Dec/13/19 Test #2.

SEAWATER PROPERTIES

4.6 / 3.2 / 1.3 / 4.2 / 4.4 / 4.3

* Definitions:

elmt: substance consisting of atoms with the same # of protons. (object)

Atom: the smallest substance that maintain the property of an element.

bond: ~~the chemical attraction between two atoms to form~~ an attraction betwn atoms that allows the formation of chemical substances that contain 2+ atoms.

molecule: substance made when two or more atoms are connected chemically. (joined)

compound: ~~substance~~ molecule with two or more different ~~atoms~~ elements.

ion: electrically charged molecule. (atoms)

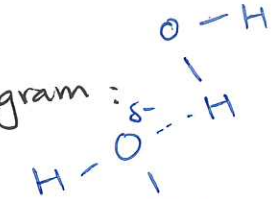
- ~~anion~~ : + Cation
- ~~cation~~ : − anion

* Wate:

- 2H, 1O connect by ~~cova~~ Covalent bonds. ⇒ hydrogen bond.
- a polar molecule (unequal distribution of charge)
- O is more electronegative.

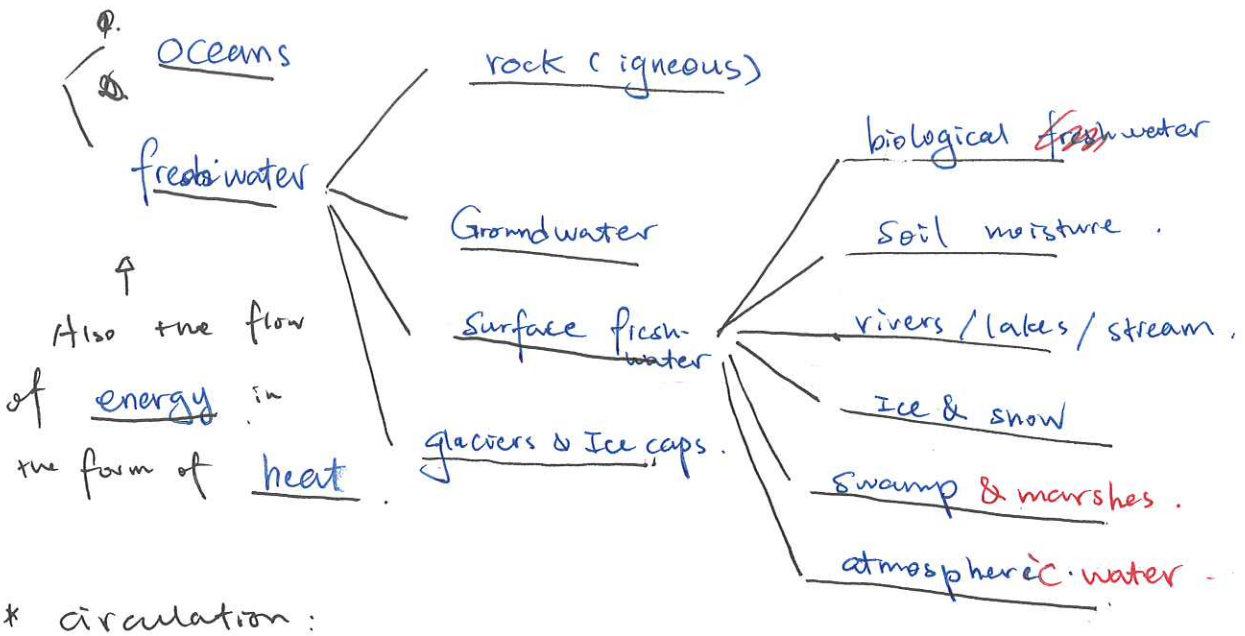
* Properties of water & its significance:

diagram:

