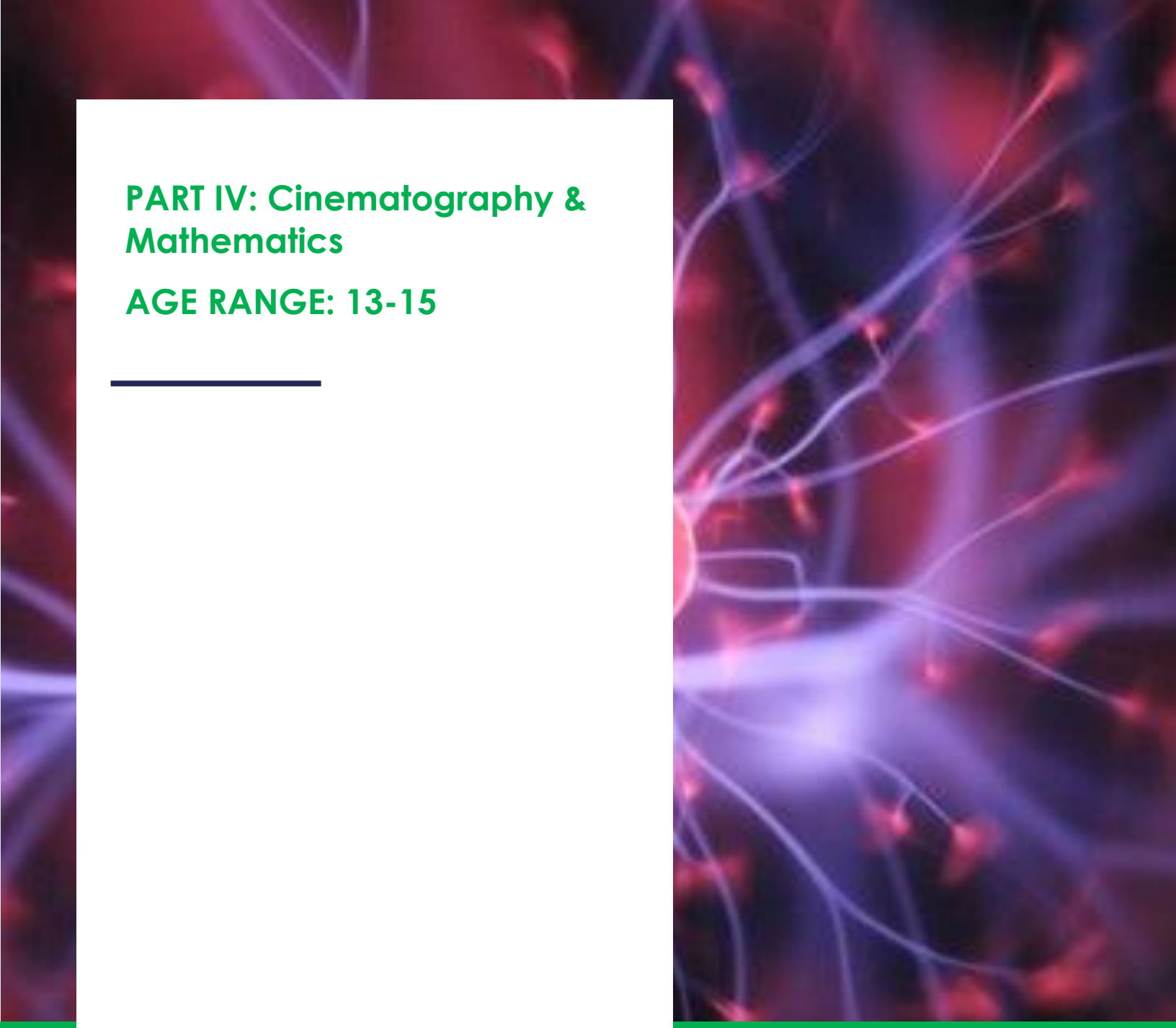

PART IV: Cinematography & Mathematics

AGE RANGE: 13-15

TOOL 32: PRIME NUMBERS IN "THE BIG BANG THEORY" BY CHUCK LORRE AND BILL PRADY

LogoPsyCom

TheArtOf Maths

Co-funded by the Erasmus+ Programme of the European Union

Educator's Guide

Title: Prime Numbers in "The Big Bang Theory" by Chuck Lorre and Bill Prady

Age Range: 13-15 years old

Duration: 2 hours

Mathematical Concepts: Prime Numbers

Artistic Concepts: Palindrome, conjecture, binary, Morse code, theoretical physics

