Chapter 7 - Radioactivity

Science 10

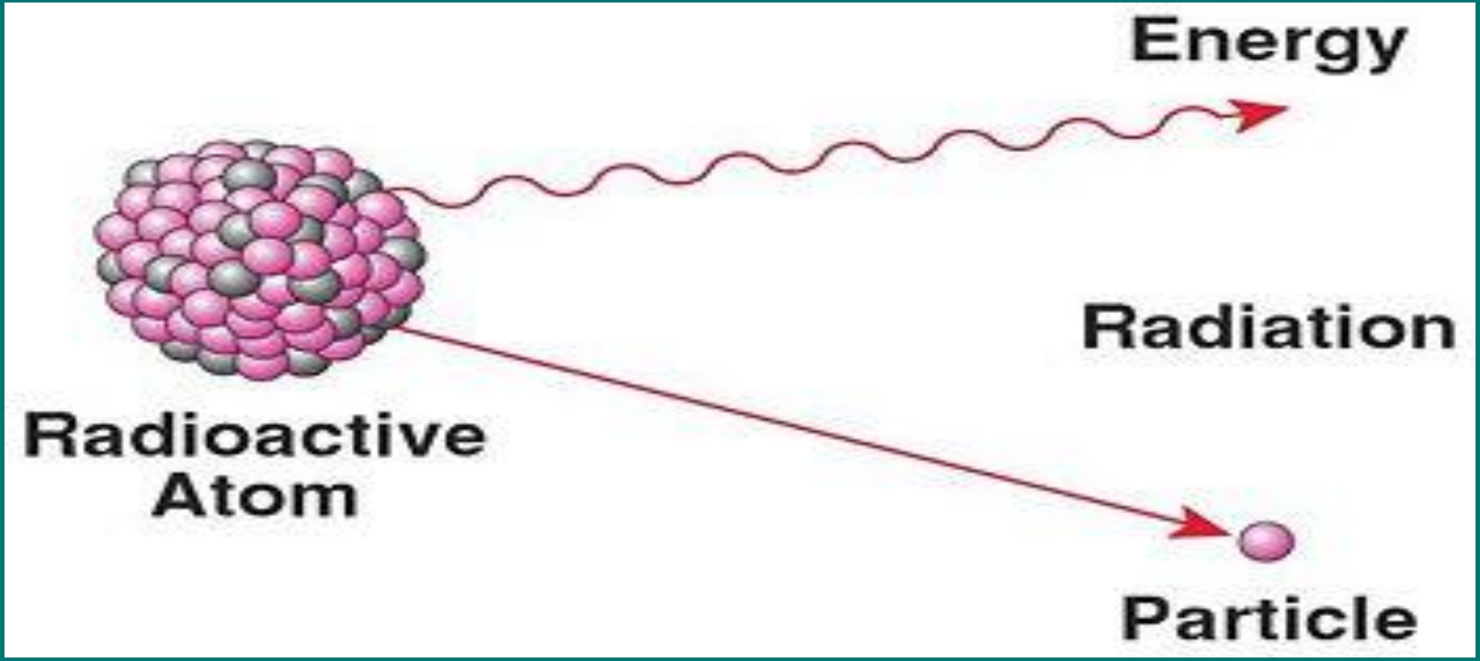
P286-328

What is Radiation?

- Radiation is:
  - anything that radiates away from something.
- Radiation may be in the form of:
  - **particles** (neutrons, alpha particles, and beta particles), or
  - **waves of pure energy** (light, radio waves, X-rays, and gamma rays gamma and X-rays).

Radioactivity - definition

- **Radioactivity** is the **release of high energy** particles or waves being emitted (released) from the decay (breakdown) of an **unstable nucleus** of an atom.



What is Radiation?

