

Last Name _____ First Name _____

Student ID# _____ Signature _____

I hereby authorize the use of the last 5 digits of my bar code number for the purpose of posting my grades in OCN 201. (Please sign above; your grades cannot be posted without a signature.)

OCEANOGRAPHY 201

Fall, 2008

Exam #1: 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. Science is a powerful way to find out about the natural world, but it has its limitations.
2. An informal rule in science is that extraordinary hypotheses require extraordinary evidence.
3. Longitude can be told from the declination of the Pole Star, whereas latitude requires an accurate clock.
4. Stars get their energy mainly from the fusion of hydrogen atoms to form helium.
5. Heavy elements like gold are only produced during the explosion of stars in supernovae.
6. The four inner planets are relatively richer in volatile elements and compounds than are the four outer gas-giant planets.
7. Earth is believed to have originated by accretion from planetesimals.
8. Free oxygen has always been an important component of the Earth's atmosphere.
9. Refractory elements are those that tend to form gases, even at relatively low temperature.
10. Earth is massive enough to retain all of its constituent chemical elements.
11. Oceans of liquid water are common in our Solar System.
12. The continental crust is much thicker than the oceanic crust.
13. The amount of land exposed above sea level has remained about the same for the last 600 million years.
14. The oldest rocks from the seafloor are much older than the oldest rocks from the continents.

15. The lithosphere is rigid and brittle, whereas the asthenosphere is plastic and ductile.
16. Hot spots can only occur in the oceans, and never on the continents.
17. The Hawaiian Islands are an example of island arc volcanism.
18. The Earth's mantle is entirely molten.
19. Worldwide, sea level is falling today.
20. Sand that lies on the beach in the summer is often stored in an offshore bar during winter.

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

21. Which of the following is true about the scientific method?
 - a) The scientific method is a systematic way of asking and answering questions about the natural world.
 - b) In science simple theories are preferred over complex ones.
 - c) Scientific theories are always subject to challenge and may be overturned.
 - d) Scientific theories are continuously updated as new information becomes available.
 - e) All of the above.
22. What is the most recent scientific estimate for the age of the Universe?
 - a) 10 thousand years
 - b) 14 million years
 - c) 1 billion years
 - d) 14 billion years
 - e) the same as the age of the Earth.
23. Which of the following statements is true?
 - a) Magnetic North is always the same as True North.
 - b) Magnetic North has never varied by more than about 20° from True North.
 - c) Magnetic North is always the same as Geographic North.
 - d) The Earth's magnetic field is constant and unchanging.
 - e) None of the above.
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. The process of large-scale chemical differentiation of the Earth has produced
 - a) the Earth's core.
 - b) the Earth's mantle.
 - c) continental and oceanic crust.
 - d) the oceans and atmosphere.
 - e) all of the above.

26. The Earth is relatively depleted in noble gases because
- its present mass is too small to hold them.
 - they have been removed by reaction with surface rocks.
 - they were vaporized and lost when the Earth melted.
 - they were lost early on from the planetesimals that eventually accreted to form the Earth.
 - they have never outgassed from the Earth's interior.
27. Unlike the other planets, the Earth has oceans of liquid water. This is because
- Earth formed originally from a water-rich comet.
 - Earth inherited a primitive, water-rich atmosphere from the Solar nebula, which condensed into oceans as the Earth's surface cooled.
 - Earth formed rapidly from cold, water-rich planetesimals, and this water subsequently outgassed from Earth's interior.
 - Earth is the proper distance from the Sun, such that water can exist in the liquid state.
 - both c) and d).
28. Evidence that Earth is still outgassing today exists in:
- helium plumes at hydrothermal vents
 - mantle plumes
 - Yellowstone geysers
 - Eruption of Mt. St. Helens
 - none of the above.
29. 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
- in rocks, as CaCO_3 in limestone.
 - dissolved in the oceans.
 - tied up as organic matter in soils.
 - stored in coral reefs.
 - stored in deep-sea sediments.
30. Which of the following statements is/are true?
- On Earth, H_2O is in the oceans, CO_2 is in rocks, and N_2 and O_2 are in the atmosphere.
 - On Venus, H_2O was lost to outer space as H_2 , CO_2 and N_2 are in the atmosphere, and O_2 was never present.
 - On Mars, H_2O and CO_2 are frozen out as ice, N_2 was lost to space, and O_2 was never present.
 - On Venus the atmosphere is very thick whereas on Mars it is very thin. Both atmospheres are mainly CO_2 .
 - All of the above.

31. Sea level can change as a result of
- change in the rate of seafloor spreading, which produces a change in the volume of the ocean basins.
 - change in the volume of ice stored on land.
 - local, tectonically induced vertical motions of the crust.
 - change in the temperature of ocean water.
 - all of the above.
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 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. 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.
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.
 - iron bar magnet, liquid outer core, rocky mesosphere, rocky crust.

