Q: Describe different methods to estimate the age of Universe?

1- Calculating the expansion rate of the universe:

According to scientists, the universe is approximately 14 billion years old. It is the age of the universe that is estimated from the big bang. According to this method, we assume that the universe is expanding at a constant rate by using Hubble's constant (Ho).

Hubble noted that the distance of a galaxy is directly proportional to its speed, and means. The further the galaxy was, it was moving away.

$$d=vt$$

$$t=d/v$$

where, $v= Hod$

$$t=d/ Hod$$

$$t=1/H$$

Hence, scientists were able to use the Hubble constant to estimate the age of the universe by working backwards to Big Bang.

2- By determining the age of the oldest universe:

Scientists determine the age of the universe from the following

✓ **Spectrum:**

The star's spectrum helps determine the age of stars because blue stars tend to die faster than red stars.

✓ **Luminosity**:

A brighter star will exhaust its energy faster than a less bright star. Therefore, the star with less luminous intensity exists for a longer time than with a more luminous intensity

✓ **Mass:**

The amount of a star's mass also helps in finding the life of a star. If a star is dense, it tends to die quickly as compared to a less dense star. Thus, the density factor also helps calculate a star's life.

✓ **Motion/Speed:**

The brighter star tends to have more energy; in turn, its speed will be greater than the comparatively less luminous star. Eventually, the brighter star will consume its energy quickly and die before the other less bright star, thus, will have a short life and vice versa.

Mass of Oldest globular clusters also helps in finding age of universe:

The oldest globular clusters contain only stars less massive than 0.7 solar masses. These low mass stars are much dimmer than the Sun. This suggests that the oldest globular clusters are between 11 and 18 billion years old. The uncertainty in this estimate is due to the difficulty in determining the exact

distance to a globular cluster (hence, an uncertainty in the brightness (and mass) of the stars in the cluster).

Another way to estimate the age of Universe using Hubble Constant

- The Hubble constant (H_0) is a measure of the current expansion rate of the Universe. Cosmologists use this measurement to extrapolate back to the Big Bang. This extrapolation depends upon the current density of the Universe and on the composition of the Universe.
- If the Universe is flat and composed mostly of matter, then the age of the Universe is $2/(3\ H_0)$. If the Universe has a very low density of matter, then its extrapolated age is larger: $1/H_0$. If the theory of general relativity is modified to include a cosmological constant, then the inferred age can be even larger.
- The current best estimates of H_0 range from 50 kilometers/sec/Megaparsec to 100 km/s/Megaparsec. In more familiar units, astronomers believe that $1/H_0$ is between 10 and 20 billion years.
- ***POTENTIAL CRISIS IN COMPARE THE TWO AGE DETERMINATIONS***

If the astronomers who estimate that $1/H_0$ is as small as 10 Billion years are correct, then the age of the Universe would be shorter than the age of its oldest stars. This contradiction implies that either the Big Bang theory is incorrect or that we need to modify general relativity by adding a cosmological constant.

If the astronomers who have measured the larger values of $1/H_0$ are correct and the smaller estimates of globular cluster ages are also correct, then all may be well for the Big Bang theory.

Q: Discuss the Evidences of Bigbang?

Einstein Equation

"Energy can neither be created nor destroyed."

Einstein's famous equation, $E = mc^2$, also validates this theory. According to this equation, matter and energy can be converted into each other. And this theory also states that the singularity contained undifferentiated matter and energy, which resulted in matter and energy after expansion.

According to the E=mc 2 equation, energy and matter are different forms of the same thing, like steam and water. Here are salient points of this theory which clearly shows Energy has always been present in Universe and this universe is formed by using that energy.

Salient points of the theory:

Before expansion

- When there was nothing, there was a singularity, highly dense and very hot.
- All matter and energy were present in the singularity in undifferentiated manner.
- Gravity was strong enough to hold mass and energy together.
- At that time, there were no space and time.
- Somehow opposite force dominated gravity and singularity began to expand.

After the start of expansion

- Time and space came into existence
- The temperature of singularity started drastically decreasing.
- Formation of atomic sub particles took place, and, consequently, first atom, Helium, came into existence.
- With the decrease in temperature, other elements also came into existence.
- When these elements came into contact with each other, they laid the foundation of constituents of the universe: stars, plants, galaxies, asteroids, gases, dust etc.

