

The exam is divided into six parts covering the essentials of Earth History. Please answer the following questions as **succinctly** (short and clear) as possible. Whenever possible, use **drawings** and **sketches** to explain your arguments.

**Formation of the universe and the solar system**

**1. Big Bang Theory (8 p)**

During the Big Bang when the universe formed, only H, He, and minor amounts of light elements such as Li formed. However, the Earth primarily consists of heavier elements such as Fe, O, Si, Mg, and other rock-forming metals.

Briefly explain how and where these elements formed, and how they ended up in the Earth.

**2. The Goldilocks Zone (8 p)**

Earth is situated in the habitable zone (Goldilocks Zone) in the solar system. Briefly explain how and why this is essential for the evolution of Life.

**3. The Moon (2 p)**

Where did the Earth's moon come from?

**Earth's crust and plate tectonics**

**4. Pangaea and sea level (8 p)**

At the end of the Paleozoic all the continents came together to form one supercontinent called Pangaea. Briefly explain how and why this influenced global sea levels and climate.

**5. Break up of Pangaea (8 p)**

During the Mesozoic, Pangaea started to break up. Briefly describe the timing and the continents involved in the collision that led to the formation of the Himalaya Mountains.

**Stratigraphy and sedimentary environments**

**6. Fill in the blanks in the geological time scale below (10 p)**

Eon	Era	Period	Age (Ma)	
		Quaternary	2.58 - present	
	Mesozoic	Paleogene	(1) _____ - 23.03	
		Cretaceous	(2) 145 - _____	
			201.4 - 145	
		Triassic		
			Carboniferous	(3) 358.9 - _____
				419.2 - 358.9
			Silurian	
				(4) _____ - 443.8
		Cambrian		
			(5) _____ - 541	
Hadean			4560 - 4000	

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**7. Biogenic sediments and sedimentary rocks (6 p)**

Give three examples of biogenic (formed through biological processes) sediments or sedimentary rocks, and briefly explained how these sediments or rocks formed.

**Evolution of Earth's climate****8. Earth's early atmosphere (4 p)**

Earth's first atmosphere was lost to space. Earth's second atmosphere was rich in CO<sub>2</sub>. Briefly explain how this is believed to have prevented the early Earth from freezing to ice despite the Sun being 30 % weaker than today.

**9. Phanerozoic oxygen levels (8 p)**

During the late Paleozoic (Carboniferous-Permian) the atmosphere's oxygen level is believed to have reached >30 % (vs ~21 % today). Briefly explain the cause of the higher oxygen levels.

**10. Milankovitch cycles (6 p)**

Variations in climate on glacial-interglacial time scales are believed to be controlled by variations in Earth's orbit (Milankovitch cycles) around the Sun. Briefly explain:

- (1) Eccentricity
- (2) Obliquity (tilt)
- (3) Precession

**Origin of Life and evolution****11. First eukaryotes (6 p)**

The very first prokaryotic single cell organisms were very primitive lacking organelles such as mitochondria and chloroplasts. Briefly explain how the first eukaryotic plants got their mitochondria and chloroplasts.

**12. Stromatolites (6 p)**

Stromatolites are common in shallow marine strata of Proterozoic age, but largely missing in Phanerozoic rocks. Briefly explain what a stromatolite is, how they form, and why they largely disappeared with the rise of multicellular animals.

**13. Cambrian Explosion (4 p)**

The Cambrian is the first period of the Phanerozoic eon. During this time, life evolved from the very primitive Ediacaran fauna to basically all the animal groups that we see today. One of the groups that evolved were the trilobites. Briefly give two reasons why we can find so many trilobite fossils in Phanerozoic rocks from all over the world.

**Phanerozoic Life****14. Phylogenetic tree of the vertebrates (4 p)**

All vertebrates (animals with a spine) originate from very primitive chordates that evolved in the early Cambrian. Briefly explain why a mouse and a snake are more closely related than a shark and a salmon.

**15. Dinosaurs (8 p)**

The dinosaurs ruled the world for much of the Mesozoic. Briefly explain when and why the dinosaurs went extinct.

**16. Evolution of plants (4 p)**

During the Phanerozoic, marine green algae conquered land. Briefly describe at least four adaptations that were necessary for algae to evolve into land plants.