37. Evidence that the Earth's outer core is molten comes from
- Alfred Wegener's theory of continental drift.
 - comparison with conditions on Venus.
 - the s-wave shadow zone and the fact that s-waves are not transmitted by fluids.
 - the location of the carbonate compensation depth in the Pacific.
 - all of the above.
38. The principle of isostasy states that
- the Earth's surface is dominated by two levels: the continents and the oceans.
 - the lithosphere is in gravitational equilibrium through a buoyancy mechanism, with compensation occurring in the asthenosphere.
 - crust is produced by differentiation from the mantle, by upwelling and solidification of molten rock.
 - if the Earth were perfectly smooth, it would be covered by nearly 3000 m of ocean water.
 - 25% of the continental crust presently lies below sea level.
39. According to the Geodynamo theory, the Earth's magnetic field originates from
- a bar magnet at the center of the Earth.
 - the Solar wind.
 - cosmic rays bombarding the upper atmosphere.
 - convection currents within the Earth's outer, liquid iron core.
 - outgassing of the planet and formation of the core.
40. The Earth has dry land because
- there is not enough water to cover the surface completely.
 - all planets have dry land.
 - it has continental crust, which rides isostatically higher than oceanic crust because it is relatively thick and less dense.
 - sea level has dropped throughout Earth history.
 - 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
- life
 - an oxygen-rich atmosphere
 - oceans and subduction
 - both a and b
 - 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. Earthquakes occur
- a) when brittle rocks of the lithosphere crack and move, mainly along plate boundaries.
 - b) at shallow depths (<100 km) except in the Wadati-Benioff zone of subduction zones.
 - c) within the Earth's lower mantle and outer core.
 - d) both a and b.
 - e) All of the above.
44. Which of these statements **WAS NOT** part of Alfred Wegener's theory of continental drift?
- a) Centrifugal force from the Earth's spinning pulled the continents apart.
 - b) Originally there was only one land mass, Pangaea, and one ocean, Panthalassa.
 - c) The seafloor becomes progressively older as you move off the mid-ocean ridge axis.
 - d) The Atlantic shorelines of Africa and South America fit very well together.
 - e) Coal and tropical plant fossils have been found on Antarctica.
45. The continents drift because
- a) they "plow through" the ocean basins in response to "polflucht".
 - b) of convection in the Earth's outer core.
 - c) they ride passively on the lithospheric plates, which are moving relative to one another and the mantle.
 - d) the Earth's magnetic field reverses its polarity.
 - e) all of the above.
46. The three main geologic settings on Earth where active volcanoes occur are
- a) abyssal plains, abyssal hills, and continental margins.
 - b) Hawaii, Iceland, and the Andes.
 - c) mid-ocean ridges, subduction zones, and hotspots.
 - d) convergent, divergent, and conservative plate boundaries.
 - e) 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. Which of the following is an example of an active subduction zone?
- Mid-Atlantic Ridge.
 - East Pacific Rise.
 - San Andreas Fault.
 - Tibetan Plateau and Himalayan Mountains.
 - Peru-Chile Trench and the Andes Mountains.

53. Continent-continent collisions

- a) result when the ocean basin between them is consumed by subduction.
- b) cause the crust to thicken locally, as continental crust is too thick and buoyant to subduct.
- c) cause the subducting lithospheric slab to break off, after which it continues to descend on its own.
- d) can cause a reorganization of plate motions.
- e) all of the above.

54. Which of the following is a “rule” of plate tectonics?

- a) Oceanic crust is too thick and buoyant to be subducted.
- b) The volcanic arc always forms on the upper surface of the subducting plate.
- c) When continents collide with one another they tend to “stick”.
- d) The major process driving the plates is convection in the Earth’s outer core.
- e) All of the above.

55. Which of the following statements about hot spots is/are true?

- a) They originate from plumes of unusually hot mantle that remain fixed as the plates move over them.
- b) They provide a means to estimate the direction of plate motion relative to the mantle.
- c) They represent a third geologic setting for volcanism on Earth.
- d) They can occur on land or on sea, at or away from axes of seafloor spreading.
- e) All of the above.

56. Atlantic-type continental margins are considered to be aseismic, or passive, because

- a) they lack earthquakes.
- b) they lie along a plate boundary.
- c) they lie far from a plate boundary.
- d) both a) and c).
- e) none of the above.

57. 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.

58. 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).

59. 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.
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. **(3 points)** How was the Hawaiian Island chain formed? (You must provide some detail to gain the full three points.)

62. (4 points)

- a) What general process is driving plate tectonics? (I am looking for a one-word answer here).
- b) Where is this process occurring?
- c) Why is this process occurring?

63. (8 points) Consider the chemical reaction $\text{CO}_2 + \text{H}_2\text{O} = \text{CH}_2\text{O} + \text{O}_2$.

- a) As written, what process does this reaction represent? (one word)
- b) If written in the opposite direction (i.e., right to left), what processes would this reaction represent? (two words)
- c) What general group of biological organisms makes this reaction go as written? (1-2 words)
- d) What energy source do these organisms utilize? (one word)
- e) What effect has this reaction had on Earth's atmosphere? (one sentence)
- f) What additional process is necessary to keep the molecule in part e) in the atmosphere more or less permanently? (one sentence)