Hubble's Law and Hubble Constant:

- Hubble's law provides a strong base to this theory to be accepted. According to this law, "all the galaxies are moving away from each other with certain receding speed, which is proportional to the distance between their centres, as evidenced by red shift". He observed the red shift, a phenomenon in which the energy of a wave emanating out of a body decreases as it moves away, while galaxies were moving away from each other. So, it means that if the galaxies are moving away from each other, at some point of time, they were united.

Hubble Constant:

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If the astronomers who have measured the larger values of $1/H_0$ are correct and the smaller estimates of globular cluster ages are also correct, ***then all may be well for the Big Bang theory.***

A second piece of evidence that supports the big bang theory is cosmic background microwave radiation. Arno Penzias and Wilson detected a **cosmic microwave background radiation** while studying radio signals. These radiations are received from all parts of the universe and is thought to be the heat left over from the original expansion or big bang.

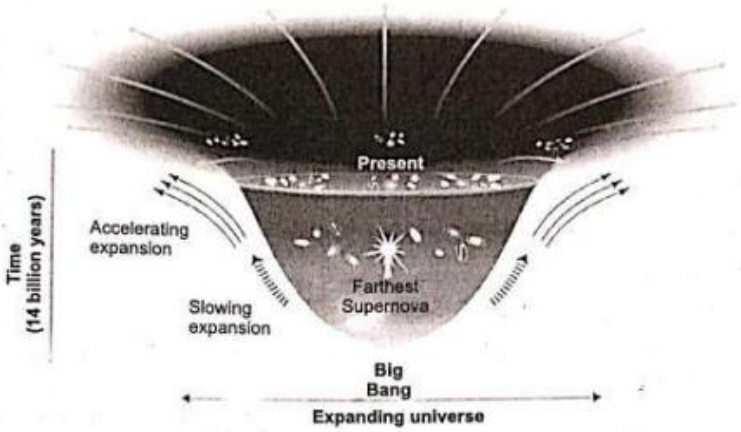


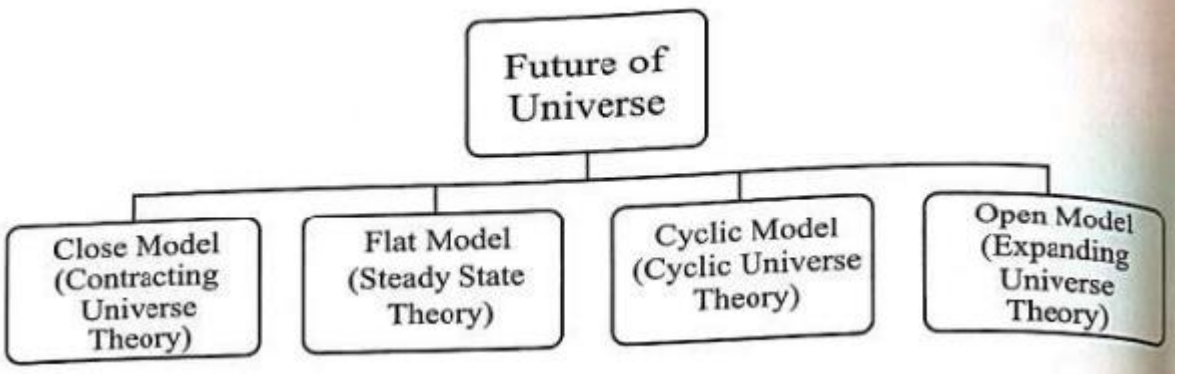
Figure: Big Bang

Q: What is the shape of the universe? Or Will the universe ever expanding?