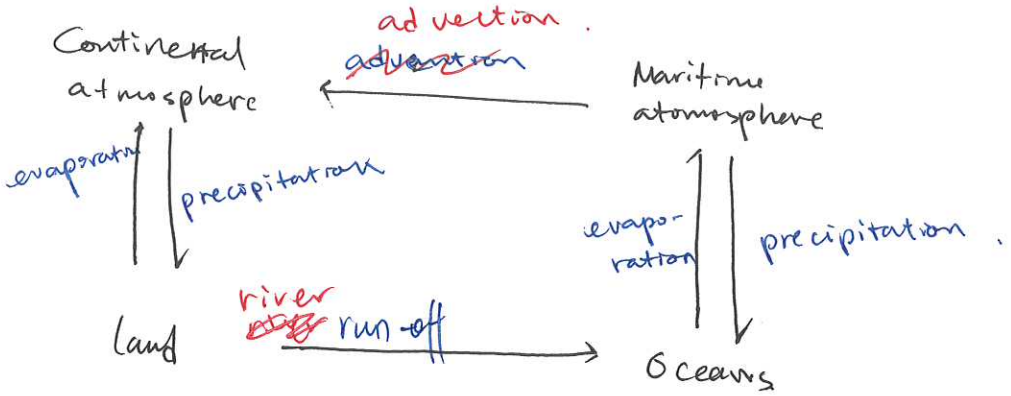


1. Transparency
   ① organisms can see through ② light can go through for photosynthesis. e.g phytoplankton seaweed.
2. Cohesion & adherence.
   ① surface tension ② organism can walk on surface e.g. water strider; sea slug.
3. Density > ice.
   ① ice can float to protect organisms underneath ② The whole lake/ocean won't freeze.
4. High specific heat capacity.
   ① constant temp. ② ~~modifier~~ for global warming. moderation. ③ store more heat than land.
5. low viscosity.
   ① organisms can swim through. ② it can flow.
6. Solvent.
   ① dissolve nutrients. ② dissolve gases. ③ salinity of oceans.
7. neutral pH.
   ① $H^+ = OH^-$ at 25°C.

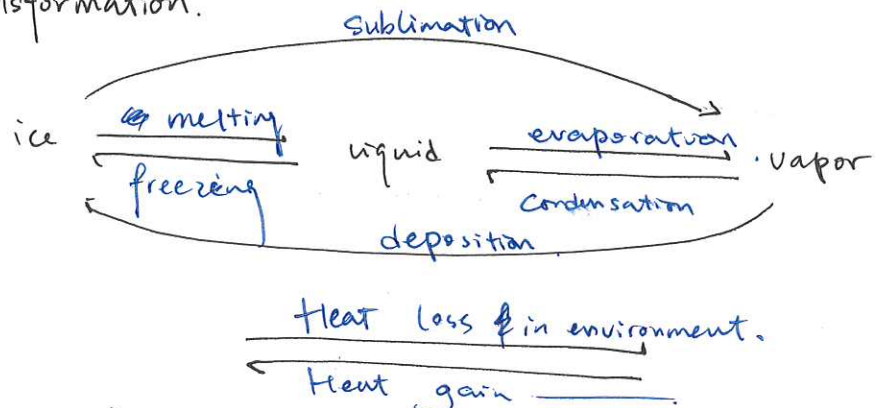
* water storages.



* circulation:



* transformation.



* origin of wather theory:

1. ~~volcanism in the early earth brought up the water~~ off-gasing of igneous rocks via volcanos. → condensation → precipitation → accumulation.
2. Comets bring rocks ~~with~~ ice (with water).

* conditions of early Earth.

. 4.6 billion * years old. red (color), hot snowball.

. Early atmosphere formed by volcanism.

(·) Compositian of gas:

mostly CO_2. little/no O_2.

less water vapor. methane. ammonia

. Evidence from ice core.

* Measurements:

1. temprature.

(i) temprature probe & meter

description:
put the probe underwater
metal extends
because of heat.

evaluation:
☺ accurate
easy
☹ expensive

(ii) thermometer (alcohol/mercury.)

description:
put it into water
V↑ when t↑.

evaluation:
☺ easy
Cheap
☹ limited depth.

(iii) reversing thermometer

description:
thread → reverse
under water → read

evaluation:
☺ depth. easy
☹ one depth at a time.

(iv) Bathythermograph

description:
launch it, V↑
according to temp. leave
trace on a coated glass.

evaluation:
☺ multiple depths, reusable
☹ expensive
heavy

(v) disposable.

evaluation:
☹ ☺
☹ pollution, unsustainable.

(v). CTD.

description
sent it down.

evaluation
☺ collect other data also.
☹

(vi) Satellite Remote Sensing (SST)

description
Satellite ~~detect~~ detect

evaluation
☺ range ↑
☹ only surface.

