

How Quantum Mechanics Makes Your Flash Drive Work

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Typical Flash Drive



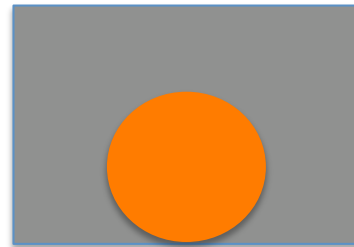
Inside: Lots of Little Circuits...



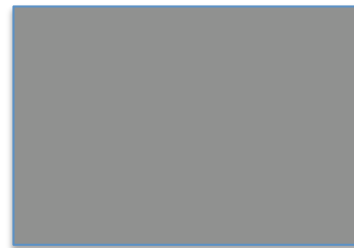
...What Makes The Circuits?

Floating Gate Transistors

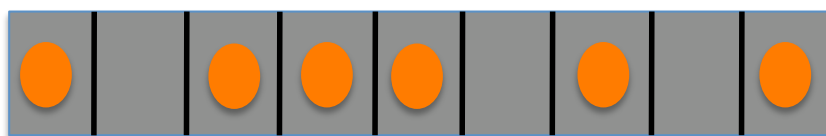
- Electron Stored: Logical 0



- No electrons: Logical 1



- Your computer can then “read” the 1’s and 0’s to know what you have stored on the USB:

