

Which of the following is the best description of an Sc galaxy?

- A) a barred spiral galaxy with a very bright nucleus
- B) a spiral galaxy with loose, open arms
- C) a relatively faint quasar
- D) an irregular galaxy in the Sculptor cluster

One would expect the Hertzsprung-Russell diagram of an elliptical galaxy to resemble that of

- A) globular star cluster
- B) open star cluster
- C) star formation region
- D) supernova remnant

A rotation curve for a galaxy is a plot of

- A) orbital speed versus distance from center
- B) number of rotations versus time
- C) orbital distance versus eccentricity
- D) temperature versus luminosity

What evidence do we have that galaxies have extended haloes of dark matter?

- A) orbital speed doesn't fall off in the outer parts of galaxies
- B) the outer parts of galaxies are intense infrared sources
- C) light from background galaxies is blocked by the dark matter
- D) the orbits of distant globular clusters are distorted by the dark matter

How was Hubble able to determine the distances of nearby galaxies?

- A) by using radar
- B) by measuring trigonometric parallaxes
- C) by measuring the typical angular separations of stars in them
- D) by observing Cepheid variables in them

A galaxy at a distance of 100 Mpc is receding at 6000 km/s. How far away is a galaxy that is receding at 18,000 km/s?

- A) 300 Mpc
- B) 5400 Mpc
- C) 33 Mpc
- D) 11 Mpc

Hubble's law describes the relationship between

- A) red shift and velocity
- B) age and mass
- C) distance and velocity
- D) distance and age

B, A, A, A, D, A, C.

How do we know that the quasars are at large distances?

- A) they are extremely dim
- B) they have large redshifts
- C) they have large parallaxes
- D) they are greatly obscured by interstellar dust

How do we know that quasars are no larger than the solar system?

- A) they vary in brightness on a timescale of days or weeks
- B) they appear point-like when viewed through a telescope
- C) they contain black holes, which must be small
- D) they are too luminous to be very large

Absorption lines in quasars are usually at lower redshifts. They are likely caused by

- A) black holes at the center of quasars
- B) intervening matter between the quasar and the observer
- C) clouds of hydrogen in the back of the quasar
- D) new galaxies surrounding the quasar

The Local Group is:

- A)** a group of about 30-50 galaxies containing the Milky Way galaxy
- B)** the local group of Population II stars in the solar neighborhood
- C)** a large supercluster of galaxies centered on the Milky Way
- D)** all stars within 10 pc. of the sun

Which of the following statements about the Local Group of galaxies is true?

- A)** it contains a few dozen galaxies
- B)** the Milky Way is the only large spiral galaxy in the Local Group
- C)** the Virgo cluster is part of the Local Group
- D)** the galaxies in the Local Group are all rushing toward the Milky Way

Which of the following types of galaxies make up the majority of the members of the local group?

- A)** elliptical
- B)** spiral
- C)** barred spiral
- D)** irregular

The Virgo Cluster of galaxies is receding from us at about 1500 km/sec. How does its distance compare with the diameter of the Milky Way galaxy?

- A)** its distance is about ten times the diameter of the Milky Way
- B)** its distance is about 50 times the diameter of the Milky Way
- C)** its distance is about 500 times the diameter of the Milky Way
- D)** its distance is about 10000 times the diameter of the Milky Way

Which of the following statements best describes the distribution of galaxies in the universe?

- A)** the galaxies lie on sheets and chains surrounding empty regions
- B)** the galaxies are distributed uniformly in space
- C)** there are a few large clusters of galaxies with nothing in between
- D)** there are many clusters near us in space, but nothing beyond

A, A, A, C, A

Evidence that much of the mass of the universe consists of dark energy has come from

- A) measuring the density of matter in the solar system
- B) determining the distance to the Coma cluster
- C) determining the distances to quasars
- D) observing extremely distant supernovae

Which of the following is NOT an implication of Hubble's law?

