

Last Name _____ First Name _____

Student ID# _____

OCEANOGRAPHY 201

Fall, 2005

Exam #2: Section #1

Answer 1-60 on the computer-scan sheet (1 point each). Use a dark (#2) pencil only, and make marks neatly within the circles. If you change an answer, erase completely. Also, be sure your ID number is coded correctly.

PART 1: True/False (1 point each = 20 points). Mark (a) for "true" and (b) for "false".

1. An informal rule in science is that extraordinary hypotheses require extraordinary evidence.
2. The four inner planets are relatively richer in volatile elements and compounds than are the four outer gas-giant planets.
3. Earth is believed to have originated by accretion from planetesimals.
4. Earth contains elements that were formed in a supernova explosion.
5. The age of the Earth is indistinguishable from that of the Moon and meteorites: about 4.5 billion years.
6. Free oxygen has always been an important component of the Earth's atmosphere.
7. An hypsometric curve shows two levels on Earth, implying two kinds of crust, and only one on Venus.
8. Earth's crust originated by solidification of molten rock that rose up from the mantle.
9. The Earth's crust constitutes about 30% of its total mass.
10. Because seismic s-waves do not travel through liquids, the s-wave shadow zone indicates that at least part of the Earth's core is molten.
11. The amount of land exposed above sea level has remained about the same for the last 600 million years.
12. The oldest rocks from the seafloor are much older than the oldest rocks from the continents.
13. Sea level changes have been modest throughout Earth's history, never exceeding more than about 10 m up or down.

14. The lithosphere is rigid and brittle, whereas the asthenosphere is plastic and ductile.
15. Hotspots can occur both at plate boundaries and in the middle of plates, and both in the oceans and on the continents.
16. The Hawaiian Islands are an example of island arc volcanism.
17. The Earth's mantle is entirely molten.
18. On the island of Oahu, sea level is falling at present.
19. Beaches are normally very stable in shape and width unless disturbed by human activities.
20. Seawalls are usually effective in preventing beach erosion.

PART 2: Multiple Choice (1 point each = 40 points).

21. Which of the following processes characterizes the interior of the Sun?
 - a) infall of iron under the influence of gravity.
 - b) outgassing of volatile elements and compounds.
 - c) reaction of a rocky mantle with an iron core.
 - d) a runaway greenhouse effect.
 - e) nuclear fusion of two hydrogen atoms to form helium
22. The element gold is formed
 - a) in the centre of the Earth.
 - b) during fusion in our Sun.
 - c) during supernova explosions.
 - d) all of the above.
23. Compared with the gas-giant planets, the rocky or terrestrial planets are enriched in
 - a) hydrogen
 - b) helium
 - c) volatile material
 - d) refractory material
 - e) methane.
24. Four elements make up 93% of Earth's mass. They are
 - a) iron, oxygen, silicon, and magnesium.
 - b) iron, oxygen, magnesium, and hydrogen.
 - c) hydrogen, helium, nitrogen, and oxygen.
 - d) iron, nickel, calcium, and aluminum.
 - e) oxygen, nitrogen, carbon dioxide, and water vapor.
25. Processes that caused large-scale chemical differentiation of the Earth include
 - a) a supernova explosion in a distant galaxy.
 - b) bombardment by cosmic rays originating from an unknown source.
 - c) separation of volatile elements and compounds from refractory elements and compounds.
 - d) separation of dense materials from less dense materials by gravity stratification.
 - e) both c) and d).

