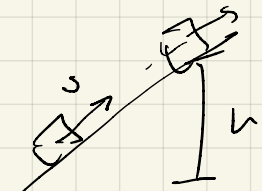
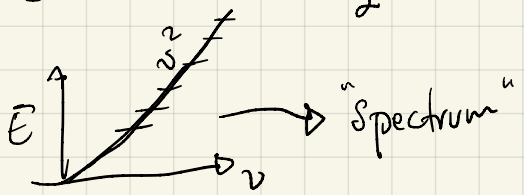
QM1 : Quantum

- uncertain ✓
- probabilistic ✓
- quantized ✓

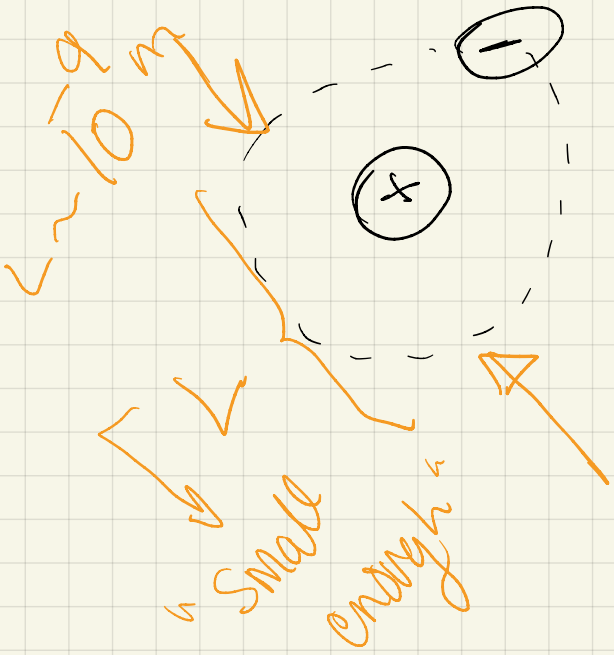
- classical object → v → "$F=ma$"

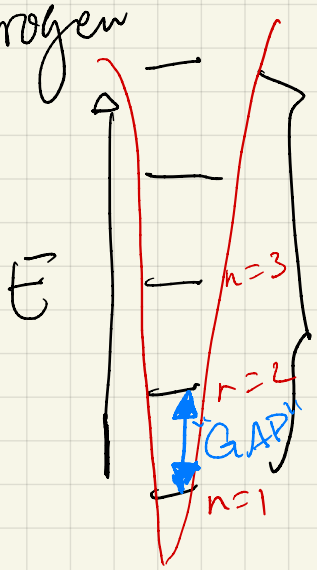
$$E = K + V = \frac{1}{2}mv^2 + mgh$$





"one atom of Hydrogen"



