The Universe Before and After Edwin Hubble

1. Examples of answers include:

a) Who—Edwin Hubble

b) What—new discoveries of other galaxies including Andromeda; changed our ideas about the universe

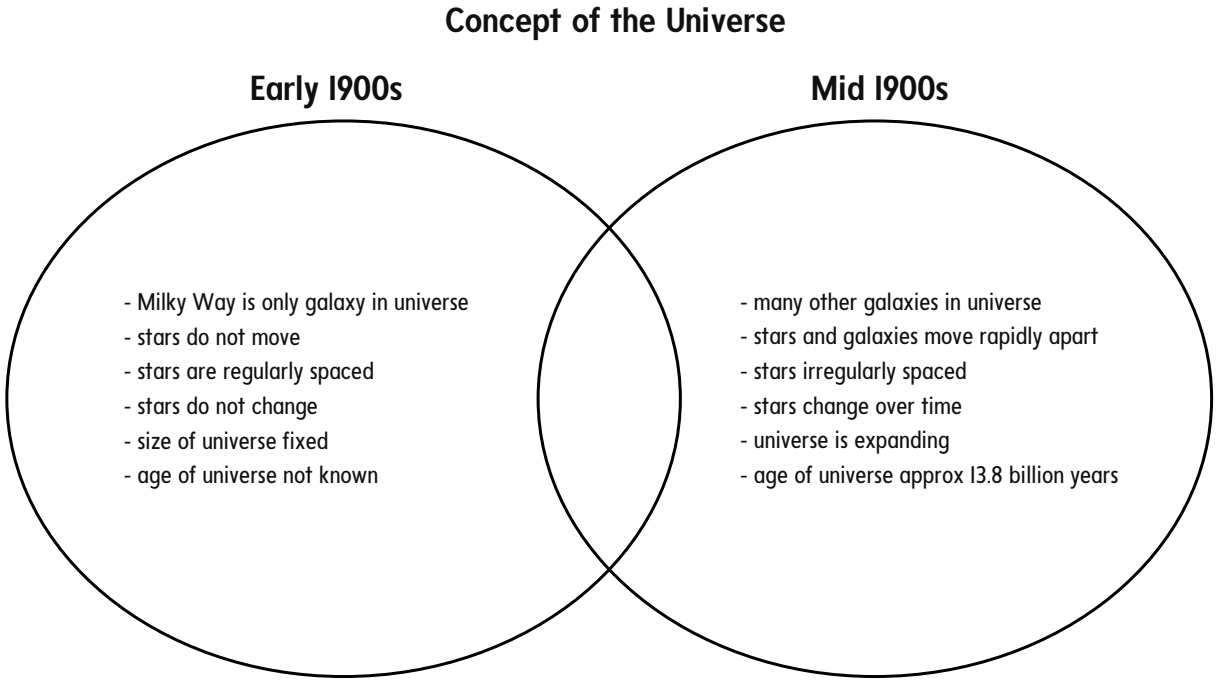
c) When—around 1924

d) Where—Mount Wilson Observatory, California, United States

e) Why—world's largest telescope at the time gave best images

f) How—new discoveries led to changes in accepted scientific ideas

2.



3. Sample answer: Edwin Hubble studied law and jurisprudence. He taught high school before starting graduate studies in astronomy. Hubble served in the United States Army during World War I. After the war, he returned to his studies. He also worked at the Mount Wilson Observatory.

His discovery of nebulae that were actually galaxies outside of the Milky Way was rejected by other astronomers. Despite this, he published his findings and presented them at a meeting of the American Astronomical Society. His findings were later accepted and changed the scientific view of the universe.

Components of the Universe

Answers may vary but could include:

	Meaning	Examples	Application to the "Universe" Concept
matter	• material, made of atoms • anything with mass and volume	• people, Earth, air, liquids, organisms	• includes us, our planet, our Sun
energy	• not matter • the ability or potential to do work	• light • heat • sound • many different electromagnetic wavelengths	• stars give off energy of many types • can be detected by different telescopes
planet	• rocky or gaseous body revolving around a star	• Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune • exoplanets now found around distant stars too	• found throughout universe too • vast universe, huge number of exoplanets
star	• huge sphere of gases • produces light and other forms of electromagnetic radiation • fuelled by nuclear fusion	• the Sun • Alpha Centauri • North Star • hundreds of billions of stars in Milky Way, and all other galaxies too	• important part of universe • can be seen in telescopes
galaxy	• huge collection of stars in an area of space	• Milky Way, our home galaxy • Andromeda galaxy • hundreds of billions of other galaxies	• big component part of the universe
space	• the final frontier • really huge • emptiness, a void	• where spaceships travel • dark	• the place where everything is located

What Do You Wonder About?

Students' responses should showcase and reflect authentic questions. This exercise provides good opportunities for students and teachers to assess Curricular Competencies, especially those that connect to Core Competencies of critical and creative thinking, as well as positive personal and cultural identity.

How Big Is Big?

How Long Ago Was...	Date (year)	Number of Years Ago (# of dimes) –for 2018	Calculation (number of years × 0.001 22 m/y)	Height of Stack of Dimes (m)	Height of Stack of Dimes (km)
your birth?	e.g., 2003	15	15 y × 0.001 22 m/y	0.02 (or 2 cm)	
your school built?	e.g., 1990	28	28 y × 0.001 22 m/y	0.03 (or 3 cm)	
Galileo born?	1564 C.E.	454	454 y × 0.001 22 m/y	0.6	

(continued on next page)

How Long Ago Was...	Date (year)	Number of Years Ago (# of dimes) –for 2018	Calculation (number of years × 0.001 22 m/y)	Height of Stack of Dimes (m)	Height of Stack of Dimes (km)
the Crab Nebula supernova bright enough to be visible in the daytime sky?	1054 C.E.	964	964 y × 0.001 22 m/y	1.2	
the end of the last glacial period?		11 700	11 700 y × 0.001 22 m/y	14.3	
Pangaea?		250 000 000	250 000 000 y × 0.001 22 m/y	305 000	305
the origin of Earth?		4.5 billion	4.5×10^9 m × $0.001\ 22 \times 10^{-3}$ m/y	5.5×10^6 5 500 000	5500
the birth of the universe?		13.8 billion	13.8×10^9 m × $0.001\ 22 \times 10^{-3}$ m/y	16.8×10^6 16 800 000	16 800

For 13.8 billion years, the stack of dimes would be close to **2000** times the height of Mount Everest.

4.1 Assessment

1. F
2. G
3. A
4. H
5. I
6. B
7. C
8. D
9. E
10. A
11. D
12. B
13. D
14. C
15. D
16. C
17. A
18. B
19. D

20. Samples of possible student responses for each of the spokes from the spider map:

Interconnectedness—we are part of the universe, related to it and all aspects of it

Reciprocity—we show care for Earth as part of the universe; we respect knowledge that comes from First Peoples sources and demonstrate gratitude for it

Transformation—change is a normal part of the universe; stars, planets, and even space change over time

Renewal—seasons change, stars are born and die, stardust becomes new stars, or even we change

Connection with place—knowledge of local star and Moon changes can be used to predict and/or plan for seasons, hunting, travelling routes, ceremonies