The Ultimate Fate of the Universe

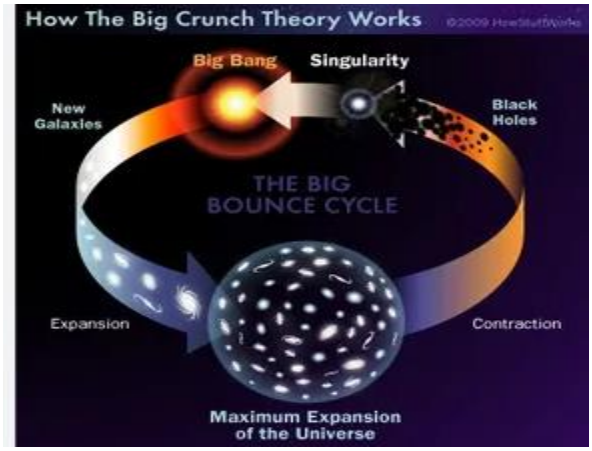
Once the notion that the universe started with a rapid expansion nicknamed the Big Bang became accepted by the majority of scientists, the ultimate fate of the universe became a valid cosmological question, one depending upon the physical properties of the mass/energy in the universe, its average density, and the rate of expansion.

There is a growing consensus among cosmologists that the universe is flat and will continue to expand forever. The ultimate fate of the universe is dependent on the shape of the universe and what role dark energy will play as the universe ages. Astronomers recognize four models of possible futures for the universe.



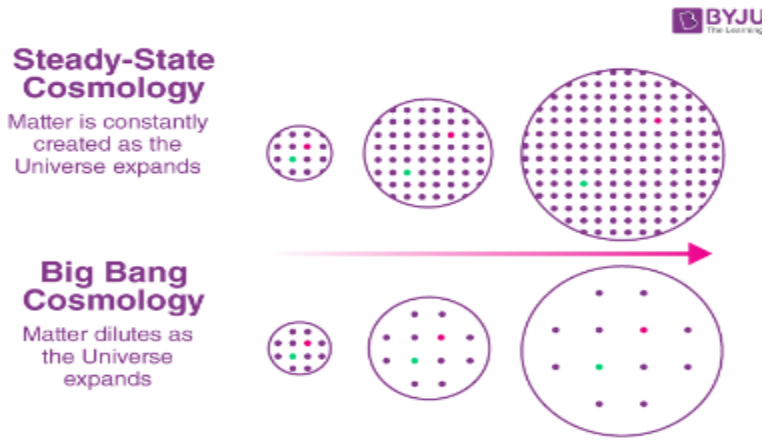
Close Model:

According to this theory, the universe will one day stop expanding. Then, as gravity pulls on the matter, the universe will begin to contract, falling inward until it has collapsed back into a super-hot, super-dense singularity. **If the theory holds true, the universe** is like a **giant soufflé**. It starts out small, then expands as it heats up. Eventually, however, the soufflé cools and begins to collapse.



Steady-state theory, According to this theory **Universe is flat . Flat universe** (in which expansion continues infinitely but gradually approaches a rate of zero) In cosmology, this theory gives a view that the universe is always expanding but maintaining a constant average density, with matter being continuously created to form new stars and galaxies at the same rate that old ones become unobservable as a consequence of their increasing distance and velocity of recession.

Difference between Steady state Theory & Big bang theory



Cyclic Theory:

In *Cycles of Time: An Extraordinary New View of the Universe* (2010), Penrose posited his theory of conformal cyclic cosmology, formulating the Big Bang as an endlessly recurring event. He received the Copley Medal of the Royal Society in 2008.

Open model theory:

- **Universe expands continuously** If space has negative curvature, there is insufficient mass to cause the expansion of the universe to stop. In such a case, the universe has no bounds, and will expand forever. This is called an open universe. Negative curvature means **shape of universe is Saddle-shaped.**

Date: / /20 Day:

Q: Cups are sold 5 to a package and plates are sold 10 to a package. If you want to have same number of each item for a party, what is the least no. of packages of each you need to buy for the party?
(sold)

Soln: No. of cups to a package = 5

No. of plate sold to a package = 10

Least No. of packages of cups and plates = ?

5	5
	1

2	10
5	5
	1

Factors of 5 = 1 × 5

" " 10 = 1 × 2 × 5

HCF = 5

For least no of packages of cup & plates, the no of cups and plates in packages should be max which is 5. Thus 5 cups and 5 plates maximum could be in a package.

No. of packages = ?

Packages of cups = 5 cups / 5 = 1 package

Packages of plates = 10 plates = 2 package

No. of packages = ?

