Israel Open Astronomy Olympiad 2025

Junior and Senior age group problems

Quiz (20 p.)

20 questions, 1 point for each correct answer.

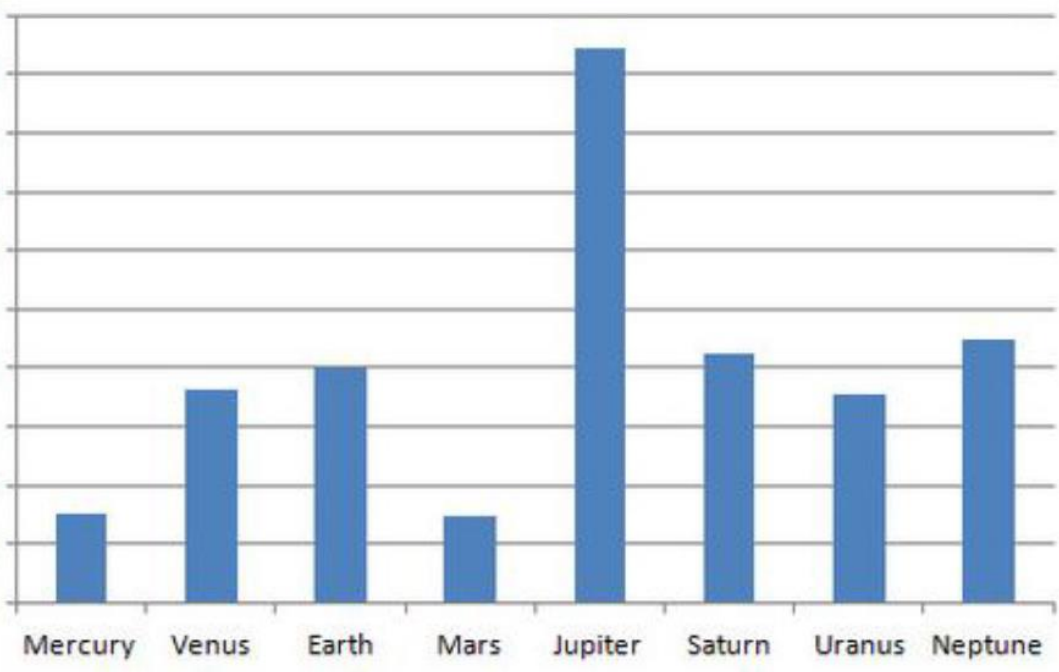
1. **Which of these stars is never visible from Israel?**
   - Antares
   - Altair
   - Algol
   - Acrux

   Answer comment: Latitude of Eilat, the southernmost city of Israel, is 29.5°N, which means that all stars with declination less than -60.5° are never visible. The declinations of the stars in questions are the following: Antares (α Scorpii) -26.5°, Altair (α Aquilae) +8.9°, Algol (β Persei) +41.0°, Acrux (α Crucis) -63.1°. Acrux is too close to the Celestial South pole to rise above horizon in Israel. The question may be answered also based on knowledge of visible constellations, as all these constellations except Crux are visible in Israel.

2. **Which of these Jupiter satellites is not a Galilean moon**
   - Amalthea
   - Io
   - Ganymede
   - Callisto

   Answer comment: The Galilean moons are four satellites of Jupiters discovered by Galileo Galilei in the first ever telescopic observations of Jupiter. They are Io, Europa, Callisto, Ganymede. Amalthea is a minor satellite orbiting closer to Jupiter that any of the Galilean moons.

3. **What is seen on the diagram below?**
   - Sizes of the planets
   - Masses of the planets
   - Free fall accelerations near surface of the planets
   - Number of known satellites



Answer comment: Incorrect options may be easily excluded. Mercury and Venus do not have any known satellites. These are not sizes or masses: diameter and mass of Saturn are much larger than that of the Earth. The only remaining option is the free fall acceleration $g = GM/R^2$. The much larger size and mass of Saturn are in the same proportion as of the Earth, Uranus and Neptune.

