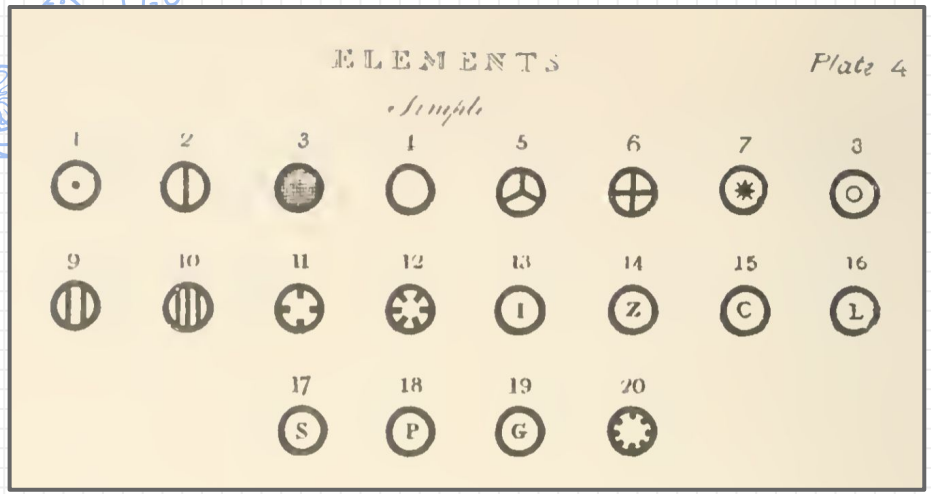
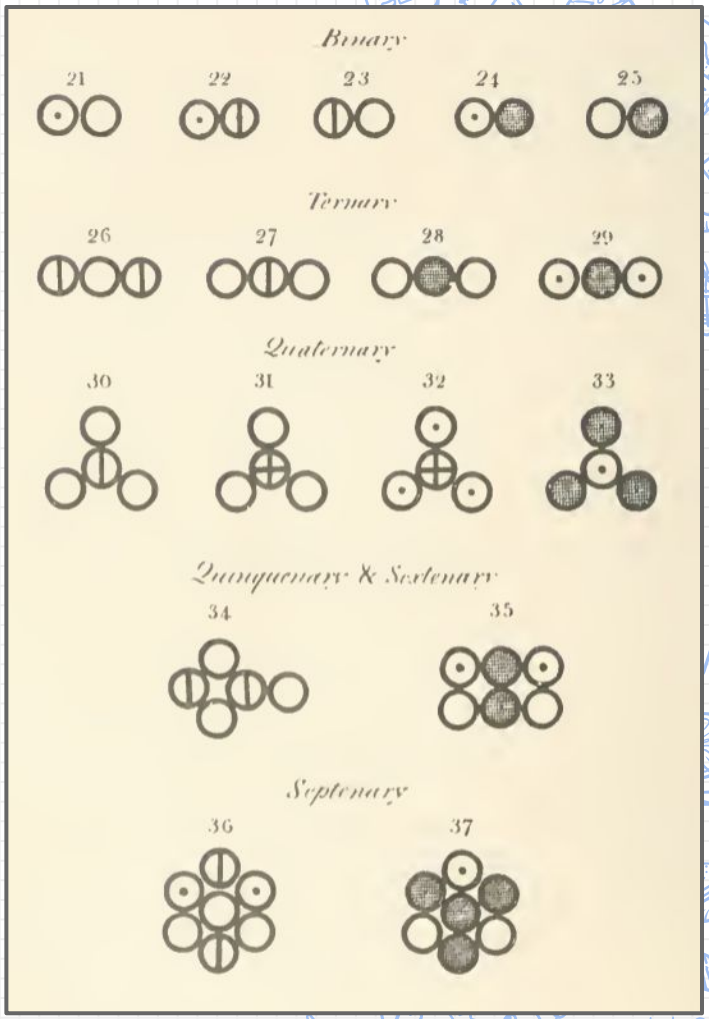
Using Models in Chemistry



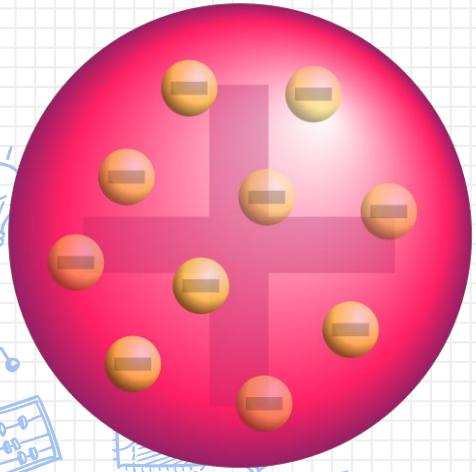


Chemistry relies on visual models.

