Bellringer: 3/16/2017

1. What have you learned from the presentations?
2. What will you do to make your project better for next time?
3. What would you like to do a project on in the future?
4. STOTD

**You need 2 colored pencils for today

**Field Trip Form & $$

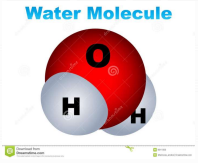
Updates & Tentative Schedule:
Thursday: Start Unit 4: Ocean Properties: Salinity
Friday: Finish Tsunami Video, **½ Day**

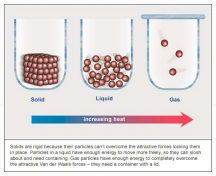
Chemical and Physical Ocean

Unit 4

Let's talk about Water (H_2O)!

- Water: **2 Hydrogens** and **1 Oxygen**
- Can be **solid**, **liquid**, or **gas**
- It is a **GREAT solvent**!
  - It will dissolve more things than any other natural substances



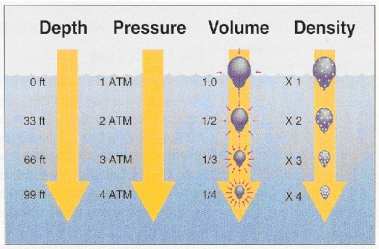


Factors Affecting Seawater

- 5 factors that affect seawater:
  1. **Salinity**
  2. **Temperature** – varies between -2ºC to 30 ºC (28-86 º F)
  3. **Density**—controlled by the temp of the water
     - **Cold water is more dense and sinks**
     - **Warm water is less dense and rises**
  4. **Dissolved Gases**—oxygen, CO_2, and nitrogen
     - CO_2 makes up 80% of dissolved gases (more soluble)

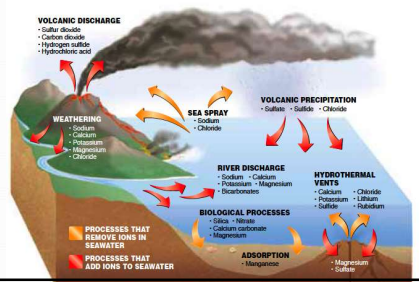
Factors Affecting Seawater

5. **Pressure**—changes with ocean depth



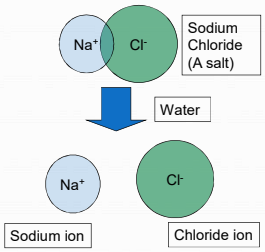
Composition of Seawater

- Minerals and Solutes
  - **Come from weathering of rocks and hydrothermal vents**
- Sodium and Chlorine account for **85**% of solutes



Seawater is a mixture of pure water and chemical compounds

On average,
- Seawater is 96.5% pure water…
- …and 3.5% compounds including dissolved **salts**
- Remember from chemistry that when salts dissolve they form **ions**



Seawater vs Freshwater

	Average Seawater		Typical Freshwater	
Ion	ppm	percent of total salinity	ppm	percent of total salinity
Chloride (Cl^-)	19300	55.1%	5	6%
Sodium (Na^+)	10700	30.6%	5	6%
Sulfate (SO_4^{--})	2700	7.7%	15	19%
Magnesium (Mg^{++})	1300	3.7%	3	4%
Potassium (K^+)	400	1.1%	2	3%
Calcium (Ca^{++})	400	1.1%	15	19%
Bicarbonate (HCO_3^-)	130	0.4%	35	44%
Bromide (Br^-)	70	0.2%	0	0%
Total Dissolved Solids (ppm)	35000		80	
Salinity (‰)	35		0.08	

What's in the water?

- 7 primary chemicals make up almost all (~99%) the salts in seawater:
  - Chloride (Cl^-): 55%
  - Sodium (Na^+): 31%
  - Sulfate (SO_4^{2-}): 8%
  - Magnesium (Mg^{2+}): 4%
  - Calcium (Ca^{2+}): 1%
  - Potassium (K^+): 1%
  - Bicarbonate (HCO_3^-): < 1%
- Can you come up with an acronym to remember them all?