26. Which of the following theories for origin of Earth's Moon *cannot* be dismissed on dynamical or chemical grounds?
- a) gravitational capture of a large planetesimal.
 - b) fission due to rapid rotation.
 - c) impact by a large planetesimal, about the size of Mars, which blasted off material that then coalesced to form the Moon.
 - d) formation in the same manner as Earth, by accretion.
 - e) condensation from the Solar nebula.
27. Unlike the other planets, the Earth has oceans of liquid water. This is because
- a) Earth formed originally from a water-rich comet.
 - b) Earth inherited a primitive, water-rich atmosphere from the Solar nebula, which condensed into oceans as the Earth's surface cooled.
 - c) Earth formed rapidly from cold, water-rich planetesimals, and this water subsequently outgassed from Earth's interior.
 - d) Earth is the proper distance from the Sun, such that water can exist in the liquid state.
 - e) both c) and d).
28. Free oxygen in the Earth's atmosphere has been produced mainly by
- a) photodissociation of water and loss of hydrogen to outer space.
 - b) change in sea level.
 - c) formation of the Earth's core.
 - d) photosynthesis and burial of organic carbon.
 - e) nucleosynthesis in stars.
29. A "runaway greenhouse" refers to
- a) what happened on Mars.
 - b) what happened on Venus.
 - c) a process involving a positive feedback between the amount of carbon dioxide in a planetary atmosphere and the temperature of that atmosphere.
 - d) both b) and c)
 - e) all of the above.
30. Carbon dioxide that has outgassed from Venus resides mainly in Venus's atmosphere, where it has caused a runaway greenhouse effect. On Earth, carbon dioxide is mainly
- a) in rocks, as CaCO_3 in limestone.
 - b) dissolved in the oceans.
 - c) tied up as organic matter in soils.
 - d) stored in coral reefs.
 - e) stored in deep-sea sediments.

31. The *major* cause of the *largest* worldwide changes in sea level known in the geologic record is
- change in the volume of ice stored on land.
 - change in the rate of seafloor spreading, which produces a change in the volume of the ocean basins.
 - local, tectonically induced vertical motions of the crust.
 - change in the temperature of ocean water.
 - storm surges.
32. From a structural standpoint, the continents consist of
- lithosphere and asthenosphere
 - cratons and mobile belts
 - volcanic arcs and subduction zones
 - andesite and basalt
 - all of the above.
33. A record of Earth's history going back nearly 4 billion years can be found
- in deep-sea sediments
 - in the ocean basins
 - on the continents
 - in subduction zones
 - all of the above.
34. The simplified reaction $\text{CO}_2 + \text{H}_2\text{O} = \text{CH}_2\text{O} + \text{O}_2$ represents:
- photodissociation
 - chemical weathering
 - photosynthesis
 - none of the above
 - all of the above.
35. The simplified reaction $\text{H}_2\text{O} + \text{CO}_2 + \text{CaSiO}_3 = \text{CaCO}_3 + \text{SiO}_2 + \text{H}_2\text{O}$ represents
- weathering of silicate rocks by rain water and removal of CO_2 from the atmosphere into rocks.
 - photosynthesis followed by burial of some of the organic material produced.
 - the reaction by which the Earth's core formed.
 - The reaction that generates energy within the Sun and similar stars.
 - the formation of evaporite deposits that can form salt domes and trap oil and gas.
36. From outside to inside, the Earth consists of
- rocky crust, brittle lithosphere, plastic asthenosphere, solid metal outer core, liquid metal inner core.
 - rocky crust, rocky mantle, liquid metal outer core, solid metal inner core.
 - rocky crust, liquid mantle, plastic asthenosphere, solid outer core, solid inner core.
 - rocky crust, liquid asthenosphere, plastic mantle, liquid outer core, solid inner core.
 - none of the above.
37. Evidence that the Earth has two kinds of crust comes from
- seismology.
 - the hypsometric curve that plots Earth surface area against its elevation.
 - the Moon.
 - both a) and b).
 - all of the above.

