CH1

- Expansion of Universe 宇宙扩张

  Big Bang Model

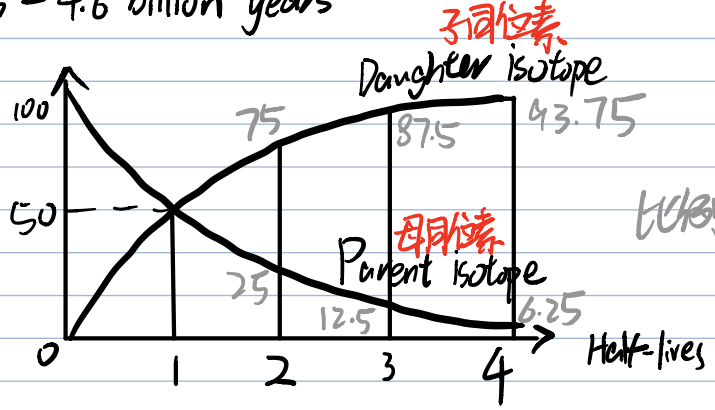
  stars, galaxies, clusters, and nebula
  恒星 星云 星团 星云

  - First stars produced elements and galaxies

- Radiometric dating 放射性测年法

  Age of Earth 4.5 - 4.6 billion years

  half-life 半衰



比例 0 1/1 3/1 7/1 15/1

- Latitude and Longitude 经纬度

  $1^\circ = 60' = 3600''$

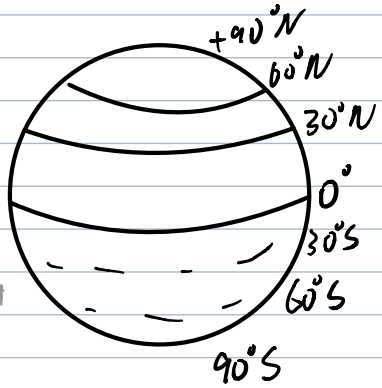
  degree minute second

Sun's zenith 太阳天顶,正头顶

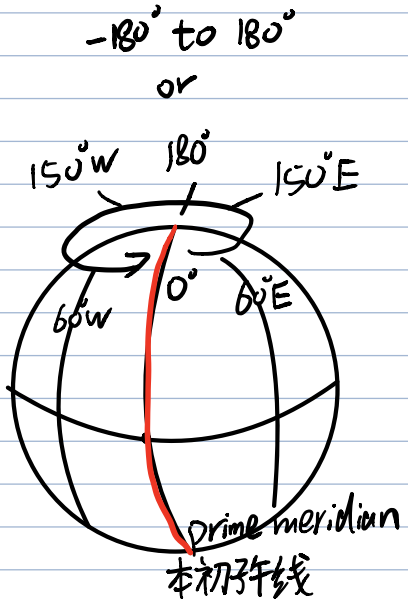
A zenith at 12

B zenith at 1pm

则 B比A要西多1区



纬度 latitude



经度 longitude

地球自转 逆时针 太阳东升西落

- GPS (Global Positioning System)

  signal travel 3×10^8 m/s speed 光速

- Modern Navigational Techniques

  GPS

  Each satellite transmits unique digital code

- Hypsographic curve 等高线

  show depth elevation area volume
  深 海拔 面积 体积

- Hydrological cycle 水循环 (water cycle)

  Earth surface { 71% water / 29% land

  water reservoirs 水库

  Evaporation 蒸发 transpiration 蒸腾 sublimation 升华

  Precipitation 降水 rain snow ...

- Five Ocean 五大洋

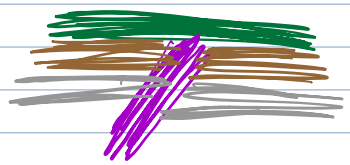
  Pacific 太平洋
  Atlantic 大西洋
  Indian 印度洋
  Southern 南冰洋
  Arctic 北冰洋

