Notes: the Ocean

What is the Ocean?

- Ocean water covers most of Earth (about 70%).
  - 97% of water on Earth is sea/salt water.
  - All sections of the ocean are connected.

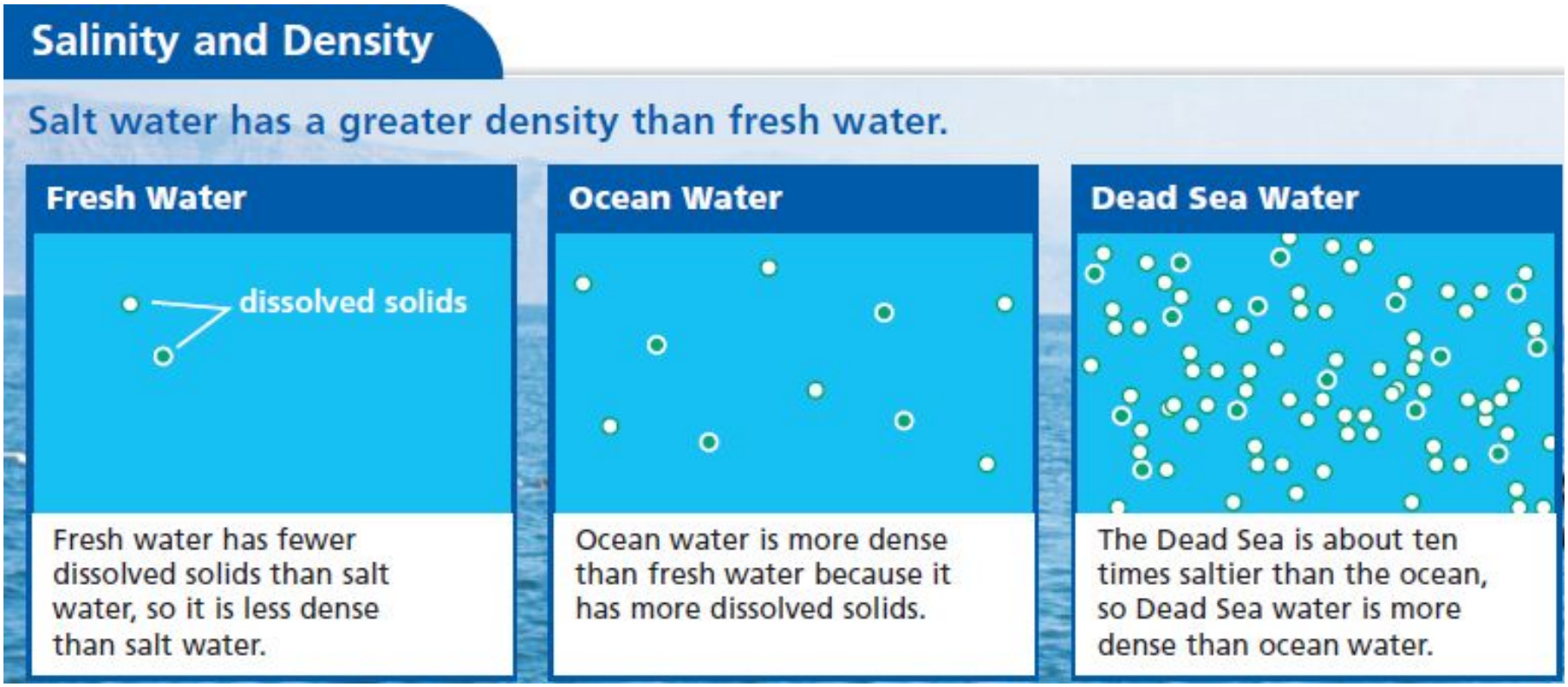
Why is the ocean important?

- The ocean covers most of Earth's surface.
- It is an important source of food and mineral resources.
- We use it for transportation and recreation.
- The ocean stores heat—water has high specific heat, so it takes a lot of energy to heat it up. Water holds on to this heat energy and stays warmer longer than the air.
  - The stored heat in the ocean drives much of Earth's weather and causes climate near the ocean to be milder than climate in the interior of continents.
- Ocean currents distribute energy (heat) and resources.

What is the relationship between density and salinity?

