

Study Guide for OCEA 112 Midterm Examination 2

Atmospheric Circulation

- Why does a square meter of ground at the equator receive more solar energy than does a square meter at the north pole? What does this mean in terms of average temperature of land and water at the equator vs the poles? How does this temperature difference cause air to flow from the equator to the poles? What are the significance of the Tropics of Cancer and Capricorn, and the Arctic and Antarctic Circles?
- Describe the Coriolis effect. Explain it in the context of a missile fired from the north pole towards New Orleans. How does the Coriolis effect influence the motion of objects, air, and water moving in the northern hemisphere? In the southern hemisphere? How does the Coriolis effect vary with latitude? Is it strongest at the poles, or at the equator?
- Sketch and name the three circulation cells that move air from the equator to the poles. At what latitudes does air generally rise, and at what latitudes does it sink?
- What causes wind? Sketch the general directions of the trade winds, the prevailing westerlies, and the polar easterlies on both sides of the equator. Explain them in the context of Hadley cells, Ferrel cells, and polar cells.
- Thermodynamics: What happens to the temperature of air as it rises? As it sinks? What about the pressure? What is the effect of water vapor (humidity) in the thermodynamic behavior of air?
- What are conditions like at the equator and at 30°N and S in terms of 1) rainfall, 2) humidity, 3) air pressure 4) wind. Explain these conditions in the context of Hadley cells and thermodynamics. Where are many of the world's deserts located? Why?
- What are the doldrums, the horse latitudes, and the intertropical convergence zone (ITCZ)?
- What is a seabreeze? Explain the summer seabreeze in San Diego.
- Explain the summer and winter monsoons of southern Asia. What are the consequences in terms of agriculture for India and southeast Asia?
- Explain how a hurricane works. What is the source of energy for a hurricane? Which way does the air rotate around the eye 1) at sea level, 2) at 50,000 ft altitude? Why? How and where are hurricanes born? How do they die? What is storm surge? What causes the greatest property damage and loss of life (wind? Rain? Storm surge?)?
- Explain how an extratropical cyclone (a nor'easter) works.
- How does sea ice form? How do icebergs form? What time of year are each formed? What is *shelf ice*?
- What is the greenhouse effect? What are greenhouse gases? Explain the reasoning behind the idea that humans are causing global warming? What possible consequences are there to global warming?

Ocean Circulation

Surface Currents

- What is a surface current? What is the chief source of energy for surface currents?
- How is wind energy transferred into the sea? Which winds drive the equatorial currents?
- What is meant by the Ekman spiral?
- What is meant by cyclonic circulation? What is anti-cyclonic circulation?
- Explain the concept of geostrophic balance. How does geostrophy help currents to flow when the wind isn't blowing? Where are the 5 major oceanic gyres located? Which direction does each one flow, and why?
- What is a western boundary current? What is an eastern boundary current? What are the differences between the two? What is western intensification, and what causes it?
- What is an equatorial counter-current? What causes it?
- What is the Antarctic Circumpolar Current? Why is it different from all other major currents? Why is it sometimes called the West Wind Drift?
- Be able to locate on world map or globe the following currents: North Equatorial Current, South Equatorial Current, Equatorial counter-current, Gulf Stream, Canary Current, California Current, Peru Current, Brazil Current, Benguela Current, Somali Current, Antarctic Circumpolar Current (West Wind Drift).

Upwelling and downwelling

- Describe the mechanism by which a cyclonic (counterclockwise) gyre produces upwelling. How do we get coastal upwelling and equatorial upwelling. What other ways can upwelling occur? What is a cold-core ring? What are some of the consequences of upwelling (for example, what happens to oceanic plants in upwelled water, and how does upwelling explain San Francisco's climate?)
- List and explain mechanisms for downwelling. What are the consequences of downwelling? Explain the Great *Pacific Garbage Patch* in the context of convergence and downwelling. What is a warm-core ring?

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El Niño – Southern Oscillation (ENSO)

Describe the “normal” conditions of the southern equatorial Pacific ocean. Include the upwelling conditions off the Peruvian coast, the state of the trade winds and south equatorial current, sea level on both sides of the Pacific, water temperature, and the atmospheric circulation (specifically, the Walker cell).

Now describe what happens to trigger an El Niño event, and the consequences in terms of upwelling conditions off the Peruvian coast, the state of the trade winds and south equatorial current, sea level on both sides of the Pacific, water temperature, and atmospheric circulation.

What is La Niña? What is meant by Southern Oscillation?

What are some of the consequences to human beings of an El Niño event?

