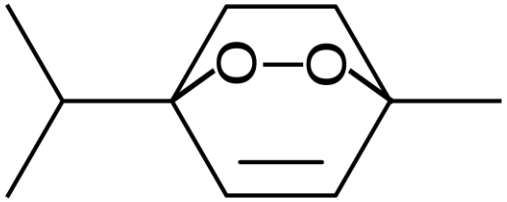
Moore's Law numbers

Moore's law states the number of transistors will double every two years

Gordon Moore

Determining the molecular formula of Ascaridole

Ascaridole is a molecule used in cooking. If a **2.103 g** sample is combusted in excess oxygen to form **5.50 g** of CO_2 and **1.80 g** of H_2O. If the molecular mass of the molecule is found to be **168.23** g/mol, what is the molecular formula?



Ascaridole

The wormseed plant itself (Mexican tea) is traditionally used in Mexican cuisine for flavoring dishes and preventing flatulence fro m bean-containing food.

Melting a railroad spike

First, lets consider this ½ lb railroad spike made of iron. If Fe melts at 1538 °C with a heat capacity of 0.458 J/g*°C. How much energy is required to increase the spike from room temperature (20.0 °C) to it's melting point?

453.59 g = 1 lb

Melting a railroad spike

Now let's consider water with a heat capacity of 4.184 J/g*°C. How much water can we boil (starting at room temp, 20.0 °C) using the same amount of energy it took to melt the railroad spike?

How much snow?

After long suffering drought, in 2023 California saw a historic snowfall. In April, at it's peak, the snowpack was measured by scientists to contain 40 million acre-feet of snow. Our own Lake Cachuma can hold 238.4 billion liters of water at capacity. How many "Lake Cachuma's" can be filled by the peak snowpack?

1 acre = 4840 yds^2 and 1 in = 2.54 cm.

Source: LA Times

It doesn't take a rocket scientist

The majority of rocket launches at Vandenberg SFB are the state-of-the-art Falcon 9 rockets. Made by SpaceX, they are reported to cost over $200,000 to refuel. They are refueled by liquid O_2 and liquid RP-1 rocket fuel. Liquid fuels increase energy capacity but require immense cooling.

RP-1 is a highly refined kerosine, a mixture of hydrocarbons with sulfur strictly removed. It's found to have a ratio of $C_nH_{1.963}$ and with the known optimal combustion ratio (stoichiometry) of 1:2.326, making C_6H_{12} the most accepted analog. Using this assumption and the following data, determine the total energy (kJ) produced from both stages of our local controlled explosions.

$$\Delta H°_{rxn} = \sum BE_{\text{reactant bonds broken}} - \sum BE_{\text{product bonds formed}}$$

Density:
O_2 (l) 1.141 g/cm^3
RP-1 (l) 0.846 g/cm^3

First Stage:
245,620 L O_2 (l)
146,020 L RP-1 (l)

Second Stage:
28,000 L O_2 (l)
17,000 L RP-1 (l)

Bond Energies:
O=O 498 kJ/mol C=O (CO_2) 799 kJ/mol
C-H 413 kJ/mol O-H 467 kJ/mol
C-C 347 kJ/mol

Source: Rook Andalus

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Concentration Terms

Strawberries are an important crop in our valley which may need fertilizer for nutrients. According to the following data, what molarity solution of magnesium is necessary and how much magnesium chloride would be necessary to make 2.5 L of solution?

Table 1. Suggested critical levels for soil nutrient status.

Nutrient	Deficient at less than (ppm):
Phosphorus (P; Bray 1)	45
Phosphorus (Olsen)	20
Potassium (K)z	75–175
Calcium (Ca)	1,000
Magnesium (Mg)	120
Boron (B)	0.3–1.0 y
Electrical conductivity (EC)*	No greater than 2 dS/m

Adapted from *Strawberries: Western Oregon—West of Cascades Fertilizer Guide* (FG 14).

