

Name _____

Period _____

Questions for Understanding – 1919 Cosmic Times

1. According to Astronomers in 1919, what are the age and size of the Universe?

Age Infinite Size 300,000 ly

Sun's Gravity Bends Starlight

2. Both Newton and Einstein's theories of gravity made predictions about light. What was the SAME about their predictions?

They both predict that massive objects like the sun will bend light

3. What was different about their predictions?

How much the light would bend
Einstein predicted it would bend twice as much

4. Of the two, whose prediction was proven to be most accurate?

Einstein

Why did scientists need a total solar eclipse to detect the bending of starlight around the Sun?

It allowed them to view the Hyades cluster during the day and then compare it to months later when it wasn't near the sun

Mt. Wilson Astronomer Estimates Milky Way 10 Times Bigger Than Previously Thought

6. Describe the size and shape of the galaxy, according to Shapley.

disk-shaped, 10x bigger than previously thought
300,000 ly.

7. Where is the sun located in the galaxy?

closer to the edge than the center

8. What special collection of stars did Shapley study to learn the size and structure of the galaxy?

9. Why did Shapley believe there could be no other galaxies outside the Milky Way?

They would have to be "inconceivable" distances away to look the way they do in our sky
globular cluster

Expanding or Contracting?

10. Why did Einstein add the cosmological constant to his equation for General Relativity? What problem did it solve?

His mathematical model predicted the universe had to be either expanding or contracting. He believed that was wrong, so he added the

Questions for Understanding – 1929 Cosmic Times

1. According to Astronomers in 1929, what are the age and size of the Universe?

Age 2 billion years Size 280 million ly.

Andromeda "Nebula" Lies Outside the Milky Way Galaxy

2. Explain what Dr. Edwin Hubble discovered about our galaxy.

"Spiral nebulae"
That our galaxy is one of many others and that "Spiral nebulae" are actually different galaxies very far from the Milky Way

3. What types of stars did Hubble find in the Andromeda Galaxy that allowed him to calculate its distance?

Cepheid Variable Stars

4. Who was the first person to recognize the importance of Cepheid variable stars?

Henrietta Leavitt

5. What three types of galaxies did Hubble identify?

Elliptical Spiral Barred Spiral

The Universe is Expanding

6. Using the 100-inch Hooker Telescope, Hubble discovered two things that prove the universe is expanding. Describe those discoveries.

Red Shift + Expanding Universe -

Galaxies are moving away from us
The further away, the faster they are moving. (Hubble Constant)

7. Before 1929 a famous scientist developed a very famous theory that predicted the Universe should expand. Who was the scientist and what was the name of the theory?

Einstein's Theory of General Relativity

(He's still not convinced the universe is expanding)

Questions for Understanding – 1955 Cosmic Times

1. According to Astronomers in 1955, what are the age and size of the Universe?

Age 6 billion years Size 4-8 billion ly

Death of a Genius

2. Albert Einstein's ideas provide the basis for which science?

modern physics

Origin of Everything: Hot Bang or Ageless Universe?

3. Name the two competing theories that explain the nature of the universe and the scientists who support each theory.

steady-state theory - Hoyle, Greenstein, Fowler

evolutionary theory - Gamow, Alpher, Herman

4. What behavior of the Universe do both theories explain?

the fact that the Universe is expanding

5. What direct evidence of a gigantic blast does George Gamow think must exist?

faint left-over heat in the form of microwaves

6. What is needed to determine which theory is correct?

more research & better telescopes

'Yardsticks' in Neighbor Galaxy Double Universe's Size

7. What did Walter Baade discover about the size of the universe?

twice as large as we thought

8. Explain how the distance to a star can be calculated based on the period (cycle time) of Cepheid variable stars.

using rate of pulsing to determine how bright they are, and then comparing that to how bright they look, you can calculate distance