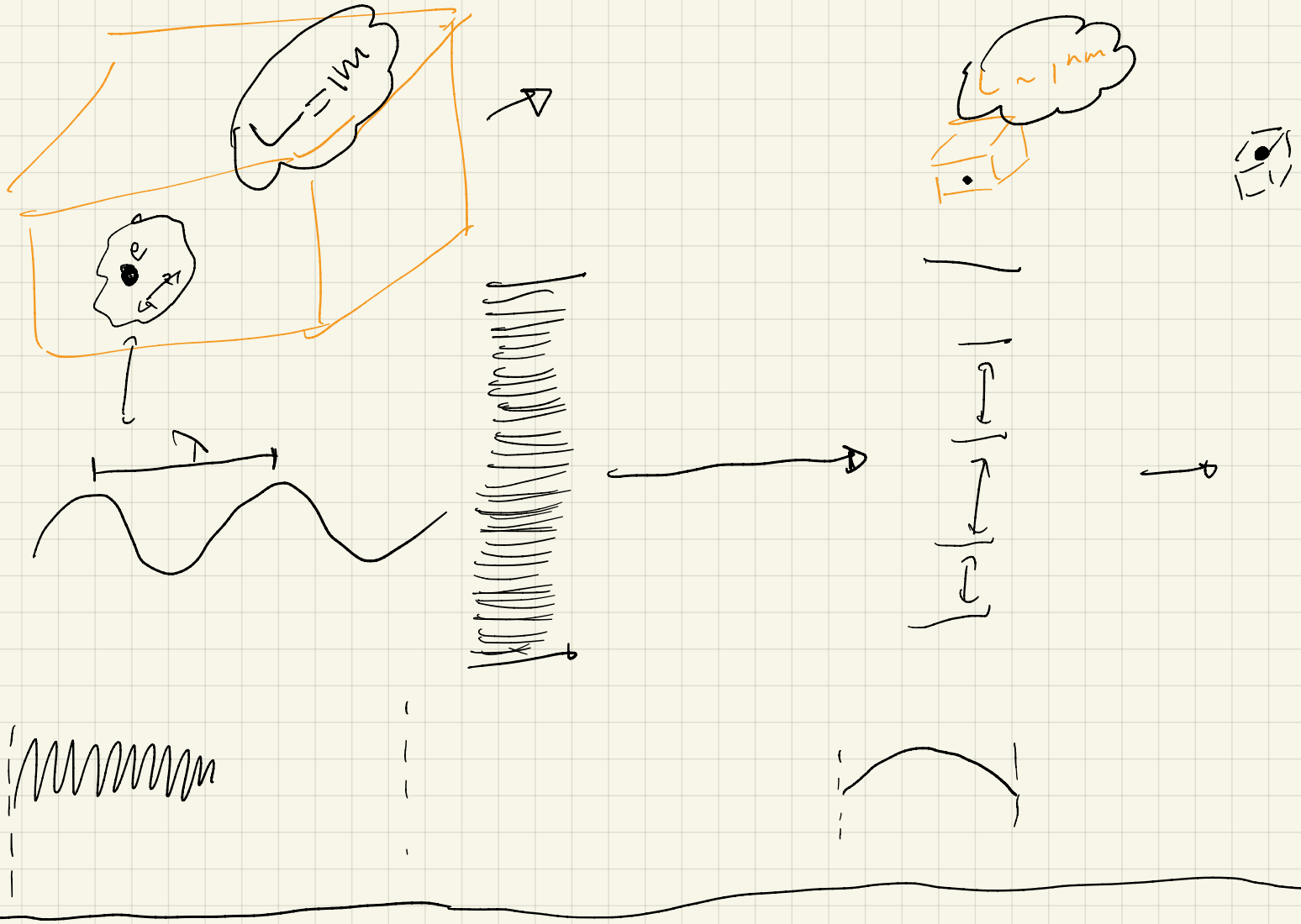


$$E = \frac{-13.6\ eV}{n^2}$$

Discrete values for energy $n = 1, 2, 3, \ldots$

$n=1$ $\quad -13.6$

$n=2$ $\quad -13.6/4$



"Schrodinger Equation"

(time-dep, time-independent)

$E = K + V$

energy → Kinetic → velocity

potential → Gravity, Electric

$\Rightarrow F = ma$

⋮

Classical → Quantum

Classical → Action $= S$

$\frac{\partial S}{\partial x} = \frac{\partial L}{\partial \dot{x}}$ ...

