

The Sea and Surfing

Question:

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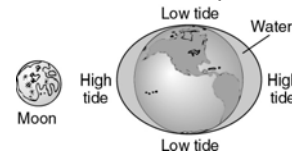
- drift shoreward at the speed of the waves
- drift gradually but steadily shoreward
- move in a circle as each wave passes, but make little or no progress toward shore

Observations About The Sea and Surfing

- The sea is rarely calm—it has ripples on it
- The broadest ripples (waves) travel fastest
- Waves seem to get steeper near shore
- Waves break or crumble near shore
- Waves bend after passing over sandbars
- You can sometimes ride waves

The Tides, Part 1

- The moon's gravity acts on the earth
- The moon's gravity isn't uniform
- The earth's oceans are pulled out of round

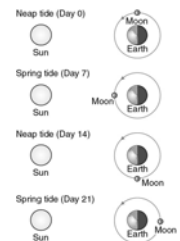


The Tides, Part 2

- There are two tidal bulges in the oceans
- As the earth rotates, these bulges moves
- Almost 2 high and 2 low tides per day
- Strongest tides are near equator
- Weakest tides are near poles

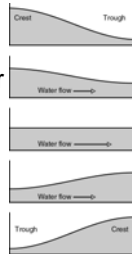
The Sun's Influence

- Sun's gravity affects tides
- Strongest tides are when moon and sun are aligned
- Weakest tides are when moon and sun are at right angles



Tidal Resonance

- Water in a confined channel can slosh back and forth
- It's another harmonic oscillator
- Period depends on inertia and stiffness of the restoring force
- If the sloshing time matches the tidal period, resonance occurs

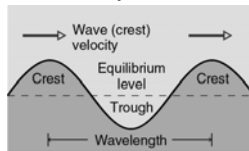


Standing and Traveling Waves

- Sloshing involves standing waves
 - Water exhibits fixed nodes and antinodes
- Open water surf involves traveling waves
 - Wave crests and troughs shift continuously

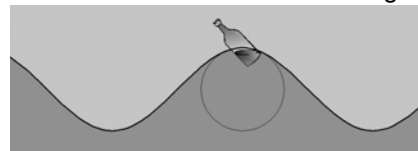
Water Waves

- Sloshing involves deep water waves: the whole liquid moves back and forth
- Surface waves only affect the liquid's top



Water's Motion

- Surface water circles as the wave passes
- Circling is strongest at surface
- Motion is weak about 1/2 wavelength deep



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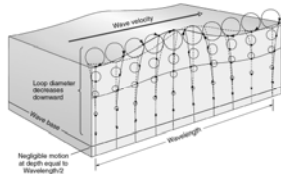
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Wavelength

- Longer the wavelength of surface wave,
 - faster it travels
 - deeper water moves as it passes
 - more energy it contains for a given amplitude
- Tsunamis are very long wavelength, very deep, very high energy waves (and not strictly surface waves, either)

Water in a Wave

- Only the wave travels, the water circles
- Crests are formed from local water



Breaking Waves

- Surface waves slow down in shallow water
- Waves bunch as the water gets shallower
- Waves get taller as water gets shallower
- Waves break when water can't form crest
 - Gradually sloping bottom: rolling surf
 - Steeply sloping bottom: plunging breakers

Surfing

- Waves act as moving ramps
- Forces on a surfer:
 - Ramp force (Downhill) formed by sum of
 - buoyant force
 - weight
 - lift
 - Drag force (Uphill)
- Net force is zero during steady surfing

Changing Wave Speeds

- Reflection
 - Wave speed change causes partial reflection
 - The bigger the change, the more reflection
- Refraction
 - Wave speed change can redirect wave
 - Waves bend toward shore as they slow

Summary of The Sea and Surfing

- The moon's gravity causes the tides
- The tides can cause resonant motion
- Tidal resonances are standing waves
- The open sea supports traveling waves
- Water moves in circles in those waves
- Waves break when water gets too shallow