9. Dr. Baade discovered an error in Dr. Shapley's work. Describe the error.

There are two types of Cepheids, and each type has a different period to luminosity relationship (yardstick)

Questions for Understanding – 1965 Cosmic Times

1. According to Astronomers in 1965, what are the age and size of the Universe?

Age 10-25 billion years Size 25 billion ly

Murmur of a Bang

2. What type of radiation was discovered coming from all regions of space?

microwaves (Cosmic Background Radiation)

3. What is the importance of this discovery?

Evidence for "Big Bang" (evolutionary theory) that the universe was once very small + hot + it expanded + cooled

4. Why does this discovery weaken the Steady State Theory of the Universe?

It can not explain the presence of this cosmic background radiation

Quasars: Express Train to Netherlands

5. What do we know about the speed and brightness of quasars?

very fast + very bright

6. What do scientists hope to learn by studying quasars?

more about the size + shape of the universe

Galaxies Still Misbehaving

2. How are galaxies misbehaving?

In NGC 3521 and NGC 972, astronomers are finding they the amount of light we see doesn't match what we would expect from that much matter.

3. How much of the mass in the Coma cluster of galaxies appears to be "missing" or not giving off light?

99%

Questions for Understanding – 1993 Cosmic Times

1. According to Astronomers in 1993, what are the age and size of the Universe?

Age 12-20
Billion years Size 30 billion ly

Baby Universe's 1st Picture

2. Explain the stages of the Big Bang.

The Universe started as a dense ball of energy that began to expand, distributing hot radiation and space outward in all directions. As the Universe expanded and cooled, it produced quarks and electrons, then protons and neutrons. These combined to make hydrogen and helium. This hot gas gave off radiation in all directions that gradually cooled into microwave energy range, which scientists call the cosmic microwave background (or CMB).

3. What is significant about the "lumps" in the map created by COBE?

The "lumps" in the early universe 300,000 years after the Big Bang lead to the current structures in the universe (galaxies, stars, etc) through gravity.

Cool-proofing Galactic 'Candles'

4. In your own words, explain the meaning of the term "standard-candle".

It is a ~~star~~ celestial object that we can use for a comparison to calculate distances.

Dark Matter Hunt Heats Up

5. Why was the ROSAT's discovery of a gigantic gas cloud so unexpected?

It's great heat should have made it dissipate quickly.

6. What is needed to hold the gas there?

strong gravitational force (caused by large amount of matter)

7. What are two ideas that try to explain what "dark matter" is?

- 1) Sub-atomic particle that has mass but only interacts with normal matter through gravity (WIMP)
- 2) dark, dead stars that we can't detect, mostly near galactic disk

Questions for Understanding – 2006 Cosmic Times

1. According to Astronomers in 2006, what are the age and size of the Universe?

Age 13.7 billion years Size 94 billion light years

Faster Walk on the Dark Side

2. As of now, what two things are known about "dark energy"?

- it works against gravity

- it causes galaxies to move apart faster than expected

3. In 1998, what did two teams of astronomers discover about the rate of expansion of the Universe?

Galaxies are moving apart faster than they should be

Seeds of Modern Universe

4. What is the significance of the WMAP data?

much clearer than COBE, shows "peaks" in temperature, the variations were the seeds of galaxy clusters

5. What are the seeds of the gigantic clusters of galaxies found today?

Biggest Mystery: What is Dark Energy?

6. Using the graph, what is the composition of our Universe?

Dark Energy 73%, Atoms 4%, Dark Matter 23%

Sorting out Dark Stuff

7. What "bad news" and "good news" does this article discuss?

bad - matter we can see is only 4% of univers

Good - we are starting to understand the other 96%

8. How did dark matter and dark energy get their names?

B/C we can't see them directly

9. What do we know about dark matter?

it must be there to explain gravitational effects, it does not interact w/ normal matter except through gravity

10. What do we know about dark energy?

It flings everything else apart at faster + faster rates.