Question:

You float motionless in an inner tube, just far enough from the shore that the waves aren’t breaking on top of you. You will

- 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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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