John Dalton, one of the "founders of modern chemistry", knew this - and included many visual references in his 1808 publication in which he declared the existence of "atoms".

Source: A New System of Chemical Philosophy

"But why are models so important? That's not even what atoms really look like..."



"Why can't we look at a real atom?"

Well, the size of an atom is between 0.1 - 0.5 nanometers.

How large is that really?

(1:32 - 4:00)

Checkpoint:

What tool is strong enough for us to actually see an atom?

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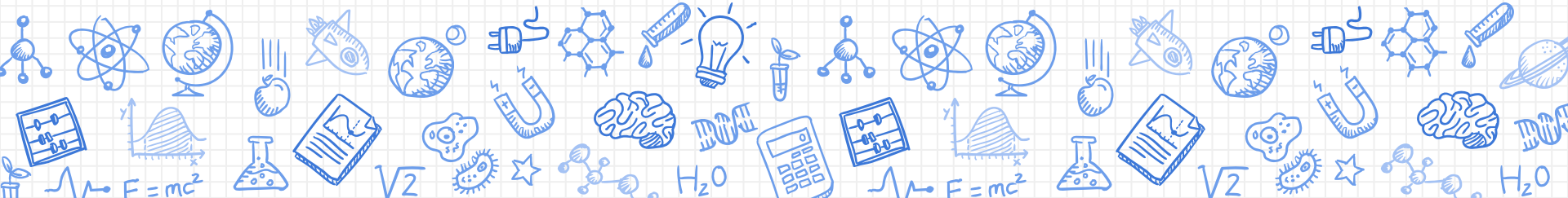
Trick question! An atom is SMALLER than a wavelength of LIGHT- it's impossible to really "see"!
But we can image them using an electron microscope.

So how do we know what an atom looks like?

Quick answer: We can't see it ourselves, but through time , testing, and trial and error, we've gotten a fairly good idea.



Although we can't see the structure of an atom in detail...

We've made some guesses through history based on experiments.

Models of the Atom

A HISTORY OF THE ATOM: THEORIES AND MODELS

How have our ideas about atoms changed over the years? This graphic looks at atomic models and how they developed.

SOLID SPHERE MODEL

JOHN DALTON

1803

Dalton drew upon the Ancient Greek idea of atoms (the word 'atom' comes from the Greek '*atomos*' meaning indivisible). His theory stated that atoms are indivisible, those of a given element are identical, and compounds are combinations of different types of atoms.

- ⊕ RECOGNISED ATOMS OF A PARTICULAR ELEMENT DIFFER FROM OTHER ELEMENTS
- ⊖ ATOMS AREN'T INDIVISIBLE - THEY'RE COMPOSED FROM SUBATOMIC PARTICLES

PLUM PUDDING MODEL

J.J. THOMSON

1904

Thomson discovered electrons (which he called 'corpuscles') in atoms in 1897, for which he won a Nobel Prize. He subsequently produced the 'plum pudding' model of the atom. It shows the atom as composed of electrons scattered throughout a spherical cloud of positive charge.

- ⊕ RECOGNISED ELECTRONS AS COMPONENTS OF ATOMS
- ⊖ NO NUCLEUS; DIDN'T EXPLAIN LATER EXPERIMENTAL OBSERVATIONS

NUCLEAR MODEL

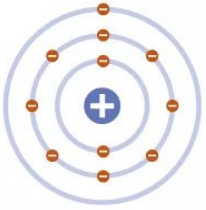
ERNEST RUTHERFORD

1911

Rutherford fired positively charged alpha particles at a thin sheet of gold foil. Most passed through with little deflection, but some deflected at large angles. This was only possible if the atom was mostly empty space, with the positive charge concentrated in the centre: the nucleus.

- ⊕ REALISED POSITIVE CHARGE WAS LOCALISED IN THE NUCLEUS OF AN ATOM
- ⊖ DID NOT EXPLAIN WHY ELECTRONS REMAIN IN ORBIT AROUND THE NUCLEUS

PLANETARY MODEL



NIELS BOHR

1913

Bohr modified Rutherford's model of the atom by stating that electrons moved around the nucleus in orbits of fixed sizes and energies. Electron energy in this model was quantised; electrons could not occupy values of energy between the fixed energy levels.