(vii) Acoustic ~~Sensing~~ Tomography.
→ $\vec{v}$ → t. (CAT...)

☺ at depth;
☹ disturb marine animals
unaccessible.

(viii) Ocean surface topography
~~t~~ t↑ → H↑

☺ range
☹ surface.

(ix) ARGO Floats.

2. Salinity.

(i) probe & meter
Conductivity

(ii) ~~Chloride~~ titration.

Formula:

$NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl \downarrow$.

☹ calculate
☹ time.

(iii) ~~refractometer~~ Refractometer.
lens ← read.

☺ accurate
easy
☹ ?

(iv) SSS

(v) Evaporation.

ü easy. accurate

ñ time consuming

3. pH.

(i) universial indicator (pH paper).

ü easy

ñ inaccurate.

(ii) pH meter / probe.

ü easy

ñ expensive.

(iii) Ocean pH meter.

4. Oxygen. Colorimetric method.

(i) ~~de~~ chrom—.?

(ii) Winkler titration.

colorimetric reagents that react and change color when reacted w/ O_2 in H_2O.

titrant amount ∝ O_2 concentration.

(iii) Oxygen probe & meter.

* Chem properties of seawater

- dissolved material 35 ppt. (3.5 %)
- ions: Chloride (Cl^-) > Sodium (Na^+) > Sulphate (SO_4^{2-}) > Magnesium (Mg^{2+}) > ~~Ca~~ calcium (Ca^{2+}) > Potassium (K^+).

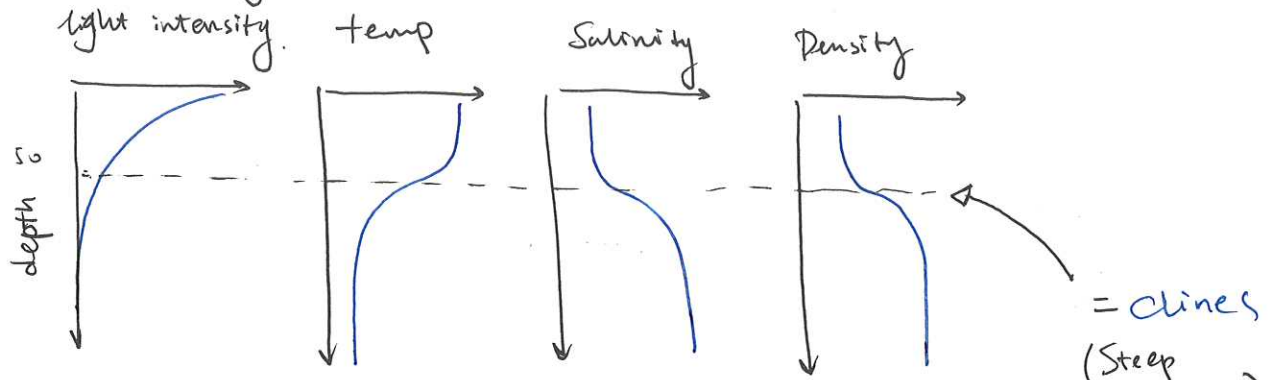
* why is ocean salty?

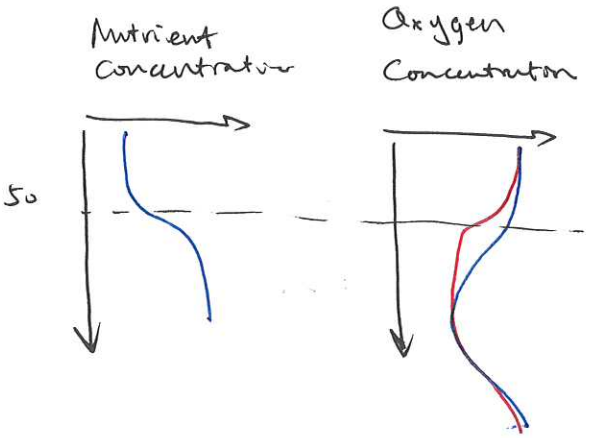
→ turn page

- Inputs / sources of salt:
  - hydrothermal vents / volcanic off-gasing
  - river runoff w/ ion from eroded rocks / soil
  - from atmosphere ~~dissolution~~
- outputs to
  - atmosphere (?)
  - ~~rocks formation~~ & ocean sediment & mantle.
- within the ocean: transformation
- Different residence time of ions → different %.
  = ave. time ion stay in the ocean.

