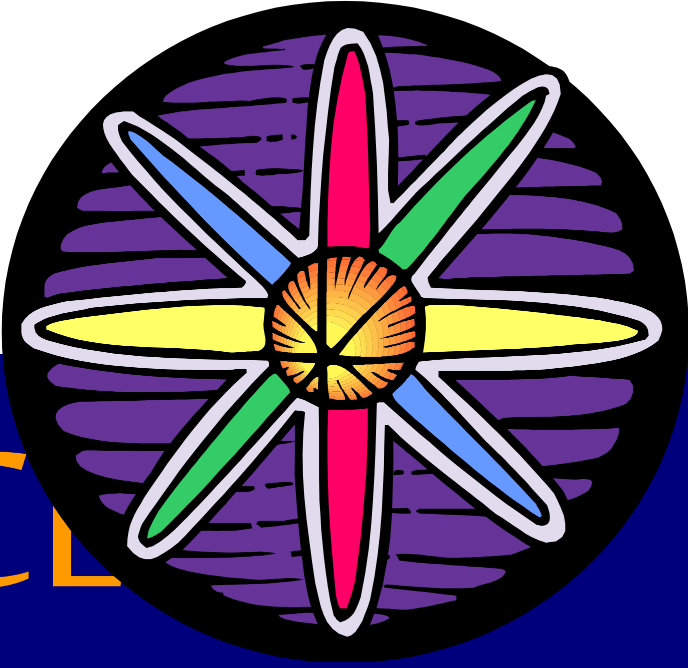
History of NUCL

CHEMISTRY

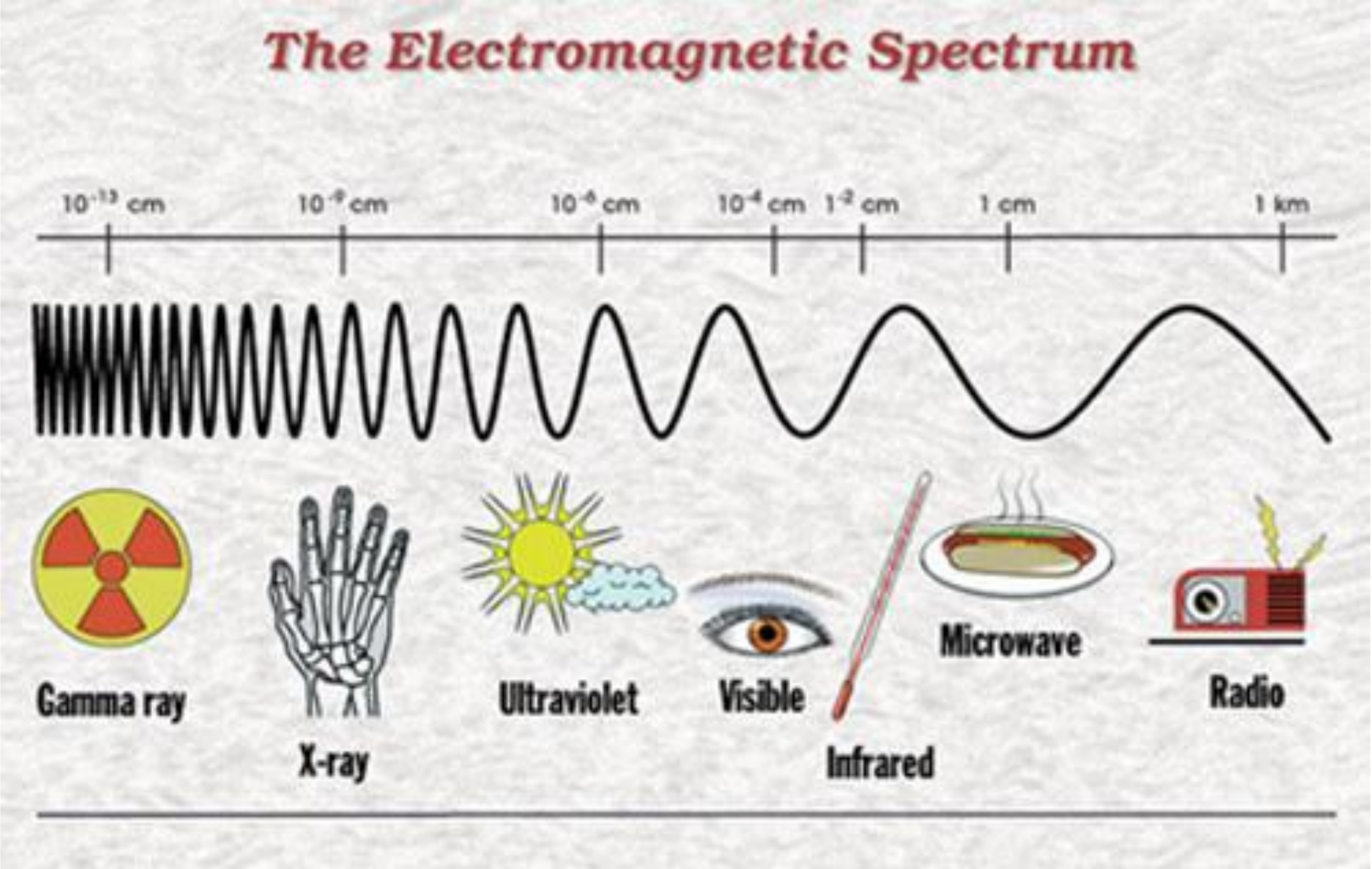


Discover of Radioactivity

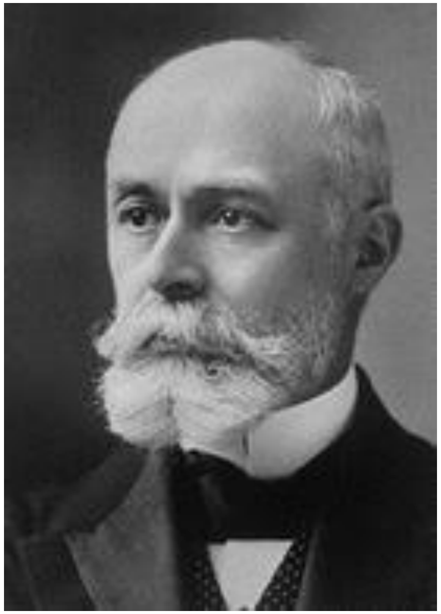
William Roentgen

- **November 1885 discovered x-rays**
  - **X-rays are energetic electromagenetic waves that can travel through matter.**

X-Rays – increased frequency, decreased wavelength