- ⊕ PROPOSED STABLE ELECTRON ORBITS; EXPLAINED THE EMISSION SPECTRA OF SOME ELEMENTS
- ⊖ MOVING ELECTRONS SHOULD EMIT ENERGY AND COLLAPSE INTO THE NUCLEUS; MODEL DID NOT WORK WELL FOR HEAVIER ATOMS

QUANTUM MODEL

ERWIN SCHRÖDINGER

1926

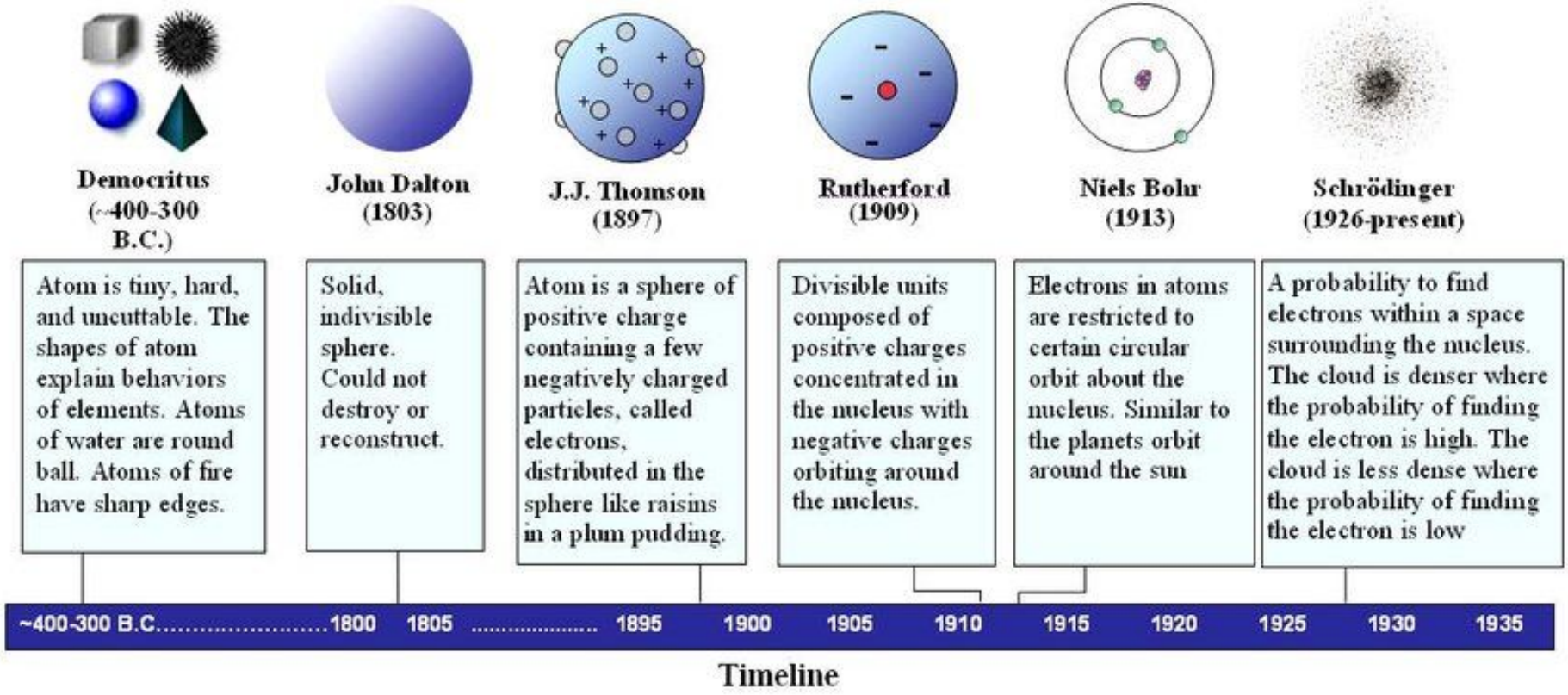
Schrödinger stated that electrons do not move in set paths around the nucleus, but in waves. It is impossible to know the exact location of the electrons; instead, we have 'clouds of probability' called orbitals, in which we are more likely to find an electron.