• Relative Age

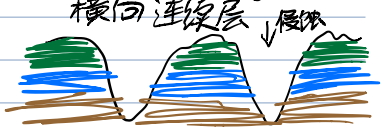
superposition 先来后到

original Horizontality 统一水平

Cross-cutting Relations 交错穿插层

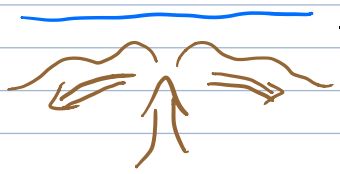


Lateral Continuity 横向连续层

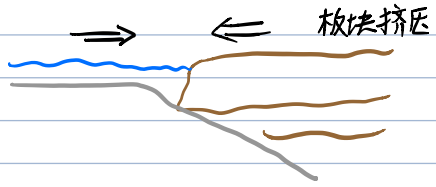


CH2

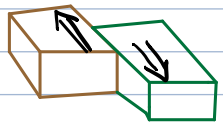
Divergent boundary 离散边界



Convergent boundary 汇聚边界



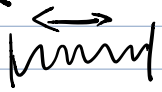
Transform boundary 转换边界



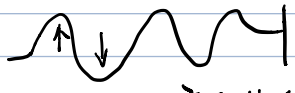
Earth's Interior 地球内部

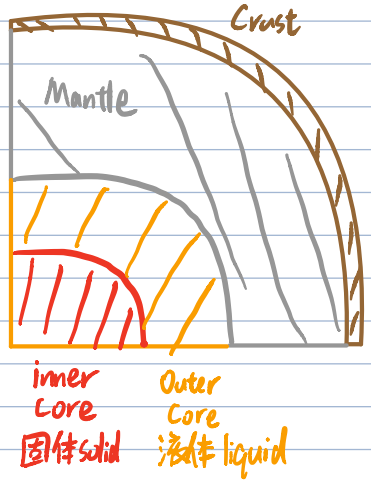
Body waves 体波:

P-waves 压力波 compressional 固液气都过，第一到



S-waves 横波 transverse 仅过固体，第二到





Mineral & Chemical 矿石成分

Chemical 化学分层

- Crust 地壳，lower density, minerals ~~S, O, Fe, Mg, K, Ca, Na, Al~~
- Mantle 地幔，higher density, minerals ~~S, O, Fe, Mg, K, Ca~~
- Core 地核，extremely dense metal ~~Fe, Ni~~

Mechanical 机械分层

- Lithosphere 岩石圈 crust + upper material 地壳和部分矿物
- Asthenosphere 软流圈 Deformable 可变形
- Mesosphere 中间圈 solid lower mantle 坚固地幔
- Outter Core 外核
- Inner Core 内核

Isostasy 地壳均衡 balance

layering System 层级

- surface Ocean 表层海洋
- deep Ocean 深海
- seafloor sediments 沉积物

Continental Drift, Plate Tectonics 大陆漂移，板块构造

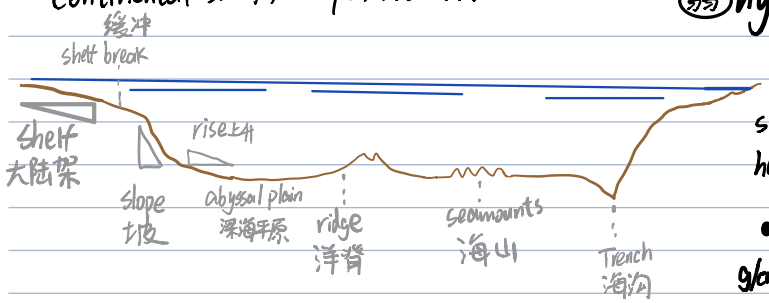
Wegener 韦格纳

- continents look like pieces of jigsaw puzzle 大陆像拼图
- fossil evidence 化石证据

CH3 # EXAM2 CH4

- Methods for measuring ocean depth
  rope 古代用绳测海深
  Echo sounder/depth recorder 回声测定深度
  satellites sea-surface elevation 卫星测海面海拔

- Bathymetric features 水深属性
  continental shelf, slope, rise...



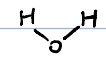
- Seamounts and barrier reef formation
  海山 堡礁 形成
  高度大于1Km

reef 礁 (岩石珊瑚群)
- Fringing Reef 边礁
- Barrier Reef 隔离礁
- Atoll Reef 环礁

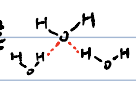
- Sediment 沉积物 Neritic 大陆架海域
  Pelagic 深海域

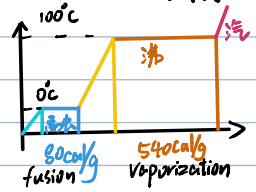
Chemistry
- Lithogenous 岩石沉积 ②
- Biogenous 生物沉积 ①
- Hydrogenous 水溶沉积 盐 ③
- Cosmogenous 宇宙(陨石生)沉积 ④

$CaCO_3$ ↓ Lysocline 补偿线 (dissolution 溶解开始)
↓ Carbonate Compensation Depth
CCD 补偿深度 (溶积平衡)
supply = dissolution