Exploring VSEPR Theory

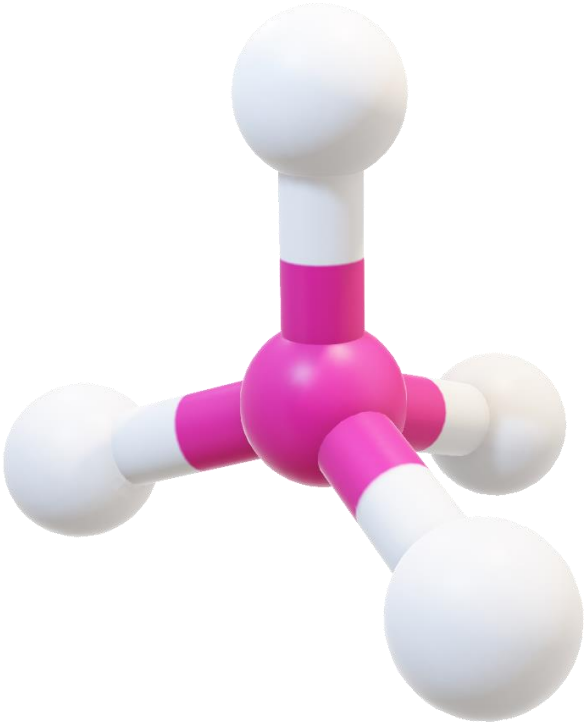
Valence

Shell

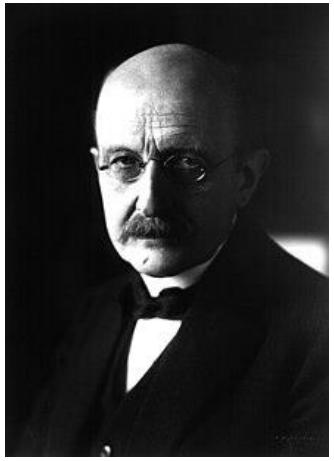
Electron

Pair

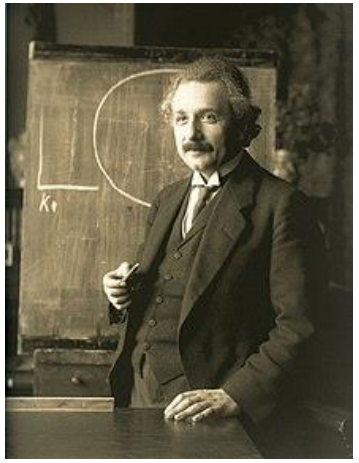
Repulsion



Faces in Quantum Physics 1920's



Max Planck
Berlin, Germany
1918 Nobel Prize for energy quanta



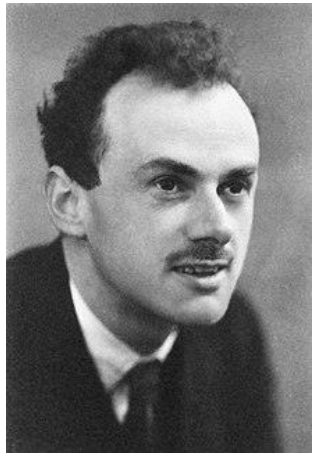
Albert Enistien
Germany / Princeton NJ
1921 Nobel Prize for Photoelectric effect. Also known for mass- energy equivalence, special relativity, and Brownian motion

Niels Bohr
Copenhagen, Denmark
1922 Nobel Prize for atomic structure and quantum theory

Werner Heisenberg
Germany / Princeton NJ
1932 Nobel Prize for quantum mechanics. Also known for the uncertainty principle

Max Born
Breslau, Germany
1954 Nobel Prize for statistical interpretation of the wave function

Erwin Schrödinger
Vienna, Austria
1933 Nobel Prize for quantum mechanics, calculation of the wave function

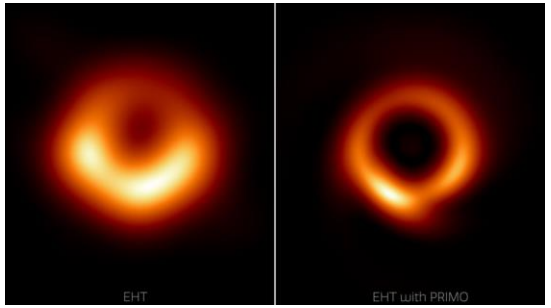


Paul Dirac
Bristol, England
1933 Nobel Prize quantum mechanics. Also known for the Dirac equation

J. Robert Oppenheimer
New York, US
Lead development of first nuclear bomb. Also known for Born- Oppenheimer approximation

Faces in Quantum Physics 2020's

Katie Bouman



Massachusetts Institute of Technology

Edward Witten

Baltimore, Maryland

Areas of study: M-theory, Seiberg-Witten Theory, Seiberg-Witten Invariants, Wess-Zumino-Witten Model, Weinberg-Witten Theorem