38. The principle of isostasy states that
- a) the Earth's surface is dominated by two levels: the continents and the oceans.
 - b) the lithosphere is in gravitational equilibrium through a buoyancy mechanism, with compensation occurring in the asthenosphere.
 - c) crust is produced by differentiation from the mantle, by upwelling and solidification of molten rock.
 - d) if the Earth were perfectly smooth, it would be covered by nearly 3000 m of ocean water.
 - e) 25% of the continental crust presently lies below sea level.
39. According to the Geodynamo theory, the Earth's magnetic field originates from
- a) a bar magnet at the center of the Earth.
 - b) the Solar wind.
 - c) cosmic rays bombarding the upper atmosphere.
 - d) convection currents within the Earth's outer, liquid iron core.
 - e) outgassing of the planet and formation of the core.
40. The Earth has dry land because
- a) there is not enough water to cover the surface completely.
 - b) all planets have dry land.
 - c) it has continental crust, which rides isostatically higher than oceanic crust because it is relatively thick and less dense.
 - d) sea level has dropped throughout Earth history.
 - e) the mid-ocean ridges push up the bottom of the seafloor, as if it were a large plastic bowl.
41. The Earth would probably have no continents if it did not have
- a) life
 - b) an atmosphere
 - c) oceans and subduction
 - d) both a and b
 - e) all of the above
42. Which of the following statements correctly describes crustal formation?
- a) Continental crust is created by wet melting of the mantle in subduction zones to produce andesite, whereas oceanic crust is formed by dry melting at mid-ocean ridges to form basalt.
 - b) Continental crust is created by erosion in mountain belts, whereas oceanic crust is created from deep-sea sediments.
 - c) Continental crust is formed above sea level, whereas oceanic crust is formed below the carbonate compensation depth.
 - d) Continental crust is formed on cratons, whereas oceanic crust is formed in mobile belts
 - e) None of the above.

43. Continents are built by
- andesitic volcanism at subduction zones.
 - basaltic volcanism at mid-ocean ridges.
 - accretion of exotic terranes onto their margins.
 - outgassing of volatiles from the Earth's interior.
 - both a and c.
44. Continental drift theory experienced a revival in the 1950's as a result of new evidence that
- animals had crossed from Africa to South America via land bridges.
 - the Earth's magnetic poles had apparently wandered through time, but the paths inferred were different for different continents.
 - the Earth's magnetic field had reversed polarity repeatedly in the past.
 - the Earth was rotating on its axis, which corresponds to the geographic and magnetic poles.
 - all of the above.
45. The continents drift because
- they "plow through" the ocean basins in response to "polflucht".
 - of convection in the Earth's outer core.
 - they ride passively on the lithospheric plates, which are moving relative to one another and the mantle.
 - the Earth's magnetic field reverses its polarity.
 - all of the above.
46. The three main geologic settings on Earth where active volcanoes occur are
- abyssal plains, abyssal hills, and continental margins.
 - Hawaii, Iceland, and the Andes.
 - mid-ocean ridges, subduction zones, and hotspots.
 - convergent, divergent, and conservative plate boundaries.
 - Indonesia, Japan, and Bolivia.
47. Which of the following represents the extraordinary evidence that convinced geologists that the outrageous hypothesis of seafloor spreading was correct?
- the elevated topography of mid-ocean ridges.
 - absence of sediment along the mid-ocean ridge axis.
 - evidence for earthquakes and volcanism along the mid-ocean ridge axis.
 - magnetic stripes on the seafloor that were symmetrical on either side of the mid-ocean ridge axis and which could be correlated globally.
 - a valley along the mid-ocean ridge axis, formed by normal faulting and extension.
48. A major *prediction* of the seafloor spreading hypothesis that was made and tested is
- that there are magnetic stripes on the ocean floor.
 - that it could cause sea level change.
 - that the age of the seafloor increases with distance from the ridge on either side.
 - that the Earth's magnetic field originates by convection in the outer core.
 - that the Earth's magnetic field reverses its polarity.