4. **During the year, the Sun passes through thirteen constellations. Which of the constellations below is in this list?**
   - Aquila (Aql, Eagle)
   - Gemini (Gem, Twins)
   - Ursa Major (UMa, Big Dipper)
   - Ursa Minor (UMi, Small Dipper)

Answer comment: The twelve constellations containing the ecliptic, the path of the Sun during the year, are classically called the Zodiac. When the IAU (International Astronomy Union) defined the constellation borders in 1919, the Ophiuchus (serpent-bearer) was set up to also include a part of the ecliptic, despite not being zodiacal constellation, thus the total number of constellations where the Sun may be located grew to thirteen. In the given list, Gemini is the only Zodiac constellation. Currently, the Sun is within IAU borders of the Gemini constellation from June 22 to July 21.

5. **Which of these object types has the highest visible surface temperature?**
   - Brown dwarfs
   - Yellow main sequence stars
   - Red giants
   - Hot Jupiters

Answer comment: Hot Jupiters and brown dwarfs are exoplanets and substellar objects with surface temperature below 2000 °C. The surface temperature of the red giants is about 3000 °C, whereas the temperature characteristic for yellow main sequence stars (such as the Sun) is about 5500 °C. The correct answer may also be obtained by knowing that the star temperature determines their color, and the growing temperature sequence is red – orange – yellow – white – light blue (even though called blue in English, the actual color of the hottest stars is light blue).

6. **Which of these planets will be visible tonight in the sky by a naked eye? (multiple choice)**
   - Mercury
   - Venus
   - Mars
   - Jupiter
   - Saturn

Note: +0.25p for the correct answer, -0.25p for each incorrect answer.

Answer comment: Now is the time of so-called planetary parade, when the planets, as seen from the Earth, are all visible in one half of the ecliptic. Venus, Saturn, Jupiter and Mars are all prominently visible in the evenings after the sunset. Uranus and Neptun are also above the horizon, even though they are not so bright. Mercury will join them for a brief period in the end of February, but currently it is located on the sky very close to the Sun and is not visible by a naked eye.

7. **Imagine there is a human base on the Moon. How long roughly it will take the moon inhabitants to send a message to the Earth and get an instant receipt confirmation?**
   - About 2.5 milliseconds
   - About 2.5 seconds
   - About 2.5 minutes
   - About 2.5 hours

Answer comment: The distance from the Earth to the Moon varies roughly between 360 and 405 thousand kilometers and is on average about $l = 384$ thousand kilometers. The light will travel the distance to the Moon and back with the speed of light c in about $2l/c \approx 2.5$ second.

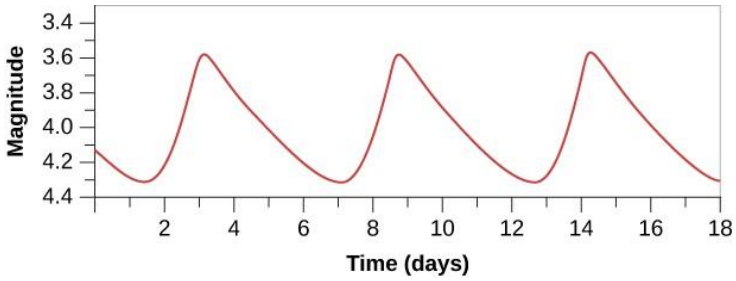
8. **There are several minor planets (asteroids) with names related to Israel. Which of the Israeli universities has an asteroid named in honor of it?**
   - Technion – Israel Institute of Technology
   - Ben-Gurion University of the Negev
   - Tel Aviv University

- The Hebrew University of Jerusalem

Answer comment: In 2013, the asteroid 271,763 was named ***Hebrewu*** in honor of the Hebrew University of Jerusalem. The asteroids are named by their discoverers, and the names are officially assigned by the IAU (International Astronomy Union). One of the discoverers of the Hebrewu asteroid, David H. Levy, decided to commemorate the name of the Hebrew University after completing his PhD studies there.

Note to the organizers: ChatGPT answers that asteroid 5535 Tel Aviv is named in honor of the Tel Aviv University.

9. **What is seen on the graph?**
   - Changes of the variable star brightness
   - Changes of the variable star temperature
   - Changes of the variable star size
   - Changes of the variable star surface gravity



Answer comment: The vertical axis is in magnitudes, so it reflects changes in brightness. This type of intensity variations is characteristic for cepheids, pulsating yellow bright giant and supergiant stars, that are used to determine distances in astronomy, since their pulsation period depends on their absolute magnitude.