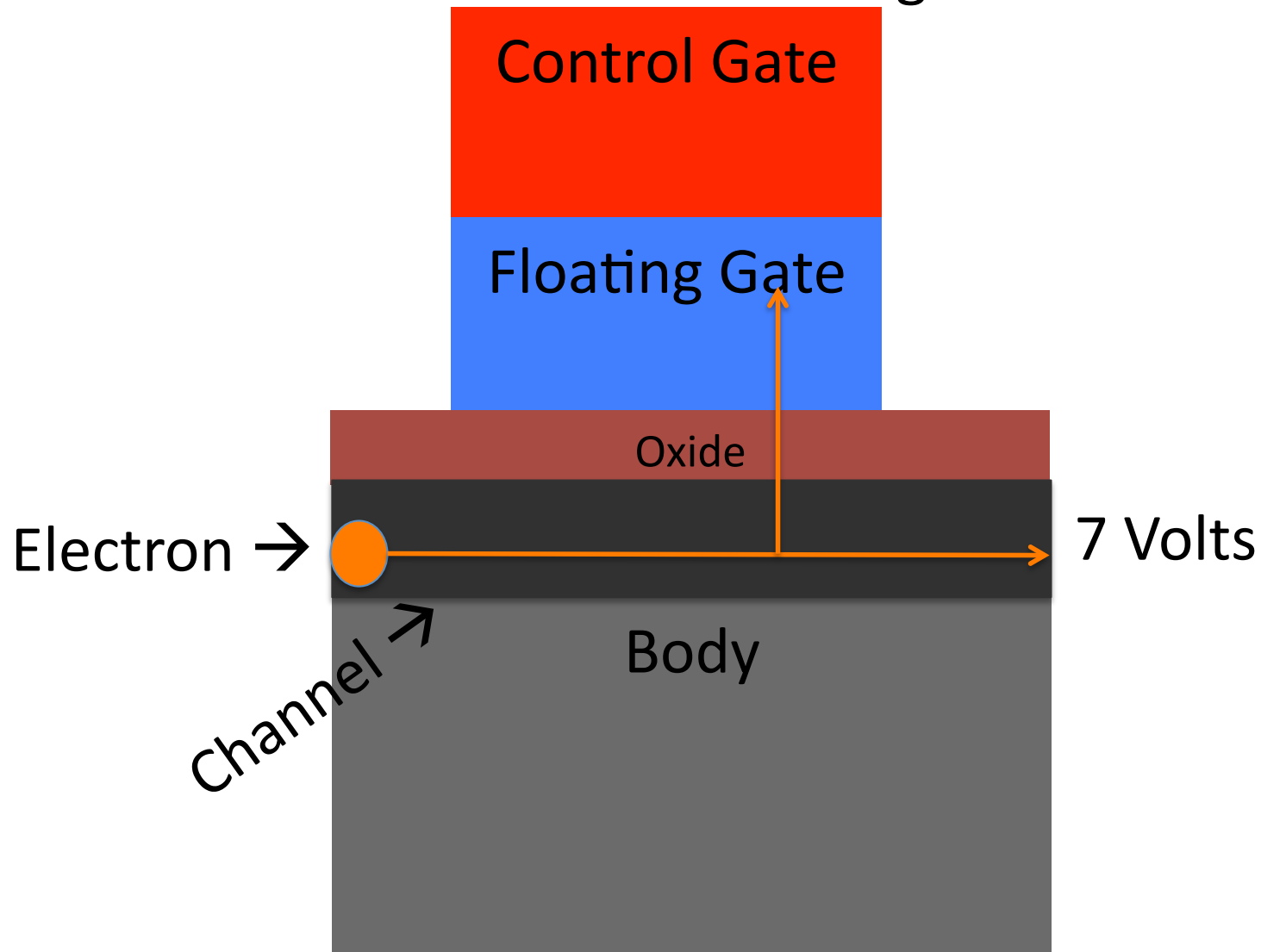


= 010001010... → Your

English Paper

What's in a Floating Gate Transistor?