⋮

Hamilton-Jacobi Equation

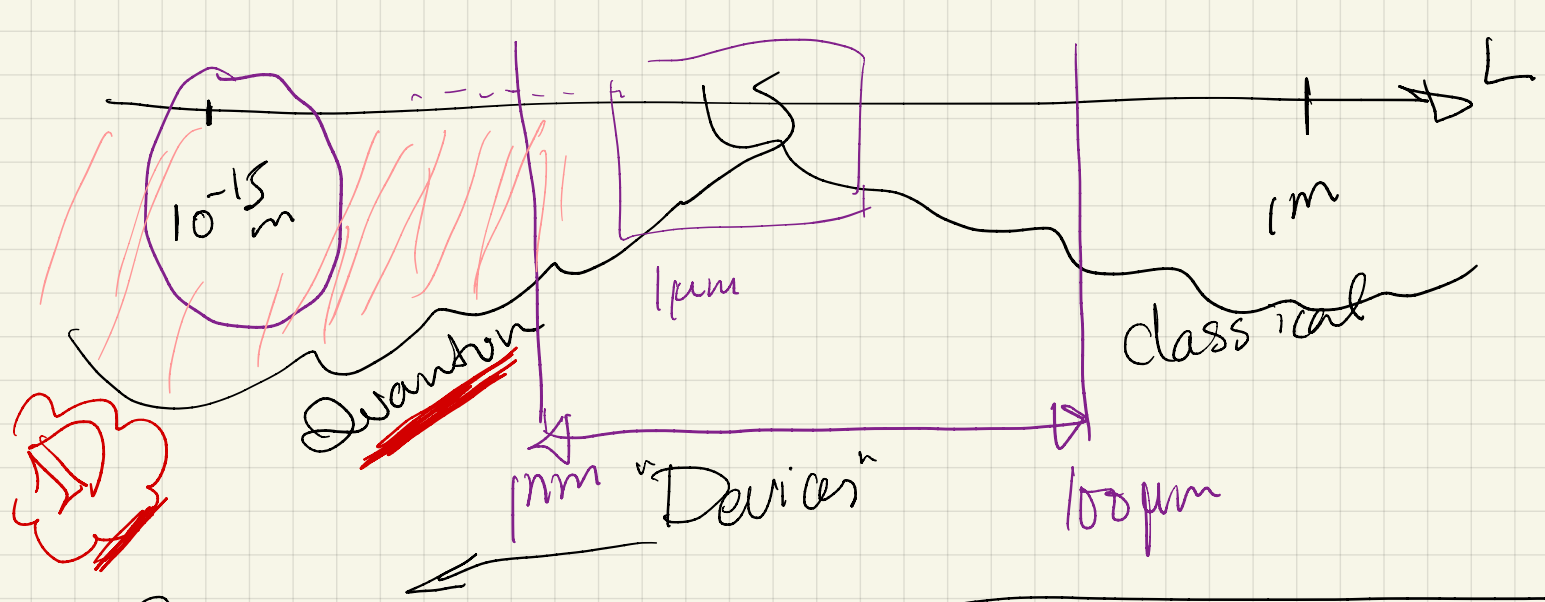
Schrodinger Eq

↓

S

↓

$O(1)$



Quantum

↖ lasers

↖ transistor (tunnel)

Faster, powerful (power of Computation)

Communication

Security ...

$E = K + V$

$H = \frac{1}{2}\frac{p^2}{m} + \frac{1}{2}kx^2$

$\frac{\partial^2}{\partial x^2}$

Schrödinger Eq.