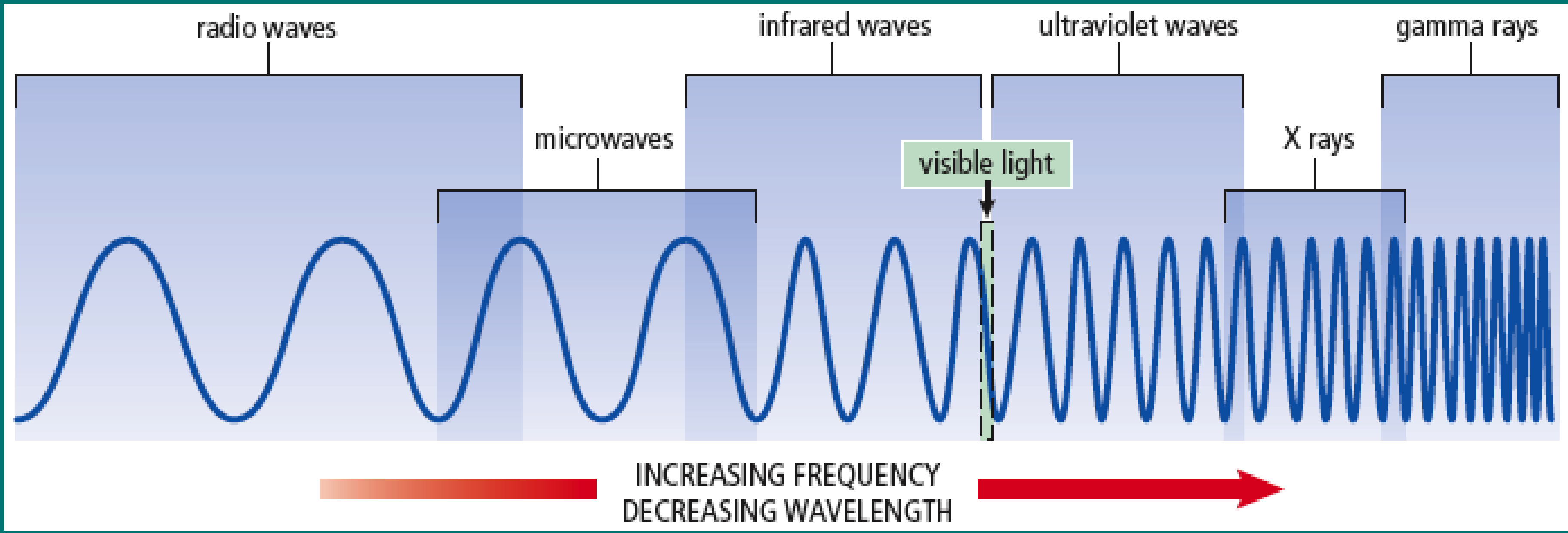
- Radiation may be in the form of:
  - **particles** (neutrons, alpha particles, and beta particles), or
  - **waves of pure energy** (light, radio waves, X-rays, and gamma rays gamma and X-rays).

Where do we find Radiation?

- **Natural background radiation** exists all around us.
- Radioactive materials are in many things:
  - X-rays, radiation therapy and electricity generation are beneficial.

The Electromagnetic Spectrum

- Radiation includes radio waves, microwaves, infrared rays, visible light, and ultraviolet ray. These make up the Electromagnetic Spectrum:
- https://www.youtube.com/watch?v=uJ3ea9fa6CA



Is Radiation Dangerous?

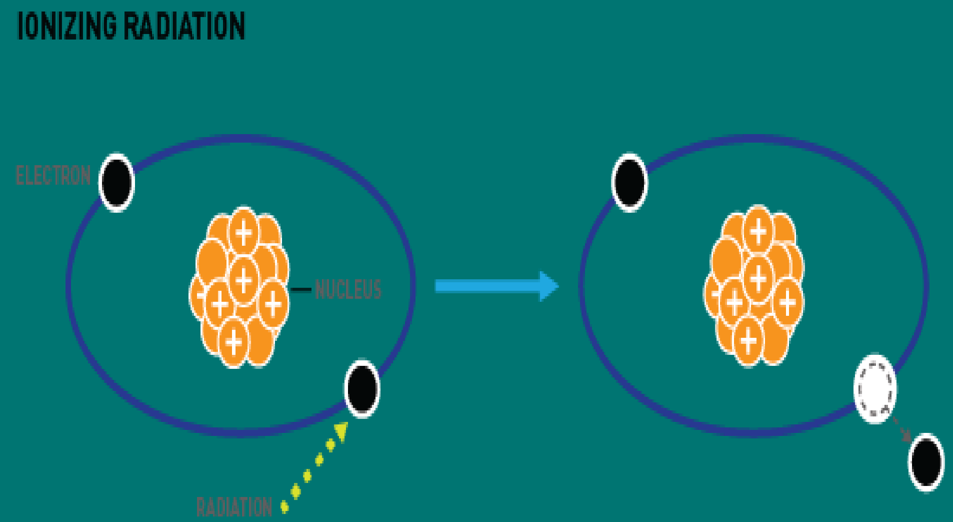
- YES: X rays, gamma rays, alpha particles, and beta particles are **ionizing radiation**.
- Ionizing radiation has a lot of energy that gives it the ability to cause changes in atoms—a process called ionization.
- NO: Radio and TV signals, microwaves, and laser light are nonionizing types of radiation.

Radiation videos

- Ted Ed: Is Radiation Dangerous?
- https://www.youtube.com/watch?v=zI2vRwFKnHQ

Radiation: What's the big deal?

