Refraction:
Lens Ray Tracing & how λ and f interact

Traditional: 13-03

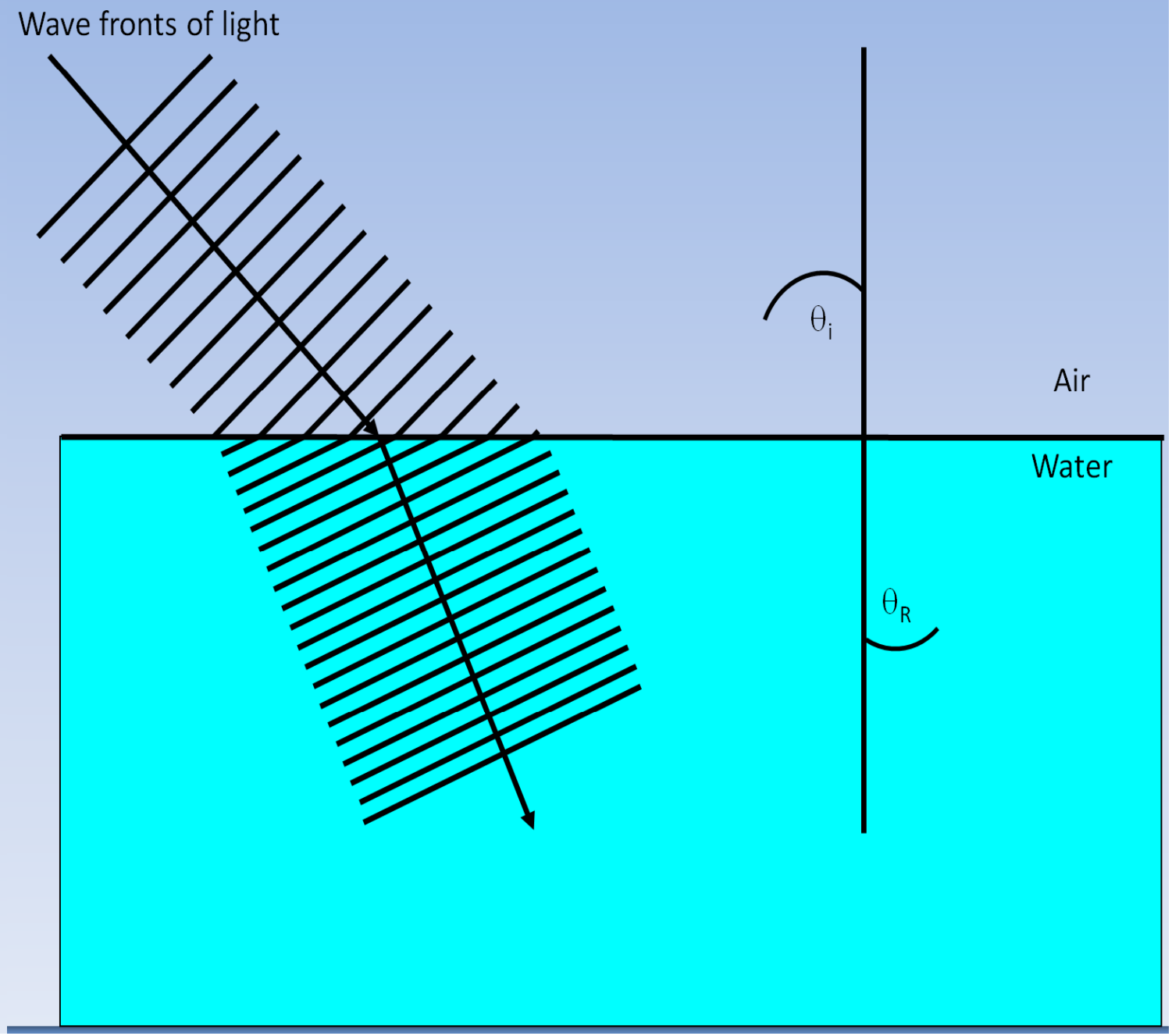
Themed: 04-03

How refraction affects wavelength & frequency

- Imagine you're an atom flinging 1 photon each second. What's your frequency?
- Imagine you fling them in air: 3 m/s, they'd be space 3 m apart, right?
- Then they reach water, where they slow down to 2 m/s, how far would they be spaced apart?
- Does slowing down the medium affect frequency (does it somehow make you fling less often)?
- Does it affect wavelength (distance between crests…or photons in this example)?

How refraction affects wavelength & frequency

- Notice: frequency of light doesn't change, but wavelength does
- Crests "pile up" when they slow down…they have to!
- Big incident angle, small refracted angle (rel. to NORMAL!)



How light bends in a lens - Ray tracing!