Carlo Rovelli

Verona, Italy

Areas of Study: Theoretical Physics, Loop Quantum Gravity

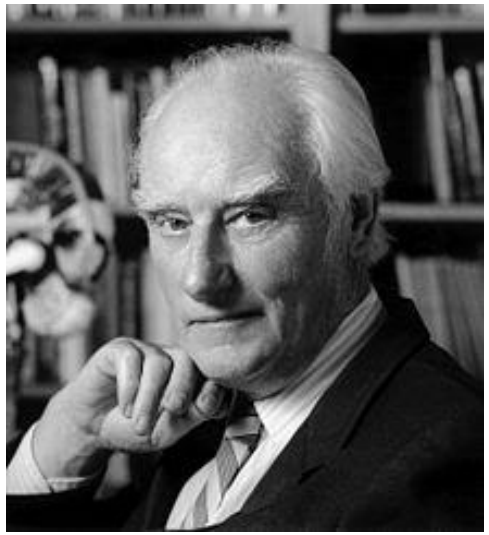
Lisa Randall

New York, New York

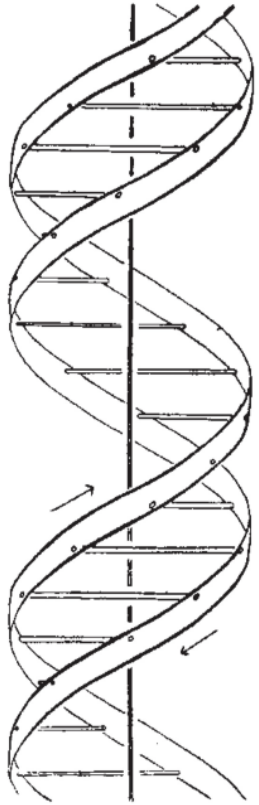
Areas of Study: Randall-Sundrum Model, Theoretical Physics, Particle Physics

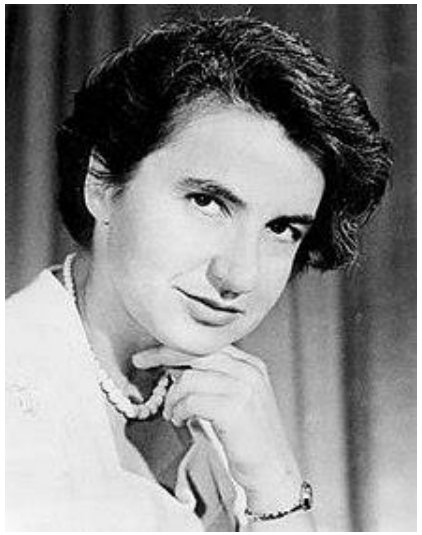
The Discovery of the Structure of DNA

James Watson



Francis Crick

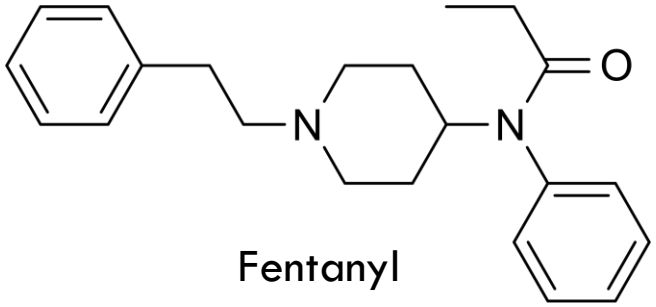




Rosalind Franklin

Unit Conversions

Fentanyl is an extremely dangerous narcotic which is fueling an opioid epidemic in the United States. It's also used medicinally as an epidural during labor. The recommended dosage is 2 ug/mL at a flow rate of 8 mL/hr. How many grams of fentanyl are administered during a 2 hour 47-minute labor



Fentanyl

Lee, et. Al., Anesthesiology 2017

Cattle Brands as Symbols

Source: The Independent

Rockets Vs. Rust

The majority of rocket launches at Vandenberg SFB are the state-of-the-art Falcon 9 rockets. Made by SpaceX, they are reported to cost over $200,000 to refuel. They are refueled by liquid O_2 and liquid RP-1 rocket fuel.

RP-1 is a highly refined kerosine, a mixture of hydrocarbons with sulfur strictly removed. It's found to have a ratio of $C_nH_{1.963}$ and with the known optimal combustion ratio (stoichiometry) of 1:2.326, making C_6H_{12} the most accepted analog.

$$C_6H_{12}\ (l) + 6\ O_2\ (l) \rightarrow 6\ CO_2\ (g) + 6\ H_2O\ (g) \qquad \Delta H = -4687\ kJ/mol$$

What types of reactions are these?

Rust is the brown, flakey oxide layer of iron. When Fe encounters water or air it will form this oxide until all the material is consumed

$$4Fe\ (s) + 3O_2\ (g) \longrightarrow 2Fe_2O_3\ (s) \qquad \Delta H = -1648.4\ kJ/mol$$

Concentration terms

Fluoride is added to water to prevent tooth decay. While at high concentrations fluoride can be dangerous, EPA studies show it's safe at or below 4.0 mg/L. If we find our water supply to have a concentration of 3.58×10^{-4} m, is it safe to drink?

