Name: _____ **Date:** _____

Answer Key: Interstellar Crisis: Collegiate Climate Synthesis

Challenge students to model feedback loops and planetary shifts in this high-stakes assessment of advanced thermodynamics and geochemical forcing.

---

1. Which mechanism best describes the 'clathrate gun hypothesis' and its potential impact on Quaternary climate sensitivity?

Answer: B) The abrupt release of methane from permafrost and seafloor sediments via positive thermal feedback

The clathrate gun hypothesis suggests that rising ocean temperatures could trigger a sudden release of methane from sea-floor hydrates, leading to an irreversible warming spiral.

2. The _____ refers to the phenomenon where the Arctic warms faster than the global average due to the loss of sea ice and subsequent change in surface reflectivity.

Answer: C) Arctic Amplification

Arctic Amplification is driven by the ice-albedo feedback loop, where melting ice exposes darker water that absorbs more solar radiation, accelerating regional warming.

3. Equilibrium Climate Sensitivity (ECS) is defined as the long-term rise in global temperature resulting from a doubling of atmospheric CO2 concentrations.

Answer: A) True

ECS is a critical metric in climate modeling used to estimate the Earth system's thermal response to a sustained doubling of CO2 relative to pre-industrial levels.

4. In the context of the Atlantic Meridional Overturning Circulation (AMOC), what is the primary risk associated with increased freshwater flux from the Greenland Ice Sheet?

Answer: B) A reduction in the density of North Atlantic surface waters, potentially halting the thermohaline conveyor

Freshwater reduces the density of surface water in the North Atlantic, which can prevent it from sinking, thereby weakening or collapsing the global ocean circulation system.

5. Which isotope ratio is primarily utilized in paleoclimatology to reconstruct sea surface temperature and ice volume from foraminifera shells?

Name: _____ **Date:** _____

Answer: B) O-16 to O-18

The fractionation of Oxygen isotopes (delta-O-18) is a proxy for both global ice volume and local temperature, as lighter O-16 is preferentially evaporated and locked in glaciers.

6. The _____ effect describes the cooling influence of sulfate particles in the stratosphere, which is often discussed as a potential but risky geoengineering pathway.

Answer: A) Stratospheric Aerosol Injection

Stratospheric Aerosol Injection (SAI) mimics volcanic eruptions by spraying reflective particles into the upper atmosphere to increase the planet's albedo.

7. A 'Negative Emission' strategy refers specifically to the practice of reducing carbon footprints to zero through lifestyle changes like plant-based diets.

Answer: B) False

Negative emissions refer to technical or biological processes (like BECCS or DAC) that actively remove CO2 from the atmosphere, rather than just reducing current output.

8. How does ocean acidification specifically inhibit the biological pump in pelagic ecosystems?

Answer: B) By lowering the saturation state of calcium carbonate, making it difficult for calcifying organisms to build structures

As seawater absorbs CO2, its pH drops and the concentration of carbonate ions decreases, which impairs the ability of organisms like coccolithophores to form shells.

9. In the Keeling Curve, the annual 'sawtooth' oscillation in atmospheric CO2 concentration is primarily caused by _____ in the Northern Hemisphere.

Answer: B) Seasonal vegetation growth

The Northern Hemisphere's massive land areas undergo seasonal photosynthesis, drawing down CO2 during spring and summer and releasing it during autumn decay.

10. The RCP (Representative Concentration Pathway) 8.5 scenario represents a 'business-as-usual' world with high greenhouse gas emissions and significant warming by 2100.

Answer: A) True

Name: _____ Date: _____

RCP 8.5 is the highest forcing scenario used by the IPCC, assuming a future with few climate policies and continued high reliance on fossil fuels.