10. **An observer in Israel went out to see the starry sky at midnight and saw a culmination of the brightest night sky star within an hour. When this could have happened?**
    - In September
    - In December
    - In March
    - In June

Answer comment: The brightest night sky star, as seen from Earth, is Sirius, α Canis Majoris (α CMa). The Canis Major (Great Dog), Orion and other neighboring constellations are best seen in winter nights, so the correct answer is “In December”. As

seen from Israel, Sirius culminates (that is, visible at the highest angle above the horizon in the south) between within an hour after midnight between December 12 and 27, every day rising and culminating by about 4 minutes earlier, as every star does.

11. The Moon was rising during the sunset on January 01. Where did the Moon rise?

- Directly in the East point
- To the south from the East point
- To the north from the East point
- Directly in the West point
- To the south from the West point
- To the north from the West point
- Cannot be determined from this information

Answer comment: If the Moon rises during the sunset, it is positioned opposite to the Sun in the sky, being on the same great circle, the ecliptic. The Moon is thus in the Full Moon phase. In winter, the Sun is raising low in the sky, rising in Israel about 60° to the south from East point and setting about 60° to the south of West point. The Moon thus will rise in a point opposite to the sunset point, that is, about 60° to the north from East.

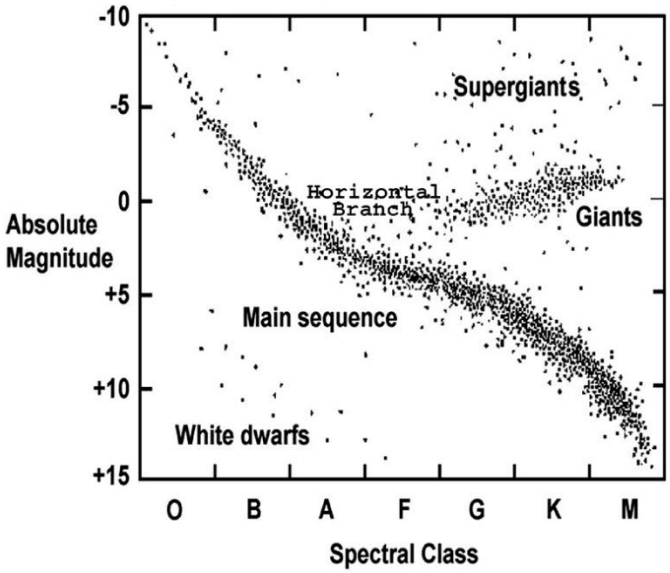
12. Why are the stars not seen during the daytime?

- The stars do not shine during the daytime
- Atmosphere is not transparent for the light of stars during the daytime
- The sunlight scatters in air and makes the sky too bright to notice stars
- Stars are easily seen during the daytime, if you know where to look at

Answer comment: If the Moon rises during the sunset, it is positioned opposite to the Sun in the sky, being on the same great circle, the ecliptic. The Moon is thus in the Full Moon phase. In winter, the Sun is raising low in the sky, rising in Israel about 60° to the south from East point and setting about 60° to the south of West point. The Moon thus will rise in a point opposite to the sunset point, that is, about 60° to the north from East.

13. What cannot be determined from the graph below if the star position on it is known?

- Brightness class of the star
- Absolute magnitude of the star
- Distance of the star from the Sun
- Size of the star



Answer comment: This graph is called Hertzsprung-Russel (or HR) diagram. The vertical axis depicts the absolute magnitude of the star, proportional to its luminosity. The horizontal axis shows the spectral class of the star, defined by its surface (more exactly, photosphere) temperature. The brightness classes (from supergiants to white dwarfs) are seen as more densely populated regions on the diagram. The stellar radius can be determined from the star location on the diagram based on the surface temperature and luminosity.

The distance from the Sun however does not affect the star position on the HR diagram, as the diagram is built to represent the internal properties of the star itself. Therefore the distance also cannot be determined from the star position on the diagram.

14. The meteor showers are named after constellations where their radiant lies. Which of these meteor showers is named after a constellation that is not currently accepted?