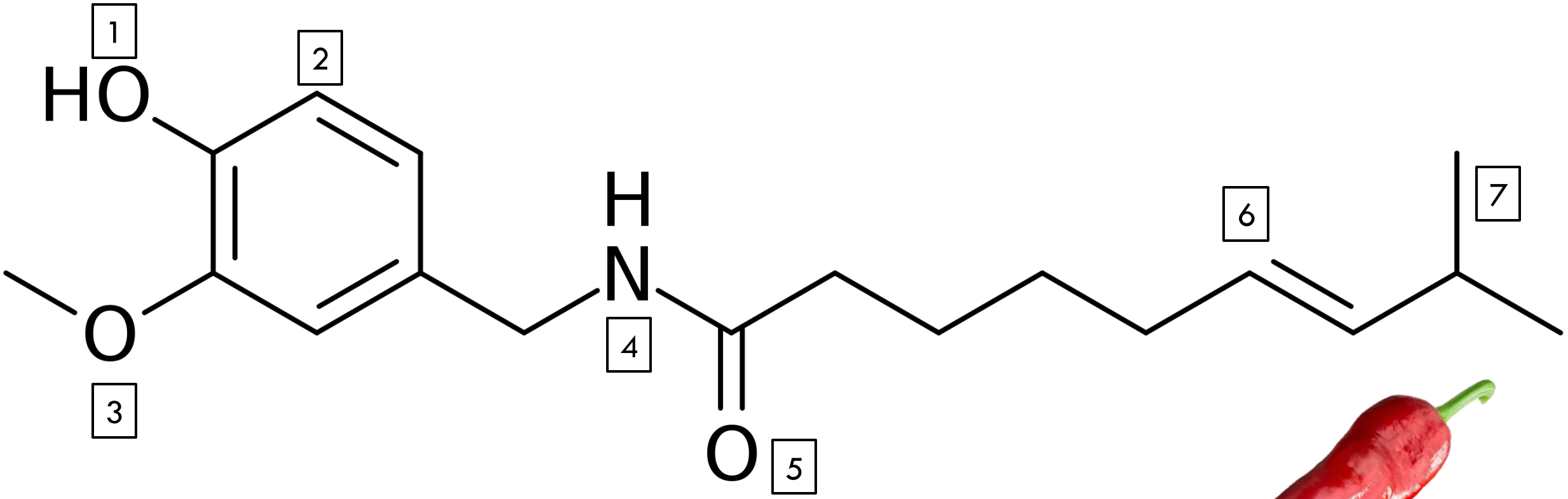
Source: EPA.gov

Calorie Conversions

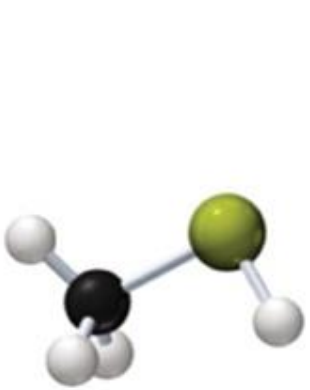
A nursing mother typically burns an additional 700 Calories a day. How many joules of energy is this?

Functional Groups in Action

Capsaicin is the active ingredient in chili peppers, the molecule which gives the pepper it's spicy flavor. Name the functional groups observed on capsaicin

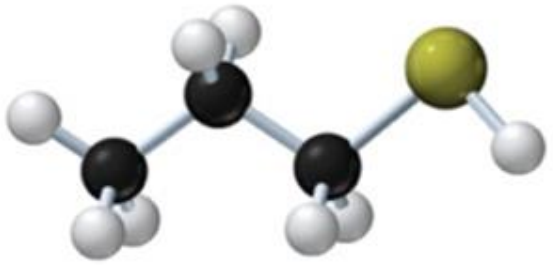


Flavor in Functional Groups



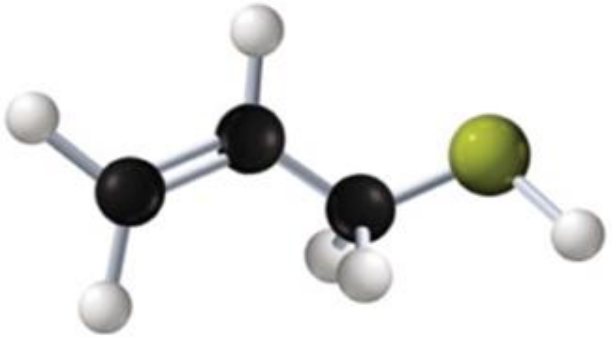
$CH_3—SH$

Methanethiol
(oysters and cheese)



$CH_3—CH_2—CH_2—SH$

1-Propanethiol
(onions)



$H_2C=CH—CH_2—SH$

2-Propene-1-thiol
(garlic)

Source: K. Timberlake; Chemistry: An Introduction to General, Organic and Biological Chemistry

The Speed of Waves

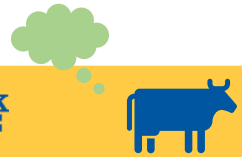
While watching the sunset at Jalama beach you see a flash of lightning over the water. Exactly 2.5 seconds later you hear the crack of thunder. How far away is the lightning from your position. With that distance in mind, how quickly (sec) did it take for the light to reach your eyes?