- ⊕ SHOWS ELECTRONS DON'T MOVE AROUND THE NUCLEUS IN ORBITS, BUT IN CLOUDS WHERE THEIR POSITION IS UNCERTAIN
- ⊕ STILL WIDELY ACCEPTED AS THE MOST ACCURATE MODEL OF THE ATOM

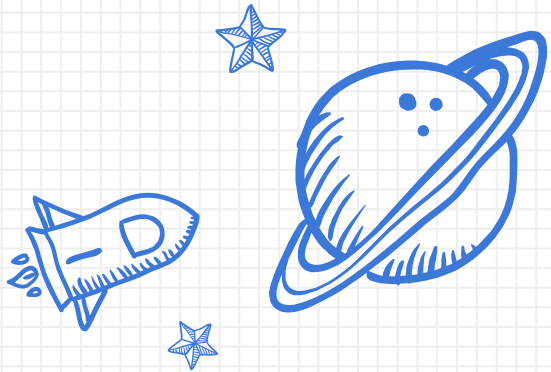
But now, we basically just use the quantum model, right?

- ✘ Though the **quantum model** is most recent and mathematically accurate...
- ✘ **Other models** are still really useful! We still use the Bohr planetary model often...
- ✘ Because it's easier to ***visualize*** **electrons** as if we think of them orbiting nicely.

There are times when we still use basically *all* the models, depending on our needs.



(Chamrat, 2009)



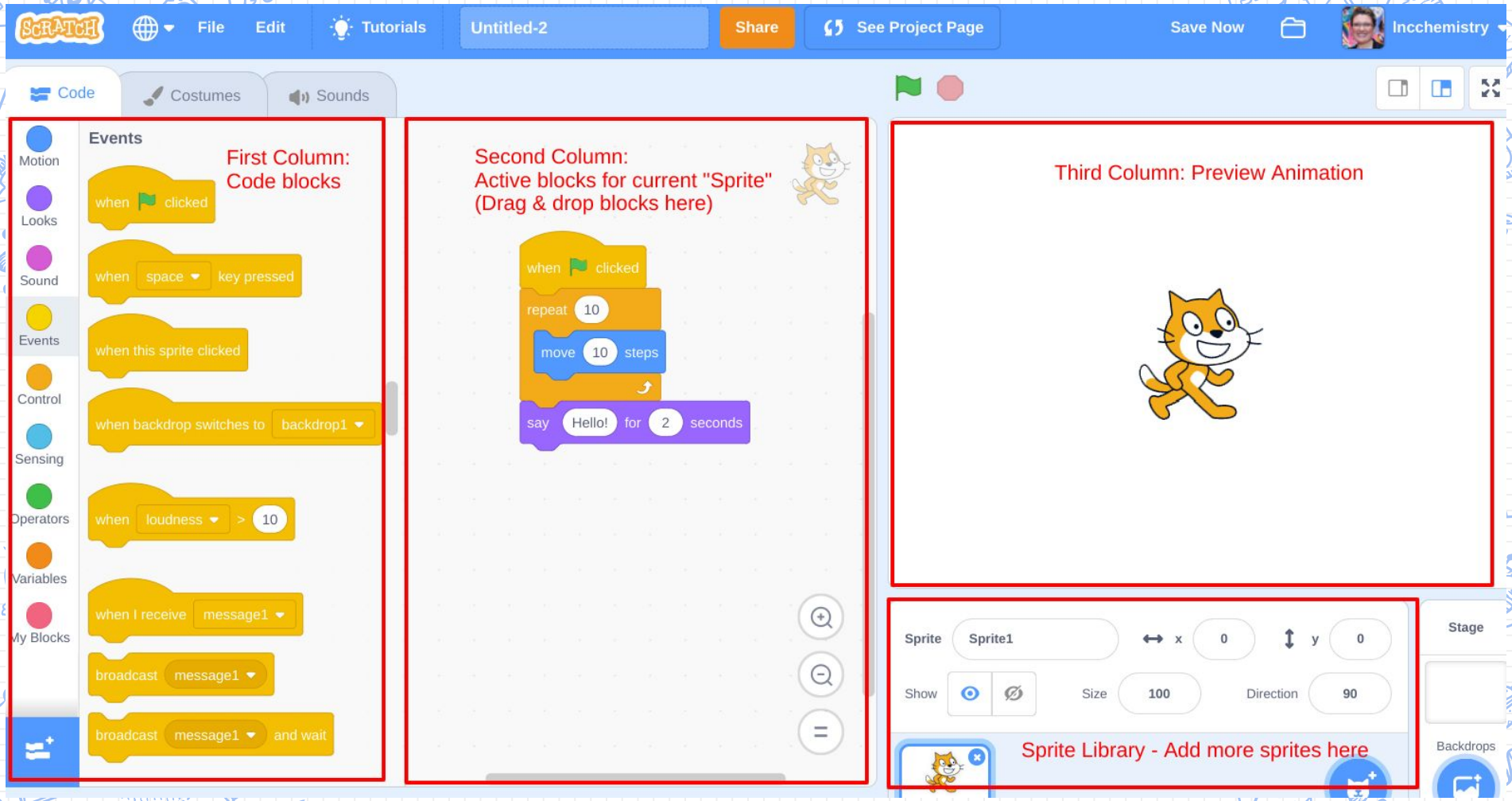
Let's try making our own atomic models.

