A. Fill in the blank (2 points each)

1. The zigzag motion that carries sand grains along a beach is known as ______ longshore drift ______.

2. As waves approach a beach, the rows of waves gradually bend to a direction more parallel to the shore. This change in direction is called wave refraction ____.

3. All of the following statements concerning seawalls are true EXCEPT:
   - A. Seawalls can cause buildup of sand and sediment immediately seaward of itself
   - B. Seawalls can accelerate erosion in other coastal areas where waves have been refocused
   - C. Seawalls can cause an interruption in longshore currents
   - D. Seawalls disrupt movement of sediment that nourishes beaches

4. As a result of wave action, erosion will cause the shoreline to straighten with time.

5. Shoreline erosion occurs when beaches have an insufficient supply of ___sand__.

6. Which one of the following does not have a direct influence on Milankovitch cycles?
   - A. Precession of the Earth's axis
   - B. Tilt of the Earth's axis
   - C. Eccentricity of the Earth's orbit
   - D. Tidal interactions between the Earth and the Moon

7. Two major types of weathering are chemical and mechanical.

8. The height of a wave in the open ocean increases mainly a function of wind speed.

9. The circulation of the deep ocean is control mainly by the _density_ of seawater.
10. Which of the following situations is most likely to undergo mass wasting?

    A. a dry, moderate slope of unconsolidated material
    B. a wet, moderate slope of unconsolidated material
    C. a dry, steep slope of unconsolidated material
    D. a wet, steep slope of unconsolidated material

11. **Gravity** is the driving force of all mass wasting.

12. **Oxygen**, which is a major component making up Earth’s modern atmosphere, was in very low concentrations in Earth’s earliest atmosphere.

13. The most common Precambrian fossils are called **stromatolites**, which are layered mounds of calcium carbonate and prokaryotic algae.

14. Mammals became the dominant land animals during the **Cenozoic era** (Paleozoic, Mesozoic, or Cenozoic).

15. The major source of free oxygen in the atmosphere is from **photosynthesis**.

16. Abundant fossil evidence did not appear in the geologic record until about 500-600 million years ago.

17. The **gymnosperms** were the dominant trees of the Mesozoic era.

18. The two most abundant greenhouse gases in Earth’s atmosphere are **H₂O** and **CO₂**.

19. Do greenhouse gases trap incoming solar energy or outgoing infrared radiation? **Outgoing infrared radiation**

20. Bacteria and photosynthetic unicellular organisms on Earth evolved between **3.5** and **1.5** billion years ago.

21. What caused dust and condensing material to accrete into planetesimals?

    A. heating of gases
    B. **gravitational attraction and collisions**
    C. nuclear fusion
D. rotation of the proto-sun

22. The process by which an originally homogeneous Earth developed a dense core and a light crust is called __differentiation____.

23. Which of the following choices lists events in chronological order, from oldest to youngest?

A. Earth aggregates, Earth differentiates, oldest Moon rocks form, giant impact(s) occurs.
B. Nebula evolves to Sun and planetisimals, giant impact(s) occurs, molten Earth cools, Earth differentiates.
C. Nebula evolves to Sun and planetesimals, Earth aggregates, molten Earth cools, age of oldest meteorite.
D. Molten Earth cools, Earth aggregates, giant impact(s) occurs, Earth differentiates.

24. The type of rock that tells us that oxygen levels in the Earth’s early atmosphere was low and reducing is call a(n) Banded Iron Formation.

25. The type of rock that tells us that oxygen levels in the Earth’s early atmosphere were rising and oxidizing is call a(n) Continental red bed.

**B. Short Answer. Briefly answer the following questions. Use the back of the page if necessary. Each question is worth 5 points. Write neatly and legibly – if I cannot read your answer, I will consider it wrong and give you no credit.**

1. Once astronomical factors initiate a period of glaciation, how does albedo reinforce global cooling?

Albedo is the percentage of incoming solar radiation reflected from the surface of the Earth. When astronomical factors initiate a period of glaciation, the increased ice and snow reflect an increased higher percentage of incoming solar radiation back into space. Thus there is less available to warm the Earth's surface, the climate cools even further, and the cycle of increased global cooling continues.

2. Describe the methods used to armor or protect coasts from wave erosion and the effects such armoring can have on the width of a beach.
Efforts to prevent the effects of coastal erosion involve building structures to deflect waves and absorb the brunt of wave energy. These structures have included rocks, abandoned cars, vegetation, driftwood, old tires, and other forms of riprap, and seawalls, which are strong structures built parallel to the shore. The beach may be narrowed leading to beach loss (the shoreline is saved but the beach is lost).

3. What are four ways to mitigate coastal hazards?

1. avoid building near the shore (avoidance)
2. restore beaches and dunes (restoration)
3. move threatened structures (redevelopment)
4. purchase coastal lands

4. What are the most important factors controlling chemical weathering?

Temperature, water, oxygen, carbon dioxide, rock type, surface area of the rock, vegetation

5. What is the evidence that Island of Oahu has undergone massive landslides removing large portions of the Island?

Fact that ½ of the Koolau volcano is gone and the field of massive volcanic boulders north of the island.