Discover of Radioactivity



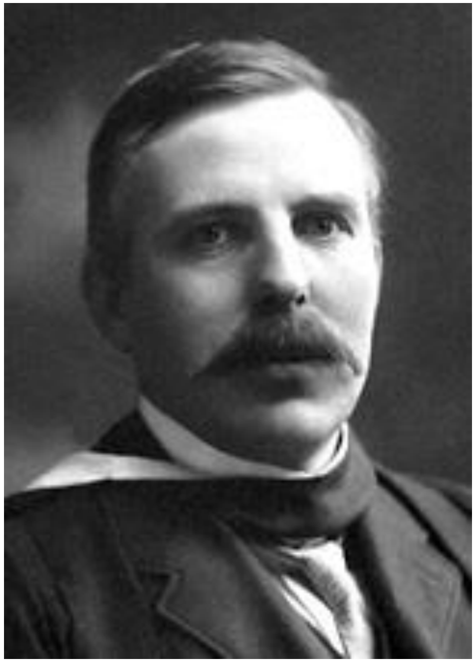
- **Within a few months, Henri Becquerel discovered the presence of naturally occurring radiation in uranium salts.**

Discover of Radioactivity

1898

Marie Curie found that compounds of thorium were also radioactive. She eventually isolated two more radioactive elements, polonium and radium.