12 Volts = Gate Voltage



An Analogy

12 Volts

Control Gate

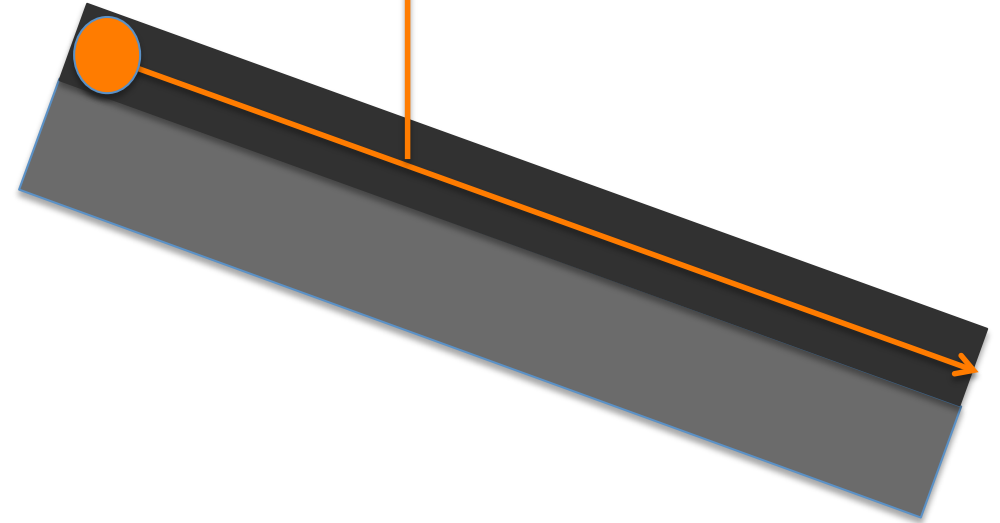
Floating Gate

Oxide

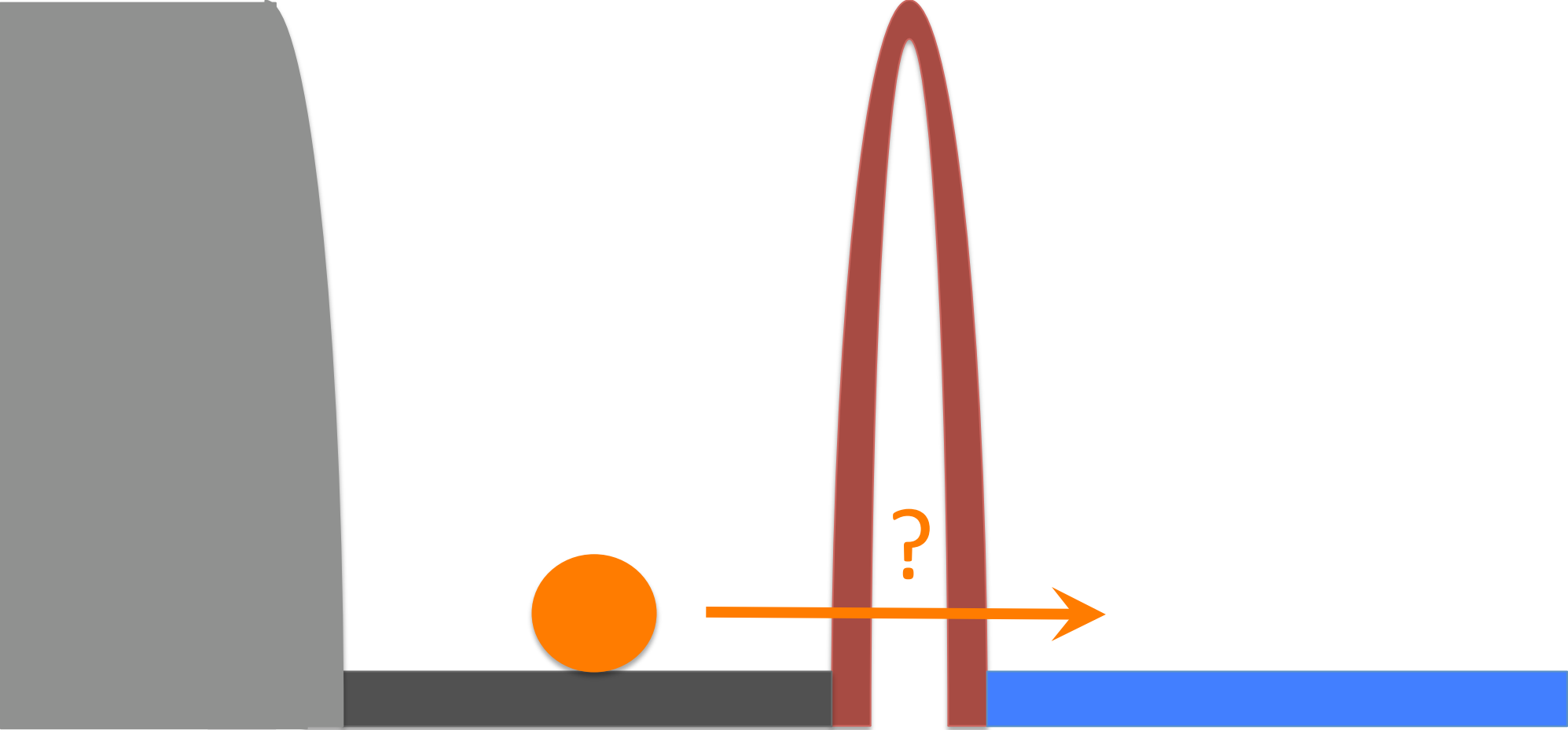
Body

7 Volts

Wall



Potential Profile



Body

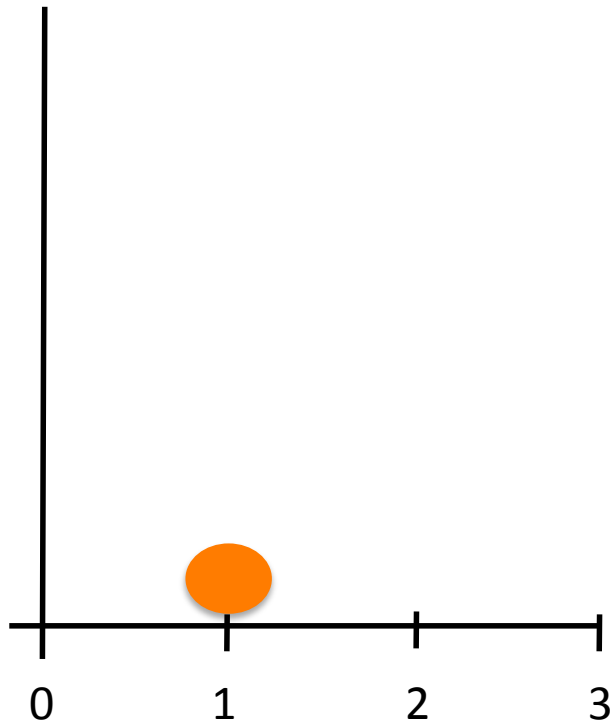
Channel

Oxide

Floating Gate

Where is the Ball?