Deep Currents

Where does the energy come from to drive deep currents? Why are deep currents sometimes called *density currents*, and what is meant by *thermohaline circulation*?

How is Antarctic Bottom Water (AABW) generated? What about North Atlantic Bottom Water (NABW), Mediterranean Intermediate Water (MIW), and Antarctic Intermediate Water (AAIW).

What is a TS diagram? How can we use it to visualize density as a function of temperature and salinity? How can we use it to compare (for example) AABW to NABW?

Describe the Conveyer Belt model of ocean circulation. Why is it called that, and what are the consequences in terms of overall mixing of the ocean? Specifically what does the conveyer belt do to get oxygen to deep-water animals.

Waves

What is a wave? What is transmitted in a wave? What is not transmitted?

Be able to define all of the following in the context of waves and indicate them with a sketch: 1) peak, 2) trough, 3) wavelength, 4) wave height, wave period, wave speed.

How are wave speed, wavelength, and period related? Be ready to use the relationship to solve simple problems.

How do particles in a transverse wave move? How do they move in a longitudinal wave? In an orbital wave?

Give an example each of a transverse wave, a longitudinal wave, and an orbital wave.

An orbital wave is sometimes called an *interface* wave. Why is that? What difference is needed in the two media to support an interface wave?

In ocean waves, what is meant by the *still water level*, and the *wave base*? What is the depth of the wave base?

How are deep-water waves defined? What is the relationship between the length of a deep-water wave and the wave speed? Do long waves travel faster or slower than short waves?

How are shallow-water waves defined? What does the orbital motion of a water particle look like in a shallow-water wave? What is the relationship between the speed of a shallow-water wave and the water depth? Does wave length matter?

What is a transitional wave? What affects wave speed in a transitional wave?

How is the steepness of a wave defined? What is the maximum steepness of a water wave? What happens if the wave gets steeper?

Wind waves

What is a capillary wave? What is the restoring force? How are capillary waves different from gravity waves? What is the maximum wavelength of a capillary wave? What role do capillary waves play in transferring energy from wind to waves? Why are larger waves called gravity waves?

What are the two ways to increase wave energy?

What is meant by *sea* in the context of wave generation? What is meant by *chop*?

What 3 things govern how much energy is transferred from wind to waves?

What is meant by “fully developed seas”?

What is meant by *swell*? What happens to waves when they become swell?

What is meant by constructive and destructive interference? What is a rogue wave?

What happens to the length, speed, and height of waves as they approach the shore?

What is surf? Explain how waves turn into surf. What are the three types of breakers, and what causes them?

How does refraction relate to surf? What is meant by the surfing expression “The point draws the waves”?

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Tsunamis, seiches, storm surge, splash waves, and internal waves

What causes a tsunami? What are the typical wave height and wavelength of a tsunami at sea? Is a tsunami a deep-water wave, or a shallow-water wave? How fast does a tsunami move?

What happens to a tsunami when it reaches shallow water? Does it become a breaker?

What is a seiche? How can *you* create a seiche? What is the wavelength of a seiche?

What causes a storm surge? How does it appear out at sea, and how does it appear when it encounters land?

What is a splash wave? What happened in Lituya Bay, Alaska in 1958?

What is an internal wave? Give reasons why internal waves are important.

Tides

Equilibrium Theory

Outline the equilibrium theory of tides, starting with the interaction between Earth and moon. Explain why there are two tidal bulges associated with the moon.

Why is there a new high tide 12 h, 25 min after the previous high tide?

What role does the sun play in the tides? Why are the highest high tides, and the lowest low tides associated with the new and full moon? What happens with a quarter moon? Define spring tide and neap tide.

What effect does the moon's orbital plane relative to the earth have on the tides?

Explain why the tide, according to the equilibrium theory, is a wave with $L = 20,000$ km.

Dynamic Theory

Why is the equilibrium theory insufficient to explain everything about the tides? How fast would the tidal wave have to circle the earth to keep up with the moon?

What is a progressive wave? What is a standing wave? How does the concept of a standing wave play a role in the dynamic theory of tides? What is an amphidromic point?

Describe the motion of the tidal wave in the context of dynamic theory. Which direction does it move? Does San Diego or San Francisco experience high tide first?

Explain the immense tidal range in the Bay of Fundy.

Other tidal topics

What is a diurnal tide? A semidiurnal tide? A mixed tide? Which of these three typifies San Diego's tides?

What is a tidal datum? What is meant by mean lower low water (MLLW)?

What is meant by ebb current, flood current, and slack water in the context of tides in enclosed basins?

What is a tidal bore?