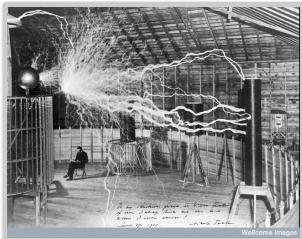
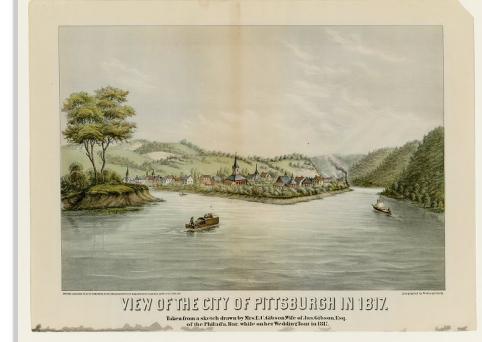


## Matter and Energy

### The Second Scientific Revolution



George Matthews, Plymouth State University  
2020



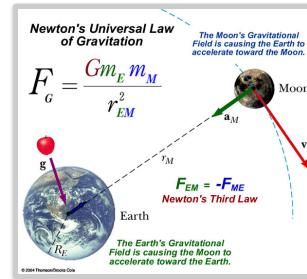
Even though the Scientific Revolution was complete by the end of the 18th Century, science had not yet had much impact on ordinary people's lives.

### Accomplishments of the Scientific Revolution



- Development of experimental methods -- formulation and testing of empirical hypotheses.

### Accomplishments of the Scientific Revolution



- A comprehensive mathematical model of mechanical and gravitational motion.

### Accomplishments of the Scientific Revolution



- Establishment of scientific societies devoted to the development and publication of scientific findings.

### Accomplishments of the Scientific Revolution



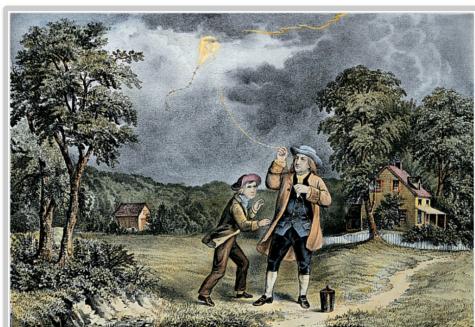
- A growing body of observational data in many areas as Europeans colonized and explored the rest of the world.

*Unknowns in 1800*

- What are material things made of?

*Unknowns in 1800*

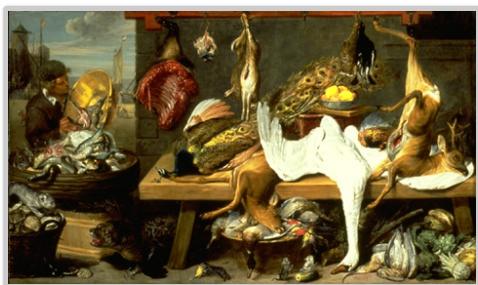
- How do chemical reactions work?

*Unknowns in 1800*

- What is electricity?

*Unknowns in 1800*

- What is magnetism?

*Unknowns in 1800*

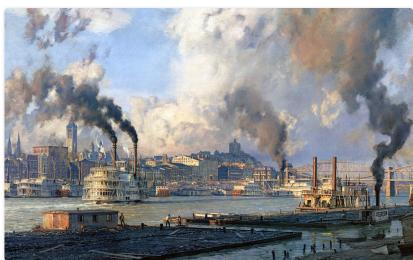
- What is the difference between animate and inanimate things?

*Unknowns in 1800*

- What is heat and why does it make some processes happen faster?

These questions would all be answered in the 19th Century with the development of scientific understanding of the material world.

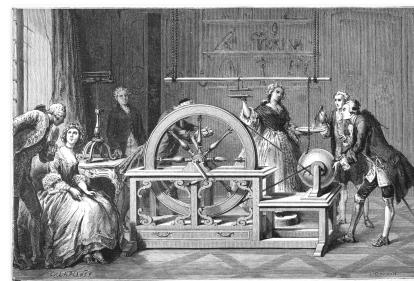
*The result...*



Pittsburgh 1900

Scientific understanding of matter and energy would transform the world as never before in less than a century.