- A) the universe is expanding
- B) we are in the center of the universe
- C) the universe had a beginning
- D) the universe was once denser than it now is

The expansion age of the universe is about

- A) 1 billion years
- B) 10 billion years
- C) 100 billion years
- D) 1000 billion years

If the universe is dominated by dark energy, then the rate of expansion of the universe is

- A) slowing down
- B) accelerating
- C) exactly constant with time
- D) zero, the universe is neither expanding or contracting

Most of the helium in the universe was produced

- A) in stars
- B) in quasars
- C) at the time the cosmic background radiation was formed
- D) during the first ten minutes of expansion

Suppose our universe has positive curvature. Which of the following statements would be FALSE?

- A) the universe has a center
- B) the universe will eventually begin to contract
- C) the universe has a finite volume
- D) the universe has no boundary

Why can't we see radiation produced during the first 300,000 years of the history of the universe?

- A) it was all absorbed and destroyed soon after it was emitted
- B) it hasn't reached us yet
- C) it has been deflected by black holes
- D) it passed by our part of the universe a few billion years ago

What will happen if the density of the universe is less than the critical density?

- A) the universe will contract
- B) the universe will contract and then rebound
- C) the universe will stop expanding, but not begin to contract
- D) the universe will expand forever

Which of the following is not true of the cosmic background radiation?

- A) it is nearly equally bright in all directions
- B) it is starlight
- C) it was produced about a million years after the beginning of the expansion
- D) it is brightest in the radio (microwave) part of the spectrum

D, B, B, B, D, A, A, D, B

The term "metastable levels" refers to

- regions within a molecular cloud that are not moving relative to the rest of the cloud.
- the upper energy level of the 21-cm transition in the hydrogen atom.
- the lower energy level of the 21-cm transition in the hydrogen atom.
- the boundary layers between HI regions and the hotter intercloud medium.
- energy levels in an atom that require a much longer time than average to decay and emit a photon.

The sky appears blue during the day because

- small dust particles in the atmosphere absorb blue light less efficiently than red light.
- small dust particles in the atmosphere scatter blue light more efficiently than red light.
- the atmosphere contains a large amount of water vapor which, in large quantities, appears blue.
- 70% of Earth's surface is water and its blue color is reflected off small particles in the atmosphere.
- the ozone in the atmosphere absorbs ultraviolet light and passes more red light than blue.

To an observer on Earth, dust in the interstellar medium will cause a star to appear

- brighter and cooler than it really is.
- brighter and hotter than it really is.
- fainter and cooler than it really is.
- fainter and hotter than it really is.
- unchanged in brightness or apparent color.

_____ require(s) that a young hot star ($T \geq 25,000$ K) be relatively nearby.

- HII regions
- HI regions
- Molecular clouds
- The hot gas of the interstellar medium
- 21 cm radiation

Elements such as iron, calcium, and titanium are less abundant in the interstellar medium than in the sun. This is most likely due to these elements

- not producing spectral lines, and hence we underestimate their abundances.
- being destroyed by ultraviolet photons.
- having condensed to form dust grains.
- being created in the photospheres of stars like the sun and not in low density gas clouds.
- forming the coronal gas that only emits X rays.

Coronal gas radiates energy at

- a. gamma-ray wavelengths.
- b. x-ray wavelengths.
- c. visible wavelengths.
- d. infrared wavelengths.
- e. radio wavelengths.

_____ is/are believed to be produced by supernova explosions.

- a. Coronal gas
- b. HI clouds
- c. Molecular clouds
- d. Reflection nebulae
- e. Dark nebulae

The presence of forbidden lines in the spectra of emission nebula indicates that the

- a. nebula has a very high temperature.
- b. nebula contains large amounts of hydrogen.
- c. gas in the nebula has a very low density.
- d. dust in the nebula is composed of very small grains of silicates and carbon.
- e. nebula is very near a star whose temperature is less than that of the sun.

E, B, C, A, C, B, A, C

The look-back time is

- a. how long the light from an object takes to reach Earth.
- b. numerically equal to the distance in light-years.
- c. smaller for more distant objects.
- d. all of the above
- e. a and b above

If H equals 50 km/sec/Mpc , then a galaxy with a radial velocity of 2000 km/sec probably has a distance of

- a. 2050 Mpc
- b. 1950 Mpc
- c. 40 Mpc
- d. 0.025 Mpc
- e. 100,000 Mpc

E, C