Exercise 8 Report

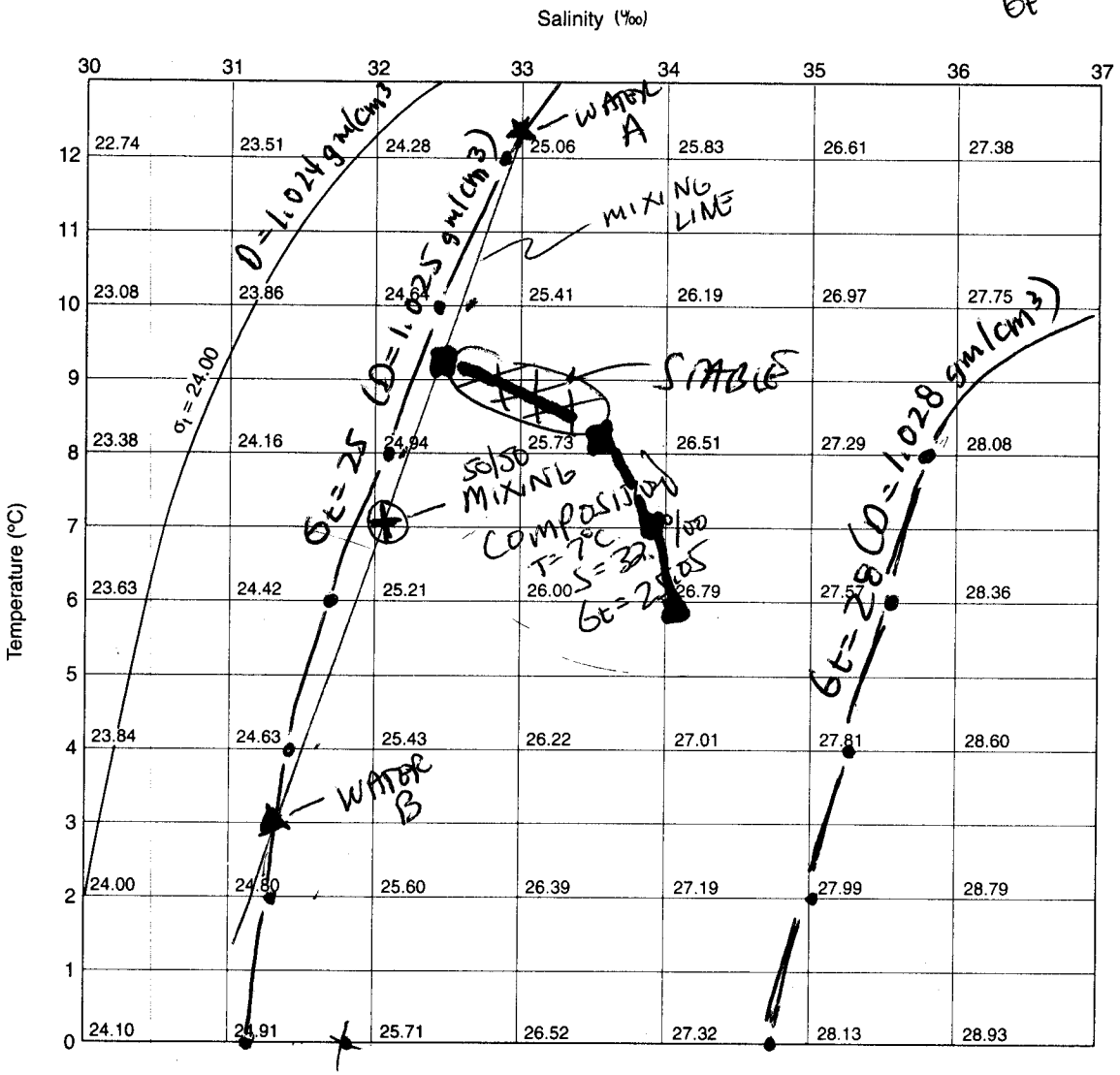
Water Masses and How We Study Them

NAME KEY

DATE

INSTRUCTOR

1. Below is a duplicate of Figure 8-1 in which the σ_t value 24 has been plotted. Plot the values from $\sigma_t = 25$ to $\sigma_t = 28$ on the T–S diagram. You may wish to approximate σ_t values between those listed for specific temperatures on salinity isohalines.