Speed of Sound: 343 m/sec

Speed of Light: 3.00×10^8 m/sec

Methane production

Methane (CH_4) is a gas with a greater greenhouse effect than CO_2. Ruminant livestock (cows) can produce 250 L to 500 L of methane per day through burping and farting. As of 2023, there are 28.9 million beef cows in the US. Assuming an average volume of methane, temperature of 14.8 °C (annual average for Santa Maria), and 1.00 atm pressure, how many grams of methane are put into the atmosphere every year from American cows?



A Different Kind of Chemical Yield

The Trinity test saw the explosion of the first nuclear bomb, "the Gadget". The 6.19 kg ^{239}Pu core detonated to produce a blast equivalent to 25 kt of TNT or 100 TJ of energy. A single ^{239}Pu atom generates 3.318×10^{-11} J per fission event. Some of the scientists present each bet $1 on the percent yield of the Gadget. Who won the bet?

Scientist	Yield
Norman Ramsey	0%
J. R. Oppenheimer	0.26%
George Kistiakowsky	1.16%
Hans Bethe	6.51%
Isidor Rabi	14.5%
Edward Teller	37.5%

The Trinity Test

An Upset Stomach

An average stomach has a volume of 80 mL of gastric acid (HCl) with a concentration $[H_3O^+] = 0.0316$ M. What is the pH of this stomach acid and how many moles are present? Having an upset stomach, you decide to take antacid ($CaCO_3$) after which the $[H_3O^+] = 0.00200$ M. What is the new pH and how many moles of HCl were removed?

The Scoville Scale

In 1912 Wilber Scoville created the Scoville organoleptic test where an exact weight of dried pepper is dissolved in alcohol to extract the heat components (capsaicinoids), then diluted in a solution of sugar water. Decreasing concentrations of the extracted capsaicinoids are given to a panel of five trained tasters, until a majority (at least three) can no longer detect the heat in a dilution. Now this test is performed by HPLC to a calibrated Scoville scale.

A panel starts the test with 10.0 mL of 1.20 M sugar solution with dissolved capsaicinoids. After 12 doubling dilutions the solution volume is 40.96 L when three of the panel can no longer taste heat. What is the final solution's concentration?

Source: K. Peter, *Handbook of Herbs and Spices*

Atoms and Molecules

How many moles of oxygen atoms are in 1.0 mole of $Fe(ClO_4)_3$? How many moles of oxygen atoms in 2.0 moles of $Fe(ClO_4)_3$? In 12.7 moles of $Fe(ClO_4)_3$?

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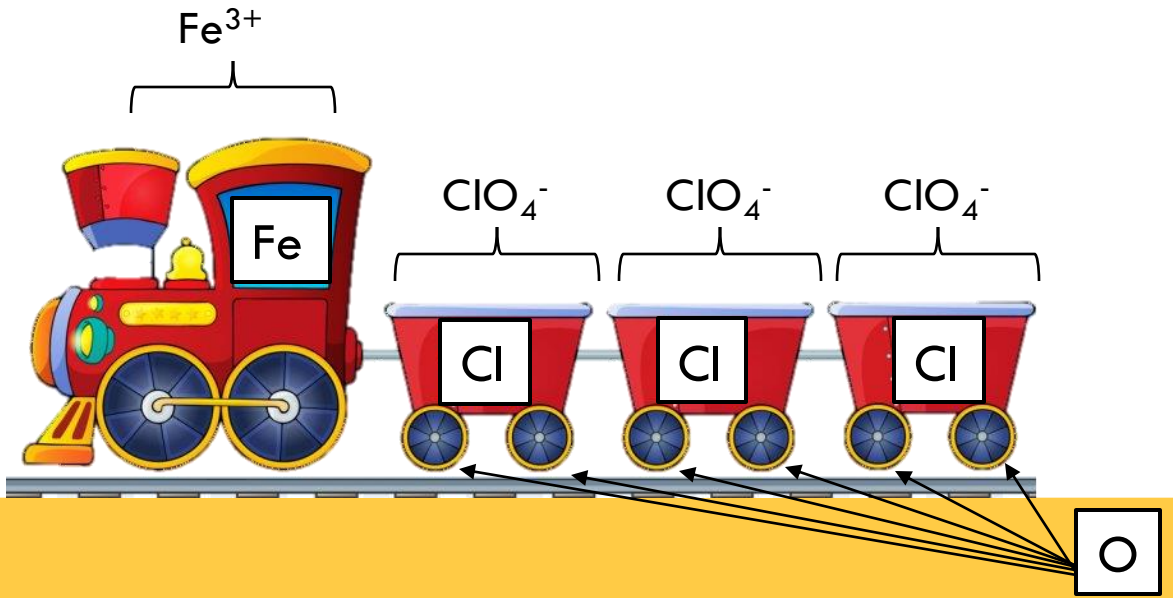