$H = \frac{\hbar^2}{2m}\nabla^2 + V(x)$

K P

$[\ \ ]_{n \times n} \rightarrow [\ \ ]_{1 \times n}$ → λ_i

Eigenvalues $[\ \ ]$

$\hat{H}$

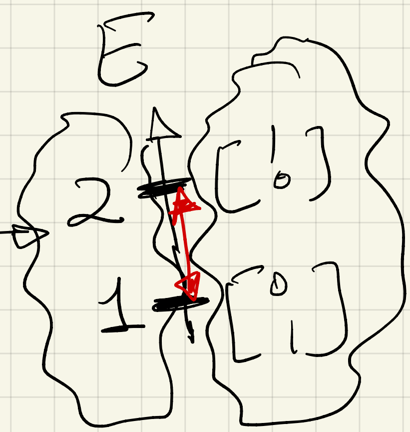
$$H\Psi = E\Psi$$

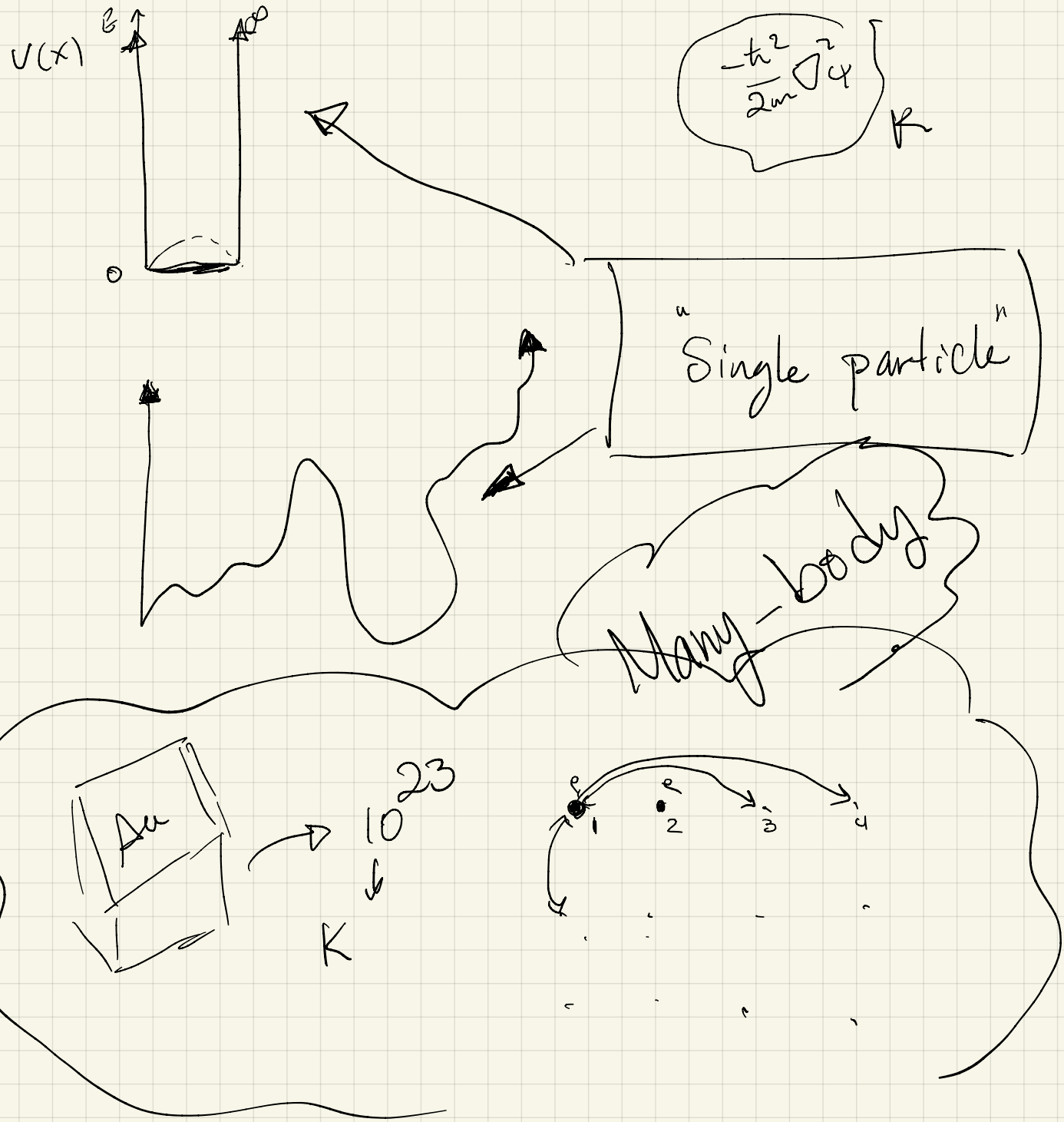
- H → kinetic + potential
- Ψ → eigenfunction
- E → eigenvalues
- Ψ → eigenfunction

vectors = eigenfunctions $[\ \ ]$

λ_i eigenvalues

$$\begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}_{n \times n}$$




V(x)
0
$-\frac{\hbar^2}{2m}\nabla^2\psi$
K
"Single particle"
Many-body
Δv
10^{23}
K
1
2
3
4