Advanced Cosmological Principles

Cosmology · Answer Key · 25 Questions

1. What is the numerical value of the Hubble constant, expressed in km/s/Mpc, as determined by the Planck mission's analysis of the CMB?

A) 67.4
B) 73.2
C) 69.8
D) 71.9

2. The Sunyaev-Zeldovich effect is primarily caused by the interaction of cosmic microwave background photons with what?

A) Cold dark matter
B) Hot electrons in galaxy clusters
C) Primordial magnetic fields
D) Baryonic acoustic oscillations

3. Which fundamental epoch in the early universe saw the transition from an opaque, photon-baryon plasma to a transparent universe?

A) Hadron Epoch
B) Recombination
C) Inflation
D) Electroweak Symmetry Breaking

4. The Sachs-Wolfe effect describes the shift in energy of CMB photons as they travel through what?

A) Galactic magnetic fields
B) Changing gravitational potentials
C) Dense clouds of interstellar dust
D) High-velocity ionizing radiation

5. What is the characteristic temperature of the cosmic microwave background radiation today?

A) 2.725 K
B) 3.141 K
C) 1.826 K
D) 4.002 K

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6. Which element has the highest primordial abundance by mass in the universe, following hydrogen and helium-4?

A) Lithium-7
B) Deuterium
C) Beryllium-9
D) Boron-11

7. What defines the 'Baryon Acoustic Oscillation' (BAO) feature observed in the distribution of galaxies?

A) The sound horizon at recombination
B) The turbulence of the Big Bang
C) The effect of dark energy on clustering
D) Gravitational lensing by dark matter halos

8. In the Friedmann-Lemaître-Robertson-Walker (FLRW) metric, what parameter represents the spatial curvature of the universe?

A) w
B) k
C) Omega_m
D) H

9. Which particle is currently considered the primary candidate for Cold Dark Matter in the Lambda-CDM model?

A) Axion
B) WIMP
C) Sterile neutrino
D) Graviton

10. The 'Jeans Mass' is the critical value for what physical process in the early universe?

A) Gravitational collapse of gas clouds
B) Expansion rate of the cosmos
C) Nucleosynthesis efficiency
D) Formation of the cosmic web

11. What is the primary evidence for the acceleration of the universe's expansion?

A) Redshift of Type Ia supernovae
B) Anisotropies in the CMB
C) Abundance of light elements
D) Spectral shift of Quasars

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12. In the context of the Big Bang, what is the duration of the Inflationary epoch?

A) 10^-32 seconds
B) 10^-6 seconds
C) 380,000 years
D) 100 million years

13. The Alcock-Paczynski effect is used to constrain what cosmological parameter?

A) Matter density
B) Expansion history
C) Dark matter mass
D) Neutrino oscillations

14. Which term in the Friedmann equation represents the current energy density of the vacuum?

A) Omega_lambda
B) Omega_k
C) Omega_b
D) Omega_r

15. What is the significance of the 'GZK limit' in high-energy astrophysics?

A) Maximum energy for cosmic rays
B) Density limit for galaxies
C) Size limit for black holes
D) Temperature limit for the universe

16. What is the approximate age of the universe according to the Planck 2018 results?

A) 13.8 billion years
B) 12.6 billion years
C) 14.4 billion years
D) 15.2 billion years

17. Which type of inflation predicts the existence of 'preheating' as a mechanism to produce particles?

A) Slow-roll inflation
B) Eternal inflation
C) Chaotic inflation
D) Hybrid inflation

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18. The 'Cosmic Web' is composed primarily of which two components?

A) Filaments and Voids
B) Clusters and Superclusters
C) Stars and Planets
D) Black holes and Quasars

19. What does the 'Big Freeze' (Heat Death) scenario predict for the ultimate fate of the universe?

A) Infinite expansion and entropy maximization
B) A final collapse to a singularity
C) Transition to a new vacuum state
D) Cyclical rebirth

20. Which discovery provided the first strong confirmation of the Big Bang over the Steady State theory?

A) Cosmic Microwave Background
B) Dark Matter detection
C) Inflationary expansion
D) Baryon Acoustic Oscillation

21. The 'Lyman-alpha forest' is a set of absorption lines observed in the spectra of what?

A) Distant quasars
B) Nearby stars
C) Active galactic nuclei
D) Supernova remnants

22. Which epoch followed the Big Bang Nucleosynthesis but preceded the Recombination?

A) Photon Epoch
B) Dark Ages
C) Hadron Epoch
D) Era of Matter Domination

23. What is the 'Hubble Volume'?

A) The region where the recessional velocity < c
B) The total volume of the observable universe
C) The volume of the early universe at t=0
D) The scale of galaxy clusters

24. What is the value of the 'deceleration parameter' (q0) in a flat, matter-dominated universe?

A) 0.5
B) 1.0
C) 0
D) -1.0

25. What is the 'reionization' period associated with?

A) Formation of the first stars
B) Big Bang nucleosynthesis
C) Inflation ending
D) Galaxy mergers

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