- Ocean water contains salts and gases.
  - Ocean water has all 92 natural elements.
  - Salinity: a measure of the amount of dissolved salt contained in water
    - many kinds of salts in the ocean (mostly NaCl)
    - salt water is more dense (heavier) than fresh water.
  - Density: a measure of the amount of matter packed into a given volume (mass/volume)
    - More salt = greater density = more objects float
    - Ex. Dead Sea is VERY dense!

Salinity and Density



Salinity (continued)

- Salinity & density vary in the ocean (different depending on where you are).
  - Higher salinity: cold areas (freshwater), shallow areas (more evaporation)
  - Lower salinity: areas where ocean is diluted by freshwater (estuaries—where rivers meet the ocean—or where a lot of rain falls).

What gases are dissolved in the ocean?

- Ocean water has many different gases dissolved in it, mostly nitrogen, oxygen, and carbon dioxide.
- The movement of wind over the ocean and waves agitates (mixes up) the water at the surface, speeding up the exchange of gases between the ocean and the atmosphere (like shaking a soda bottle!).
- Marine (ocean) plants need carbon dioxide dissolved in the water to go through photosynthesis photosynthesis releases oxygen into the water, which is then used by ocean organisms (like fish) to go through respiration.
- As atmospheric levels of gases rise, so do levels of those gases dissolved in ocean water.

Why is carbon dioxide so important?

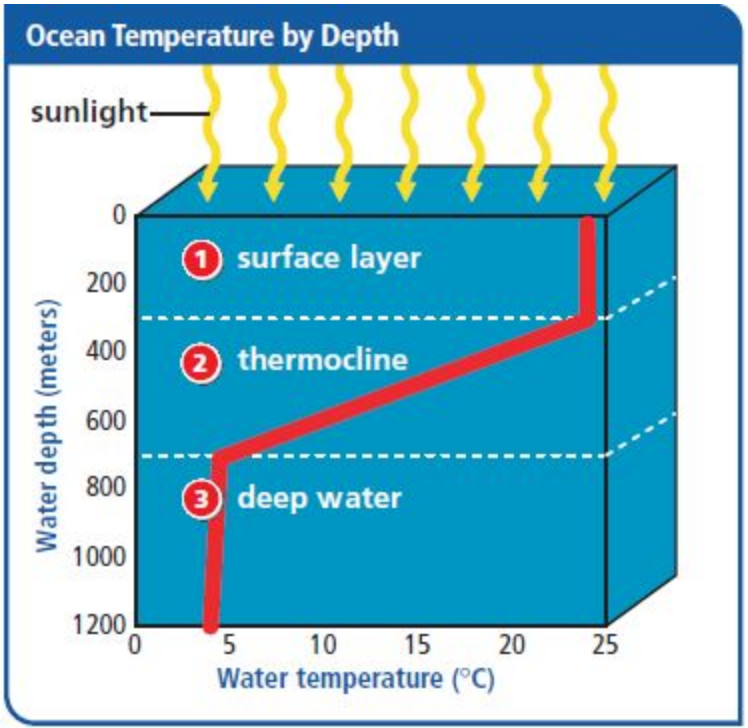
- Carbon dioxide is one of the most important gasses dissolved in the ocean (along with oxygen!)
- Some carbon dioxide stays dissolved as gas, but most reacts with water to form carbonic acid or reacts with other carbonates to form bicarbonates. This removes carbon dioxide from water.
  - Bicarbonates are used by many marine organisms to form calcium carbonate shells. When these organisms die, some of the bicarbonate is returned to the water, but a lot of it settles into the sea bed. This process locks up carbon that originated as carbon dioxide in the atmosphere for long periods of time.

What determines how much gas can be dissolved in seawater?

- Cold water holds more gas than warm water.
- Seawater with low salinity holds more gas than high salinity water.
- Deep water, which has a high pressure, holds more gas than shallow water.

What is the temperature of the ocean?