General Objectives: To discover the mathematical concepts presented in the TV show and learn how to build math reasoning in everyday life.

Instructions and Methodologies: The students will explore math through cinematography, by applying it to real-life situations and watching the suggested videos. Your class will discover Prime Numbers through Sheldon's reflections.

Resources: This tool provides videos and online resources. The topics addressed in these resources will be an inspiration for you to find other materials to personalize and give nuance to your lesson.

Tips for the educator: Learning by doing is very efficient, especially with young learners with learning difficulties. Explain the practical aspect of each math concept.

Desirable Outcomes and Competences: At the end of this tool, the student will be able to:

- Understand what a Prime Number is;
- Understand what a Composite Number is;
- Do a Prime Factorization.

Debriefing and Evaluation:

Write 3 aspects you liked about this activity:	1. 2. 3.
Write 2 aspects that you have learned	1. 2.
Write 1 aspect for improvement	1.

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Introduction

Watching a TV show can either be an active or a passive leisure activity. TV shows can be valuable resources for learners to explore the different topics addressed. Some of them use mathematics in their plots, which students often don't really focus on though they will be more likely to understand a topic they heard about on TV.

Seeing the characters reflect on mathematical problems and concepts makes the viewer want to understand those concepts and solve those problems with them in the same way as they often try to guess the end of a movie, here they will learn new things just by following characters throughout the story.

Therefore, teaching students the mathematics that hide behind some TV shows can be a great added value to a math course, often considered too abstract, by giving learners a more practical and real-life sense of the possible uses of mathematics.

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"The Big Bang Theory" by Chuck Lorre and Bill Prady

Synopsis

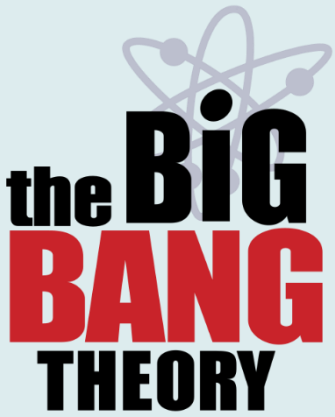

Figure 1: Official Title of the TV Show "The Big Bang Theory"

This series has 12 seasons during which we follow the evolution of the main characters: Sheldon, Leonard, Howard, Rajesh, Penny and later Amy and Bernadette. The plot focuses on the evolution of both their personal lives and their careers. Sheldon Cooper is a very bright theoretical physicist who lacks social skills. However, he loves telling fun scientific and mathematical facts to his friends.

Trailer: https://www.youtube.com/watch?v=WBb3fojgW0Q

The Best Number

In this scene, you can see the group gathering to eat at Sheldon's apartment. They are all silent because Sheldon cannot stand people who talk with their mouth full. He notices the awkwardness of the moment and decides to cheer up the atmosphere by asking them what the best number is.

Watch the following video to find out the answer:
https://www.youtube.com/watch?v=RyFr279K9TE

This scene of the show occurs in the 73rd episode and was inspired by mathematics professor emeritus Carl Pomerance's prime number theory equation. He and Chris Spicer wrote a paper called "Proof of the Sheldon Conjecture", which demonstrate the theory using more complex concepts such as integrals and logarithms.

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There are many more fun facts about this number!

