REFLECTION, REFRACTION, AND DIFFRACTION (31)

I Main Topics

A Huygens' Principle

B Reflection

C Interference

D Refraction

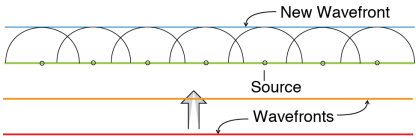
E Diffraction

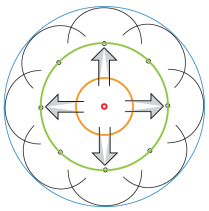
II Huygen's Principle

A Every point on a wave front is a source of spherical secondary wavelets

B The new wave front is tangent to the secondary wavelet fronts

C The points on a wavelet front are in phase



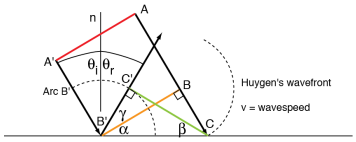


III Reflection

A Reflection: "to ~~bend~~ (bounce) back"

B Angle of incidence = angle of reflection

C Waves reflect better off vertical walls than gently sloped beaches



Consider wavefront AA' that advances to BB' and then to CC'
Ray A'B' ⊥ to wavefront B'B because wavefronts are normal to rays
Ray B'C' ⊥ to wavefront C'C because wavefronts are normal to rays
(Ray B'C' ⊥ to wavefront C'C because CC' is tangent to Arc B')

BC =B'C' = $v\Delta t$; B'C = CB'; and both ΔB'BC and ΔCC'B' are right triangles, so

ΔBB'C ~ ΔC'CB'. So angle BB'C (i.e., α) = angle C'CB' (i.e., β).

Now A'B' ⊥ B'B, and nB' ⊥ B'C, so $\theta_i = \alpha$.

Also, $\alpha+\beta+\gamma = 90^o$, and $\alpha+\gamma+\theta_r = 90^o$, so $\theta_r = \beta$.

Whereas $\alpha = \beta$, $\theta_i = \theta_r$.

The angle of incidence = the angle of reflection.

III Reflection

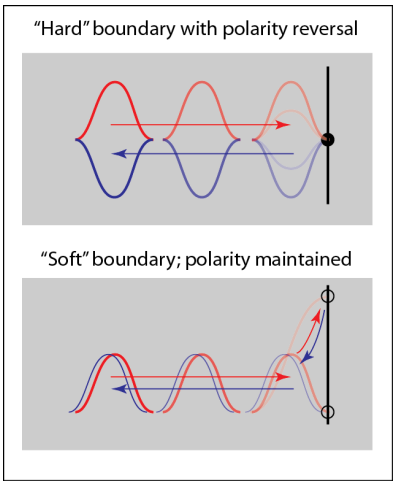
https://www.youtube.com/watch?v=PevRZAxDxZw

III Reflection

D Polarity of reflected waves can change depending on conditions at the reflector

1 Polarity reverses at a "hard" boundary

2 Polarity is maintained at a "soft" boundary



III Reflection

https://www.youtube.com/watch?v=0mZk2vW5rWU

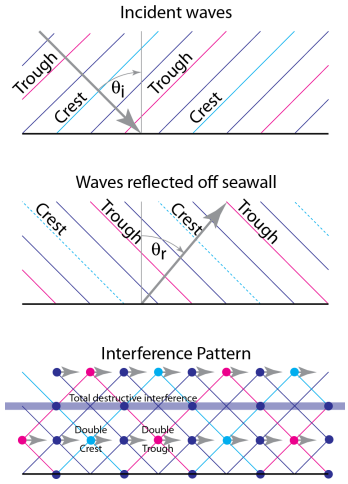
IV Interference

A Based on superposition

B The total amplitude of two waves at a point is the sum of the amplitudes of the individual waves

C Constructive interference where total amplitude increases

D Total destructive interference where total amplitude goes to zero



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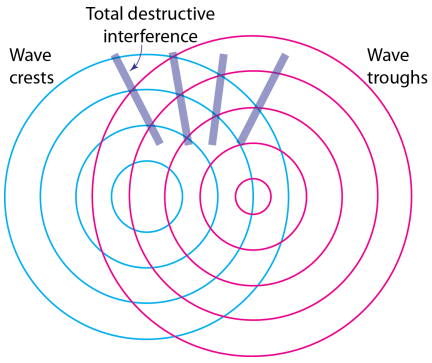
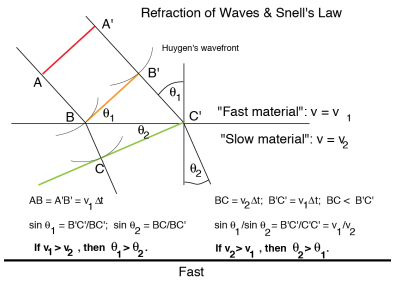