- Ocean is divided into 3 layers based on temp.
  - surface layer warmest, varies with depth
    - warm water is less dense, stays on top
  - thermocline temperature drops with depth
  - deep water cold all year long, barely above freezing
- Draw:

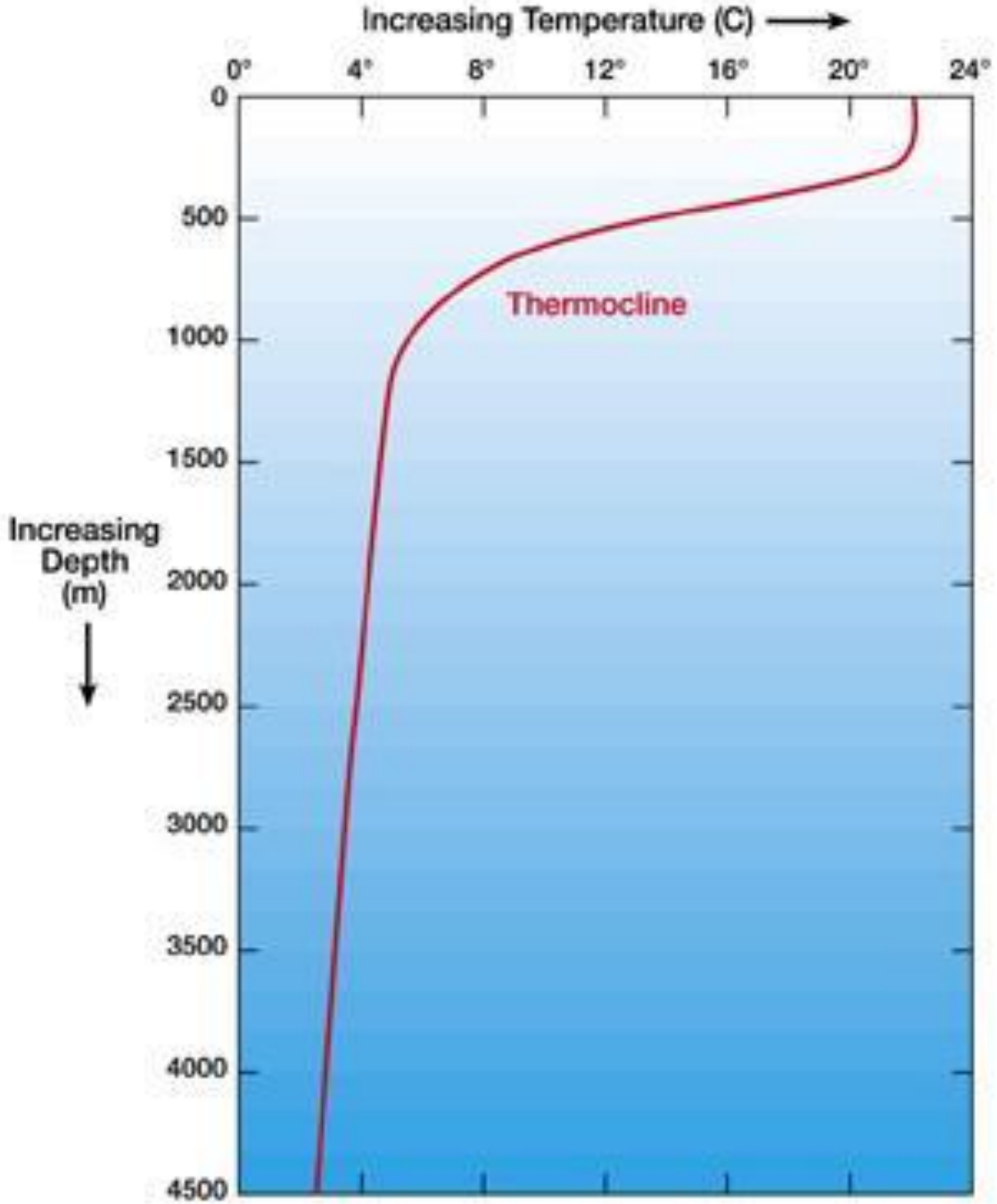


How does the ocean affect our climate?

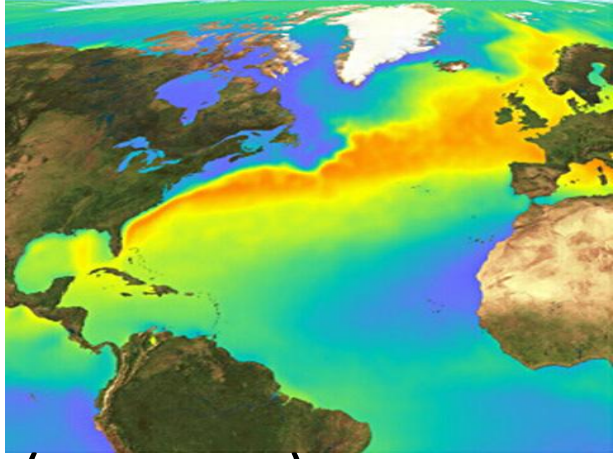
- The ocean is an important factor in the global climate because it collects and moves water, heat, and carbon dioxide
  - These components are constantly exchanged between the atmosphere and hydrosphere (water on Earth)
    - Ex: evaporation: water goes from the hydrosphere to the atmosphere
- Because the ocean can store so much heat, seasons occur later than they would and air above the ocean is warmed.
- Heat energy stored in the ocean in one season will affect the climate almost an entire season later.