2. On the 25.00 contour, plot a water type A where the isopycnal (density contour) crosses the 33‰ salinity line, and a water type B where the isopycnal crosses the 3°C temperature line. Plot a point in the middle of this mixing line. Note that it falls below and to the right of the 25.00 σ_t contour and is therefore denser. This midpoint is the temperature and salinity of a 50–50 mixture of water types A and B. The line itself represents all possible mixtures of water types A and B and thus the water mass that would form from such a theoretical mixture.

(a) What is the range of T and S that defines the water mass produced by mixing water types A and B in all proportions? T = 7° C - 12.2°C = S = 31.3 - 33‰

6t = 25.05 (b) What is the density of the 50–50 mixture of water types A and B? D = 1.02505 gm/cm³

(c) What is the temperature of the 50–50 mixture of water types A and B? T = 7°C

What is the salinity of the 50–50 mixture of water types A and B? S = 32.1‰

3. The table below lists temperature and salinity data from an oceanographic station in the eastern North Pacific Ocean. Plot these data on the T–S diagram you contoured in Question 1, and connect the data points with straight lines.

Depth (meters)	Temperature (°C)	Salinity (‰)
0	9.1	32.4
10	9.1	32.4
20	9.1	32.5
50	9.1	32.5
100	8.2	33.6
200	7.1	33.9
300	6.2	34.0
400	5.5	34.1

