

**I. Tidal Dynamics (About 20 points, 10 questions)**

Terminology of tidal waves, heights, periods

Cause of length of tidal day

Cause of semidiurnal, tidal pattern

Cause of mixed semidiurnal tidal pattern

Cause of diurnal tidal pattern

Causes of spring & neap tides

Causes of seasonal changes in tidal range

General effects of continents on direction of tidal wave propagation

General effects of continents and sea floor on timing of wave propagation

General effects of shape & depth of ocean basins on tidal range

Definition of flood, ebb, & slack, and relationship to tidal height stages

**II. Planning a SCUBA dive (About 20 points, 10 questions)**

Definitions of tidal height & currents reference stations & differences

Locations of tidal height & currents reference & difference stations for diving at Turn Rock Light

Ability to use tidal height & current tables to identify safe & dangerous diving times and reasons for them

Effects of narrow, shallow channels on tides

How tidal data are gathered

General way that tidal predictions are derived

Unpredictable natural processes that are not included in tidal predictions and their effects

Ability to identify spring & neap tides in tide tables

**III. Density (About 10 points, 5 questions)**

Definition of salinity, density & sigma-t

Ability to read sigma-t & density from T-S diagram

Effects of temperature & salinity on density

Ability to recognize thermocline, halocline, pycnocline, mixed layer on diagrams

Definitions of vertical stratification, stability & instability, and neutral stability

Stratification, stability, instability and neutral stability in an example using T-S diagram

Processes that create & break down stratification, stability, instability and neutral stability

Examples of unstable stratification in the oceans

**IV. Estuaries & Puget Sound (About 20 points, 10 questions)**

Definition of estuary

5 types of estuary based on their geologic origin

Stratification and stability in estuaries and processes that reinforce and break them down

Generic pattern of instantaneous vs. net estuarine circulation & causes

Definitions of 4+1 types of estuaries as defined by salinity profile

Ability to recognize of 4+1 types of estuaries from diagrams of salinity profile  
 General topographic characteristics of 4+1 types of estuaries  
 Vertical salinity difference criteria for classifying estuaries  
 River input vs. tidal exchange criteria for classifying estuaries  
 Differences in generic estuarine circulation pattern observed in each of 4+1 types of estuaries and reasons for differences  
 Definition & cause of flushing in estuaries  
 How flushing time is calculated in estuaries  
 Extent of flushing in each of 4+1 types of estuaries and reasons for differences  
 Examples of types of estuaries in Puget Sound and reasons for differences  
 Flushing in Puget Sound

### Additional Vocabulary

Amphidromic point	Bar-built estuary	Center of mass
Centrifugal effect	Cotidal lines	Crest
Diurnal tide	Drowned rive valley estuary	Dynamic theory
Entrainment	Equilibrium theory	Equinox
Fjord estuary	Isohalines	Isopycnals
Isotherms	Lunar declination	Mean tide level
Minus tide	Mixed semidiurnal tide	Partially mixed estuary
Resonance	Reverse estuary	River-mouth estuary
Salt wedge estuary	Semidiurnal tide	Sill
Solar declination	Solstice	Spring & neap tide
Tectonic estuary	Tidal datum	Tidal day
Tidal period	Tidal pumping	Tidal range
Trough	Water column	Well mixed estuary

