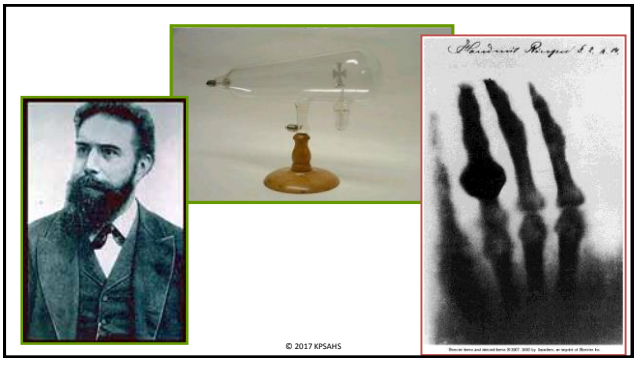
Fluoroscopy for Physician Assistants

Introduction to X-rays and Radiation

1A: Discovery of X-rays, Types of Radiation, and the X-ray Tube

The Discovery of X-rays

- Wilhelm Conrad Roentgen
- November 8, 1895
- Experimenting with a Crookes tube and noticed a plate coated with barium platinocyanide started to glow at a distance of several feet
- Created an image of his wife's hand on December 22, 1895



The Discovery of X-rays (cont)

- Roentgen was awarded the first Nobel Prize in Physics in 1901 for his discovery
- Never patented his discovery
- Died in 1923 of colon cancer

Early fluoroscopy unit

Using calcium tungstate instead of barium platinocyanide, fluoroscopy could be used even in a lighted room.

Over time, many experienced terrible radiation burns that resulted in amputations. In February of 1896, the dean of the medical school at Vanderbilt University sat for an experimental radiograph of the skull. Three weeks later his hair fell out.

https://coursewareobjects.elsevier.com/objects/elr/Bushong/radiologic10e/IC/jpg/Chapter05/005001b.jpg

Radiation

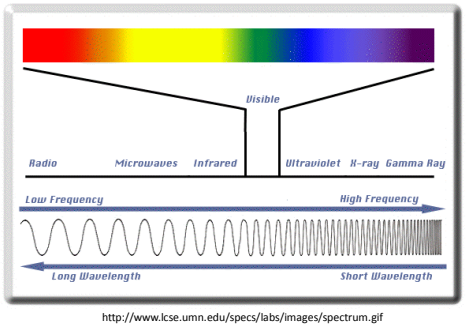
- Radiation is energy in transition (radiant energy)
- It can take the form of mass, kinetic energy through motion, light, or heat
- It exists in the form of background radiation (terrestrial, cosmic)
- It can be produced

Radiation (cont)

- Non-ionizing radiation
  - Low energy ultraviolet radiation
  - Visible light
  - Infrared rays
  - Microwaves
  - Radio waves

Radiation (cont)

- Ionizing radiation
  - High energy ultraviolet light (> 10 eV)
  - X-rays
  - Gamma rays
  - Dose



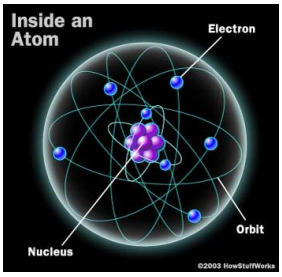
http://www.lcse.umn.edu/specs/labs/images/spectrum.gif

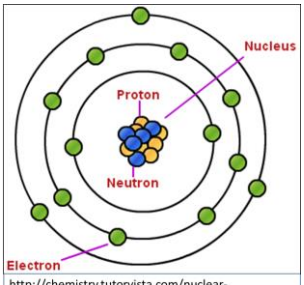
Common Diagnostic Radiations

- Particulate radiation
  - Alpha
  - Beta
- Electromagnetic Radiation
  - Gamma rays
  - X-Rays

X-Rays

- Originate in the electron cloud
  - No net charge
  - Weakly ionizing
  - Strong penetration
  - No mass
  - Travel in straight lines (unless scattered)
- When x-rays are produced, they are really radiant energy packets we call photons

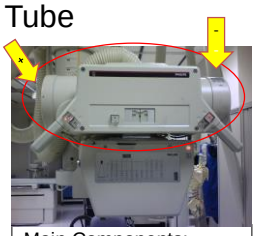




http://chemistry.tutorvista.com/nuclear-chemistry/protons-and-neutrons.html

The X-Ray Tube

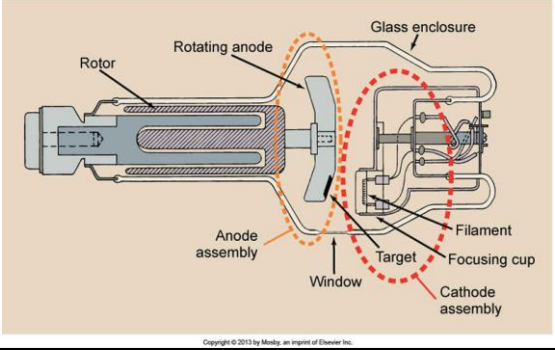
- Most x-ray tubes are electronic vacuum tubes with the components contained in glass or metal enclosures
- At each end of the tube are electrical cables



