOT provided in the diagram.
   (i) As in (c), mark NADW on the salinity and oxygen sections.
   (ii) List the 3 new water masses that join together to form NADW.
   (iii) List the 2 old water masses that mix into the NADW.

4. The figure shows an early idealized theoretical calculation of the ocean’s abyssal circulation, ignoring any deep topography, and assuming that all dense water sources feed into the same abyssal layer. It also greatly simplifies the source water masses (for instance, compared with your answer for Problem 3).

(a) On this map, circle Stommel’s simplification of the two principal sources of deep and bottom water. (They are marked subtly on the map.) What are the water masses associated with these sources?
(b) Look at the circulation in the North Atlantic. Explain in words why the flow in the ocean interior is towards the north.
(c) What is the name of the current in the North Atlantic indicated by the heavy black contour?
(d) If this were the actual deep circulation, then would the velocities depicted here be geostrophic? Why or why not?

(The figure, from Stommel, is reproduced in DPO as Fig. S7.42.)