- Although there are many beneficial uses of radiation, prolonged exposure to high energy particles and waves can do damage to DNA.
- When atoms lose high energy particles and waves, (like in background radiation) they have the potential to interact with an atom and turn it into an ion or even a new atom can be formed.



Uses of Radiation

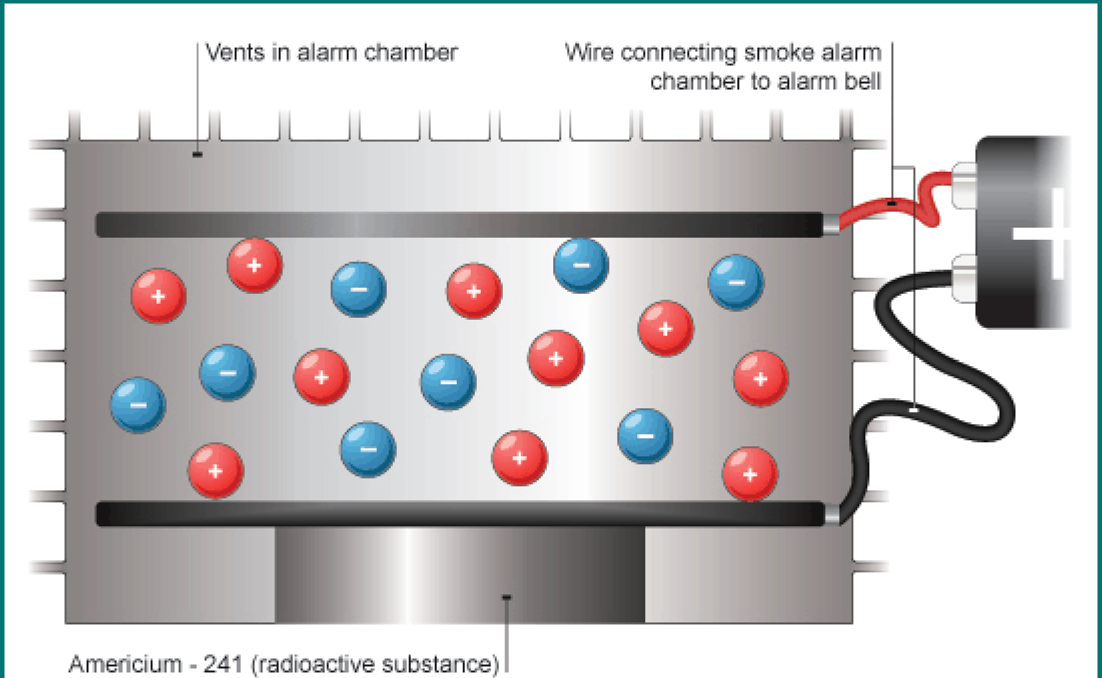
- in smoke detectors
- thickness gauges for measuring the thickness of materials in, for example, a paper factory
- for sterilising medical instruments
- for killing cancer cells
- for dating rocks and materials such as archaeological finds
- in chemical tracers to help with medical diagnosis

Smoke Detectors

- Radiation ionises the air particles inside the smoke detector.
- This allows a small electric current to flow.
- If there is a fire, smoke particles going into the detector are hit by alpha radiation, reducing the ionisation of the air particles causing the current to drop.
- The drop in current is detected by the smoke detector, setting off the alarm.