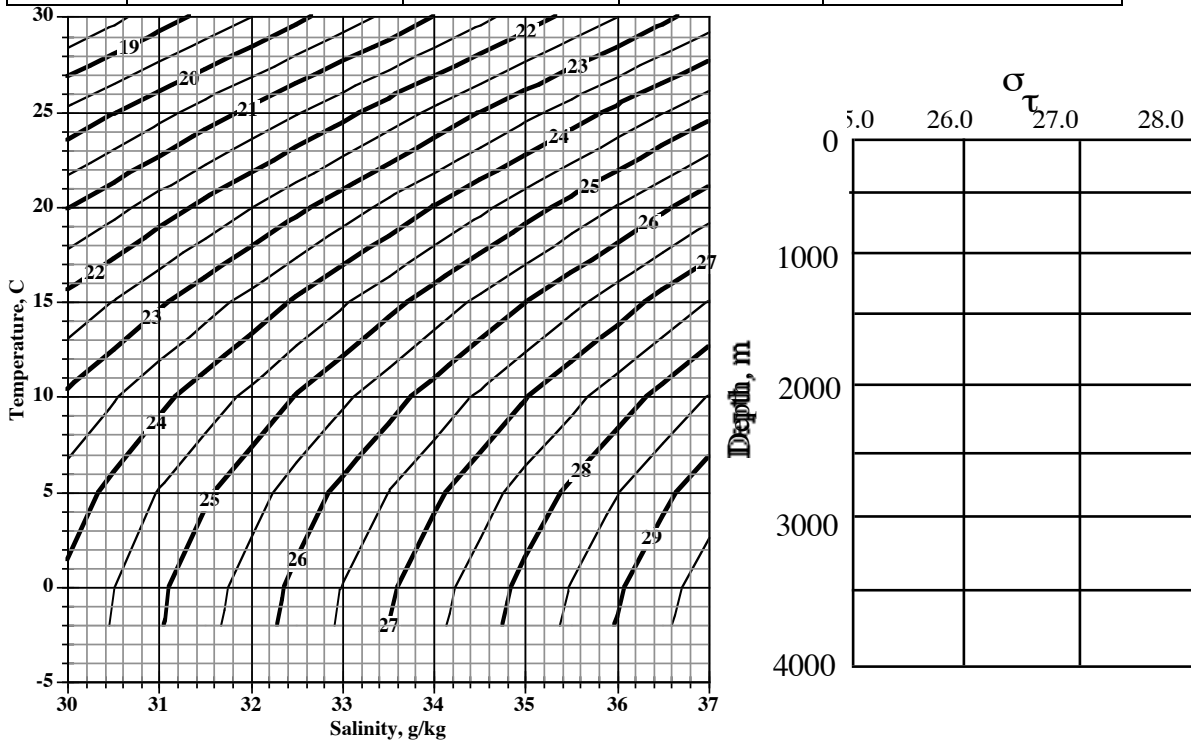
### Practice Exercises

I. Match the tidal phenomenon in the left column to the physical mechanism in the right column. These simple matches are no substitute for understanding the phenomena & mechanisms.

Tidal day	A. Lunar gravity
Semidiurnal tidal period	B. Blocking effect of continents
Mixed semidiurnal tidal ranges	C. Earth's rotation
Diurnal tidal period	D. Duration of the moon's orbit around the Earth
Spring/neap tides	E. Shape & depth of ocean basins
Rotary tidal motion	F. Earth-moon center of mass & centrifugal effect
Tidal crests not directly under sun & moon	G. Lunar declination (angle of moon's orbit to Equator)
Seasonal change in tidal range	H. Lunar phases
	I. Solar declination (angle of Earth's axis to its solar orbit)

II. The following data were gathered from a hypothetical station in the open ocean. Use the T-S diagram to determine the density values and stratification & stability of the water column.

Depth	Temperature (°C.)	Salinity, g/kg	Density ( $\sigma_t$ )	Density ( $\rho$ )
0	21	36		
250	20	35.9		
500	19	35.8		
750	12	35.5		
1000	6	35.0		
1500	5	34.95		
2000	3.6	34.9		
2500	3.2	34.85		
3000	3.0	34.85		



a/ Using the T-S diagram, fill in the values for  $\sigma_t$  and  $\rho$  in the table above. Round to the nearest 0.25  $\sigma_t$  units. Draw a vertical profile of  $\sigma_t$  on the graph provided to help you answer the questions below.

b/ Over what depth interval do you observe the thermocline? \_\_\_\_\_

The halocline? \_\_\_\_\_ The pycnocline? \_\_\_\_\_

The mixed layer? \_\_\_\_\_

c/ Is this water column **stratified** or **unstratified**? (Circle one) Why?

d/ If you looked at temperature alone, would this water column be **stable**, **unstable**, or **neutrally stable**? (Circle one) Why?

e/ If you looked at salinity alone, would this water column be **stable**, **unstable**, or **neutrally stable**? (Circle one) Why?

f/ Is this water column in fact **stable**, **unstable**, or **neutrally stable**? (Circle one) Why?

III. Summarize the properties of the 4 principal types of estuaries in the table below. You do not need to memorize numerical values of properties such as  $\Delta S$  (salinity difference between layers in an estuary) & R/P (relative importance of river inflow compared to tidal mixing). Instead, use them as a guideline for the qualitative differences among the estuary types.

	Salt Wedge	Fjord	Partially Mixed	Well Mixed
$\Delta S$				
R/P				
Stratification (strong/moderate/weak)				
Tidal Mixing (strong/moderate/weak)				
Halocline (strong/moderate/weak)				
Entrainment (strong/moderate/weak)				
Net estuarine circulation (strong/moderate/weak)				
Flushing (strong/moderate/weak)				