Name: _____ **Date:** _____

Answer Key: Stellar Synthesis: Superlative Senior-Level Space Survey

Examine the Lambda-CDM model and baryon acoustic oscillations to decode the gravitational evolution of large-scale structures in our expanding cosmos.

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1. In the context of the ΛCDM model, what specific role does the Integrated Sachs-Wolfe (ISW) effect play in our understanding of the universe's evolution?

Answer: B) It provides evidence for dark energy by observing photon energy shifts as they traverse evolving potential wells.

The ISW effect occurs when CMB photons pass through gravitational potentials of large-scale structures that change as the universe expands; in a flat universe, this change is a signature of dark energy.

2. The GZK (Greisen-Zatsepin-Kuzmin) limit suggests that ultra-high-energy cosmic rays from distant galaxies are suppressed due to interactions with the Cosmic Microwave Background.

Answer: A) True

The GZK limit is a theoretical upper limit on the energy of cosmic rays from distant sources, caused by interactions with CMB photons over long distances.

3. The _____ relation is a correlation for spiral galaxies that links their rotational velocity to their total luminosity, effectively serving as a distance indicator.

Answer: C) Tully-Fisher

The Tully-Fisher relation specifically addresses the relationship between the width of the 21-cm line (rotation) and luminosity in spiral galaxies.

4. Which mechanism is primarily responsible for the 'quenching' of star formation in massive elliptical galaxies located within dense galaxy clusters?

Answer: B) AGN feedback and ram-pressure stripping

Active Galactic Nucleus (AGN) feedback injects energy into the interstellar medium, while ram-pressure stripping removes gas as galaxies move through the intracluster medium, both halting star formation.

5. The _____ epoch refers to the period between roughly 150 million to 1 billion years after the Big Bang when the neutral hydrogen in the intergalactic medium became ionized.

Name: _____ **Date:** _____

Answer: B) Reionization

Reionization occurred when the first stars and quasars emitted high-energy UV radiation that stripped electrons from neutral hydrogen atoms.

6. According to the Jeans Criterion, a molecular cloud will collapse only if its internal gas pressure exceeds its self-gravitational potential energy.

Answer: B) False

The Jeans Criterion states the opposite: collapse occurs when gravity overcomes the internal gas pressure (thermal energy).

7. What does the 'Flatness Problem' in classical Big Bang cosmology refer to?

Answer: B) The extreme fine-tuning required for the initial density of the universe to result in the near-critical density observed today.

The Flatness Problem highlights that if the early universe deviated even slightly from the critical density, the curvature would have grown exponentially over time.

8. The _____ field is a scalar field theorized to have driven the exponential expansion of the universe during the first fraction of a second after the Big Bang.

Answer: B) Inflaton

The inflaton field is the hypothetical field responsible for Cosmic Inflation, which solved the horizon and flatness problems.

9. Which of the following describes the 'Laniakea' structure in the local universe?

Answer: A) A supercluster of galaxies defined by the flow lines of cosmic velocity fields.

Laniakea is our home supercluster, mapped by defining boundaries based on the peculiar velocity toward a common gravitational center.

10. In the hierarchical model of galaxy formation, large elliptical galaxies are formed primarily through the 'monolithic collapse' of a single, giant gas cloud rather than mergers.

Answer: B) False

Modern cosmology favors the hierarchical model, where large galaxies (especially ellipticals) are built over time through the mergers of smaller systems.

Name: _____ Date: _____