- Quadrantids
- Perseids
- Leonids
- Eta-Aquarids

Answer comment: The constellations giving names to these meteor showers are respectively Quadrans Muralis, Persei, Leo and Aquarius. Within borders of Aquarius there are several active meteor showers, therefore the names of individual showers include not only the constellation name, but also the name of the star near the radiant.

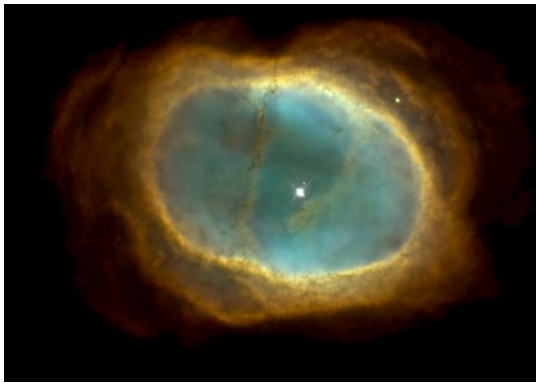
The Quadrans Muralis (wall quadrant, an astronomical instrument) was proposed in 1795 by Lalande, but not accepted by IAU in 1922, when the 88 modern constellations and their borders were defined. Lalande also proposed the Cat (Felis) and two other constellations, but none were also accepted by IAU.

15. **Which of the following is true for all these objects: Andromeda nebula, Pleiades, Orion nebula, Crab nebula?**
    - They were all known in the time of David and Solomon
    - They are all emission nebulae
    - They are all included in the Messier catalogue
    - Each of them contains multiple stars

> **Answer comment**: The incorrect options may easily be excluded. The Crab nebula is a remnant of a supernova that exploded in 1054, many years after times of David and Solomon, and contains only one neutron star in the center. Andromeda nebula is a galaxy, not nebula. But each of these objects is bright enough to be noticed by Charles Messier and included already in the first edition of his catalog compiled in 1774 as items M31, M45, M42, and M1 respectively.

Note for us: ChatGPT gives that the correct answer is the last option about multiple stars.

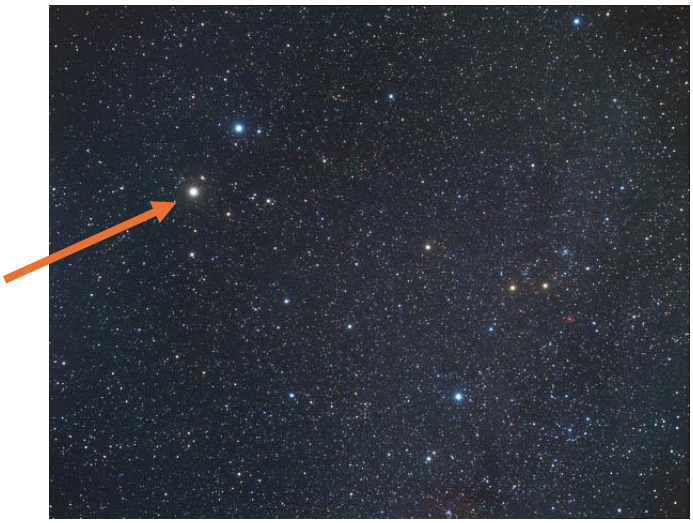
16. **What is this?**
    - A protoplanetary disk
    - A galaxy
    - A stellar cluster
    - A planetary nebula



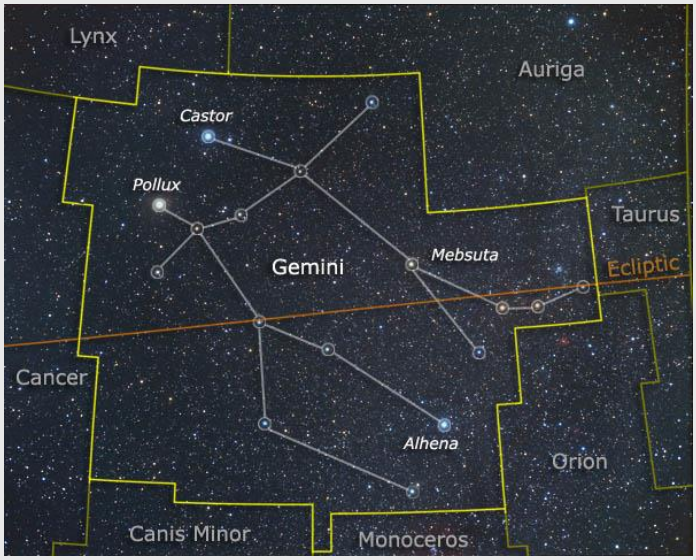
> **Answer comment**: Let us exclude wrong options first. A stellar cluster must contain many stars, but the object on the image shows only one star in the center. The same argument speaks clearly against identifying this object as a galaxy. A protoplanetary disk is a flat object with circular traces of orbits of the growing planets. The imaged object is not flat and not circular.
>
> A planetary nebula is a result of stellar event, when the star ejects its envelope, but continues to illuminate and ionize it from the middle. The star remains in the middle, and a roughly circular colorful shell is expanding around it. The image presented here is