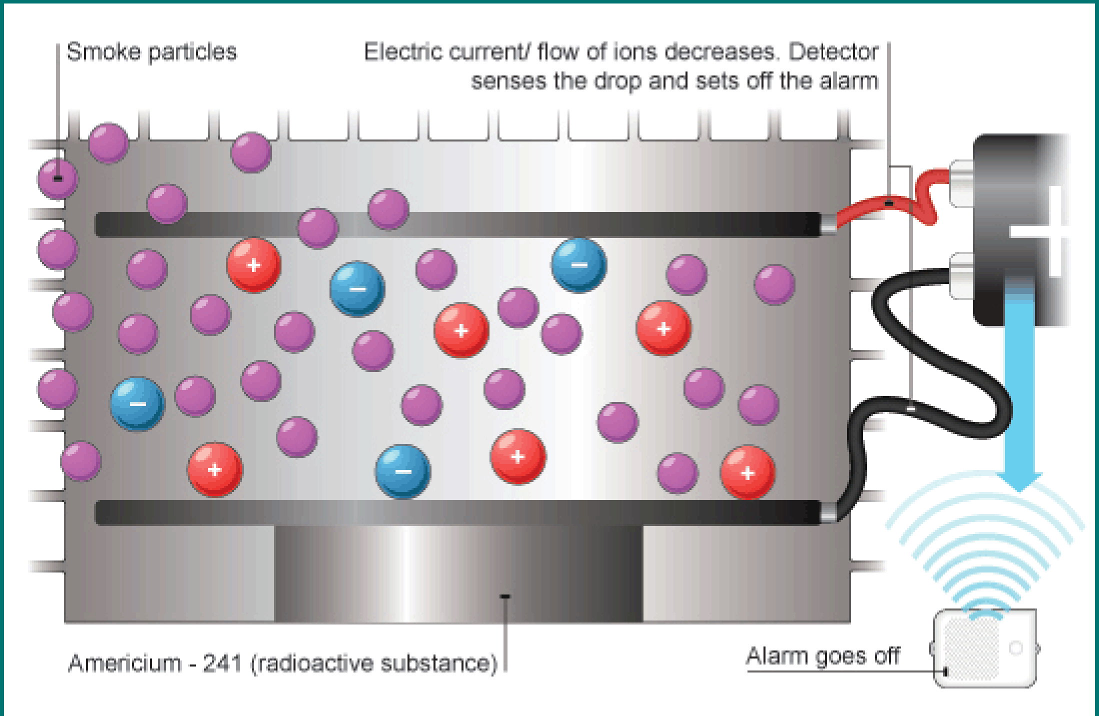
Smoke Detectors

- The alpha particles pass between the two charged metal plates, causing air particles to ionise (split into positive and negative ions).
- The ions are attracted to the oppositely charged metal plates causing a current to flow.



Smoke Detectors

- When smoke enters between the plates, some of the alpha particles are absorbed causing less ionisation to take place. This means a smaller than normal current flows so the alarm sounds.



Tracers in Medicine

- Certain chemicals concentrate in different damaged or diseased parts of the body, and the radiation concentrates with it.
- Radiation detectors placed outside the body detect the radiation emitted and, with the aid of computers, build up an image of the inside of the body.
- When a radioactive chemical is used in this way it is not normally harmful, because:
  - it has a short half-life and so decays before it can do much damage
  - it is not poisonous