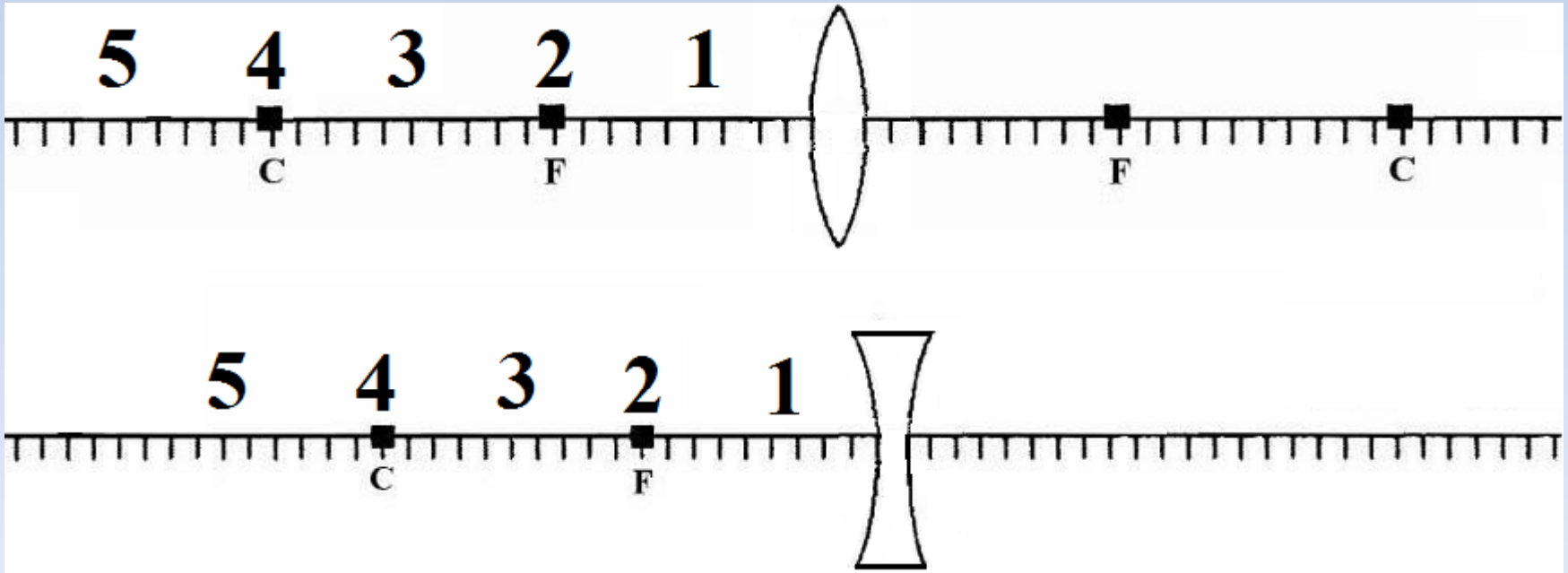
- Main difference between lenses and mirrors:
  - ❑Light **passes through** lenses to the other side!
  - ❑Lenses for images too for same reason (light re-converges or seems to re-converge at a single point)
- Try the simplified model of concave lens and the simplified model of convex lens in packet
  - Which lens type has rays converge?
  - Which lens type has rays diverge?
  - Which lens seems likely to make a real image? Virtual?

How light bends in a lens - Ray tracing!

- Still have three principal rays
  - Focal ray: lens refracts to horizontal
  - Horizontal ray: lens refracts to focal point
  - Center ray: IMPORTANT…**through center of lens**, not twice the focal length any more
- Find easiest two & ALL light will converge or diverge on/from this point
- Think about how light will bend and go through correct focal point
- You are now looking into lens, the same as you looked into mirror
- Which kind of lens can project an image, like upside down tennis players playing?
- Show website examples: Which would be a magnifying glass?

Cheat Sheet

- You get a 3” x 5” cheat sheet on this test
- Make it soon, get used to it (part of cheat sheet)
- Use simulation to make results table:
  - 5 locations x 3 properties
  - For both lenses (convex, concave)
  - Here are the five regions…can you do it yet? More help?



More Table Hints?

- OK, I'll give you some more hints, but I won't do it all for you!
- First though, know flat mirrors too (up, same size, virtual)
- **Meaning of regions**: 1: Object relatively close to mirror surface; 2: Object on focal pt. 3: Object between focal and center; 4: Object on center; 5: Object beyond center
- Possible Table Format (5 regions x 3 properties)
- Go to simulation and start discovering!

Region	Up/Inverted?	Enlarged/Reduced?	Real/Virtual
1)Close			
2)Focal			
3)Focal-center			
4)Center			
5)Beyond center (far)			

Uses for lenses

- Science (microscopes, telescopes)
- Binoculars, cameras, magnifying glass, etc.
- Vision correction (contact lenses, glasses)
  - We'll learn how this works!
- Exist in nature (you have one in each eye)
- Start fires (convex "converging" lens)