Climate (continued)

- Air temperatures around the world are regulated by movement of heat in the ocean.
- Most heat in the ocean is stored in the top 2 meters because seawater has a high density and high specific heat—this allows the ocean to store a lot of heat.
  - The ocean can then buffer changes in temperature by storing and releasing heat.
  - Evaporation cools ocean water (just like sweat cools your body), which cools the atmosphere. This is more important near the equator, where there's a lot of evaporation, than near the poles.


Increasing Temperature (C)
0°
4°
8°
12°
16°
20°
24°
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Increasing Depth (m)
Thermocline

Climate (cont.)



- Moving air (wind) causes moving water (currents).
- Surface currents: help distribute heat around the globe
  - Ex. Gulf Stream current causes the climate in Great Britain to be mild, whereas at the same latitude in Canada, there would be polar bears.
- A change in surface currents can cause a HUGE change in weather patterns.
  - no wind = no surface currents = different climate/weather
  - El Niño
    - Pacific Ocean: wind normally blows west (□), some years it's not as strong
    - causes changes in weather around the world; lasts 12-18 months

La Scie, Newfoundland

Fowey, England

How does wind affect the ocean?

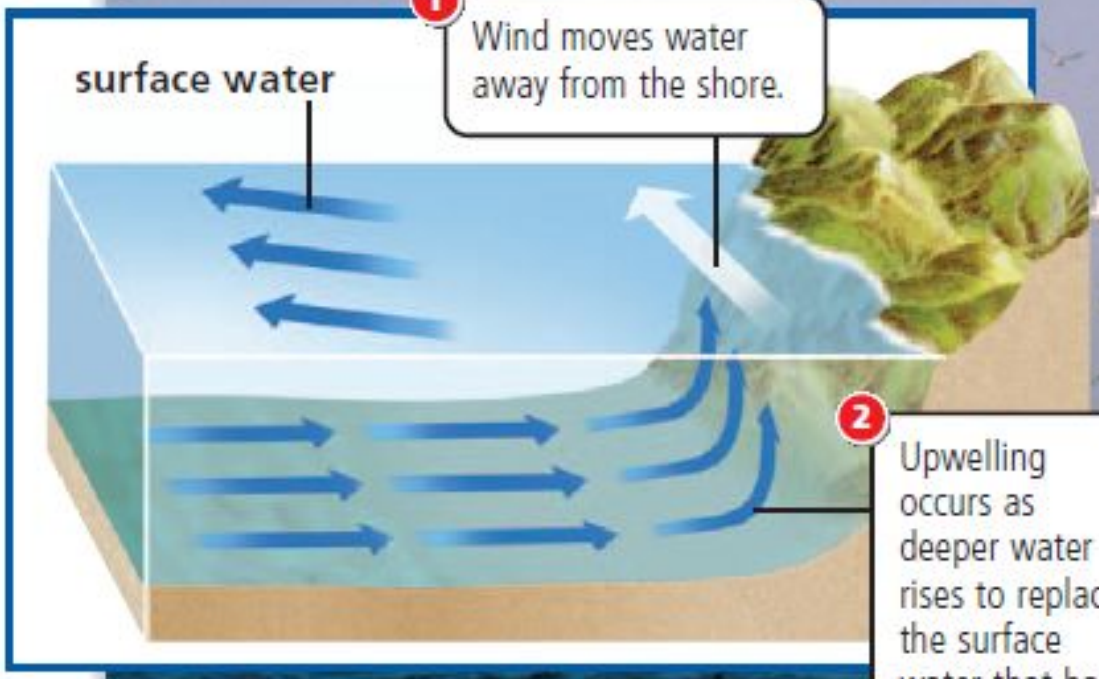
- Wind causes waves:
  - A wave is an up-and-down motion along the surface of a body of water.
  - Moving air drags across the water's surface and gives energy to the water, causing waves.
- Wind blows over the ocean, causing surface currents.
  - carry warm water away from the equator & cold water away from the poles
  - Earth's rotation makes them spin in circles (clockwise in N. Hemisphere, counterclockwise in S. Hemisphere)
- Ocean current: mass of moving water; many currents in the ocean distribute heat and nutrients
- Currents move water, waves move energy.

