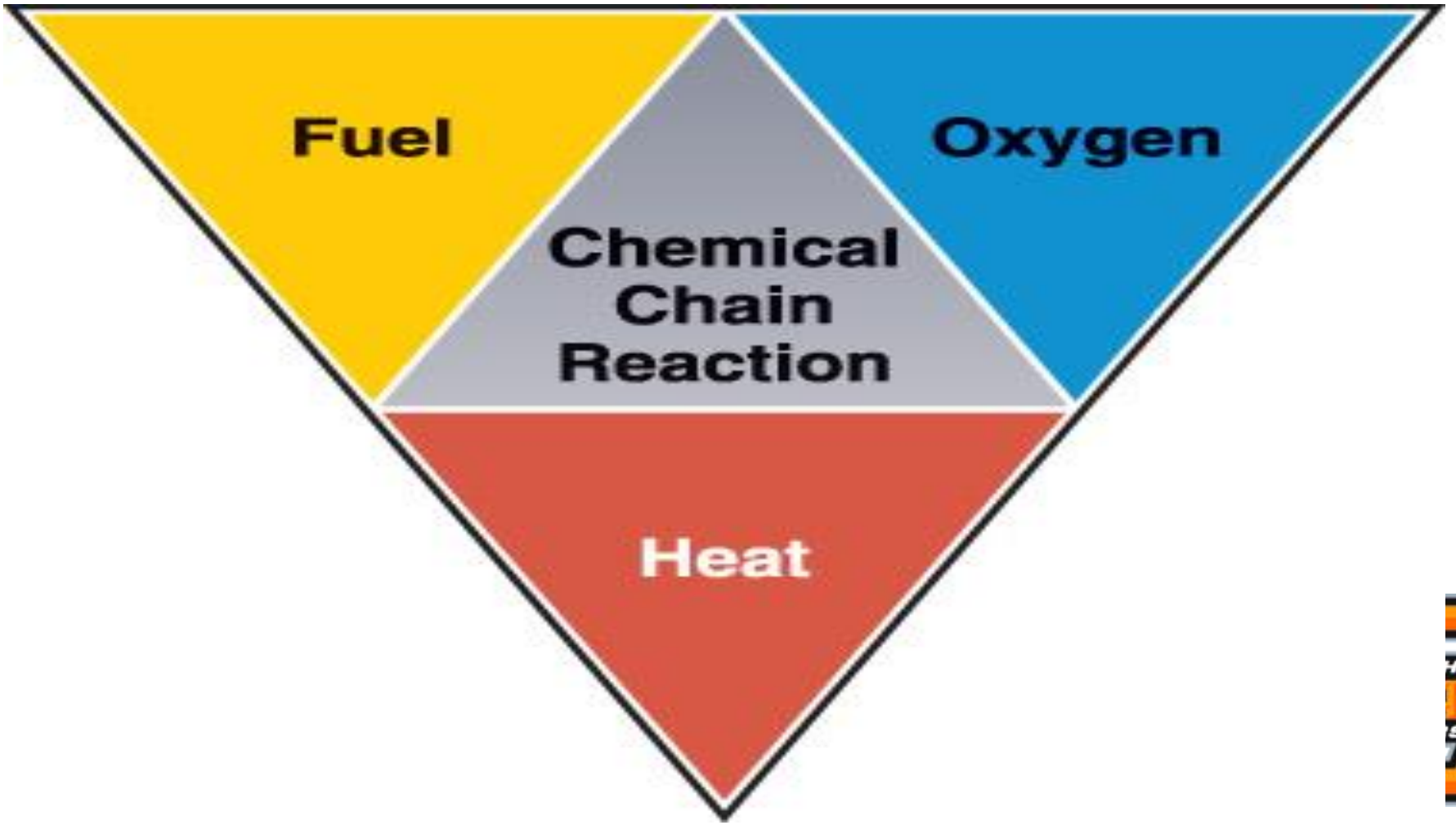
Fire Behavior

- Describe the hazards created by fire
- Identify the different products of combustion
- Identify the different fire signatures that detectors use