* Seawater Density
→ ~~after~~ temp & salinity. → Graphs!

* The "two layered" ocean.





* Mixed layer.

- Defn: surface to clines ← steep gradient in abiotic factors
  - Δ: water temp & salinity remain constant in mixed layer.
  - RS: ~~~~ mixed by wind blow & wave.
  - Deepening of the mixed layer w/ ↑ wind strength & duration.
  - 25 ~ 200 in depth.

* Clines:
  - thermocline → temp
  - halocline → salinity
  - ~~pycnocline~~ pycnoclines → density

- Stratification (defn).
  layering of water.
- Seasonal thermoclines:
  RS: 1. radiation longer from the sun. → ↑ stratification.
  2. more wind in winter.

* Pycnocline:
  - act as a barrier to ~~biological activities~~ water circulation & organism movement
  - system is stable. (stable / instable)

* Which layer for phytoplankton?
  - Why neither is optimal?
    surface: ↓ nutrients. deep: ↓ light.
  - Why choose which?
    surface. light is necessary
  - Nutrients come from runoff, ~~diffusing~~ wind mixing, upwelling
  - Nutrient concentration fluctuate seasonally

↓↓ defn. near shore. deep water w/ nutrient brought up.

* Spring bloom of phytoplankton. why?
  more light, more nutrient, ~~lower~~ more stratification.
  - ↓ fresh water run off from ice & snow
  - ↓ heat & freshwater runoff.

* layering in the ocean.

pycnocline as a barrier to mixing.

Mixing can be caused by wind & current.

* Seasonal variation

• salinity Rs:

winter: ↓ because of precipitation.

summer: ↑ ↓ ← heat, evaporation.

Fall: ↑ ↑ ← runoff

* Global pattern of

• temp: latitude ↑, temperature ↓.

Rs: at equator, solar radiation most direct.

• Salinity:

pattern & Rs:

pole: precipitation & melting.

tropics: less precipitation. max evaporation.

equator: precipitation.

* Dissolved Gas.

3 most ↑ gases in 海水: N_2 > O_2 > CO_2.

• All gases diffuse in & out of the ocean.

* Processes affecting dissolved gases in seawater.

• Nitrogen: inert gas. not effect. except some Nitrogen-fixing bacteria.

• Argon: inert gas no effect on biological process.

• Oxygen: ↑ created by photosynthesis. consumed by respiration.

• CO_2: Can _____.

* Solubility:

Inverse relationship btw gas & temp.

* O_2 minimum layer.

RS: 1. Mixed layer:
- ~~ozone~~ atmosphere
- photosynthesis

2. O_2 minimum layer:
- bacteria decomposer
- lack of

3. Deep ocean:
- little consumption.
- ~~hydro~~ ~~thermal haline~~ thermohaline circulation from the poles. O_2 rich water

* pH.

Q How and why does CO_2 affect pH?
- $CO_2 \uparrow \rightarrow$ pH $\downarrow$
- $CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$

* Ocean acidification.
- Ocean pH is _____ (acid / basic)
- why more acidification at the poles?

① Colder water, absorb more. ② Ice melting, more open water

- Why pH $\downarrow$? intake of ~~CO_2 from~~ anthrogenic ~~activities~~ CO_2.
- Cause: Combustion of fossil fuels $\rightarrow$ CO_2 emission.
- Effects:

生物
1. ~~Dissolve~~ Dissolution of Shells & skeletons
   ex. pteropods, coccolithophores, urchins, barnacles
2. $\downarrow$E for reproduction & forage
3. ~~Less~~ $\downarrow$ resilliance to face other threat

eco-syst.
4. coral reefs
5. destruction of food web

human
6. less food
7. $\downarrow$ profit for fishery

Solutions
- 1. less fossil fuels.

Resi-lience
2. marine protected area
3. sustainable fishing
4. reducing nutrient pollution.

E
5. renewable energy efficiency
6. solar, wind, ~~hydro~~ tidal.