Gender in the Structure of the Atomic Nucleus

Maria Göppert
Germany

- Although a sixth-generation professor, was not allowed into graduate school due to her gender.
- She took classes where she could and wrote her dissertation alone.
- She wasn't allowed a professorship upon graduation as she had no references.
- The work she was allowed to do was unpaid and intentionally unnecessary ("what makes colors" and "separating uranium with flashing lights").
- Her theory on the magic numbers of nuclear geometry was mocked by the male centric science community

Magic Numbers: 2, 8, 20, 28, 50, 82, and 126

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Until her theory was proven correct, and she was awarded the Nobel prize in 1963

WORLD RENOWNED—Dr. Maria Goeppert Mayer, 57, holds the slide rule she uses in the study of nuclear physics that won her a Nobel Prize today. She is a University of California professor here.

S.D. Mother Wins Nobel Physics Prize

Dr. Mayer 1st Woman in U.S., 2nd in History So Honored

By FRANK HOGAN

Dr. Maria Goeppert Mayer, 57, a research physicist at the University of California here, today was named 1963 Nobel Prize winner in physics.

The red-haired college professor, mother of two, is the first woman residing in America to win a Nobel

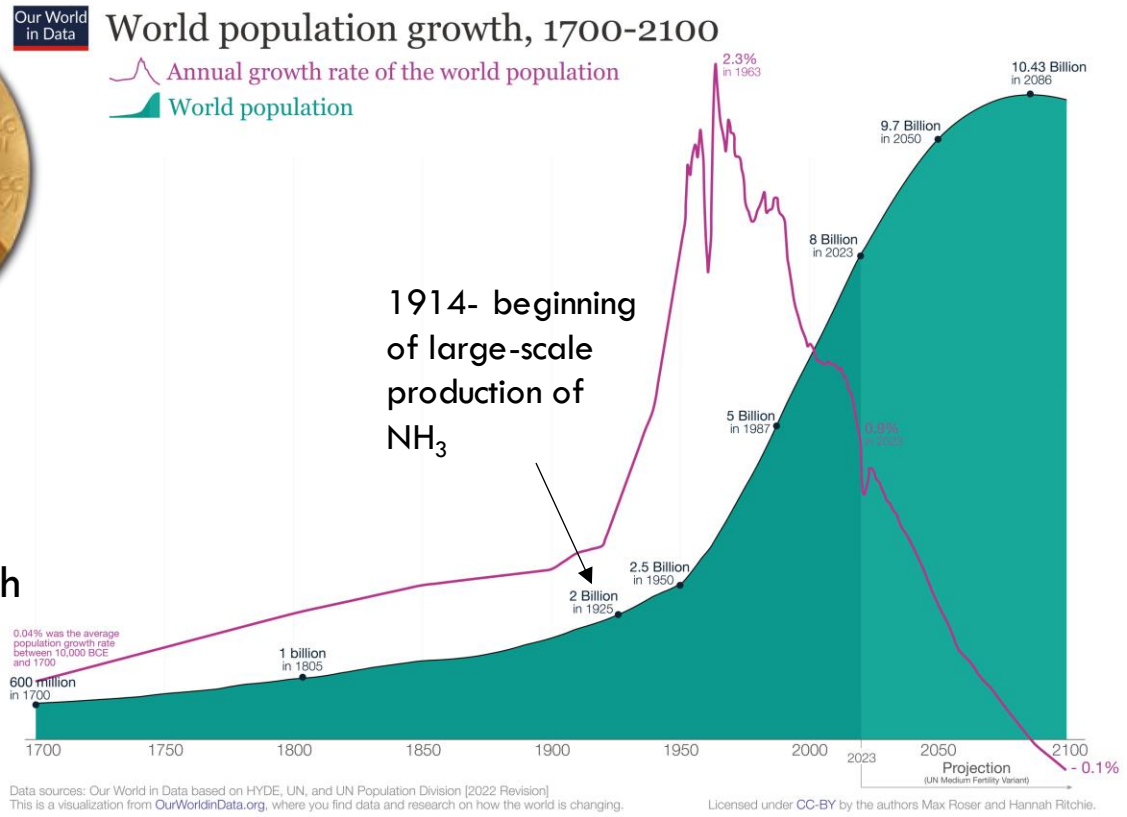
Magic Numbers: 2, 8, 20, 28, 50, 82, and 126

Fritz Haber – Giver of Life

$$\mathrm{N_2} + 3\,\mathrm{H_2} \longrightarrow 2\,\mathrm{NH_3} \quad \Delta H^\circ = -91.8\ \mathrm{kJ/mol}$$

Fritz Haber, c. 1919
Jewish- German national later converted to Christianity for political reasons

Nobel Prize in 1918 for his invention of the Haber–Bosch process



- Precursor to all modern fertilizers
- "It is estimated that one-third of annual global food production uses ammonia from the Haber–Bosch process, and that this supports nearly half of the world's population."
- However, he was researching uses for explosives similar to Oklahoma City bomb

Smil, Vaclav (2004). *Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production.*

Fritz Haber – Giver of Death

- Known as the "Father of chemical warfare"
- Experimented with bromine and chlorine in WW1 eventually discovering mustard gas
- Would watch gassing of enemy soldiers personally for research

How should Fritz Haber be remembered?