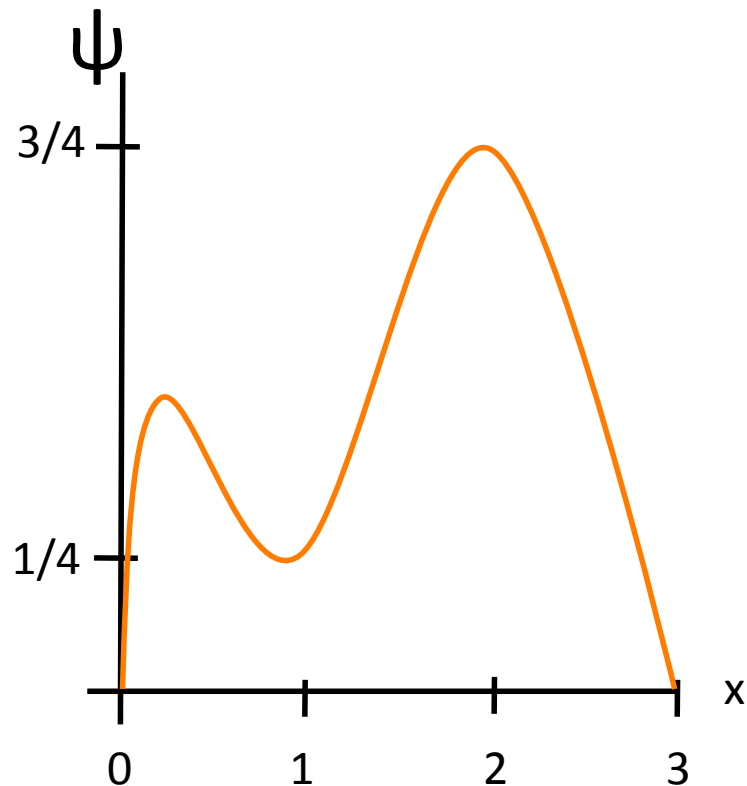
- Classically, an object is where it is.



- Probability that the ball is at 0: 0
- Probability that the ball is at 1: 1
- Probability that the ball is at 2: 0
- Probability that the ball is at 3: 0

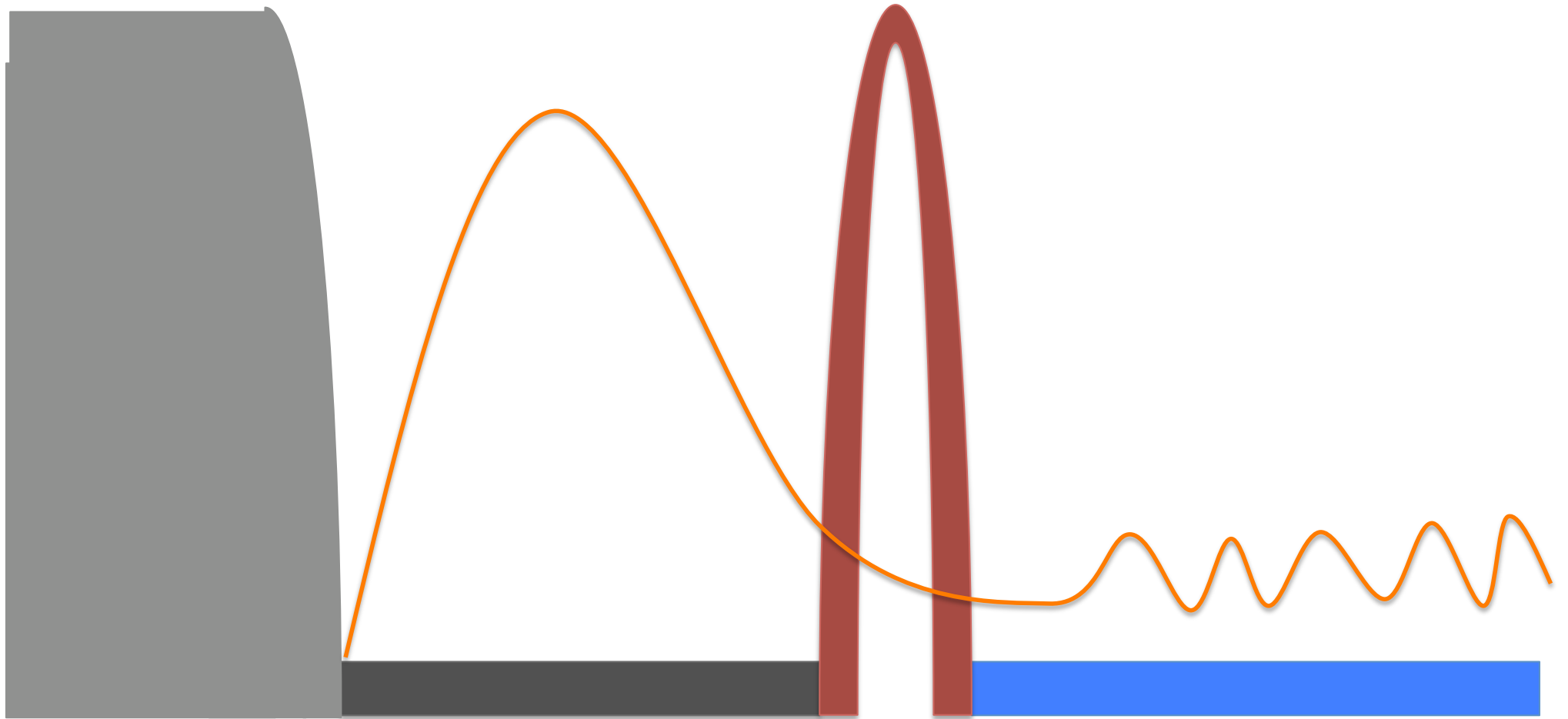
Where is the Electron?