Discover of Radioactivity



- Ernest Rutherford

Discovered two forms of radioactivity, alpha and beta particles.

A third form, gamma rays, was discovered shortly thereafter.

Causes of Natural Radioactivity

- **Protons & neutrons are held together in the nucleus by nuclear forces**

a) **Nuclear forces are only active over very short distances**

b) **Nuclei of certain isotopes of some atoms are unstable.**

c) **These unstable isotopes will disintegrate, giving off particles or rays of radiation**

What is RADIOACTIVITY?

- It is the process of nuclear decay.
- Nuclei of large atoms (83 protons or more) are radioactive.
- The nucleus is unstable and can begin to decay, when the nucleus decays it emits these waves of radiation.
- Elements with nuclei that have a different number of neutrons, more or less, to protons are radioactive.

Types of Radiation

1. **There are many types of radiation which can be emitted from a nucleus**
2. **Three important types are:**
   a) **Alpha particles, made up of 2 protons and 2 neutrons**
   b) **Beta particles, having the same charge and mass as an electron**
   c) **Gamma ray, a high energy ray**

D. Radioactive Decay

1. **The process of breaking down of radioactive nuclei is referred to as radioactive decay.**
2. **When an atom loses an alpha particle, the atomic weight of the atom is reduced by 4 and the atomic number reduced by 2. A new element is produced.**

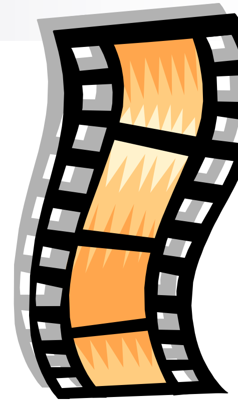
TRANSMUTATION

3. **When an atom loses a beta particle, the atomic number is increased by one. A new element is produced.**
4. **When a nucleus emits a gamma ray, there is no change in either the atomic number or the atomic weight.**

Radiation Detection & Measurement

1. The rate at which radioactive decay takes place is measured in half-life.
   a) Half-life is the amount of time required for half of a given amount of radioactive nuclei to disintegrate
   b) The activity of radioactive substances can be measured in disintegrations per second

- 2. Several devices have been developed for detecting, measuring, and studying radiation:



a) Photographic film
b) Geiger counter
c) Cloud chamber
d) Ionization chamber
e) Scintillation chamber
f) Bubble chamber
g) Spark chamber

Fission

1. **Fission is the splitting of an atomic nucleus.**
2. **It results in the loss of mass and production of energy**

Nuclear Fission

Scientists studying fission

a) **Hahn & Strassman bombarded uranium with neutrons and produced atoms of lighter elements**

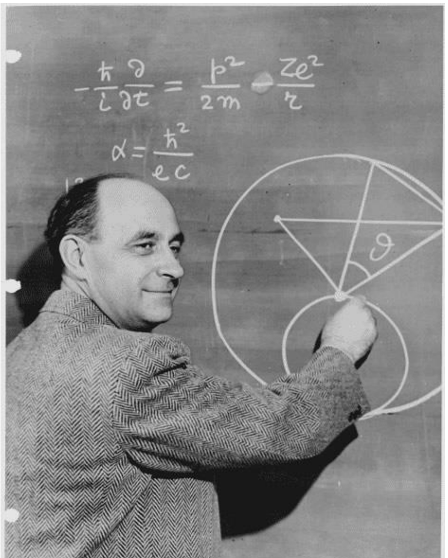
b) **Meitner & Frish explained the experiment of Hahn & Strassman in terms of splitting of the uranium nucleus**