Salinity of Seawater

- Salinity**: total amount of salt (NaCl) dissolved in seawater**
- Measured in **practical salinity units (psu)**
  - Based on conductivity
  - Greatly affects marine organisms

Refractometer—an LED light shines through a prism. The light is reflected off particles in the water to a detector that reads the salinity of the water sample

3 Factors that influence salinity

1. **Freshwater input** - High rates of freshwater input (river inflow to the sea; melting ice) will decrease salinity
2. **Evaporation** - High rates of evaporation will increase salinity
3. **Precipitation** - High levels of rainfall will decrease salinity

Salinity is variable across the ocean

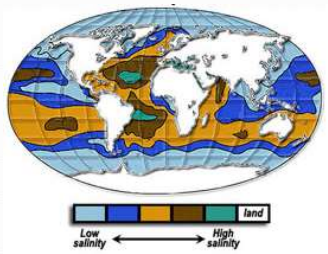
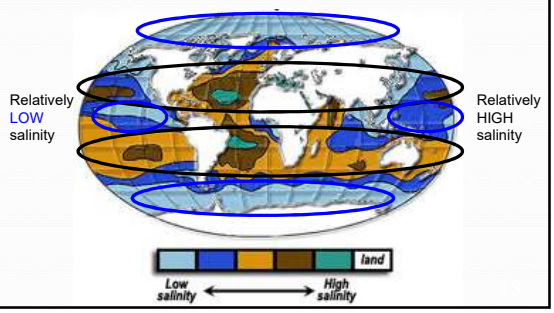


Photo: NASA

Salinity is highest in the mid -latitudes and lowest at the equator and high-latitudes

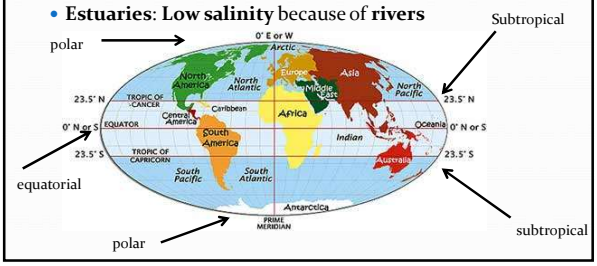
A closer look



Salinity on Map

**studies suggest that seawater is becoming fresher in high latitudes and tropical areas dominated by rain, while in sub-tropical high evaporation regions, waters are getting saltier.

- Varies depending on location
  - **Subtropical Regions** have **high salinity**
  - **Equatorial Regions: Low Salinity** because of **rainfall**
  - **Polar Regions**: **Low Salinity** because of **melting ice**
  - **Estuaries**: **Low salinity** because of **rivers**



Bellringer: 3/17/2017

1. What are 5 factors that affect seawater?
2. How does density affect seawater?
3. STOTD

**Get out "The Wave that Shook the World" Video Worksheet. We will continue with that today.

Bellringer: 3/20/2017

1. What are the 7 most common salts in the ocean?
2. What acronym do you use to help you remember then?
3. Where on the globe are the oceans the most salty?
4. Why are they the most salty in these regions?
5. STOTD **Flex period tomorrow: <80

Updates & Tentative Schedule:
Monday: Unit 4: Water Profiles
Tuesday: Unit 4: Currents
Wednesday: **Unit 4: QUIZ**, and Waves
Thursday: Unit 4: Tides
Friday: Catch-up & Review w/ Mr. Buck… **4th Period: Senior vs Staff Basketball game ($2 to attend)

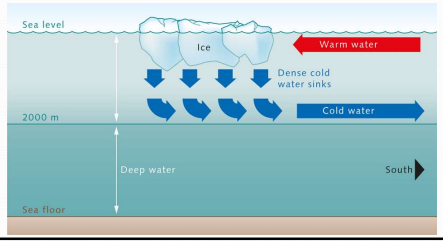
***Thursday March 30: MARINE SCIENCE MID-TERM

Fundraiser info

- Next Friday, March 31, 2017
  - Making Banners and setting up tables after school
- Bring yard sale stuff during 1st period
- Saturday shift starts at 7:15
- Carwash material
  - Buckets
  - Sponges
  - Car wash soap
  - Towels/rags
  - Window cleaner

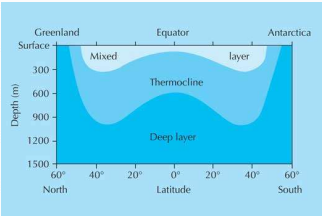
Stability and Overturn

- **The ocean is said to be layered or stratified because the densest water sinks.**
- **Shallow water = warm, less dense, lower salinity**
- **Deep water = cold, dense, high salinity**

