Unit 2: Exploring the Universe

Name: _____ Class / No: _____ Date: _____

Learning outcomes

- AST.2.1 — Comparing celestial objects
- AST.2.2 — Classifying galaxies
- AST.2.3 — Cosmic distances
- AST.2.4 — The structure of the Milky Way
- AST.2.5 — The Solar System
- AST.2.6 — The life cycle of stars

Questions

1. (AST.2.1) Which of the following produces its own light?

   ○ A) The Moon ○ B) Venus

   ○ C) Sirius ○ D) Halley's Comet

2. (AST.2.1) Why was Pluto reclassified as a dwarf planet in 2006?

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3. (AST.2.2) A galaxy whose arms start from a central bar, with a small bulge and open arms, belongs to which class?

   ○ A) E3 ○ B) S0

   ○ C) SBc ○ D) Irr

4. (AST.2.3) How many light-years away is a star with a parallax of 0.1″?

   ○ A) 0.33 ly ○ B) 3.26 ly

   ○ C) 10 ly ○ D) 32.6 ly

5. (AST.2.3) Correct the statement "We see Andromeda as it is today."

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6. (AST.2.4) Where is the Sun in the Milky Way?

   ○ A) At the centre, next to the black hole ○ B) About 26,000 ly from the centre, in the Orion Arm

   ○ C) Outside the galaxy, in the halo ○ D) At the very edge of the disc, ~50,000 ly out

7. (AST.2.5) What is the orbital period of an asteroid with a semi-major axis of 4 AU?

8. (AST.2.5) What is the main reason terrestrial planets formed in the inner region and giant planets in the outer region?

9. (AST.2.6) Which of the following stars has the shortest life?

   ○ A) 0.5 M☉ ○ B) 1 M☉

   ○ C) 2 M☉ ○ D) 15 M☉

10. (AST.2.6) How will the Sun's life end?

Score: ___ / 10

Practical tasks

1. AST.2.1: In the mission records below, write three new facts learned about a comet and a dwarf planet; compare them with the definitions in the table. (SpaceTRC records: Rosetta and Philae, Giotto and Halley, New Horizons and Pluto)
2. AST.2.2: First group 10 galaxy images using your own criteria, then compare with Hubble's classes. To classify real sky images you can join the citizen-science project Galaxy Zoo. (SpaceTRC records: Edwin Hubble, Galaxy Zoo)
3. AST.2.3: In the Star Atlas choose the "closer than 30 light-years" preset. Convert the distances of five stars to parsecs and astronomical units, and find the year their light set out. (SpaceTRC records: Star Atlas, Gaia DR3)
4. AST.2.4: Build a scale model: make the disc a circle 1 m across (1 m = 100,000 ly). Put the Sun 26 cm from the centre; the disc should be only ~1 cm thick. Read about Gaia's contribution to mapping the Milky Way in the record below. (SpaceTRC records: Gaia DR3, William Herschel)
5. AST.2.5: Calculate P^2 and a^3 for every planet in the table and confirm that the ratio is 1. Then find in the Voyager 1 record the dates the probe passed the outer planets. (SpaceTRC records: Kepler, Voyager 1, New Horizons and Pluto, NASA PDS)
6. AST.2.6: Open the colour–magnitude diagram in the Star Atlas. Find the main sequence and the giants and supergiants at the upper right; place Betelgeuse, Sirius and Sun-like stars on the diagram. (SpaceTRC records: Star Atlas, Chandrasekhar, Annie Jump Cannon, Payne)

Answer key — Unit 2: Exploring the Universe

1. C. Sirius is a star and makes its light by fusion; the others reflect sunlight.
2. Because of the three conditions in the IAU definition it does not meet the one about clearing its orbital neighbourhood; Pluto shares its orbital zone with other Kuiper belt objects.
3. C. A bar is shown by “SB”, and a small bulge with open arms by “c”.
4. D. d = 1 / 0.1 = 10 pc; 10 × 3.262 ≈ 32.6 light-years.
5. Andromeda is about 2.5 million light-years away; its light takes 2.5 million years to reach us. We see it as it was about 2.5 million years ago.
6. B. The Sun is about 26,000 light-years from the centre, in the Orion Arm.
7. P = 4^1.5 = 8 years ($P^2 = 64 = 4^3$).
8. The inner region was hot, so only rock and metal could solidify; beyond the frost line ice also froze, large cores formed, and they gathered gas to become giant planets.
9. D. Lifetime shrinks roughly as M^(−2.5); the most massive star uses up its fuel fastest.
10. In about 5 billion years it will become a red giant, its outer layers will drift off as a planetary nebula and a white dwarf will remain. The Sun is not massive enough to become a supernova.

Teacher note

For AST.2.4 the curriculum asks for a relief model: the central bulge, bar, arms and the Sun’s position can be shown with modelling clay or polystyrene on card. The lesson’s “1 m = 100,000 light-years” calculation can set the scale.

Common misconceptions: (1) A light-year is a unit of time; it is a unit of distance. (2) Hubble’s tuning-fork diagram is the evolutionary order of galaxies; Hubble proposed it as a classification, not an evolutionary sequence. (3) A comet’s tail points behind it along its path; in fact the tail always points away from the Sun. (4) Massive stars live longer; in fact they live much shorter lives.

For self-study and classroom use. Based on the Turkish Ministry of National Education Astronomy and Space Sciences curriculum.
https://spacetrc.com/en/academy/astronomy-and-space-sciences/exploring-the-universe/