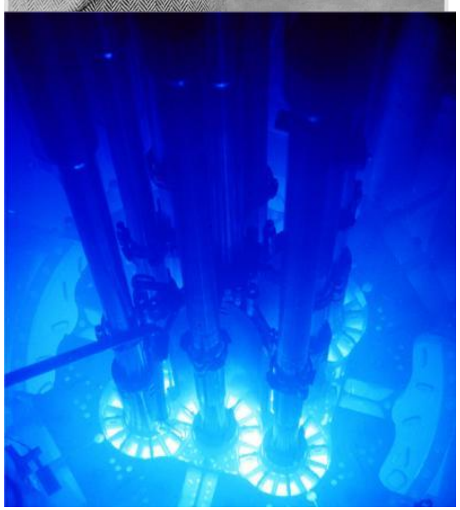
c) **Einstein set forth the theoretical basis for the conversion of mass into energy with his famous equation $E = mc^2$**

Fusion

- Fusion is a combination of atoms resulting in a loss of mass and production of energy
- When the nuclei of 2 atoms of deuterium [an isotope of hydrogen called “heavy hydrogen”] combine, helium is formed and energy is released. This is an example of fusion
- Edward Teller is known as the father of the hydrogen bomb because he discovered how to use fusion to cause explosions.

Nuclear Reactors



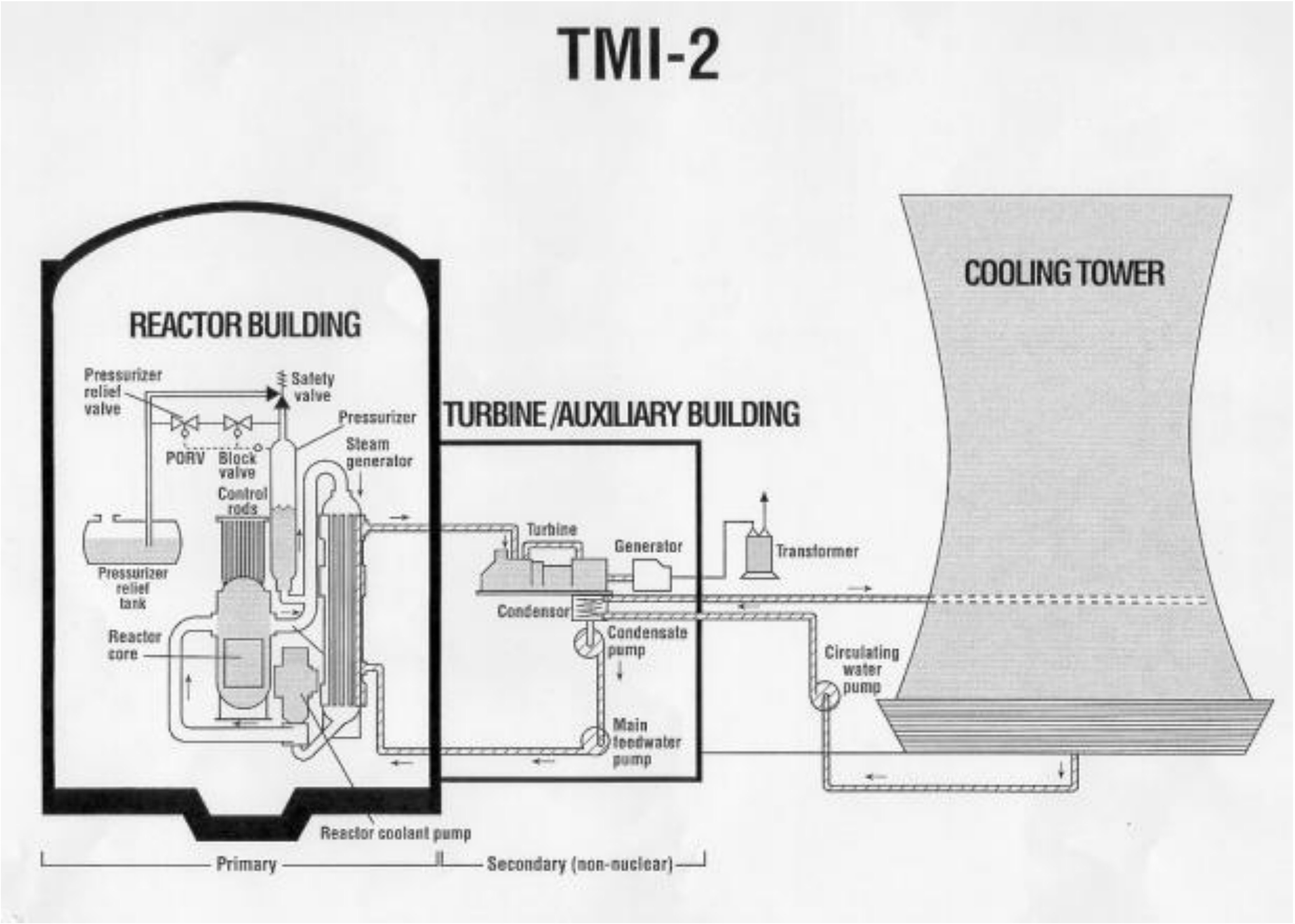


- Nuclear reactors are devices in which controlled nuclear fission takes place
- The first nuclear reactor was built by Enrico Fermi
- Nuclear reactors serve a wide range of purposes, from sources of power to devices for scientific research

Within the wide range of designs of nuclear reactors are the following common components:

a. **The fuel element containing the fissionable material**
b. **The moderator which slows down the neutrons to a speed at which they are likely to be absorbed.**
c. **Control rods to absorb neutrons and stop the chain reaction when necessary**
d. **A coolant to remove heat from the reactor**
e. **Shielding to protect workers from radiation**

Nuclear Reactor



Particle Accelerators

- **Speed up charged particles and change their structures**
- **Used to produce new isotopes and new elements**

Useful applications of radioactive isotopes

