What is Physics?

Understanding the nature and properties of matter and energy in the universe and their *interactions and relationships*: includes mechanics, heat, radiation, sound, electricity, magnetism, structure of atoms and molecules, relativity, structure and formation of the Universe.

1. Fundamental properties

Determine what are the most *fundamental* quantities in the universe that can be **precisely measured.** (e.g., position, velocity, energy, time, mass, electric & magnetic fields….).

Homework Exercise: Suggest some other possible quantities and justify why fundamental (one page maximum)

2. **Laws (relationships)**

Find relationships between those fundamental quantities (e.g., Hooke's law, thermodynamics, conservation of energy, special relativity). These relationships or patterns and correlations are expressed using words, equations, graphs, charts, diagrams, pictures, videos.

3. **How**

Design, conduct and analyze experiments: The Art of Physics.

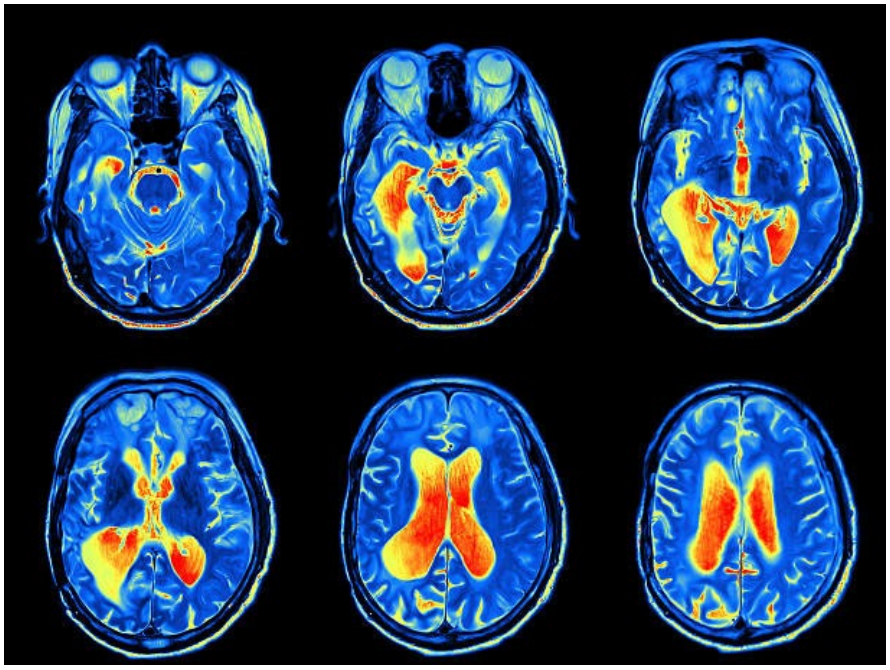
3. Why is this useful

For a new system make predictions
Design buildings safely (Hooke's law)
Place satellites in orbit (Newton's laws)
MRI (quantum mechanics)
Transistors (cell phones and all that) (quantum mechanics)

MRI

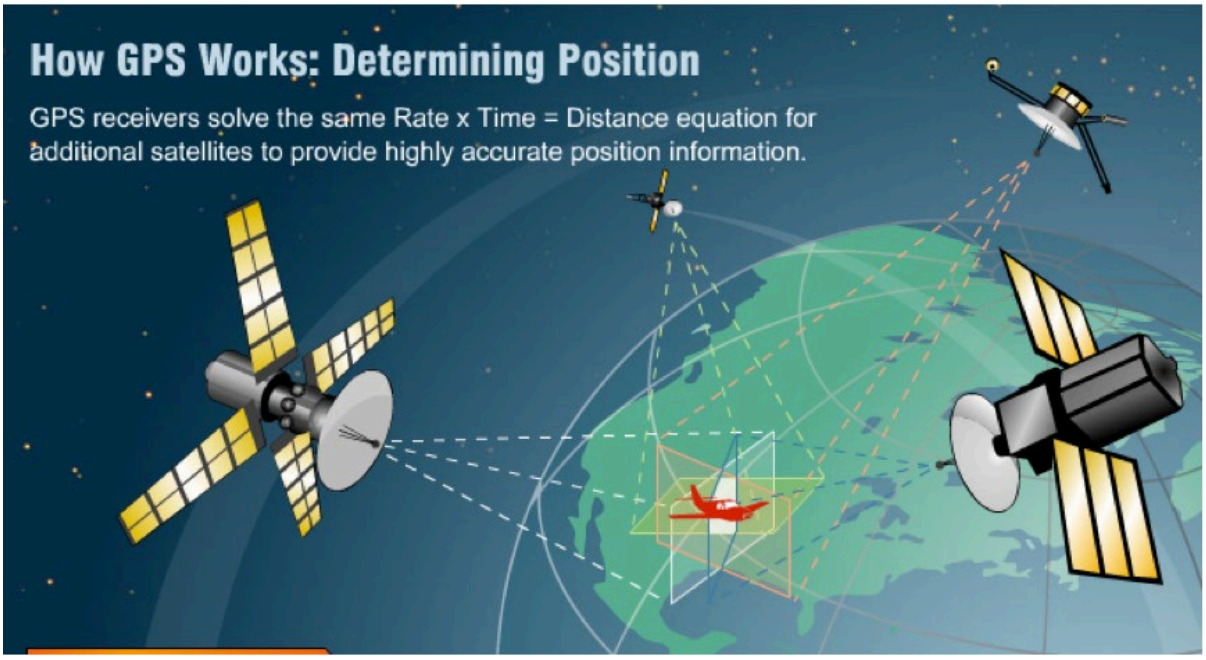
Need superconducting magnet (quantum mechanics)

Need radio waves to tickle nuclei (quantum mechanics)



GPS and General relativity

Works by receiving signals from separate satellites in orbit (at about 20,000 km. Signals tell when sent and time to be received hence have distance to satellite Need three for triangulation (actually use 4 to correct for atmospheric and other errors). Need clocks to be accurate to 20 nanoseconds for accuracy of ~ 10 m.



BUT according to **general relativity** clocks in orbit run faster (in weaker gravitational field) by about 45 microseconds per day.

ALSO clocks on satellites move with high speed and by **special relativity** those clocks run slower --- about 7 microseconds per day.

Net error: 38 microseconds or about 11 km /day