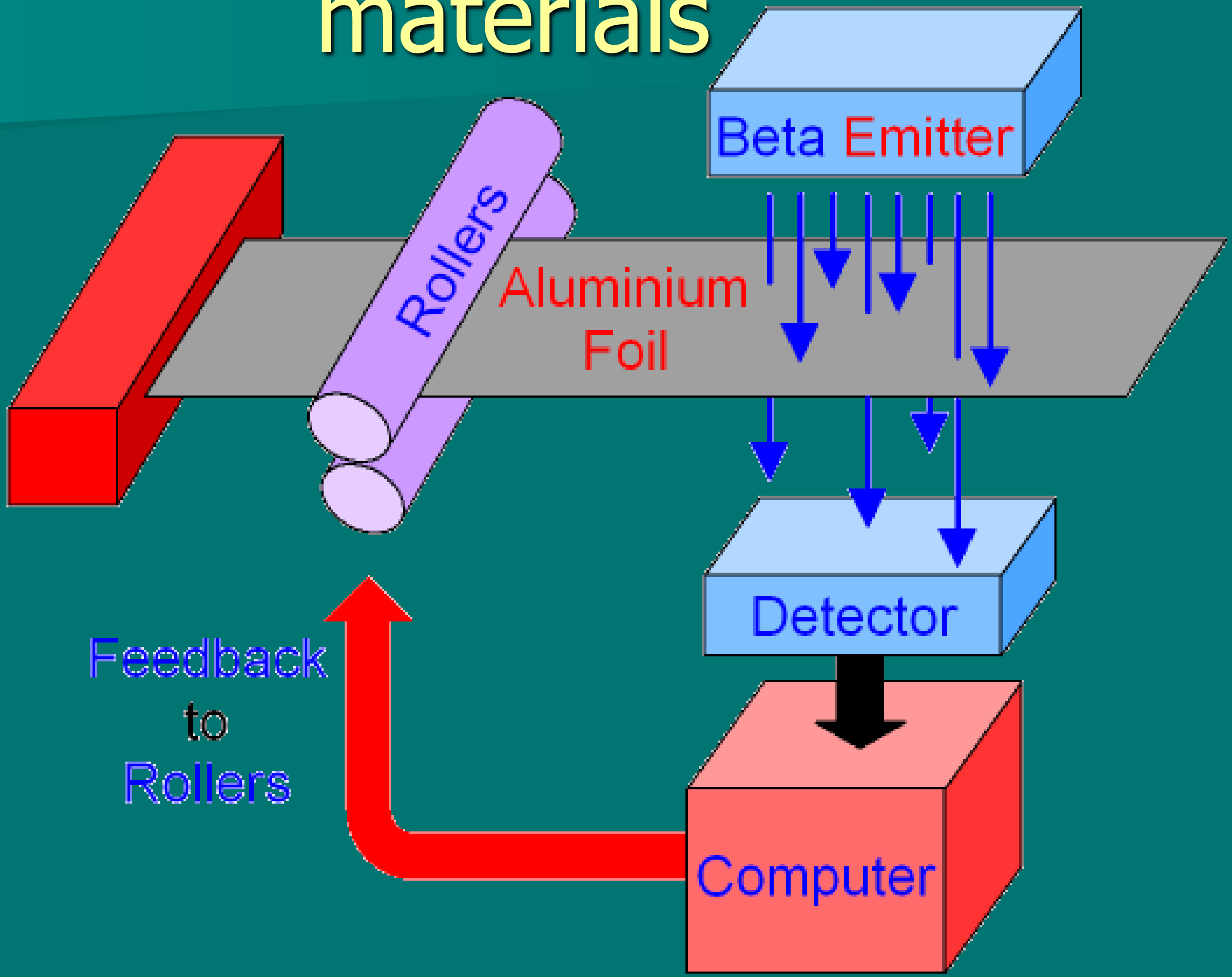
Tracers in Industry

- Find leaks or blockages in underground pipes
- Find the route of underground pipes
- Track the dispersal of waste

Monitoring thickness of materials

- Radiation is used in industry in detectors that monitor and control the thickness of materials such as paper, plastic and aluminium.
- The thicker the material, the more radiation is absorbed and the less radiation reaches the detector.
- It then sends signals to the equipment that adjusts the thickness of the material.

Monitoring thickness of materials



How was radiation discovered?

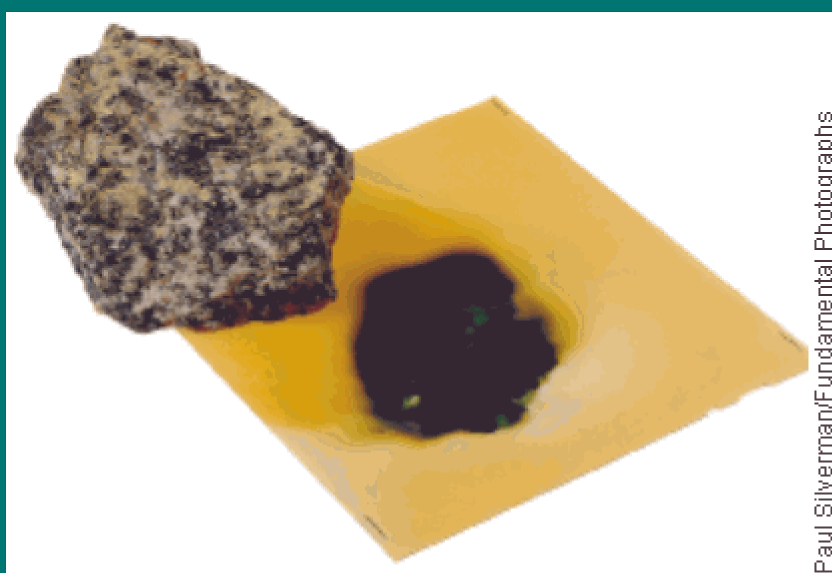
– In 1895, Wilhelm Roentgen discovered an unknown kind of energy was emitted from certain material when bombarded with electrons. These invisible rays could darken photographic film, just like visible light could. He named them X-rays. "X" for unknown.