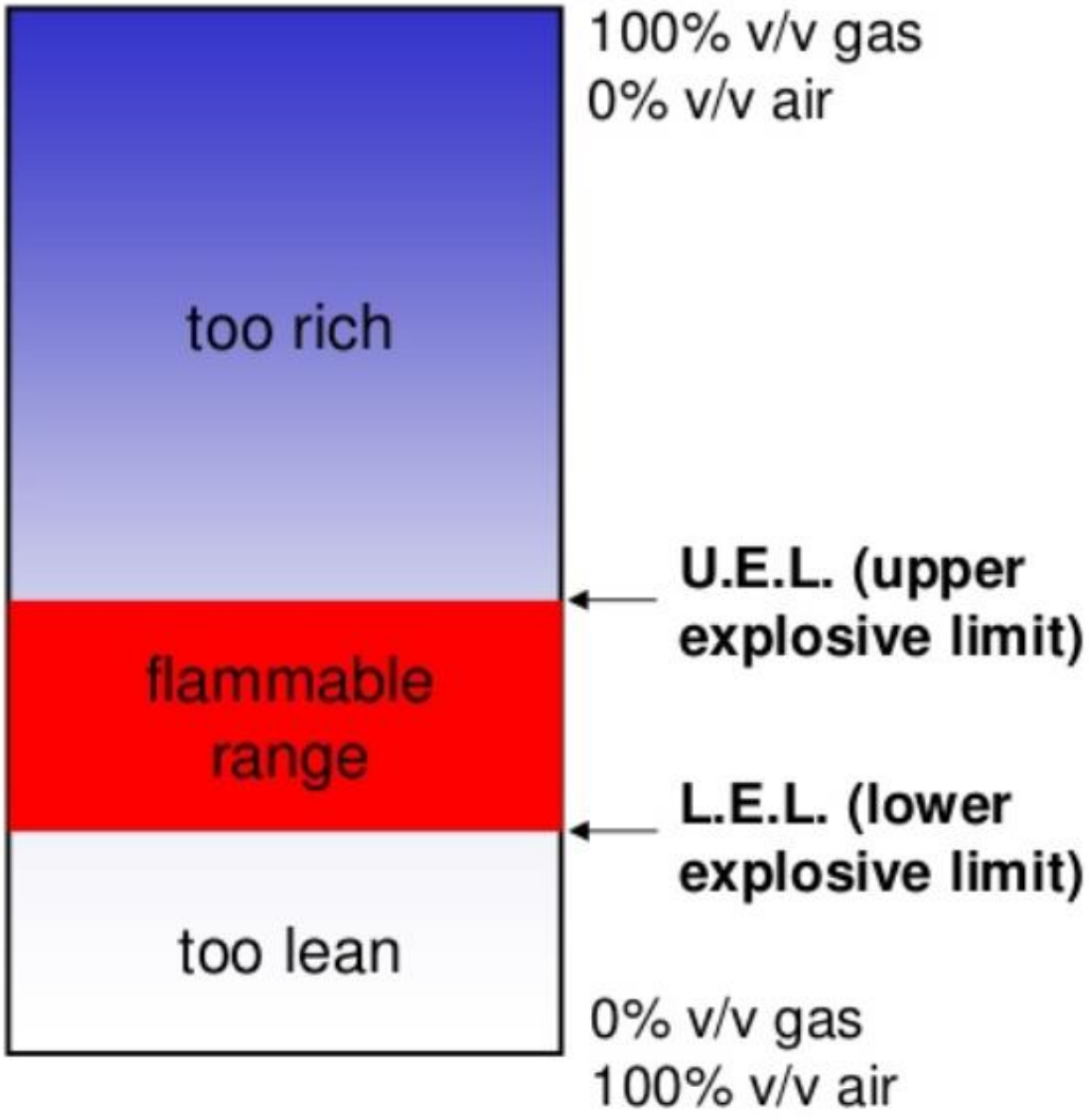
Which burns faster?

How do you know?

Fire Tetrahedron



Flammability limits



Chemistry

- Fuel + Air -> CO_2 + H_2O + N_2
- Multi-step process
  - Incomplete combustion

Fuel

- Gas phase
  - Pyrolysis
  - Vaporization

Why are the matches on the bottom not on fire?

Heat Transfer

Types of Fire

- Smoldering
- Flaming
- Transitions
- Differences
  - Heat
  - Incomplete combustion

Fire Detection

- Early detection leads to greater chance of survival and less property loss
  - Heavily dependent on the fuel burning and the rate that it burns
- Fire Signature – the results of fire that changes the ambient condition
  - Aerosols
  - Energy release
  - Gases
  - Others