Packages of cups = 5 cups / 5 = 1 package

Packages of plates = $\frac{10}{5}$ plates = 2 package

Least No of Packages of cups & plates = 1 + 2 = 3 packages

15

Assignment Qs

Ben exercises every 12 days & Isabel every 8 days. Ben & Isabel both exercised today. How many days will it be until they exercised together again?

2	12
2	6
3	3
	1

2	8
2	4
2	2
	1

Factors of 12 = 1 × 2 × 2 × 3

Factor of 8 = 1 × 2 × 2 × 2

C.F. = 1, 2, 2

U.C.F. = 3, 2

LCM = C.F. × U.C.F

= 1 × 2 × 2 × 3 × 2

LCM = 24 days

After 24 days they will execrise together again.

5

Date: / /20 Day:

Q A radio station is having a promotion in which every 12th caller receives a free concert ticket & every 15th caller receives a limo ride. Which caller will be the first to wine the ride? Which will be last one to wine the ride?

2	12
2	6
3	3
	1

3	15
5	5
	1

Factor of 12 = 1 × 2 × 2 × 3

Factor of 15 = 1 × 3 × 5

C.F. = 1, 3

D.C.F = 2, 2, 5

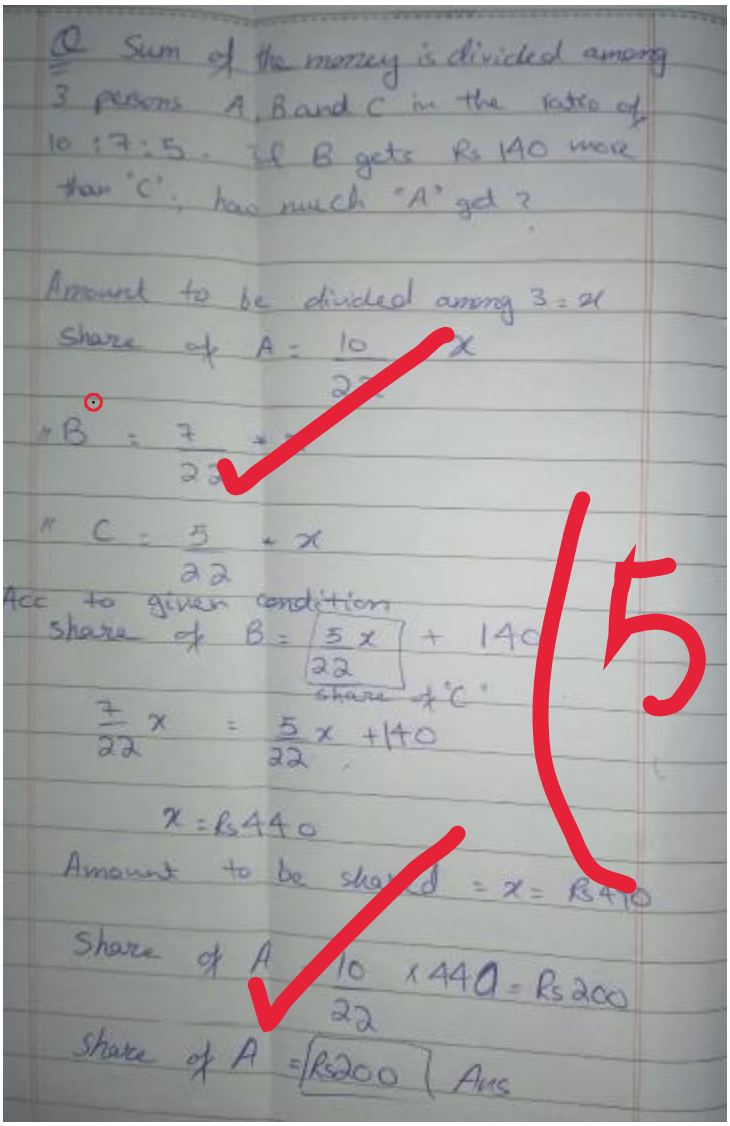
LCM = 60

12 × 5 = 60

60th caller will be the first one to wine the ride.

HCF = 1 × 3 = 3

3rd caller will be the last one to win the ride



good answers!!