Zyklon labels from Dachau concentration camp

- His work led to the creation of Zyklon B, the poison gas used to exterminate six million Jews and other "undesirables"
- So upset by his work, his first wife Clara, also a chemist, commit suicide in 1915, leaving her 12-year-old son behind

Haber's first wife, Clara Immerwahr

"No. 2287: Fritz Haber". *www.uh.edu.*

Density Scam?

In 8 carts

$10.95

1 Ten Gram 100 Mills .999 Gold Buffalo Bullion Bar

MetalsXMedals ★★★★☆

✓ Arrives soon! Get it by Jun 7-13 if you order today

✓ Returns & exchanges accepted

Quantity

1

Add to cart

Hooray! This item ships free to the US.

Gift wrapping available

Highlights

Handmade

Description

The central theme of this collector bar is the American Bison.
This collector bar would make an excellent gift for just about anyone.
Each bar contains 100 mills of .999 fine gold, as stated on the bar.
This is a highly collectable item not intended for investment.
They are not solid gold .

461 reviews ★★★★½

Reviews for this item 32 Reviews for this shop 461

Sort by: Suggested

★★★★★

my gold bar came in so fast I only bought one just to check it out and

Does this make sense?

As of 2023 Au:

Value is $1955/oz

Density is 19.3 g/cm^3

Also, 1 oz = 28.35 g

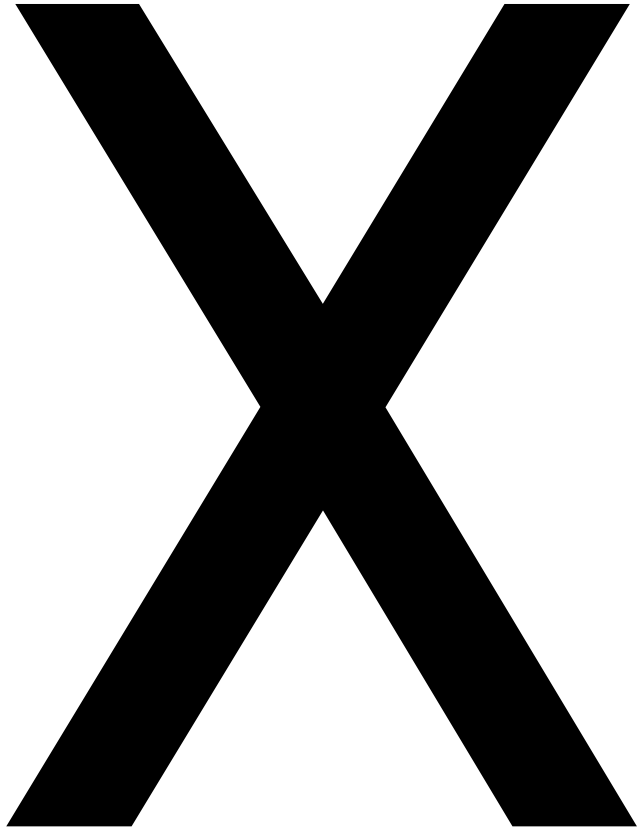
Mendeleev's Pursuit

Reihen	Gruppo I. — R^1O	Gruppo II. — RO	Gruppo III. — R^2O^3	Gruppo IV. RH^4 RO^2	Gruppo V. RH^3 R^2O^5	Gruppo VI. RH^2 RO^3	Gruppo VII. RH R^2O^7	Gruppo VIII. — RO^4
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