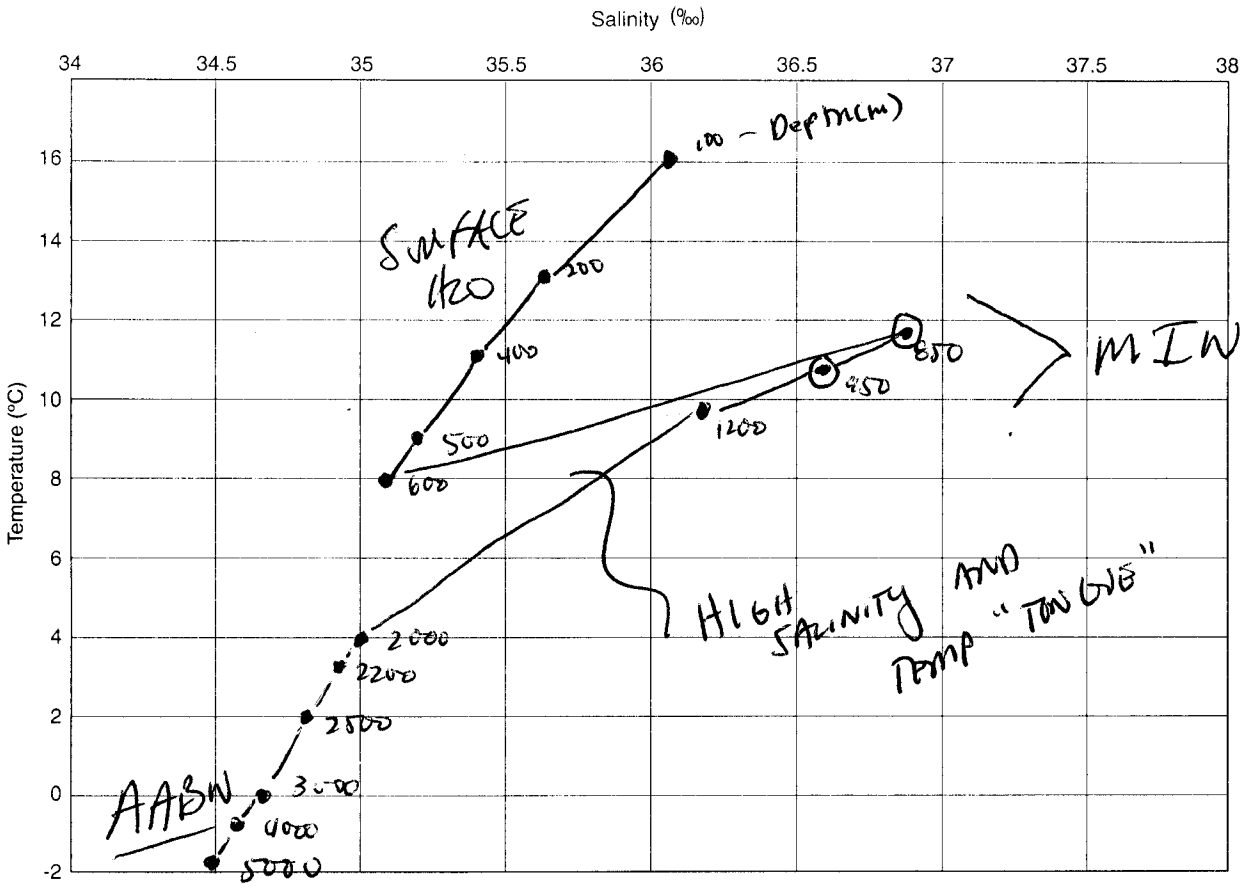
- Will have to plot on Graph

(a) How deep is the mixed layer, and in what portion of the curve is the water most stable? Use the table showing depths and also use the plot you made. See Graph

(b) Crosshatch the portion of the curve where the water mass is most stable.

4. The following are oceanographic data are from a typical station in the North Atlantic Ocean at about 20°N latitude.

Depth (meters)	Temperature (°C)	Salinity (‰)
100	16.0	36.1
200	13.0	35.7
400	11.0	35.4
500	9.0	35.3
600	8.0	35.2
850	11.8	36.9
950	11.2	36.6
1200	9.9	36.3
2000	4.0	35.0
2200	3.5	34.9
2500	2.0	34.8
3000	0.0	34.7
4000	− 1.2	34.6
5000	− 1.9	34.5



Plot the data on the blank T–S diagram above and draw a line connecting all points in order of depth. Using the diagnostic parameters provided in Table 8-2, name the major water masses represented in the diagram. Circle the two high-salinity points at depth.

DISCHARGE MIW AND AABW SEE ABOVE

5. The ~~velocity~~ of the southward flow of North Atlantic deep water through the Atlantic Ocean has been estimated at 6×10^6 cubic meters per second. (DISCHARGE = VOL./TIME)

(a) If the volume of the Atlantic Ocean is 3.24×10^{17} cubic meters, how long would it take to circulate all the Atlantic water through the deep water? Show your work.

$$Q = \frac{VOL}{t} \Rightarrow t = \frac{VOL}{Q} = \frac{3.24\times10^{17}\ m^3}{6\times10^6\ \frac{m^3}{sec}} = 5.4\times10^{10}\ sec \left(\frac{1\ yr}{3.15\times10^7\ sec}\right)$$

$$= 1712.3\ \text{YEARS}$$

(b) If the oceans are at least 3 billion years (3×10^9) old, and we assume a constant rate of mixing, how many times has the ocean been "stirred" through the deep water? Show your work.

TOTAL AGE $= 3\times10^9\ yr$

1 mixing cycle / 1712.3 yr

No. cycles $= (3\times10^9\ yr)\left(\frac{1\ cycle}{1712.3\ yr}\right) =$

1.75×10^6 cycles

(c) On these time-scales, is the ocean a well-stirred solution?

YES - very well mixed