

Lesson Plan 1

QUANTUM TUNNELING



N.L.E
NON LINEAR EDUCATION

Module 5

Note to educator: We are using NLE principles to teach a complex scientific article to students of any ability. Please use only along with the Non Linear Education course.

Note: Questions are in bold. Answers and comments to you are in italics.

This lesson intentionally tackles a complex subject - to demonstrate how ANYTHING can be taught in an easy way!

QUANTUM TUNNELING

[WOW idea!] Imagine you were in a place you didn't want to be - an elevator, this classroom or the dentist!

And imagine there was just a small chance that you could just APPARATE out of this room, come out of this wall on the other side.

Did you know APPARATE (**spell the word**) was a word that JK Rowling created in her Harry Potter series? When you apparate, you can disappear from one location, and appear in another location.

Where would you apparate to?

Open ended or Choices (Zoo, Movie Theater, Mall)

Imagine a prisoner one day just by chance finds himself outside the prison cell.

How do you think that would that feel?

Open ended or

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Do you think he / she would feel FREE or WANT TO GO BACK?

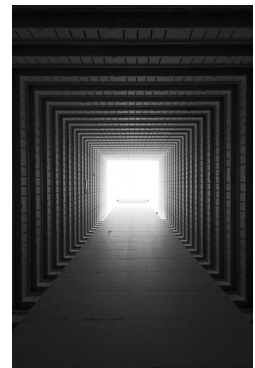
In other words if you spent just a bit of time in the prison cell, there was a low chance that you would magically appear one day outside the cell. But there was a chance. Prison sentences wouldn't be bad at all. Claustrophobia might be a thing of the past.

It turns out that this scenario is not completely imaginary. We have now observed this in sub-atomic particles and it is called Quantum Tunneling.

Let's spell TUNNELING.

It is just as it sounds. It is like creating an imaginary tunnel to appear on the other side.

[MICROLESSON] Before you get stunned by this fancy terminology, let's break "SUB-ATOMIC" apart. **Did you know that SUB means below, less than, or underneath or inferior to depending on what we are talking about?**



Q. Can you give me a few words that start with SUB? What does SUB mean in them?

[If child doesn't have open communication, say:

Let's review a few words starting with SUB - submarine, subpar, suboptimal.

What does SUB mean in each of them? Under, less than, inferior [choices]

[you can offer each word, and offer the choices]

Subatomic particles are particles that are inside an atom.

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Q. Can you give me examples of SUBATOMIC PARTICLES if you have heard of any?

OR

Q. Which do you think is a subatomic particle - an ELECTRON or a WATER DROPLET?

OR

Q. Let's spell SUBATOMIC

A few examples of subatomic particles are Electrons, Protons, Neutrons, Quarks, and there actually many more. These are particles that are found inside an atom.

[END OF MICROLESSON]

So when an electron magically appears across a wall - we are going to call the wall a BARRIER, this process is called QUANTUM TUNNELING.

This behavior is something we simply don't observe in the real world. The physics that describes the real world is called CLASSICAL physics, and the physics that describes the world of the small is called QUANTUM physics.

Personally, I think it is most unfair that electrons get to escape their boundaries, but we can't.

The question that comes up now is How is an Electron different from us?

One difference that we know right away is this: while electrons are also particles, we never know WHERE they are, only a PROBABILITY of where they are.

This is why we all curse Quantum Theory, this is why Einstein said - "God does not play dice."

This is why Werner Heisenberg said ""Not only is the Universe stranger than we think, it is stranger than we can think."

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STOP HERE OR GO TO OTHER OPTIONS FOR MICROLESSONS→

Q. Would you like to hear a story about Heisenberg

[BRING IN HISTORY]

Heisenberg's role in WWII is debated, but the truth is that unlike Born, Schrodinger and Einstein, he was one of the few Nobel winning physicists who chose to stay back in Germany despite numerous offers from outside.

When he chose to stay back, he also worked on the German efforts towards building a nuclear bomb before America. Obviously, we know that the Germans did not succeed. And there are two versions of the story here:

One is that Heisenberg was just incompetent, and the other that he deliberately chose to delay and sabotage Germany's efforts.

Micro Lesson opportunity - talk about sabotage

For now, I will choose to believe the latter. Especially because Heisenberg's famous Uncertainty Principle is key to understanding Quantum Tunneling.

.... [PARTIAL END OF LESSON, you may continue if you like, but this is a short and quick lesson]

As you can see there is a lot to continue in this lesson, but this is a good example of a late middle school to high school to college lesson plan.



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