OCEANOGRAPHY 201

Spring 2009; De Carlo

Exam #1: Section #1

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.)

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 pt 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. In 1976 when the Hokulea was fist sailed to Tahiti, Hawaiians had lost the traditional navigating skills of their ancestors.

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. Differentiation may have occurred both during initial accretion of Earth and subsequently from a “nearly completely molten” but almost fully accreted Earth.

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 except hydrogen.

11. Nainoa Thompson taught Miau Piailug the skills of traditional Polynesian navigation.

12. The continental crust is much thinner than the oceanic crust.

13. The amount of continental 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 younger than the oldest continental rocks.

15. The asthenosphere is rigid and brittle, whereas the lithosphere is plastic and ductile.

16. Hot spots only occur in the oceans, and are not found 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. The first time that surface ships traversed the Arctic occurred in the past twenty years.

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 Earth?
    a) 10 thousand years
    b) 4.55 million year
    c) 4.55 billion years
    d) 13.5 billion years
    e) the same as the age of the Universe

23. 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

24. Which of the following statements is true?
    a) Magnetic North changes polarity every 100,000 years owing to sun spot activity
    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

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
    a) its present mass is too small to hold them
    b) they have been removed by reaction with surface rocks
    c) they were vaporized and lost when the Earth melted
    d) they were lost early on from the planetesimals that eventually accreted to form the Earth
    e) they have never outgassed from the Earth's interior

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. Evidence that Earth is still outgassing today exists in:
    a) helium plumes at hydrothermal vents
    b) mantle plumes
    c) Yellowstone geysers
    d) Eruption of Mt. St. Helens
    e) 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 found
    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

30. Which of the following statements is true?
    a) The average density of oceanic crust is ~4.5 $g.cm^3$, that of continental crust is ~2.9 g/cm^3

b) The average density of oceanic crust is ~2.9 g.cm^3, that of continental crust is ~2.7 g/cm^3
c) The average density of oceanic crust is ~2.7 g.cm^3, that of continental crust is ~2.9 g/cm^3
d) The average density of oceanic crust is of ~2.9 g.cm^3, that of continental crust is ~4.5 g/cm^3
e) None of the above.

31. From a structural standpoint, the continents consist of:
    a) lithosphere and asthenosphere
    b) cratons and mobile belts
    c) volcanic arcs and subduction zones
    d) andesite and basalt
    e) all of the above

32. Evidence that the Earth has two kinds of crust comes from
    a) Seismology
    b) the hypsometric curve that plots Earth surface area against its elevation
    c) the Moon
    d) both a) and b)
    e) none of the above

33. The simplified reaction $H_2O + CO_2 + CaSiO_3 = CaCO_3 + SiO_2 + H_2O$ represents:
    a) weathering of silicates by rain and CO_2 removal from the atmosphere into limestone
    b) photosynthesis followed by burial of some of the organic material produced
    c) the reaction by which the Earth's core formed
    d) the reaction that generates energy within the Sun and similar stars
    e) the formation of evaporite deposits that can form salt domes and trap oil and gas

34. Continents are thought to be composed of accreted terrains with:
    a) Cratons being the young and active areas and subduction zones being the older areas
    b) Mobile belts having recently undergone deformation and cratons representing the older stable portions of the continents
    c) Active basaltic volcanism occurring along the mobile belts and andesitic volcanism taking place in the older cratons
    d) Accumulation of oceanic crust that could not subduct at deep ocean trenches and piling up along older segments of continental crust
    e) None of the above is correct

35. The continental shelf break is defined to occur at a depth of :
    a) 10 m
    b) 130 m
    c) 1200 m
    d) 2900 m
    e) None of the above

36. Evidence that the Earth's outer core is molten comes from:
    a) Alfred Wegener's theory of continental drift
    b) comparison with conditions on Venus
    c) the s-wave shadow zone and the fact that s-waves are not transmitted by fluids
    d) the location of the carbonate compensation depth in the Pacific
    e) all of the above

37. 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, upwelling and solidification
    d) if the Earth were perfectly smooth, it would be covered by about 2900 m of ocean water
    e) about 25% of the continental crust presently lies below sea level

38. According to the Geodynamo theory, the Earth's magnetic field originates from:
    a) a bar magnet at the center of the Earth
    b) the strong field associated with 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

39. 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

40. The Earth would probably have no continents if it did not have
    a) a separate solid inner core and liquid outer core
    b) relatively frequent magnetic reversals
    c) oceans and subduction
    d) both a and b
    e) all of the above

41. 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; 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

42. 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.