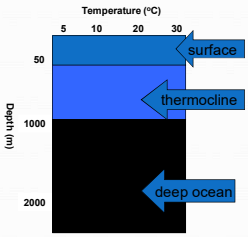


Water Profiles

- 3 water profiles:
  1. **Mixed Layer/Surface Layer**
  2. **Thermocline/Intermediate Layer**
  3. **Deep/Bottom Layer**
- Profiles can be referred to as **water masses**



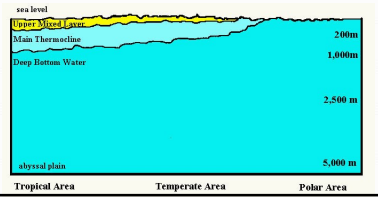
Let's take a journey down through the ocean's layers



- The ocean has **three** layers
- The **surface layer** is on top, the **thermocline** in the middle, and the **deep ocean** on the bottom

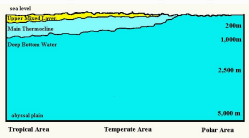
Mixed Layer/Surface Layer

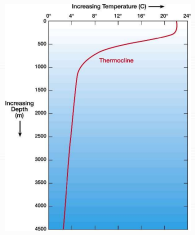
- Wind and other forces stir or "mix" this layer.
- The temperature is pretty much constant throughout
- The thickness of this layer depends on:
  - Weather
  - Season
  - Latitude



Thermocline/Intermediate Layer

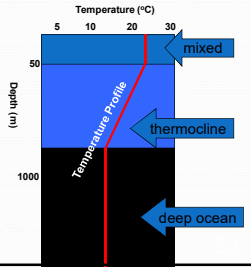
- Under surface layer ~**1,500 m** (5,000 ft)
- **Main Thermocline: zone of transition between surface layer and deep layer**
- Mainly found in **open ocean** (not continental shelf)





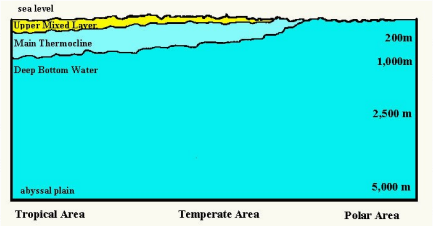
What happens as we move below the thermocline?

- Below the thermocline is the deep ocean
- Water here is cold, dense and salty
- Salinity and temperature do not change much as we move downward



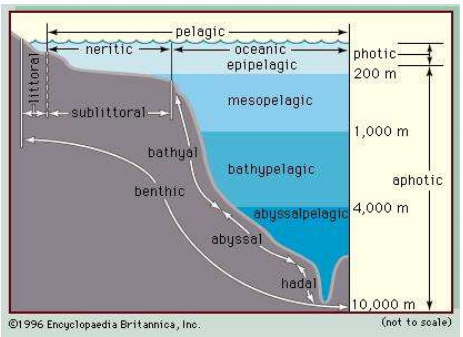
Deep/Bottom Layer

- Below **1,500** m (5,000 ft)
- **Uniformly cold** (4°C)



Zones of the Ocean

Water Column: a column of water from the surface to the bottom



Zones of the Ocean: Pelagic

- **Pelagic**: includes the entire water column
- **Epipelagic Zone**:
  - Surface layer of the ocean,
  - 0-200 meters
  - "Sunlight Zone"
- **Mesopelagic Zone**:
  - between epipelagic and bathypelagic 200-1000 meters
  - "Twilight Zone"

Zones of the Ocean: Pelagic

- **Bathypelagic Zone**:
  - 1000-4000 meters
  - dark and cold
  - "Midnight Zone"
- **Abyssal pelagic Zone**:
  - 4000-6000 meters
  - never receives light
  - uniform temperature
  - largest environment for Earth life
  - covers 60% of the earth's surface
  - 83% of the ocean is abyssal pelagic

Zones of the Ocean: Environments

- **Neritic Zone**:
  - shallow environment above the continental shelf
  - 0-200 meter
  - surrounds the coast
  - abundant nutrients and biological life
- **Benthic Zone**:
- ocean bottom environment,
- can include any ocean floor features including reefs-abyssal plain
- **Hadal Zone**:
- Named after Hades (Greek god of the underworld)
- below the abyssal zone
- high pressure
- extreme and uniform cold temperatures
- trenches