1. **Isotopes of an element can be separated by a mass spectrometer**
2. **Isotopes of an element can be separated by gaseous diffusion**
3. **These radioactive isotopes have many uses:**

Medical & biological research

1. **Calcium metabolism**
2. **Protein metabolism**
3. **Iron metabolism & rbc life**
4. **Cholesterol metabolism**
5. **Anticancer agents**

Medical diagnosis and therapy

1. **Blood volume**
2. **Water volume**
3. **Cardiac output**
4. **Blood circulation**
5. **Thyroid disorders**
6. **Location of malignancy**
7. **Radiography**
8. **Teletherapy**

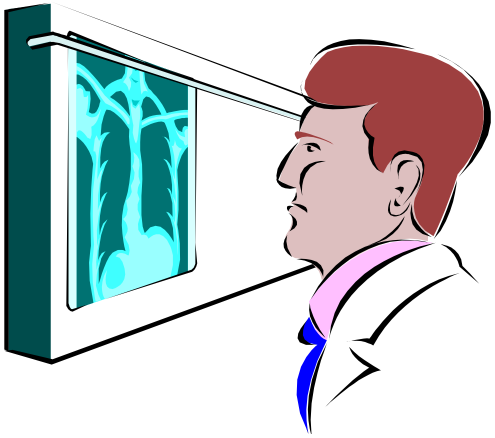
Agriculture

1. **Uptake of fertilizers**
2. **Soil fertility**
3. **Plant diseases**
4. **Genetics**
5. **Animal studies**
6. **Insect studies**
7. **Migration and hibernation**
8. **Bee culture**

Industry

1. **Radiography**
2. **Thickness gauging**
3. **Density gauging**
4. **Reflection gauging**
5. **Soil moisture testing**
6. **Luminescence**
7. **Ionization**
8. **Activation of chemical reactions**
9. **Sterilization**
10. **Wear patterns**
11. **Leak location**
12. **Tracing colors**
13. **Electronic printing**

Radiation can destroy or alter a living cell



- Radiation can cause mutations
- Since the presence of radiation can be determined by a detecting device, it is useful as a tracer and an invisible tag

Protection from Radiation

- **Special precautions must be taken when handling radioactive materials**
- **Nuclear war could cause loss of life and destruction by blast and resulting radioactive fallout**