43. Which of these statements **WAS NOT** part of Alfred Wegener's theory of continental drift?
    a) Centifugal force from the Earth's spinning pulled the continents apart
    b) A supercontinent Pangaea in a large ocean, Panthalassa, began to split up and its parts drift away to their current locations today
    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

44. 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 lithospheric plates, which are moving relative to one another
    d) the Earth's magnetic field reverses its polarity
    e) all of the above.

45. 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

46. Which of the following represents the **extraordinary** evidence that convinced geologists that the revolutionary hypothesis of seafloor spreading was correct?
    a) the elevated topography of mid-ocean ridges
    b) absence of sediment along the mid-ocean ridge axis
    c) evidence for earthquakes and volcanism along the mid-ocean ridge axis
    d) magnetic stripes on the seafloor that were symmetrical on either side of the mid-ocean ridge axis and which could be correlated globally
    e) a valley along the mid-ocean ridge axis, formed by normal faulting and extension.

47. A major *prediction* of the seafloor spreading hypothesis that was made and tested is
    a) that there are magnetic stripes on the ocean floor
    b) that it could cause sea level change

c) that the age of the seafloor increases with distance from the ridge on either side
d) that the Earth's magnetic field originates by convection in the outer core
e) that the Earth's magnetic field reverses its polarity

48. The Curie point is:
    a) The location where accretion of coral reefs cannot keep up with subsidence of the seamounts on which they grow
    b) The exact location of magnetic north relative to the geographic North Pole
    c) The equibibrium point in the radioactive decay of Uranium in the Earth's crust
    d) The temperature below which magnetic minerals in igneous rocks can no longer change their alignment with the magnetic North Pole
    e) None of the above

49. The three major types of plate boundaries are:
    a) conservative, transform, slipslide
    b) continental-continental, oceanic-oceanic, continental-oceanic
    c) divergent, convergent, conservative
    d) constructive, destructive, conservative
    e) both c) and d)
50. Which of the following terms consistently describe a subduction zone?
    a) shallow earthquakes, basaltic volcanism, young crust, sediment absent to thin
    b) shallow earthquakes, andesitic volcanism, young crust, thick sediment
    c) shallow to deep earthquakes, andesitic volcanism, older crust, thick sediment
    d) shallow to deep earthquakes, basaltic volcanism, older crust, thin sediment
    e) no earthquakes, no volcanism, older crust, thick sediment

51. Which of the following is an example of an active subduction zone?
    a) Mid-Atlantic Ridge
    b) East Pacific Rise
    c) San Andreas Fault
    d) Tibetan Plateau and Himalayan Mountains
    e) Peru-Chile Trench and the Andes Mountains.

52. 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

53. 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

54. Which of the following statements about hot spots is/are true?
    a) they originate from plumes of unusually hot mantle that remain relatively 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.

55. Large sustained mantle plume eruptions, such as that which formed the Ontong-Java plateau:
    a) originated from unusually hot mantle and erupted over several hundred million years
    b) are thought to possibly have raised global temperature by 7-13ºC
    c) are thought to have led to major realignment of plate motions
    d) are thought to have raised sea level by up to 10 m
    e) both b) and d)

56. The bend in the Hawaiian Island-Emperor Seamount chain is thought:
    a) To result from passage of two different plates over the Hawaiian hotspot

b) To result from plate motion realignment when India collided with S. Asia shutting down about 1200 km of subduction zone
c) To result from a resurgence in volcanic activity at multiple hot spots across the planet due to excessive mantle plume formation
d) both a) and c)
e) none of the above.

57. Which of the following produce calcareous tests that contribute to sediments on the seafloor?
a) Foraminifera
b) Radiolarians
c) Coccolithophores
d) Diatoms
e) both (a) and (c)

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. Large volumes of ocean sediments are transported from the continental shelves to the deep ocean floor predominantly by which of the following?
a) rivers
b) seafloor spreading
c) tidal currents
d) storm surges
e) turbidity currents

60. Turbidity currents lead to the formation of:
a) Submarine canyons
b) Sediment fans at the base of the continental slope
c) Abyssal plains
d) Both a) and c)
e) Both a) and b)

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. Please discuss the major classes of organisms that produce skeletons that become biogenic sediments. Be sure to include the classes of organisms, whether they are plants or animals and the composition of their tests to obtain full credit. (3 points)

62. What general process/mechanism drives plate tectonics? (a one-word answer suffices here). Where does this process occur? Using a simple diagram show what the major characteristics of this process? (4 points)

63. (8 points) Draw a cross-section of a typical divergent plate boundary. For full credit, (a) label 5 major features; (b) if a part is moving, label its direction of movement; (c) name a geographical location where such a boundary occurs today.