- In Quantum Mechanics, an object has a wavefunction ψ that tells you where it might be



- Probability that the electron is at 0: 0
- Probability that the electron is at 1: $1/4$
- Probability that the electron is at 2: $3/4$
- Probability that the electron is at 3: 0

Wavefunction In the Transistor



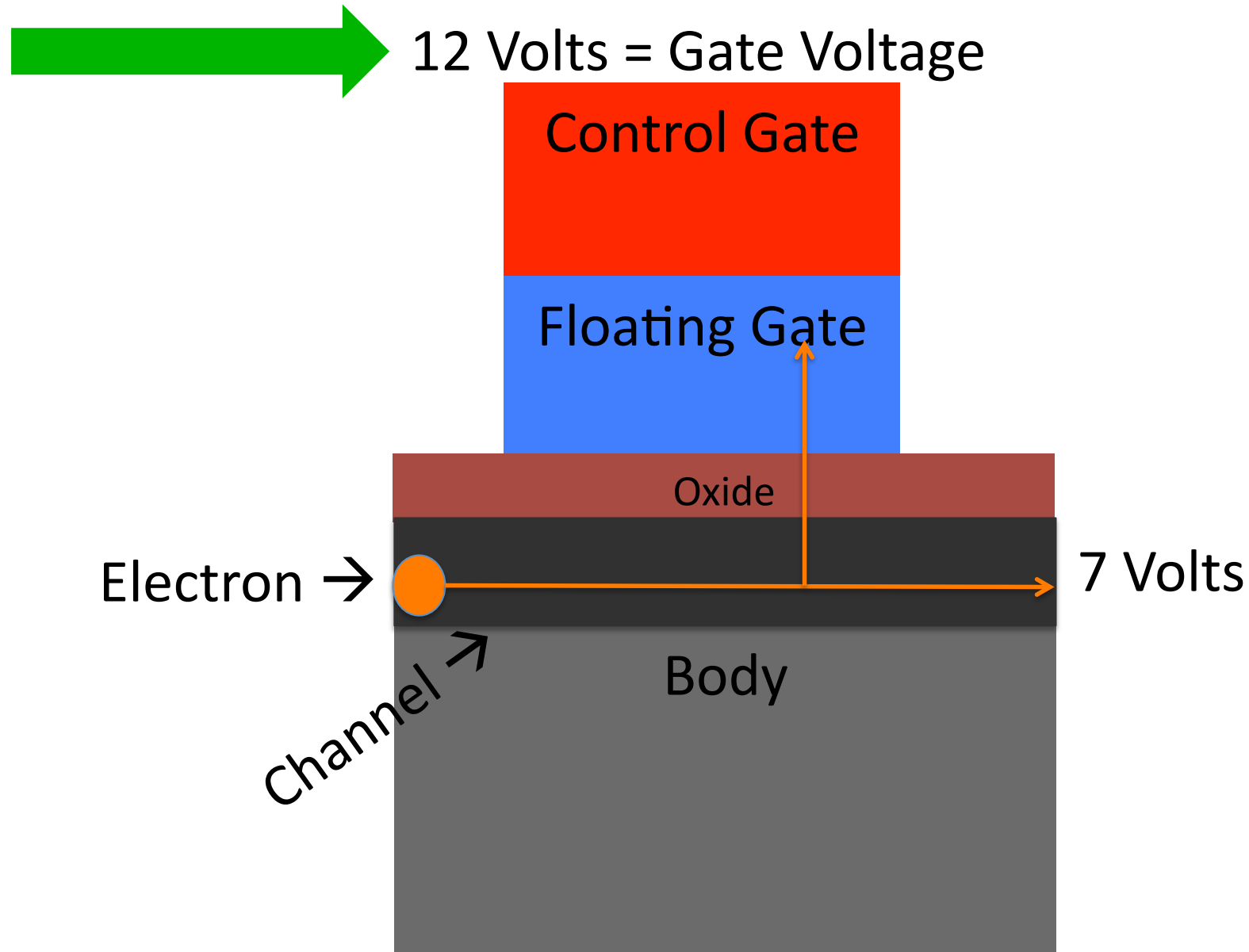