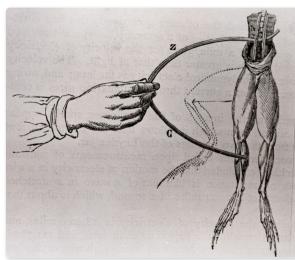
### *Understanding electricity*



1750's

- Jean-Antoine Nollet builds electrostatic generators, shocks 800 monks in demonstration.

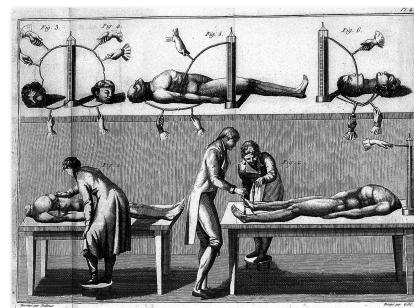
### *Understanding electricity*



1780's

- Luigi Galvani accidentally discovers that nerves are activated by electrical impulses.

### *Understanding electricity*



early 1800's

- His followers think he has discovered the "animal electricity" that all living beings posses.

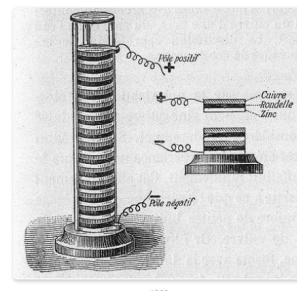
### *Understanding electricity*



1931

- Among those influenced was Mary Shelley whose novel *Frankenstein* assumed that dead tissue could be revitalized with electrical shocks.

### *Understanding electricity*



1800

- Alessandro Volta creates first battery based on his understanding of why the frog's leg twitched when touched with dissimilar metals.

*Understanding electricity*

1831

- Michael Faraday creates first electric generator by building a device that moves a conductor through a magnetic field.

*Understanding matter*

1804

- Humphrey Davy uses electric currents to isolate many elements such as sodium, lithium and potassium.

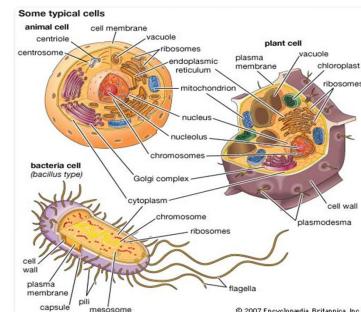
*Understanding matter*

Mendeleev's table

He	Li	B	C	N	O	F
4.00	6.94	9.03	12.0	14.0	16.0	19.0
Na	Mg	Al	Si	P	S	Cl
22.99	24.31	26.98	28.09	30.97	32.06	35.45
K	Ca	Sc	Ti	Cr	Mn	Tc
39.10	40.08	44.96	47.90	51.90	54.94	58.93
Ca	Zn	Ge	As	Se	Br	I
40.08	65.40	69.72	72.63	74.94	79.90	83.80
Rb	Sc	V	Zr	Nb	Ta	Ru
35.45	44.96	50.94	54.90	58.97	62.26	64.93
Ag	Cd	In	Sn	Sb	Te	At
107.87	112.41	113.40	118.71	121.76	127.60	132.91
Xe	Co	Ba	La	Hf	Ta	W
131.30	132.91	138.91	140.12	144.24	145.00	149.16
Rn	Ar	Hg	Tl	Pb	Bi	Po
157.81	157.81	204.20	207.20	209.20	210.00	218.00
U						

1869

- Dmitri Mendeleev formulates first periodic table of the elements based on the findings of many chemists about how different sets of elements interact with each other to form compounds.

*Understanding life*

1838

- Theodore Schwann and Matthias Schleiden develop the first cellular theory of life.

*Understanding life*

1859

- Charles Darwin develops his theory of Evolution by Natural Selection as the first comprehensive theory explaining the variety and adaptations of life on earth.

*Connections*

- Energy is the ability to do work or make things happen.
- It comes in many forms: mechanical, thermal, chemical, electrical all of which can be converted into each other.
- Electricity is moving electrons, and can be generated chemically and mechanically.
- Heat is the average kinetic energy of moving bits of matter.
- Chemical reactions involve sharing or exchange of electrically charged particles.
- Biological cells are biochemical machines that take in energy, grow, reproduce and move themselves.



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