- As Sheldon says, its binary, 1001001, is a palindrome, but the number 21 is also a palindrome in binary as it is 10101.
- Another fun fact about these two numbers is that the binary of 73 has 7 numbers in total, three of which are ones.
- If you add 73+21, you have 94 and when you add 37+12, you have 49, which satisfies the mirror property!
- In Morse code, many users use the number 73, - - · · · · · · - -, to say "best regards". Notice that is also a palindrome in Morse code!

Glossary

Palindrome: a word that is read the same forwards and backwards.

Binary: the numerical notation system that uses 2 as a base.

Morse code: is a code language where short and long light or sound signals are used to convey a message.

Theoretical Physics: is a branch of physics that explains natural phenomena using mathematics.

Conjecture: is a hypothesis or a thought that needs to be demonstrated or completed.

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The math behind the big bang theory

Prime Numbers and Composite Numbers

A whole number higher than 1 can either be composite or prime.

A **prime number** is a whole number higher than 1 that cannot be divided by any other number than itself or 1.

Examples: 2, 3, 5, 7, 11 and so on.

A **composite number** is a whole number higher than 1 that can be divided by other numbers than itself or 1.

Examples: 4, 6, 8, 9, 10 and so on.

Can you guess if these are prime or composite numbers?

55	
41	
37	
49	
17	

Prime Factorization

Remember that factors are numbers that we multiply to get another one.

Prime factorization means that we try to decompose a number to see how many prime factors are multiplied together to reach it.

Examples:

- ➔ 18 = 9 x 2 = 3 x 3 x 2
- ➔ 49 = 7 x 7
- ➔ 185 = 5 x 37

The factors can no longer be decomposed, which means they are the prime factors.

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What can we conclude from this?

That prime numbers are the ones from which all the other numbers are built!

Notice that some numbers can be repeated, you can then write them as square. For example: $18 = 3^2 \times 2$

Here are a few tips to recognize multiples of 2, 3, and 5:

Integers **ending in 0, 2, 4, 6** or **8** are divisible by 2.

Integers **ending in 0 or 5** are divisible by 5.

Integers **whose sum of digits is divisible by 3** are themselves divisible by 3.

Let's try!

Do the prime factorization for each of the following numbers, if possible:

a) 15 =

b) 36 =

c) 72 =

d) 118 =

e) 270 =

There is another technique you can use for prime factorization:

To see if an integer is prime, you can check if it can be divided by any prime number smaller or equal to its square root.

Let's take an example:

- 759 → $\sqrt{759}$ = 27.5499546279
- Let's see if it can be divided by 2, 3, 5, 7, 11, 13, 17, 19, or 23
- It can be divided by 3, by 11 and by 23
- 759 = 3 x 11 x 23

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Try that with the following numbers:

a) 493

b) 2486

c) 11541

d) 199

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TASK

Let's demonstrate the perfection of the number 73:

1. It is a prime number:

2. Its mirror is a prime number:

The prime p_n is a Sheldon prime if it satisfies both the product property and the mirror property.

Show that 73 is a Sheldon Prime:

3. The Product Property:

p_n is the n^{th} prime number.

It satisfies the product property if the product of its 10-base digits is exactly n.

4. The Mirror Property:

p_n satisfies the mirror property if the reverse of its 10-base digits is equal to the (reverse of n)th prime: $\mathbf{rev(p_n) = p_{rev(n)}}$

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LEARN MORE...

Article about Carl Pomerance's theory:
https://phys.org/news/2019-04-big-theory-math-carl-pomerance.html

Carl Pomerance and Chris Spicer's Proof of the Sheldon Conjecture:
https://math.dartmouth.edu/~carlp/sheldon022119.pdf

An explanation of the theory by MindYourDecisions:

https://www.youtube.com/watch?v=hvn8-LzqKQo

https://mindyourdecisions.com/blog/2019/04/16/a-big-bang-theory-episode-inspired-a-mathematical-discovery/

Interesting facts about number 73:
https://www.scoopwhoop.com/The-Most-Interesting-Number-In-The-World/

Explanation of the Product and Mirror Properties with number 73:
https://www.tandfonline.com/doi/abs/10.4169/mathhorizons.23.2.12

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