Microwave Ovens

Question:
If you put a CD in a microwave oven, it will
1. do nothing.
2. burn up the microwave oven.
3. burn up the CD.

Observations About Microwaves
- Microwave ovens cook food from inside out
- They can cook foods unevenly
- They don’t defrost foods well
- You shouldn’t put metal inside them?!
- Do they make food radioactive or toxic?

Electromagnetic Spectrum
- Long-wavelength EM waves: Radio & Microwave
- Medium-wavelength: IR, Visible, UV light
- Short-wavelength: X-rays & Gamma-rays

Water Molecules
- Water molecules are unusually polar
- An electric field orients water molecules
- A fluctuating electric field causes water molecules to fluctuate in orientation

Microwave Heating
- Microwaves have fluctuating electric fields
- Water molecules orient back and forth
- Liquid water heats due to molecular “friction”
- Ice doesn’t heat due to orientational stiffness
- Steam doesn’t heat due to lack of “friction”
- Food’s liquid water content heats the food
Effects of Microwaves

• Non-Conductors: Polarization
  – Mobile, polar molecules orient and heat
  – Immobile, polar molecules do nothing much
  – Non-polar molecules do nothing much
• Conductors: Current flow
  – Good, thick conductors reflect microwaves
  – Poor conductors experience resistive heating
  – Thin conductors experience resistive heating

Interference

• Identical waves that overlap can interfere
• Interference is when the fields add or cancel
  – Adding fields are constructive interference
  – Canceling fields are destructive interference
• Reflects cause interference in a microwave
• Interference causes uneven cooking
• Good microwaves “stir” waves or move food

Generating Microwaves

• Magnetron tube has tank circuits in it
• Streams of electrons amplify tank oscillations
• A loop of wire extracts energy from tanks
• A short ¼-wave antenna emits the microwaves

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