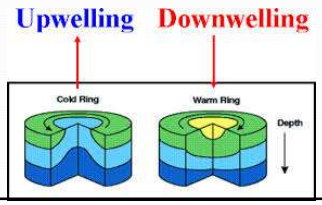
Bellringer: 3/21/2017

1. List the pelagic zones in order from top to bottom.
2. Use three characteristics to describe the abyssal pelagic zone.
3. STOTD

Updates & Tentative Schedule:
Tuesday: Unit 4: Currents
Wednesday: **Unit 4: QUIZ**, and Waves
Thursday: Unit 4: Tides
Friday: Catch-up & Review w/ Mr. Buck… **4th Period: Senior vs Staff Basketball game ($2 to attend)

***Thursday March 30: MARINE SCIENCE MID-TERM

- **Upwelling:** Brings cold, nutrient rich water from the depths of the ocean to the surface
- **Down welling:** surface water sinks and displaces deeper water



Motion of the Ocean: Currents

1. An ocean **current** is a regular movement of large amounts of water along defined paths.
2. There are two primary types of ocean currents:
   - **Surface Currents** (to a depth of about 400 m)
     - Driving factor: Wind
   - **Deep Currents** (entirely below the effect of wind)
     - Driving factor: Density differences
3. **Thermohaline circulation:** Ocean circulation driven by differences in density caused by temperature ("thermo") and salinity ("haline") variations

Motion of the Ocean: Currents

- **Surface Circulation**
  - **Currents and waves**
  - Influenced by **Coriolis Effect**
- **Wind Patterns**: wind driven from heat energy from the sun.
  - Most heat energy is absorbed near the Equator

Motion of the Ocean: Currents

- **Coriolis Effect**: Earth is round and rotating, therefore objects on the surface of the Earth do not move in a straight line.

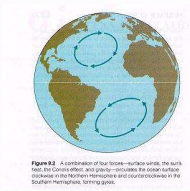
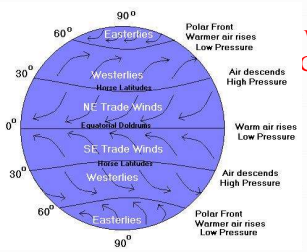


Figure 9.2 A combination of four forces—surface winds, the sun's heat, the Coriolis effect, and gravity—circulates the ocean surface clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere, forming gyres.

Northern Hemisphere:
Wind and currents go **right**
Southern Hemisphere:
Wind and currents go **left**
****Map: Gyres created by Coriolis Effect**

Motion of the Ocean: Wind

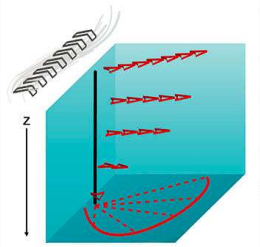
- **Wind Patterns** due to Coriolis effect



**Draw on map:
Wind Patterns due Coriolis Effect

Motion of the Ocean: Surface Currents

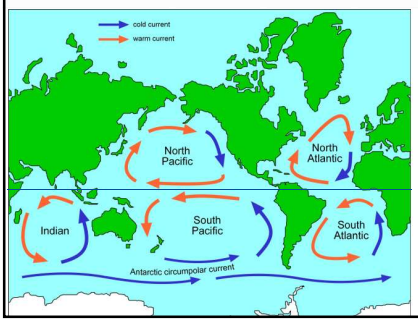
- **Surface Currents** due to Coriolis effect:



- Wind pushes surface water at 45^0
- Greater depths = greater angles
- Called **Ekman Spiral**

Motion of the Ocean: Surface Currents

- **Equatorial currents move parallel to the Equator**
  - Cause circular systems called **gyres**



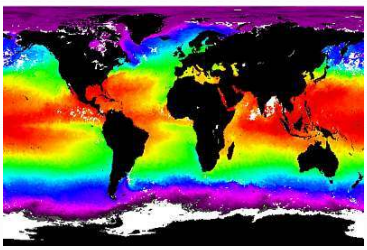
This warms the poles, cools the tropics and regulates the climate of our planet.

Currents shift according to season, weather, the bottom, the shape of coastlines, and the tides.

**Draw on map:
Equatorial currents

Motion of the Ocean: Temperature

- **Surface currents transport heat** and can be shown in the temp of the surface water



Notice the temp is warmer on the west side of the ocean basins and cooler on the east side.

Which is why coral grows on the west side of the oceans and kelp grows on the east side of the oceans.