49. The theory of plate tectonics
- is a unifying theory for the Earth sciences.
 - holds that the Earth's surface consists of a dozen or so rigid plates.
 - holds that most mountain-building occurs along plate boundaries.
 - holds that the lithospheric plates ride on the asthenosphere.
 - all of the above.
50. The three major types of plate boundaries are
- conservative, transform, slipslide.
 - continental-continental, oceanic-oceanic, continental-oceanic.
 - divergent, convergent, conservative.
 - constructive, destructive, conservative.
 - both c) and d).
51. Which of the following terms consistently describe a subduction zone?
- shallow earthquakes, basaltic volcanism, young crust, sediment absent to thin
 - shallow earthquakes, andesitic volcanism, young crust, thick sediment
 - shallow to deep earthquakes, andesitic volcanism, older crust, thick sediment
 - shallow to deep earthquakes, basaltic volcanism, older crust, thin sediment
 - no earthquakes, no volcanism, older crust, thick sediment
52. Continent-continent collisions
- result when the ocean basin between them is consumed by subduction.
 - cause the crust to thicken locally, as continental crust is too thick and buoyant to subduct.
 - cause the subducting lithospheric slab to break off, after which it continues to descend on its own.
 - can cause a reorganization of plate motions.
 - all of the above.
53. Which of the following is a “rule” of plate tectonics?
- Oceanic crust is too thick and buoyant to be subducted.
 - The volcanic arc always forms on the upper surface of the subducting plate.
 - When continents collide with one another they tend to “stick”.
 - The major process driving the plates is convection in the Earth’s outer core.
 - All of the above.
54. The main theory that explains hotspots is
- the shrinking Earth
 - seafloor spreading
 - continental drift
 - plate tectonics
 - mantle plumes.
55. The Hawaiian-Emperor seamount chain is an example of
- a fracture zone
 - a hot-spot trace
 - a mid-ocean ridge
 - a volcanic arc
 - a subduction zone.

56. Regarding its origin, most sediment in the oceans, by volume, including the continental margins, is
- a) terrigenous.
 - b) biogenic.
 - c) volcanogenic.
 - d) cosmogenic.
 - e) none of the above.
57. The carbonate compensation depth, or CCD, is
- a) the depth at which calcium carbonate dissolves in the oceans.
 - b) the depth at which calcium carbonate sediment is replaced by siliceous ooze.
 - c) the depth at any point in the oceans where the rate of delivery of calcium carbonate is equal to the rate at which it dissolves.
 - d) the depth above which calcium carbonate can accumulate, and below which it cannot.
 - e) both c) and d).
58. The major long-term cause of coastal erosion is
- a) failure of politicians to plan ahead.
 - b) sea level rise.
 - c) beach loss.
 - d) building of sea walls and groins.
 - e) continental drift.
59. According to the State Constitution of Hawaii, beaches in Hawaii belong to
- a) the state government.
 - b) the people of Hawaii.
 - c) private landowners.
 - d) the Bishop Estate.
 - e) the Native Hawaiians.
60. The best place to look for petroleum in the seabed is
- a) in shallow seas floored by continental crust.
 - b) in areas of thick sediment, of several km or more
 - c) along continental margins
 - d) in abyssal plains
 - e) a, b, and c

PART 3: Short-Answer Essay Questions (total of 15 points).

Answer the following three questions entirely within the space provided. Think your answer through before starting to write. Write legibly--print if your handwriting is poor, because if the grader can't read it, it will be marked wrong.

61. **(8 points)** Draw a cross section of the Earth. Name the layers as described by their physical and chemical properties. Please be very clear.

62. **(7 points)** The mean thickness of sediment in the Atlantic Ocean is about 1000 m. The mean thickness in the Pacific Ocean is <500 m. Why is sediment on average much thicker in the Atlantic than in the Pacific? Provide as much detail as you can, including mention of specific geographic features and names.

Answer:

According to the theory of plate tectonics, most of the Pacific shoreline corresponds with plate boundaries, mainly subduction zones, the "Pacific Ring of Fire". By contrast, the Atlantic shoreline is virtually all passive continental margin, in the middle of a plate. High mountains on the western edge of North and South America, related to the plate boundaries, divert river flow eastward into the Atlantic: the Mississippi drains North America, the Amazon drains South America, and the Congo drains much of Africa, all into the Atlantic. Along its western edge, some large rivers flow into the Pacific, but the sediment they carry is trapped in marginal (back-arc) basins, also related to the plate boundaries there, and so this sediment does not make it out into the main Pacific basin.