- Water 
  polar molecule 极性分子
  Covalent bonds 共价键 

原子Atom 不间断运动
分子Molecules
Kinetic energy 动能 °C = -273.15 + K
Temp = 平均动能/K F = 1.8°C + 32
Heat = 总动能/cal

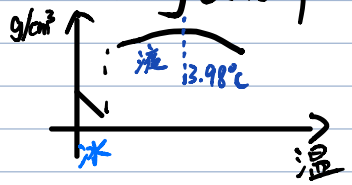
(弱) hydrogen bonds 氢键 
- surface tension 表面张力
- 固液气, 液态影响大
- Latent heat 潜热



high heat capacity 比热容大
水 1cal/(g·°C)

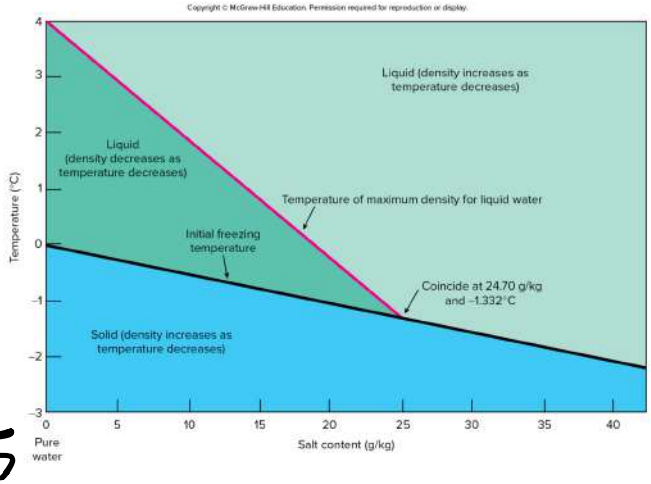
specific heat 比热容 cal/(kg·°C)
heat capacity 热容量 cal/°C 整体

- Density & Temp



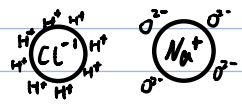
- Light 衰减快, coastal 衰减快于 ocean water
- Sound 海水 1500m/s, V_s↑ { 温↑ 盐↑ 压,深↑ }, 低频传播远

Density: Effect of Salt



CH5

- 水破坏盐键(溶解)



- 测量 Saltnity 盐量

$$\frac{\text{盐水} - \text{桶重}}{\text{水} - \text{桶重}} = \frac{\text{g(salt)}}{\text{Kg or L}(H_2O)}$$

- Major Salt in ocean

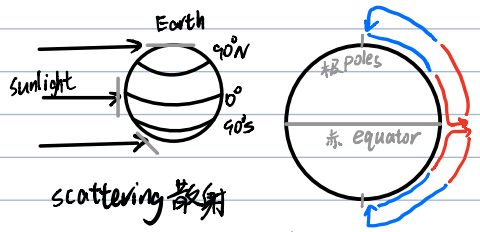
Cl^-	55%
Na^+	30%
SO_4^{2-}	7%
Mg^{2+}	3%
Ca^{2+}	1%
K^+	1%
⋮	

EXAM 3

CH5

- 海水pH 7.5 - 8.5 (7中性) 酸Acidic \ 碱Basic
- CO_2 缓冲(buffer)防止pH大变化
- 海水主要盐离子成分相同(除沿岸)
- 海洋是氧气净来源，表面 Photosynthesis 光合作用 / 各深度 Respiration 呼吸
- long residence time 长居时间 ↓ Cl^- Na^+ Mg^{2+} 有长有短
- Major Constituents/ion $Na^+, Mg^{2+}, Ca^{2+}, K^+, Cl^-, SO_4^{2-}$