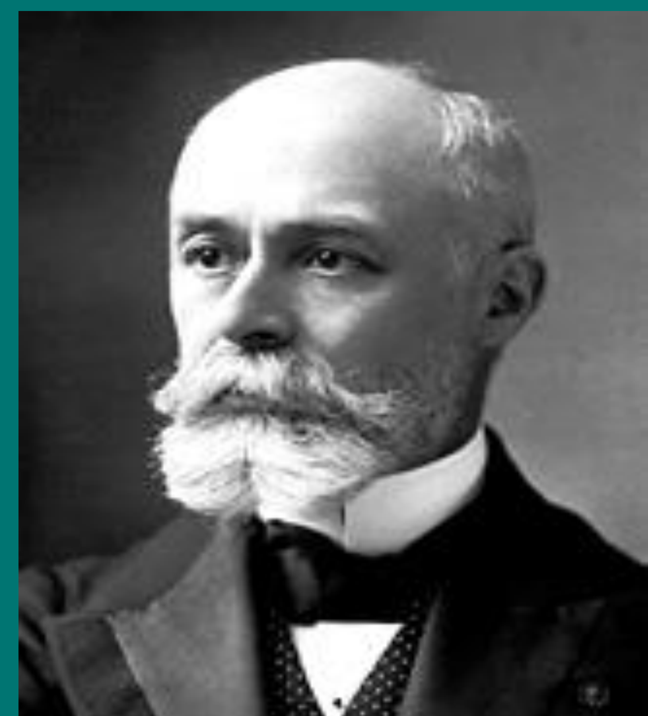
Radiation videos

- Ted Ed: X-rays
- https://www.youtube.com/watch?v=gsV7SJDDCY4

Henri Becquerel

- Roentgen's work led to the discovery of radioactivity by Henri Becquerel. Becquerel discovered that uranium salts emitted rays that darkened photographic plates. He realized the uranium emitted seemingly invisible energy.

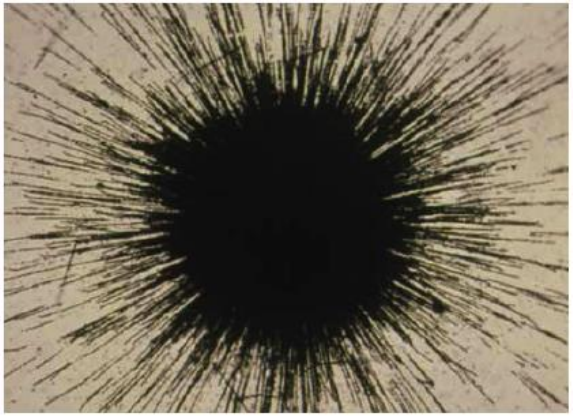




Marie Curie named the energy **radioactivity.** Using Becquerel’s mineral sample, they isolated the components emitting the rays and concluded the darkening of the photographic plates was due to rays emitted from the uranium atoms in the sample.

Though Henri Becquerel discovered radioactivity, it was Marie Curie who coined the term.

Marie Curie also discovered polonium and radium.



Radium salts, after being placed on a photographic plate, leave behind the dark traces of radiation.

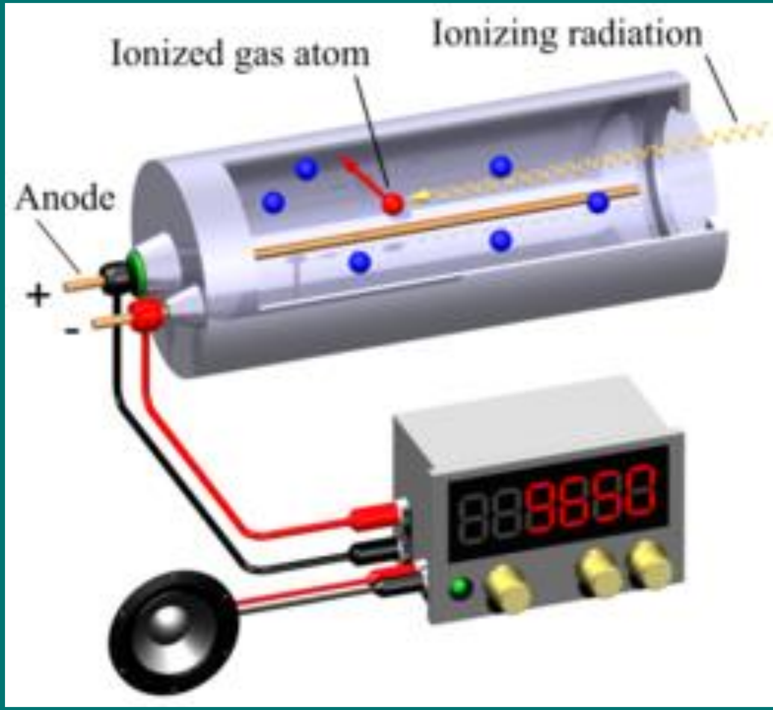
Marie Curie

- Discoveries and contributions to the field of radioactivity
- https://www.youtube.com/watch?v=ZEV4KJBJvEg

- Crash Course:
- https://www.youtube.com/watch?v=r4jCTiGSuwU

Detecting Radiation

- Early discoveries of radiation relied on photographic equipment
- Later, more sophisticated devices such as the Geiger-Müller counter were developed to more precisely measure ionizing radioactivity.