6. Discuss how different slope compositions and the structure of the rocks (bedding, jointing, etc.) affect the likelihood of mass movement.

Slopes may be composed of any combination of solid bedrock, weathered bedrock, soil, vegetation, and a variable amount of water. Solid bedrock is completely stable as long as it contains no planes of weakness. If weakness planes do exist (such as metamorphic foliation planes, sedimentary bedding planes, or igneous fractures), the rock will remain stable as long as these planes are perpendicular to the slope. If the planes are parallel to the slope, mass movement is more likely to occur. Slopes composed of unconsolidated materials can be stable only if the friction within the slope is greater than the downslope component of gravity. Excessive water in the slope can reduce the friction; reduced friction can lead to slope failure. Vegetation on the slope can increase the friction and bind the soil, thereby preventing mass movement. Different types of unconsolidated material have different angles of repose. If the slope is greater than the angle of repose of the slope material, the slope will be susceptible to mass movement.
7. List 3 *human* factors that represent potentially significant influences on climate during the past 8000 years. Explain how each factor potentially influenced climate.

1. Clearing forests to grow crops – increased CO₂ and CH₄ by biomass burning and decreased uptake of CO₂ by eliminating plants
2. Irrigation of field to grow crops like rice – increased atmospheric CH₄ by providing an environment suitable for formation of this greenhouse gas
3. Burning coal and petroleum for power – released CO₂

8. Evidence indicates that Earth has gone through many glacial-interglacial cycles on time scales ranging from 20,000 years to 400,000 years over the last 2.75 million years.

   - What provides geologists with the best evidence for these glacial-interglacial cycles?
   - The oxygen isotopic composition of benthic foraminifera

   - What causes the glacial-interglacial cycles?
   - Changes in earth’s orbit

9. How is Earth’s surface temperature distributed over the globe and what factors influence that distribution?

   - Earth surface temperature is distributed by atmospheric and oceanic circulation patterns. These are influences by continental and oceanic features that influence that circulation such as mountains influencing atmospheric circulation and continents blocking oceanic circulation. It is also influenced by Earth’s reflectivity or albedo.

10. Explain the relationship between sea level and the δ¹⁸O of ocean water. What geologic evidence supports the relationship between sea level and the δ¹⁸O of ocean water?

   - Glacial ice is enriched in the lighter isotope of oxygen (¹⁶O) so when glacial ice grows, it preferentially removes water containing ¹⁶O from the ocean lowering sea level and increasing the δ¹⁸O of seawater.
The δ\textsuperscript{18}O record of benthic foraminifera corresponds with changes in sea level. That is, the age of the most prominent δ\textsuperscript{18}O minima correspond with ages of the most prominent age of reefs recording sea level rise.

11. What is the faint young sun paradox and why is it a paradox? Explain in your answer how Earth’s temperature was moderated early in the history of our Earth.

The strength of the sun was about 25% less about 4.5 billion years ago so the Earth was receiving much less solar radiation than today. However, there is no evidence that anytime during Earth history that temperatures were low enough that all water on Earth was frozen, hence a dilemma – how did Earth stay warm with much less incoming solar radiation? The answer was that the global Greenhouse effect was likely much stronger probably due to higher concentrations of CO\textsubscript{2} in the atmosphere.

12. What have geologists learned about the evolution of the Earth's atmosphere from the study of Banded Iron Formations?

Banded Iron Formation can only form under low oxygen conditions in the environment. The widespread distribution of banded iron formations in the past indicate that the early Earth’s atmosphere had much lower free oxygen compared with our modern atmosphere oxygen levels.

13. There is a big difference in the plants and animals that live on the Indonesian islands of Bali and Lombok, even though they are only a few miles apart. Why?

The fauna and flora on these islands evolved when they were separated tectonically for millions of years. Tectonic movements have recently brought these islands close to each other.

14. What is the fundamental difference between Earth and the other inner planets (Venus and Mars) that have dramatically affected the climate of the planet?

The conditions on early Earth have allowed the presence of liquid water, which have influenced tectonics, weathering reactions and the origins of life. The interplay between plate tectonic cycles, the rock cycle and the water cycle have maintained moderate temperatures on Earth throughout Earth history.

15. What is global dimming and why might it be important today and in the future for controlling Earth surface temperature?
Global dimming describes the gradual reduction in the amount of total solar radiation at the Earth surface since 1950’s. This phenomenon is caused by the effect of pollution on cloud formation favoring the formation of clouds that reflect sunlight that has reduced incoming solar radiation. Since the early 1990’s, this effect has been diminished due to reduced industrial emissions and the use of particles filters. Some scientists believe that global dimming has masked the effects of global temperature rise due to increased atmospheric CO₂.

**Extra Credit:**

1. Imagine you are a miner who has found pebbles of quartz with small pieces of gold in a riverbed. You know that the source of these pebbles must be upstream. What qualities of the rocks would you look for to judge if you are getting close to the place were these pebbles are being weathered from the primary gold deposit? (5 points)

   One would expect the pebbles to be more angular (less rounded) closer to the source. The range in grain size close to the source should be more variable. The grains should be less well sorted.

2. How many changes of cloths did Martin de Wit wear throughout the Earth Story video series? (5 points)

   One.