taken by Hubble Space Telescope in 1998 and shows the planetary nebula NGC 3132 in constellation Vela.

17. **The photo below shows one of the Zodiac constellations. What is the name of the star showed by an arrow?**
    - Betelgeuse
    - Pollux
    - Polaris
    - Mizar



Answer comment: The photo shows the Gemini constellation; its two brightest stars are Castor and Pollux. The image source (credit: 2008 Akira Fujii/David Malin) shows both annotated and not annotated versions of the photo: https://www.davidmalin.com/fujii/source/Gem.html



Other answers options (Betelgeuse = α Orionis, Polaris = α Ursae Minoris, Mizar = ζ Ursae Majoris) can be easily excluded based on the fact that none of these constellations belong to Zodiac.

18. **The first known interstellar comet 2I/Borisov was discovered in August 2019 and passed through the central part of the Solar system in December 2019. What was its trajectory shape?**
    - Circular
    - Elliptical
    - Nearly parabolic
    - Hyperbolic

Answer comment: According to the 1st Kepler' s law, the orbits of the planets around the Sun are elliptic, nearly circular. Later, Newton derived Kepler's laws from his theory of gravity and showed that the objects may move in the gravitational field also in parabolic and hyperbolic orbits.

Hyperbola is an open curve, corresponding to the case when the object is not bound to the gravitational field of the Sun, but only changes its flight direction. This is exactly the case of all interstellar objects flying through the Solar system, also of the 2I/Borisov comet. They get into the Solar system with some initial velocity, accelerate towards the Sun by a hyperbola-shape trajectory and then leave the Solar system with roughly the same initial velocity, but heading in a different direction.

The parabolic orbit case corresponds to the limiting case when the object orbiting the Sun had almost zero initial speed. This is the typical case for Solar system comets that are orbit the Sun in the Oort's cloud which is so far that they are only loosely connected to the Solar system. Their orbits are very nearly parabolic. All recent naked-eye comets were moving on nearly parabolic trajectories: C/2024 G3 (ATLAS), C/2023 A3 (Tsuchinshan-ATLAS) and C/2020 F3 (NEOWISE).

19. **Which of these planets has the largest number of natural satellites as discovered up to now?**
    - Jupiter
    - Saturn
    - Uranus
    - Neptune

Answer comment: Irregular moons of giant planets are discovered almost every year. IAU currently recognizes the following number of the satellites for the giant planets: 95 for Jupiter, 146 for Saturn, 28 for Uranus and 16 for Neptune. The numbers are likely to grow; in 2024 alone three new satellites of Uranus and Neptune were recognized.

Historically, each of Jupiter and Saturn had title of the planet with the largest number of satellites. Jupiter was considered such planet between 1610 (discovery of Galilean moons by Galileo) to 1684 (discovery of Saturn moons by Cassini), then from 1938 to 1980, and again from 2002 to 2019. In 2023, IAU recognized 13 new moons of Jupiter and 63 new moons of Saturn, and the latter now leads the number with a wide gap.

Note for organizers. ChatGPT answers incorrectly that Jupiter has more moons than Saturn. Google AI answers correctly and gives correct numbers.

20. The Moon sets two hours after the sunset. What is its phase?

- Waxing Crescent Moon
- Full Moon
- Waning Gibbous Moon
- Cannot be determined from this information

Answer comment: On average, the Moon sets by 50 minutes later every night. If it sets two hours after, then the new Moons was about 2-3 days ago, and the Moon is a narrow growing serpent, that is, a waxing crescent.