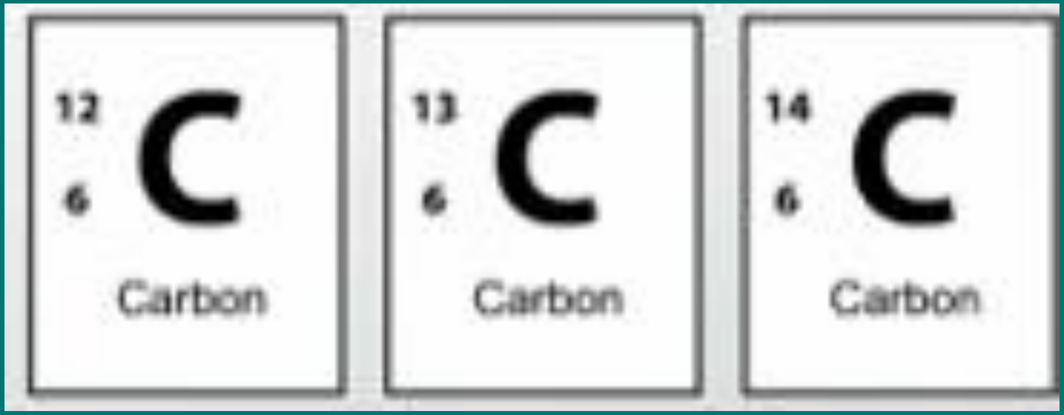


Check your understanding

1. In your own words, define radiation.
2. Where can we find radioactivity
3. Is all radiation harmful? Explain.
4. List the role of each scientist that lead to the discovery of radioactivity:
   - Wilhelm Roentgen
   - Enri Becquerel
   - Marie Curie

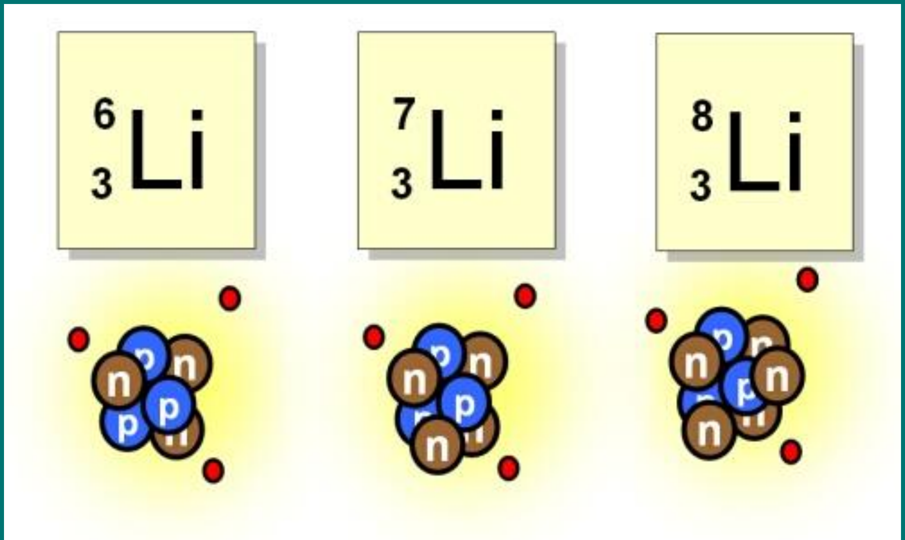
What is an Isotope?

- Isotopes are different atoms of the same element, with a different number of neutrons in the nucleus.



Isotopes

- What changes? **Atomic mass** (because number of neutrons change)
- What stays the same?
  - **atomic number** (number of protons)
  - element symbol

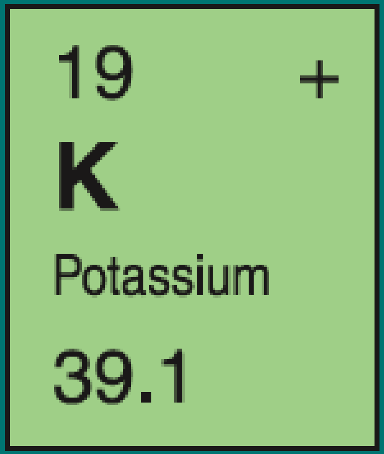


Atomic Mass (the decimal #'s)

- Atomic mass = average of the mass numbers for all isotopes of an element.
  - If 19.9% of boron atoms have 5 neutrons, 80.1% have 6 neutrons
  - 19.9% have a mass number of 10, and 80.1% have a mass number of 11
  - (.199 * 10) + (.801*11) = 10.8
  - atomic mass of boron = 10.8

5
B
Boron
10.8

- Potassium is found in nature in a certain ratio of isotopes
    - 93.2% is potassium-39
    - 1.0% is potassium-40
    - 6.7% is potassium-41