Body

Channel

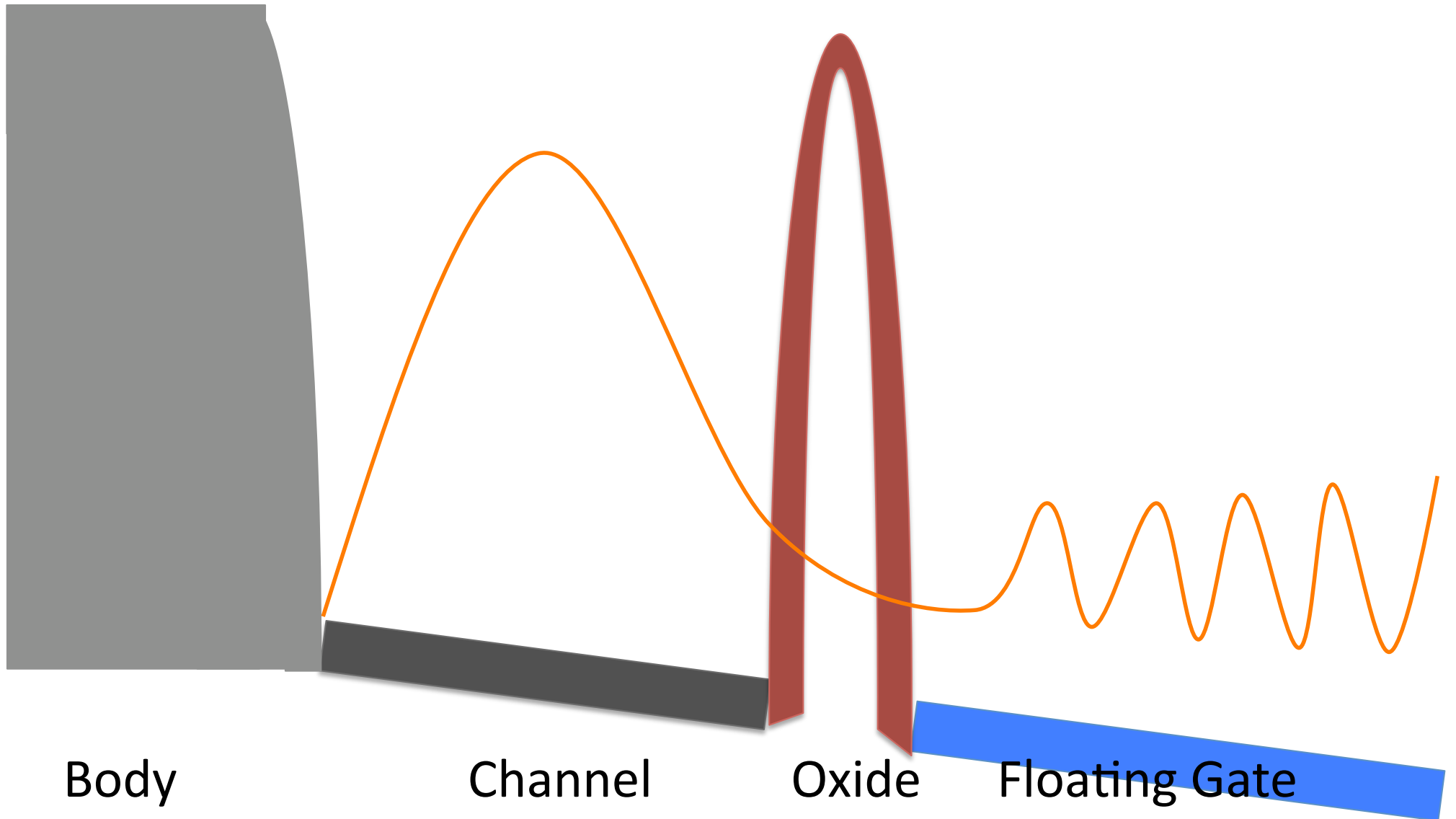
Oxide

Floating Gate

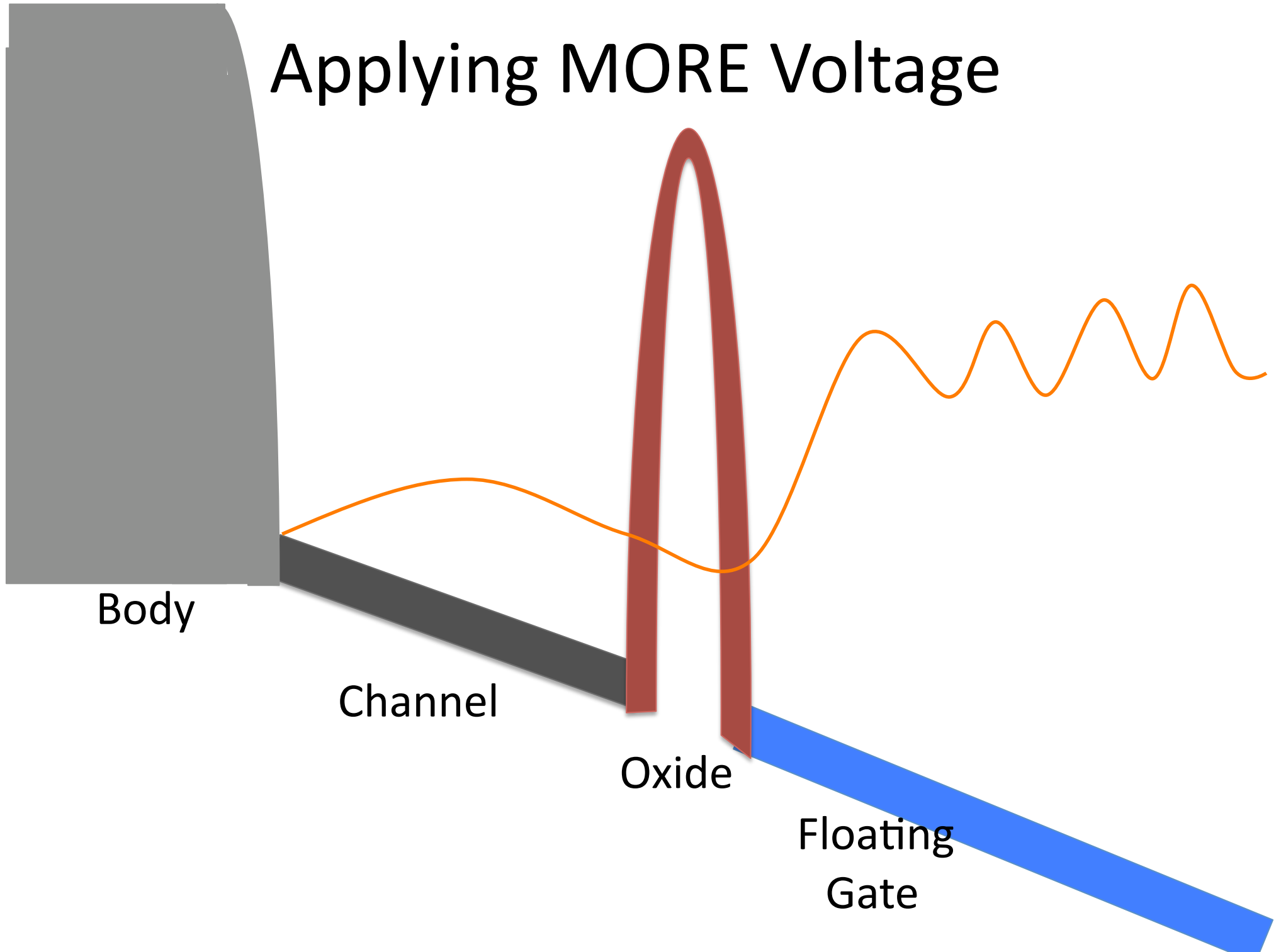
Remember the Gate Voltage?