We'll be using **Scratch**.

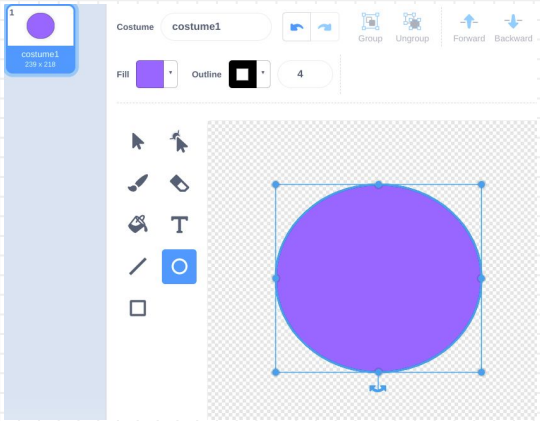
First, a quick refresher on helpful **blocks**.

Go to Scratch.mit.edu

Sign in & Click “Create”
for a new Project


File
Edit
Tutorials
Untitled-2
Share
See Project Page
Save Now
Incchemistry
Code
Costumes
Sounds
Motion
Looks
Sound
Events
Control
Sensing
Operators
Variables
My Blocks
Events
First Column:
Code blocks
when clicked
when space key pressed
when this sprite clicked
when backdrop switches to backdrop1
when loudness > 10
when I receive message1
broadcast message1
broadcast message1 and wait
Second Column:
Active blocks for current "Sprite"
(Drag & drop blocks here)
when clicked
repeat 10
move 10 steps
say Hello! for 2 seconds
Third Column: Preview Animation
Sprite
Sprite1
x
0
y
0
Show
Size
100
Direction
90
Stage
Backdrops
Sprite Library - Add more sprites here

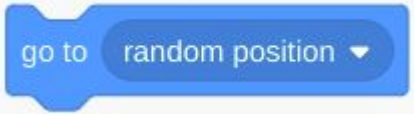
Quick Reference – Helpful Tips & Blocks



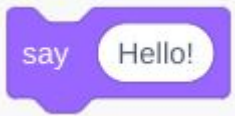
Try drawing a sprite – Circles are helpful in all the atomic models.

Always start with an event.

Use "forever" loop to keep motion going



Experiment with movement options for electrons or whole atoms



Use "say" to explain what model you're showing

Types of Other Blocks

Motion

Make your sprite turn, glide, flip, walk, or go to a specific place.

Looks

Make your sprite say text, change size, switch costume, backdrop, or be hidden.

Sound

Make your sprite play sounds (be mindful of others in the room).

Events

Always start your script with an Event. This triggers the code to start.

Control

Very helpful blocks! Repeat actions, or only play them under certain conditions.

Sensing

Detect key press or mouse click, ask for user input, or respond to other events.

Operators

Change values: Do math with numbers, alter text, or use logic (and, or, not)

Variables

Set or change variables if your code needs them.

My Blocks

Make a custom block.

When you're done,

Give your atom a title and click 

Then post the link to our discussion board.

Sources: Images & Media

- ✘ Slide 2: A New System of Chemical Philosophy, Dalton *(p. 218)*
- ✘ Slide 3: Amazing Brothers Nano Show (Boston Museum of Science)
- ✘ Slide 4: Wikimedia Commons
- ✘ Slide 9: CompoundChem.com
- ✘ Slide 11: Chamrat, 2009
- ✘ Slides 14-17 https://scratch.mit.edu/

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