Smoke

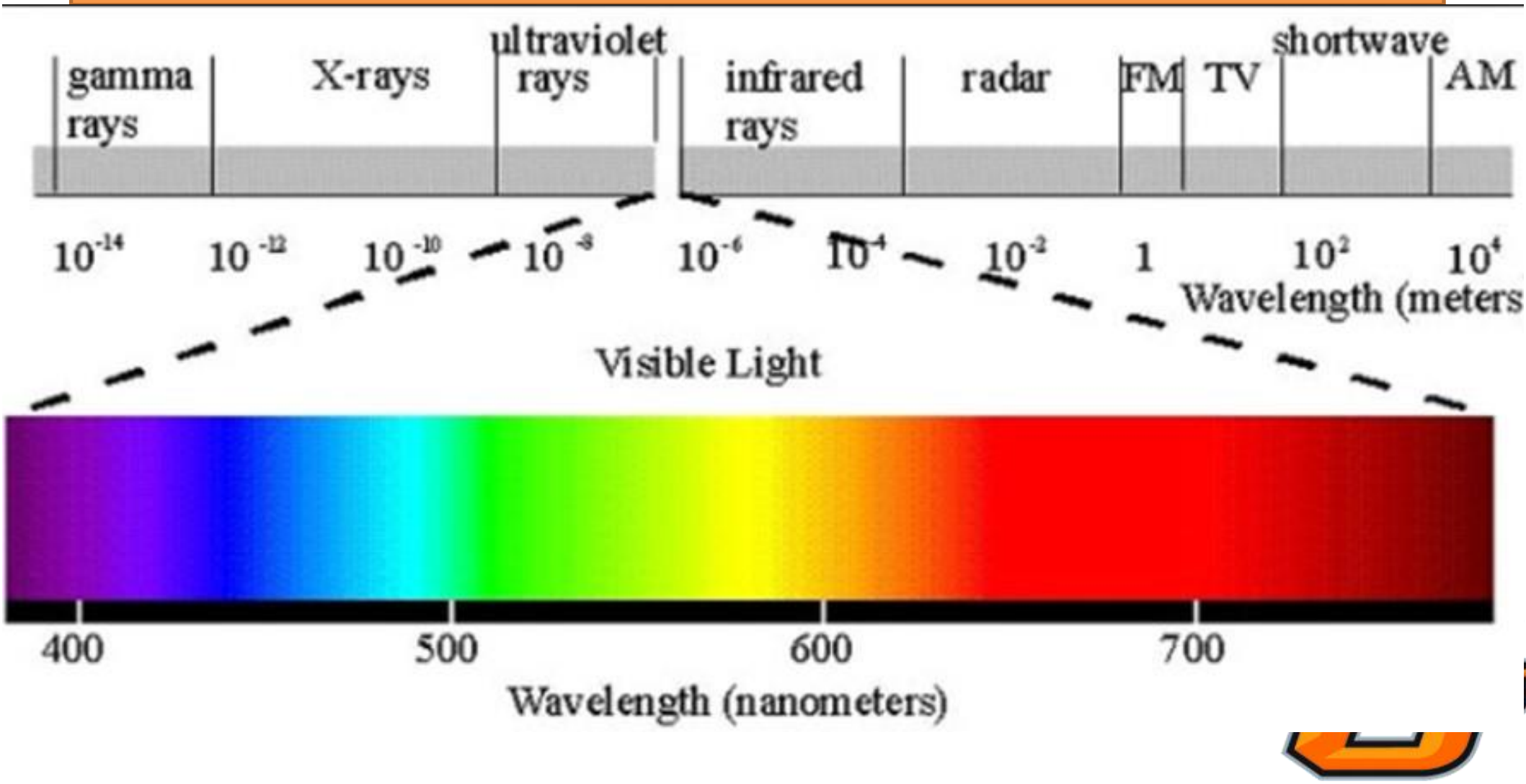
- Primarily entrained air
- Complete combustion
  - CO_2
  - H_2O
- Incomplete combustion
  - Solid soot
  - Most fatalities from CO
  - HCN more hazardous
- Low oxygen

Aerosol Signatures

- Invisible
  - Early stages
  - Detection
    - VESDA
      - Very early smoke detection apparatus – incipient stage
- Larger
  - Detection
    - Light-scattering
    - Photoelectric
    - Ionization

Energy Release Signatures

- Radiation
  - Earliest detectable energy
  - Detector must have line of sight
  - Detection
    - Ultraviolet
    - Visible
    - Infrared


gamma rays
X-rays
ultraviolet rays
infrared rays
radar
FM
TV
shortwave
AM
10^{-14}
10^{-12}
10^{-10}
10^{-8}
10^{-6}
10^{-4}
10^{-2}
1
10^{2}
10^{4}
Wavelength (meters
Visible Light
400
500
600
700
Wavelength (nanometers)

Energy Release Signatures

- Convective
  - Typically ceiling mounted
    - Depends on ceiling height
      - It is possible for them to hang too low and be below rollover space
  - Fixed temperature
    - Thermal lag
      - Time it takes the detector to reach the temperature of the room
  - Rate of rise

Gas Signatures

- Many gases released during fire
  - CO_2, CO, Cl_2, HCN, NH_3
- Difficulty is knowing the release rate of what gasses in order to detect
- Still researching incorporation into detection devices

Other/Multiple Signatures

- Research on unique fire sounds and their detectability
- Concept of the “artificial nose”
  - Developing an electronic nose to mimic the human nose
    - Detect fire and tell what type of fire
- Technologies continue to grow in sophistication