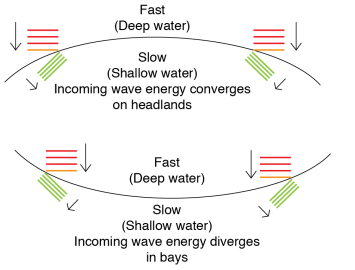
IV Interference

https://www.youtube.com/watch?v=5PmnaPvAvQY

V Refraction

- A Refraction: bending of a wave front
- B Snell's Law
- C Effect of water depth on wave speed
- D Wave fronts traveling into the slower region bend toward the normal of the fast-slow interface
- E Effects of refraction
  1. Waves become parallel to coast
  2. Waves concentrate on headlands
  3. Waves diverge in bays

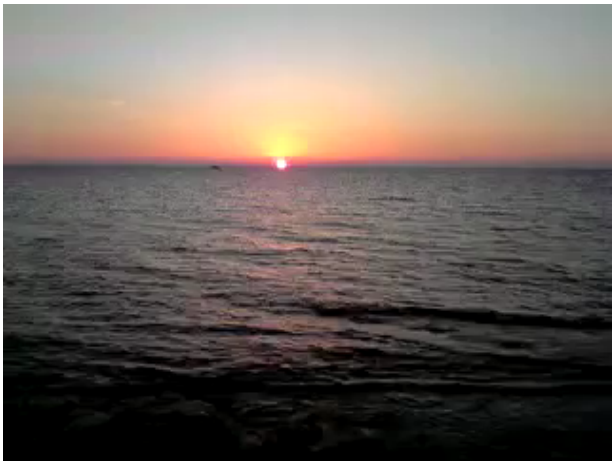




V Refraction: bending of a wavefront (Fraser River, Canada)

https://www.youtube.com/watch?v=bt08ZMj37rw

V Refraction (Benghazi, Libya)



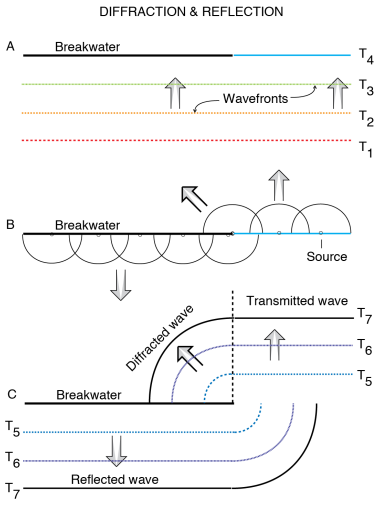
https://www.youtube.com/watch?v=wPzvWKU0-c8

VI Diffraction

A Diffraction: deflection of waves around obstacles with edges

B Manifestation of Huygens' principal

C Effects of diffraction seen at breakwaters



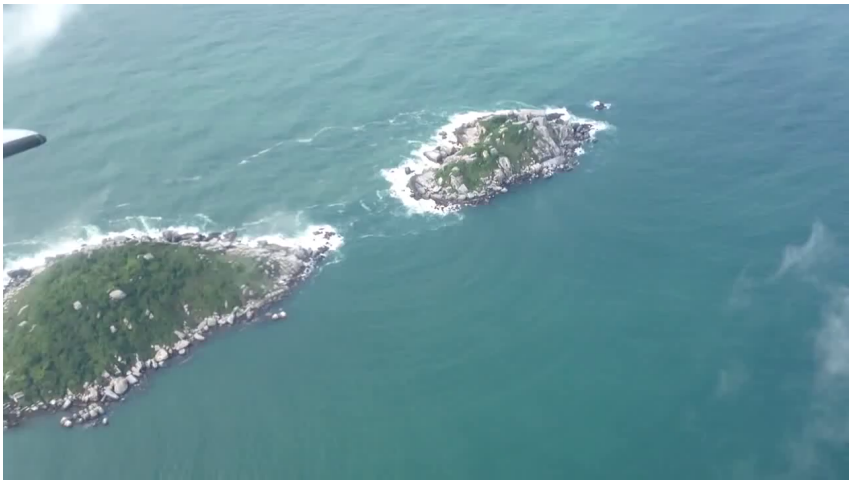
VI Diffraction (Waikiki, Hawaii)

https://www.youtube.com/watch?v=IZgYswtwlT8

VI Diffraction
(Buzzard's Bay, Massachusetts)

https://www.youtube.com/watch?v=7UhpWR0_rrE

VI Diffraction
(Joinville, Santa Catarina, Brazil)



https://www.youtube.com/watch?v=dQgknHOyatk

References

Halliday, R., and Resnick, R., 1986, Fundamentals of physics: John Wiley & Sons, New York, 880 p.

Huygens' principle

- https://www.youtube.com/watch?v=vqa4L0DuWbM