Applying a Voltage

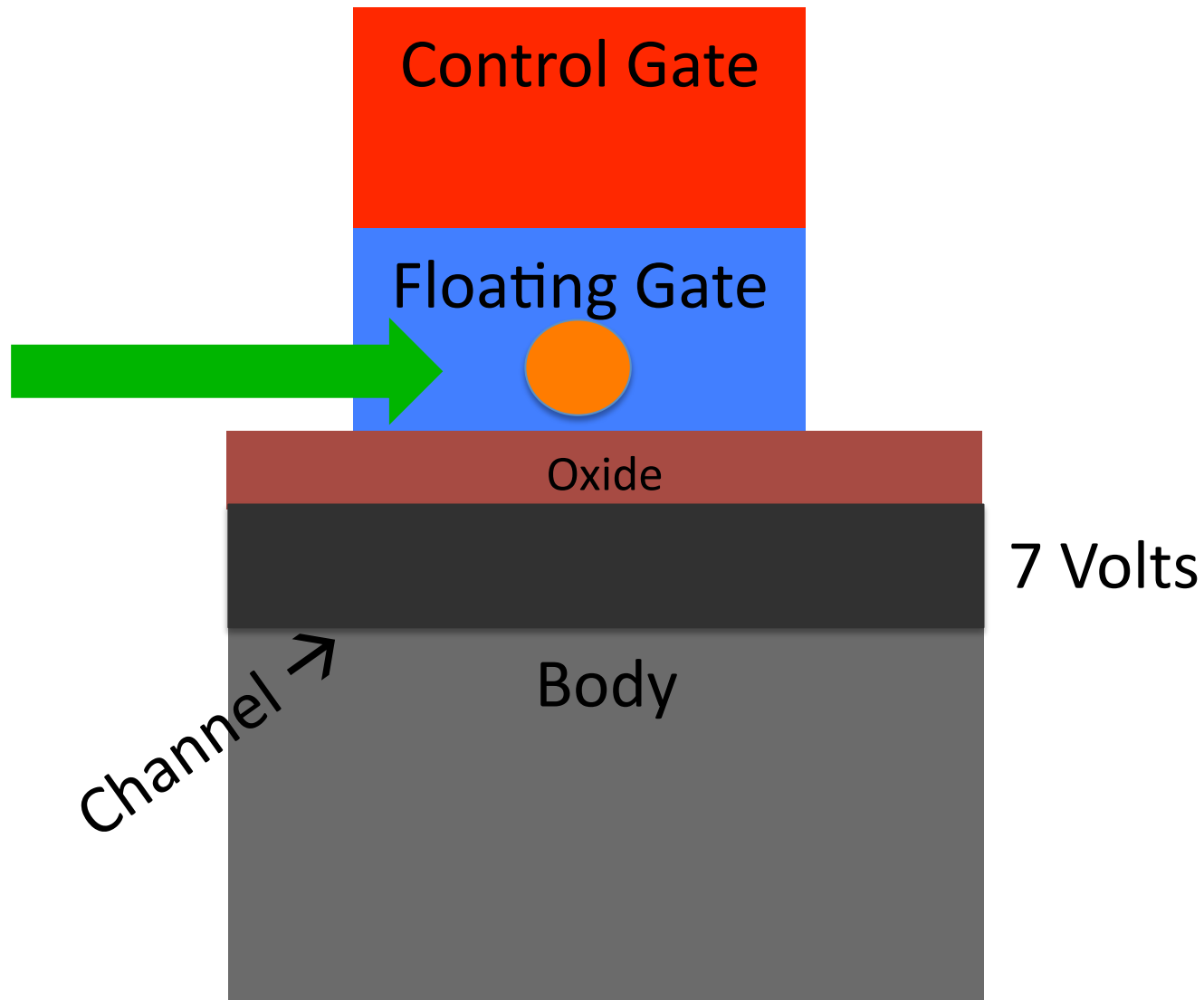


Applying MORE Voltage



We did it!
Now the Electron is Stored!

12 Volts



Summary

- Want to store 1's and 0's on a transistor
- Not possible classically
- Electrons can quantum tunnel through a “wall”
- This is the basic idea behind how your flash drive stores your documents!

Thanks! Questions?