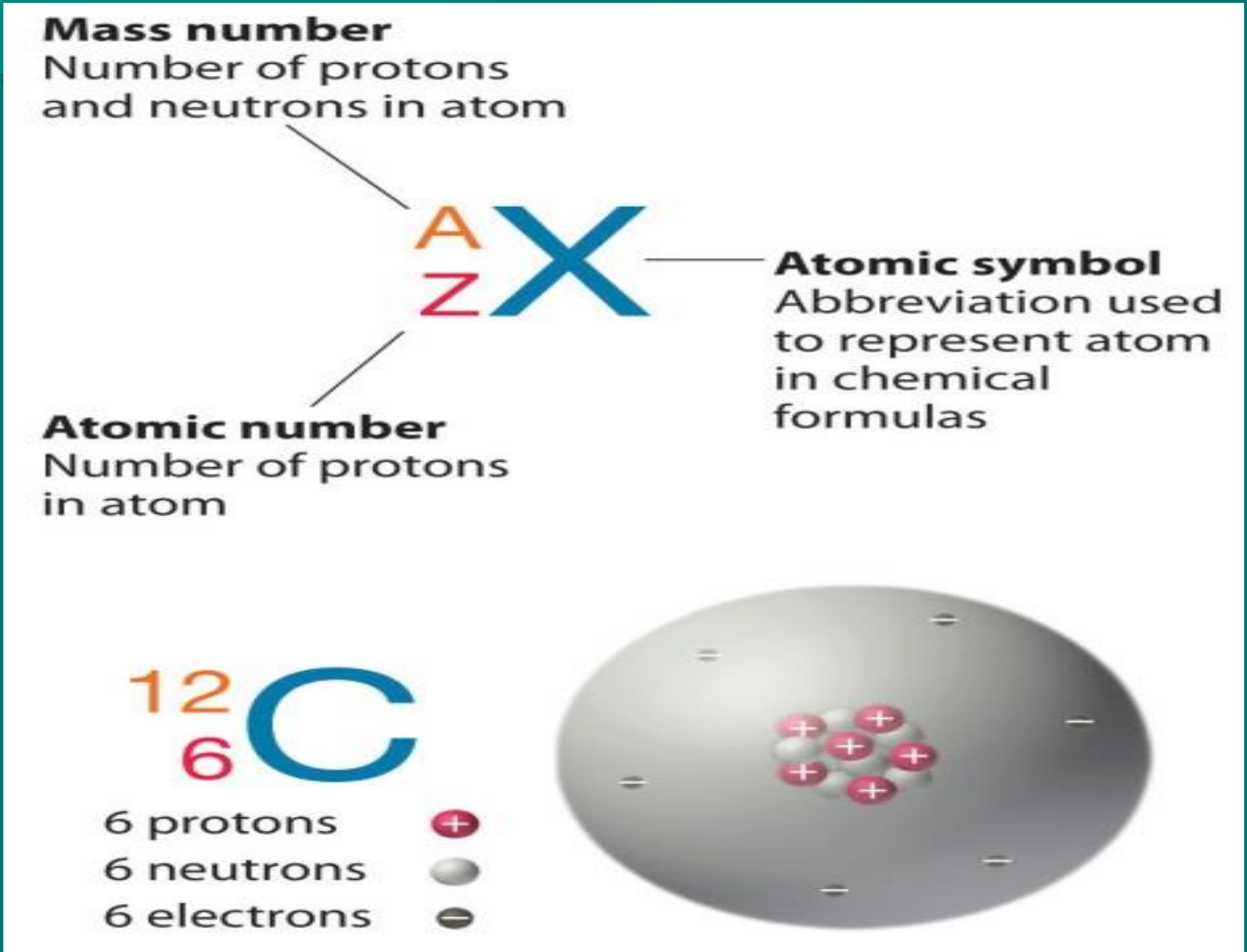


  – Atomic mass

$= (.932 \times 39) + (.001 \times 40) + (.067 \times 41)$

$= 39.1$

Representing Isotopes



Representing Isotopes

- Isotopes are written using **standard atomic notation**.
  - Chemical symbol + atomic number + mass number.
  - Potassium has three isotopes,

Write the standard atomic symbol for the following:

- Potassium-39
- Potassium-40
- Potassium-41

Write the standard atomic symbol for the following:

- Potassium-39
- Potassium-40
- Potassium-41

$$^{39}_{19}K,\ ^{40}_{19}K,\ ^{41}_{19}K$$

Representing Isotopes

– Potassium has three isotopes,

Table 7.1 Isotopes of Potassium

	Potassium-39	Potassium-40	Potassium-41
Protons (nucleus)	19	19	19
Neutrons (nucleus)	20	21	22
Electrons (in shells)	19	19	19

Practice

- In class: Practice Problems p291
- In class: Activity 7-1B page 292
- HW: Read pages 286-290
- HW: Answer Reading Check p291