X Marks the Spot

Atomic Number

Ion Charge



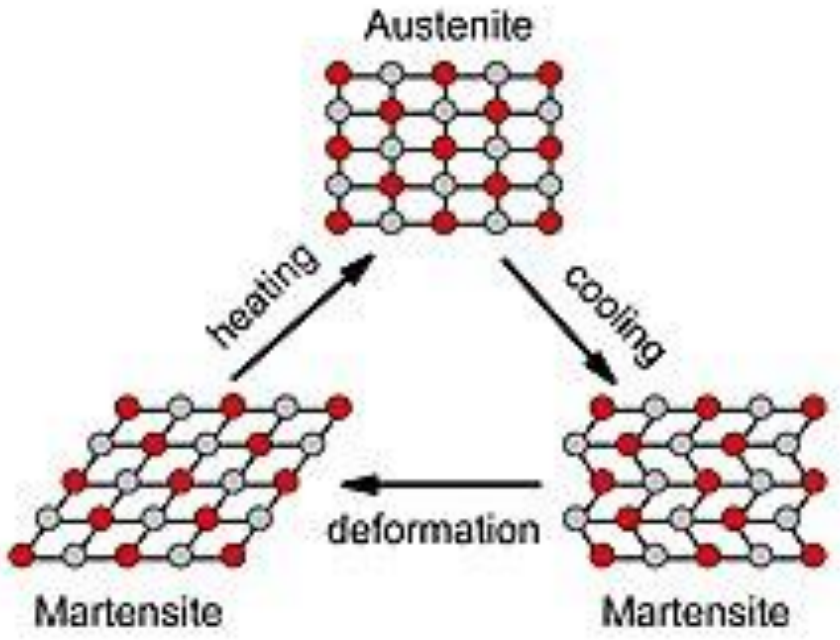
Atomic Mass

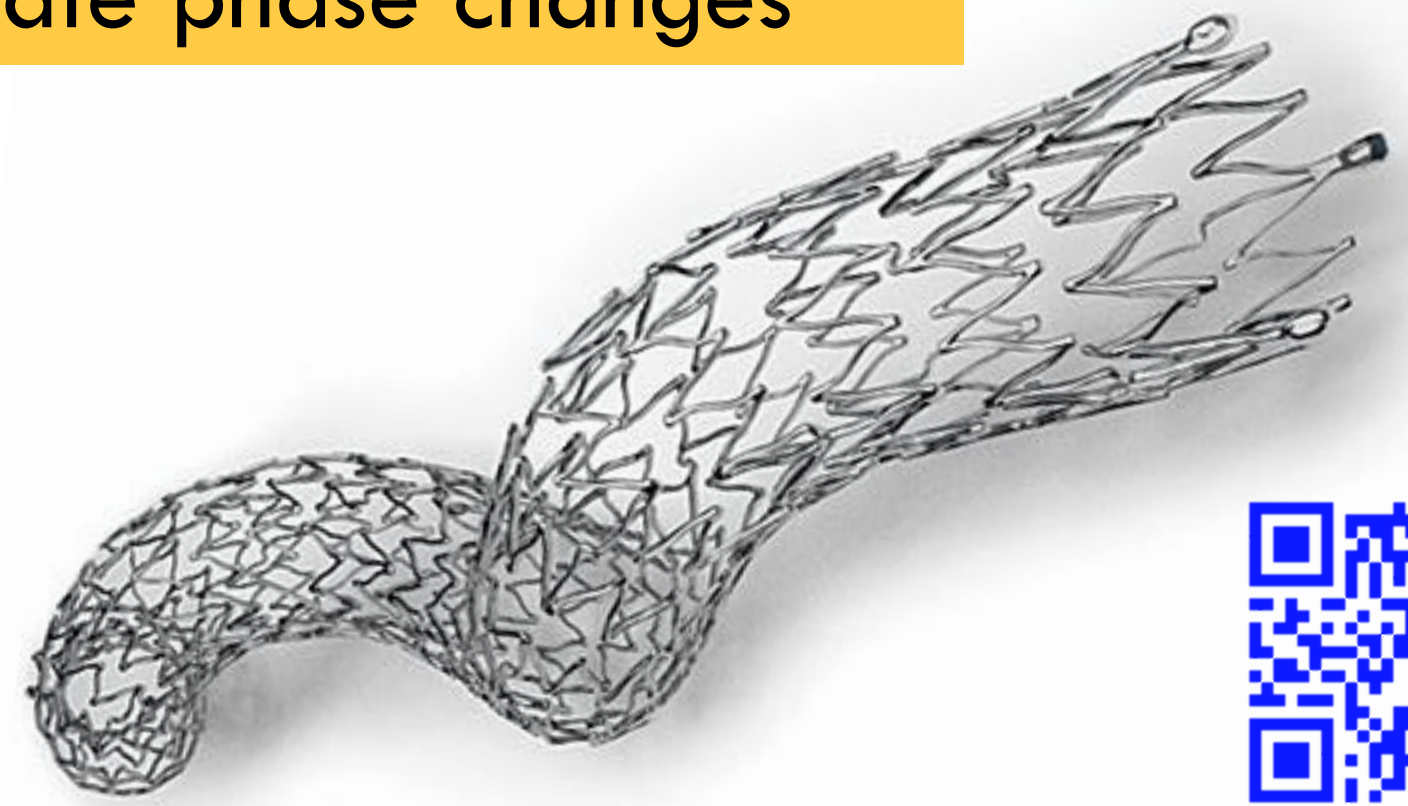
Number of atoms

Nitinol Demo

Nitinol = Ni + Ti + Naval Ordnance Laboratory

Solid state phase changes





More about NiTinol

Photosynthesis