TA lecture notes (08/29/22)

⑤ Logarithm

- monotonic
- compresses
- $\ln(ab) = \ln(a) + \ln(b)$
  ↳ multiplication turns into addition

→ last week's review

⑥ Complex numbers "2-D numbers"

- Shows the exponential and trigonometric functions are the same function

$e^{i\varphi} = \cos\varphi + i\sin\varphi$

E.g.: $e^{i\pi/2} = 0 + i \cdot 1 = i$

Today !!!

Why go quantum?

Let's look at classical mechanics first

$$E = \underbrace{\tfrac{1}{2}mv^2}_{\text{kinetic energy}} + \underbrace{V(x)}_{\text{potential energy}} = \frac{p^2}{m} + V(x)$$, where P = momentum, v = velocity $\left(v = \frac{\partial x}{\partial t}\right)$ (x → distance, t → time)

NB//: E is often used interchangeably with the Hamiltonian ($\mathcal{H}$) i.e., $\mathcal{H} = E$

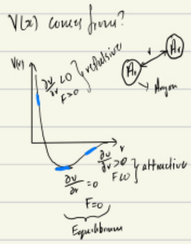
How do particles move?

$$-\frac{\partial V}{\partial x} = m\frac{\partial v}{\partial t}$$ (V → PE)

$-\frac{\partial V}{\partial x}$ } force pushing the particle downwards; can be rewritten as the force $\frac{\partial V}{\partial x} = F$, ∴ $F = m \cdot \frac{\partial v}{\partial t} = m \cdot a$

Problems with classical mechanics

1) Where does the V(x) comes from?



2) Classical mechanics predicts that atoms & molecules will collapse

→ energy emission } this isn't observed, rather e^- continues to "orbit" the nucleus.

Lewis realize that $2e^-$ participates in forming a bond

↳ he concluded that bonds are electron pair

$H^\bullet + {}^\bullet H \rightarrow H{:}H$ & $\cdot\ddot{N}\cdot + 3({}^\bullet H) \rightarrow NH_3$ (with H^+) $\rightarrow [H{:}N{:}H_3]^+ \Rightarrow NH_4^+$

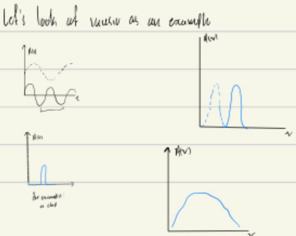
So, why quantum??

↳ There are two kinds of variables in nature

1) independent variables : classical mechanics : $\Delta x \cdot \Delta p = 0$, physicist believed x & p are independent

2) conjugate variables : not independent

Let's look at music as an example



Duration (time) and pitch (frequency) are conjugate variables that obey the "Fourier Principle" : $\Delta t \cdot \Delta \nu = \frac{1}{4\pi}$

$\Delta x \Delta p = \frac{h}{4\pi}$, where h is for Planck's constant