What are deep ocean currents?

- Deep currents are caused by differences in density (due to temp, salinity, etc)
  - Downwelling: water moving from the surface DOWN to the bottom
    - carries oxygen down
    - allows animals to live in the deep ocean
  - Upwelling: water moving UP to the surface
    - Occurs when warm surface water is blown offshore by wind. This allows the cold water at the bottom of the ocean to rise.
    - carries nutrients up
    - large numbers of animals gather in areas where upwelling occurs because of the availability of nutrients.

How Upwelling Affects Ocean Life

Upwelling provides nutrients that support animals and plants in surface waters.



The water rising to the surface is rich in nutrients. Many fisheries are located in areas of upwelling because ocean animals thrive there.

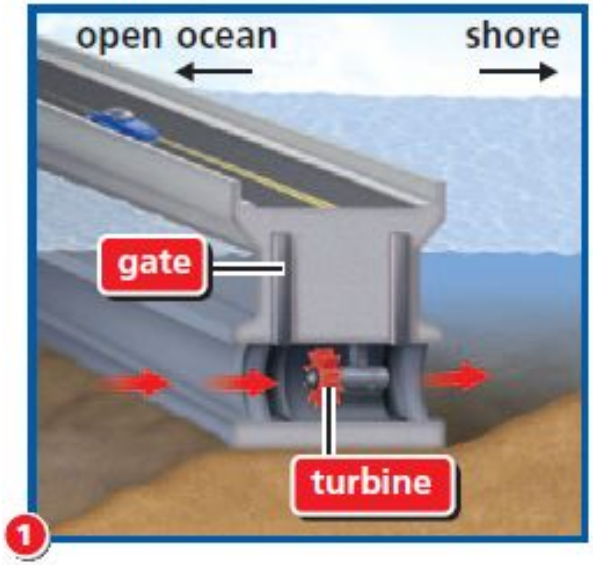
What are tides?

- Coastal waters rise and fall each day
  - The water level on coastlines varies with the time of day. This periodic rising and falling of the water level of the ocean is called the tide.
  - The water level is highest at high tide, submerging parts of the coastline.
  - The water level is lowest at low tide, exposing more of the coastline.

What is a tidal dam?

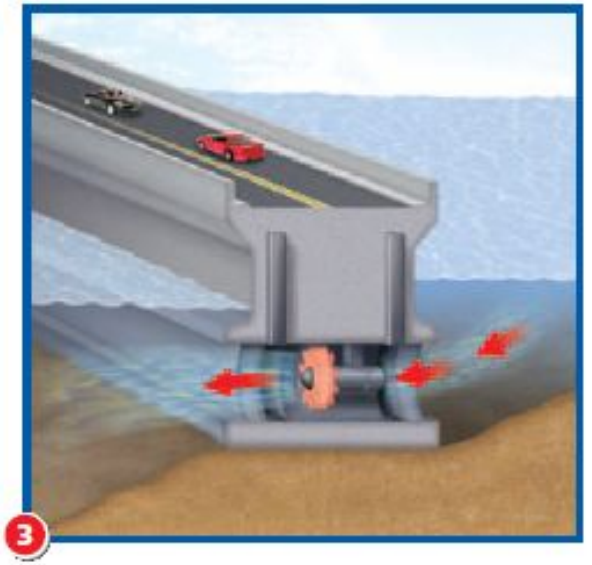
- Tides can be used to generate electricity.
  - A tidal dam is a dam built near a coast in the path of tidal waters.
  - How tidal dams work:
    - Dam's gates are open as the tide rises.
    - When tide lowers, gates close, trapping water.
    - At low tide, gates open and water rushes out, turning turbines and making electricity.
  - Benefits: renewable energy, less pollution.
  - Costs: can only be done in a few places, blocks paths of fish and can hurt marine life.

Tidal Dam



The dam's gates are open as the tide rises. Notice that the water level is the same on both sides.

When the tide begins to lower, the gates close, trapping water behind the dam.



At low tide, the gates open and the water rushes out, spinning turbines that generate electricity.