CH6



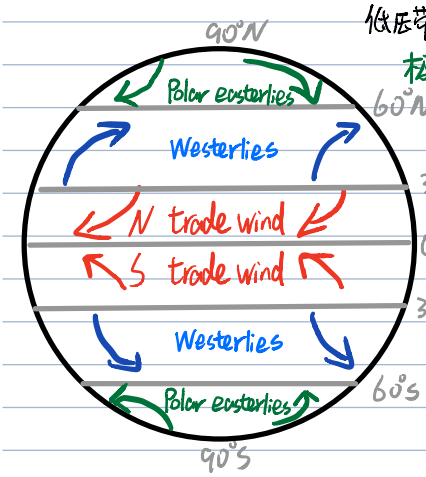
scattering 散射

- solar radiation Latitudinal 纬度变化

Heat budget: solar 需求 = output
收支平衡了 input > output T↑, 反之T↓

- Coriolis Effect 地转偏向力

南左北右，赤道无 高压带：下沉空气，日晴，少雨
低压带：上升空气，云，多雨



极地东风带
西风带
信风

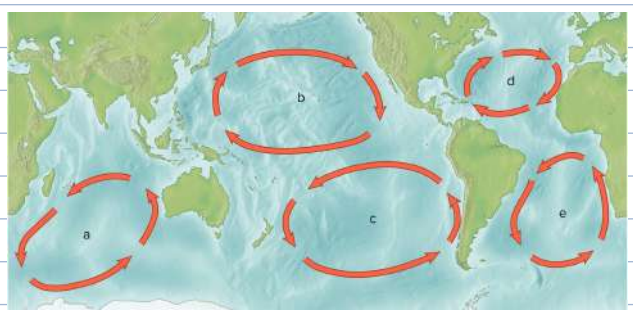
- Monsoon Effect 季风效应

夏：陆热海冷 onshore 上岸 offshore 离岸
← 风 高压
onshore wind 湿，云

冬：陆冷海热、高压 → 风 干，晴
offshore wind

地形效应
- Topographic Effect

- Ocean Gyres 五大洋流
, 南左(逆时针)北右(顺时针)



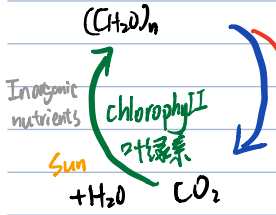
自养 Autotrophs
- Photosynthesis 光合作用
- plant 植
- phytoplankton 浮游植物
- 需 N, P, Si 等 inorganic nutrients 无机营养

异养 Heterotrophs
- animal 动
- Bacteria 菌

CH11

- Salinity Osmosis 渗透压
low salinity → water → high
+ O_2

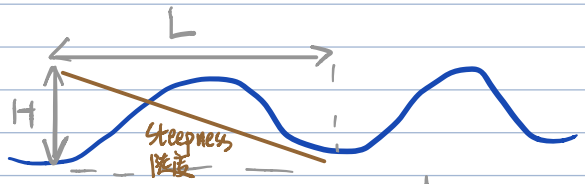
- Temp
Poikilotherms 不调体温 (most invertebrates, fish 无脊椎)
Homeotherms 恒温动物 (seabirds & mammal 哺乳)



- Buoyancy 浮力
  - density 密
  - surface to volume ratio 表比体
  - gas pocket 气袋
  - less-dense compounds 低密化合物

- EL Niño 厄尔尼诺 ⟷ La Niña 拉尼娜现象 (交替出现)
印度尼西亚低压区异常高 信风超强
南太平洋高压区 异常低 - - -
信风异常弱或逆转 - - -
Peru 秘鲁近地水温异常高 Peru 秘鲁近地水温异常冷

CH8



crest 峰 Trough 槽

Rip Currents 激流 (vertical)

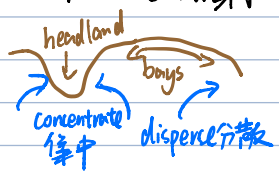
Seismic sea waves 地震海啸

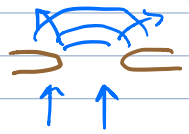
近岸 L↓ H↑ 水流变急

深水波 $D > \frac{L}{2}$
浅水波 $D < \frac{L}{20}$

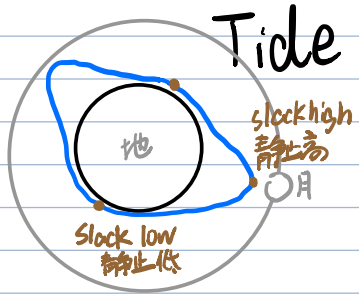
速 $v = \frac{L}{T}$ { 深水 v 关联 L 涨
浅水 v 关联 D 深度

Refraction 折射 Reflection 反射 Diffraction 衍射





Tide



CH9

- Diurnal Tide 全日潮 24h一高一低
- Semidiurnal Tide 半日潮 24h 两高两低
- Semidiurnal Mixed Tide 混合潮

Lunar tide 月潮 12h 25min & 24h 50min
Solar tide 太阳潮 12h & 24h

CH12

plankton 浮游生物

- photo autotrophs 光照自养生物

Bacterio plankton 浮游细菌 + Viruses 病毒
phytoplankton 浮游植物