**Draw on Map: Temperature Patterns

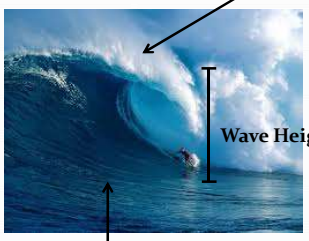
Bellringer:3/22/2017

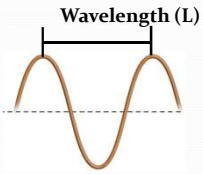
We will be watching 2 short video clips for Bellringer today. Please write the STOTD on the paper that I gave you and attach that paper to the back of your note guide.

- https://youtu.be/4M47FAkQjyo (Garbage Patch)
- http://channel.nationalgeographic.com/videos/development-of-ocean-waves/ (development of waves)

Motion of the Ocean: Waves

- Wind drives waves too!





Period: the time a wave takes to go by any given point

Understanding WAVES

A **wave** is the transmission of energy through matter – in this case through water

Two important types of waves are **deep water** and **shallow-water waves**

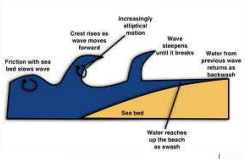
There is more than one type of wave

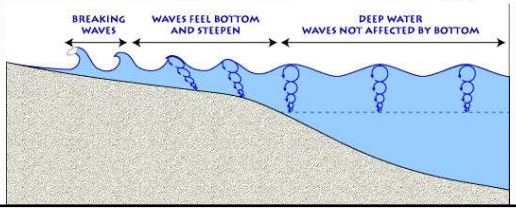
Note: D = water depth; L = wavelength

- **Deepwater waves** occur when water depth is greater than 1/2 wavelength ($D \geq 1/2\ L$)
- **Shallow-water waves** occur when water depth is less than 1/20 wavelength ($D \leq 1/20\ L$)
- Shallow and deepwater waves can occur at the same time

Motion of the Ocean: Waves

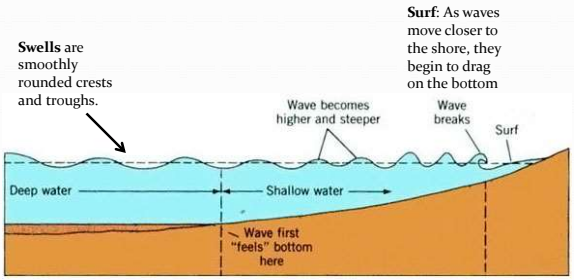
- How waves move:
  - **Water particles just move in circles, not from one place to another.**
  - **Waves carry energy not water!**





Waves Continued…

Waves are moving in differing directions at all times because of different wind directions.



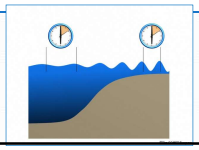
Tsunami!! The word is Japanese and means "harbor wave"

- A tsunami is a **series** of ocean waves.
- The come to shore every 5-90 minutes
- Caused by:
  - Displacement of the seafloor
  - Landslides
  - Volcanic activity

Tsunami animation: https://youtu.be/ZLFtDiGV1Ao

http://www.tsunami.noaa.gov/

- Tsunamis can range in height:
  - Deep ocean: a few inches
  - Ashore: you might not notice! OR it could come as a wall of water several meters high
  - It is unusual to have waves 100 meters (~330 ft) high, most are 10-20 meters (32-65 feet)



The wave that shook the world!

- In December 2004 a 9.0 magnitude earthquake shook the Indian Ocean (releasing energy equal to 23,000 Hiroshima-type atomic bombs)
- A tsunami was created
- Traveled 3,000 miles
- Started out as a wave less than a foot high
- As it approached shore it became 50 feet high
- At first the ocean receded
- Then, BAM, a wall of water hit the beaches and killed 150,000 people
- https://youtu.be/QUOoHhMvXnQ

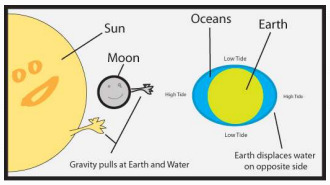
http://news.nationalgeographic.com/news/2004/12/1227_041226_tsunami.html

Bellringer: 3/23/2017

1. What have you learned about tides in previous classes?
2. STOTD

Motion of the Ocean: Tides

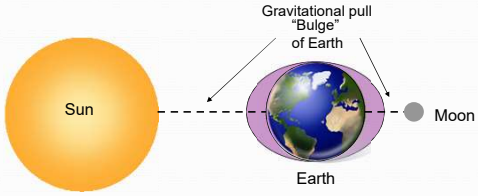
- **Tides**: the rising and falling of the ocean in rhythmic pattern.