- Main Components:
  - Cathode: negative
  - Anode: positive

The X-Ray Tube (cont)

- The cathode (negative side) has a filament and a focusing cup
- Electrical current is applied to the filament
- The anode (positive side) acts as an electrical conductor
- Its positive charge helps draw the electron beam
  - Composed of tungsten

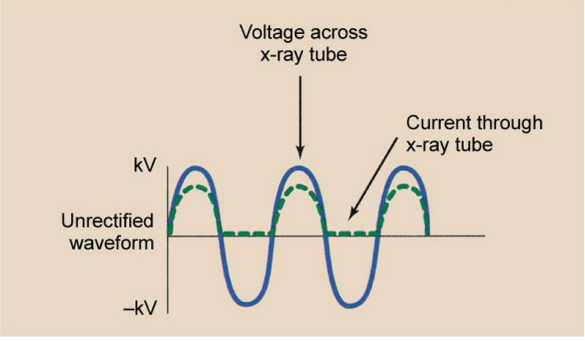


The X-ray Generator

- Most x-ray imaging systems operate on 220 V power
- X-ray circuits have a high-voltage side and a low-voltage side
- High-voltage side “steps up” voltage into kilovoltage
- Low-voltage side “steps down” current from amperes to milliamperes

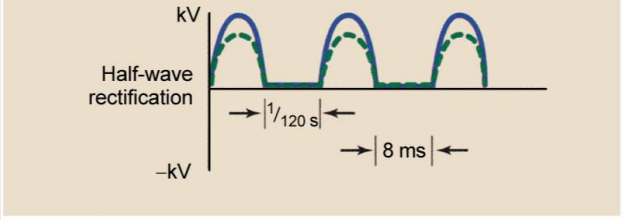
The X-ray Generator (cont)

- Electricity is in the form of AC (alternating current) and has an AC wave form
- Electrons move in one direction while current flows in the opposite direction – the flow switches roughly 120 times per second (AC current in the US is 60 Hz)
- Each cycle has a positive and negative half
- Current passing through the x-ray tube exists only during the positive half



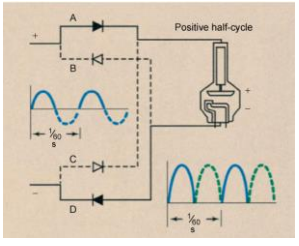
The X-ray Generator (cont)

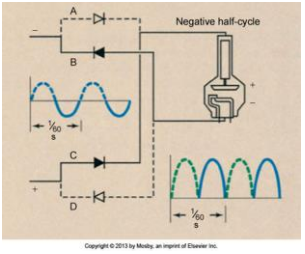
- In order to make x-ray production more efficient, the current must be rectified
- Rectification means we are doing something to the negative half of the cycle
- In order to not damage the x-ray tube, we “cancel” out the negative half through a process called “half-wave rectification



The X-ray Generator (cont)

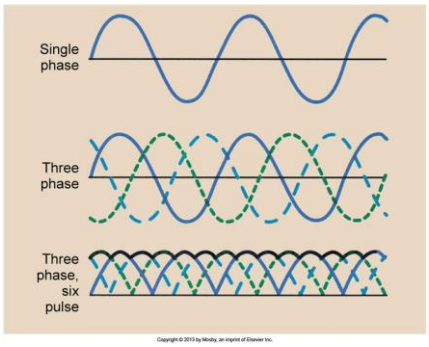
- We can also turn the negative into a positive through a process called “full-wave rectification”
- By using full wave rectification we can use all of the supplied power
- Voltage is always positive
- The problem with both half-wave and full-wave rectification is that x-rays produced when the wave form is close to zero are of lower energy





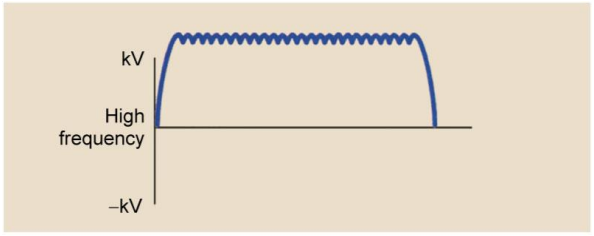
The X-ray Generator (cont)

- Instead of having just a single phase of AC, we can generate a total of three waveforms that are out of step with each other
- This results in three-phase electric power
- The power is also rectified and we end up with more efficient x-ray production



The X-ray Generator (cont)

- Most modern x-ray equipment will have either three-phase or high-frequency circuits
- Full-wave-rectified power (60 Hz) is converted to a higher frequency (500 to 25,000 Hz) then transferred to high voltage
- The benefit is near-constant tube potential, making x-ray production more efficient



The state will ask a question pertaining to high frequency generation and its impact on patient dose.