- Tides are **caused by the gravitational pull of the moon**, **sun**, and the **rotation of Earth**.

What causes tides?

The gravitational pull of the sun and the moon causes "bulges" on Earth that move as we rotate

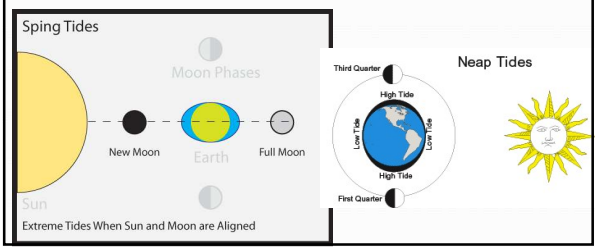


Motion of the Ocean: Tides

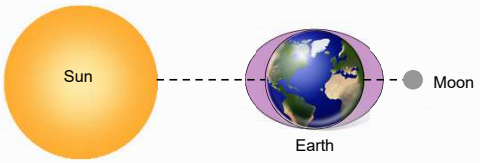
- As the Earth also spins, **the water moves.**
- High tide: **water level is at its highest**
- Low tide: **water level is at its lowest**
- Since it takes 24 hours for the earth to complete rotations, there are **2 high tides,** and **2 low tides**.
- The sun's pull also affects the tide but not as dramatically because the sun is so much father away from the earth.

Motion of the Ocean: Tides

- 2 Types of tides: Based on Moon location and Phases
  1. Spring Tide—**Large difference** between High and Low tide
  2. Neap Tide—**small difference** between High and Low tide

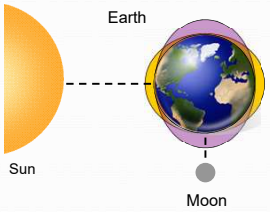


Different types of tide



- **Spring tides** occur when the sun and moon are in a straight line
- The tidal range is typically highest during spring tides

Different types of tide



- **Neap tides** occur when the sun and moon form a right angle with Earth
- Low tides are typically *higher* and high tides are *lower*
- Why is the moon's pull greater than the sun's?

- Tides vary from place to place depending on the location and on the shape and depth of the ocean basin.
- **Semidiurnal tides**: two high tides and two low tides a day. Ex: East coast of North America, most of Europe, and Africa
- **Semidiurnal Mixed tides**: many high tides of different height one after another. Ex: Wes Coast of North America and Canada.
- **Diurnal Tides**: one high tide and one low tide each day, very uncommon. Ex: coast of Antarctica, parts of the Gulf of Mexico, Caribbean, and Pacific

Motion of the Ocean: Tides

- Tides influence:
  - exposure/ submerging of shoreline organisms
  - circulation of bays/ estuaries
  - trigger spawning

Tides: Summary

- On the **side** of the Earth **closest to the moon**, the gravity of the moon **pulls the ocean toward it**.
- **Two bulges of water on Earth at any given time**.
- As the Earth also spins, the bulges change places.
- **High tide: under the bulge (2 per day)**.
- **Low tide: away from the bulge (2 per day)**.

Tides: Summary

- **Tide tables**: give the predicted time and height of high and low tides.
- These are specific for each place and can be found in most coastal areas.
- These are **remarkably accurate**.

Tide Table for Oct 2014:Atlantic Beach

Day	High /Low	Tide Time	Height (ft)	Sunrise Sunset	Moon	Time	% Moon Visible
W (10/1)	High	12:29 AM	3.6	7:02 AM	Rise	1:50 PM	39%
	Low	6:35 AM	0.6	6:51 PM			
	High	1:09 PM	4.6				
	Low	7:43 PM	0.9				
Th (10/2)	High	1:33AM	3.6	7:02 AM	Set	12:30 AM	50%
	Low	7:31 AM	0.6	6:50 PM	Rise	2:41 PM	
	High	2:15 PM	4.6				
	Low	8:48 Pm	0.8				

- Source: saltwatertides.com

Assignment:

Watch:

- Tides Recap (3: 38 mins): https://youtu.be/5ohDG7RqQ9I
- Crash Course (9:46 min): https://youtu.be/KlWpFLfLFBI

Complete:

- Test your Recall on TIDES
- After watching Crash Course, summarize how gravity and the tidal force and the impact they have on sea level, coast lines, and tides.