IMHOTEP'S LEGACY ACADEMY

ILA Nebula Knowledge Knockout- STEM Quiz Study Guide2024

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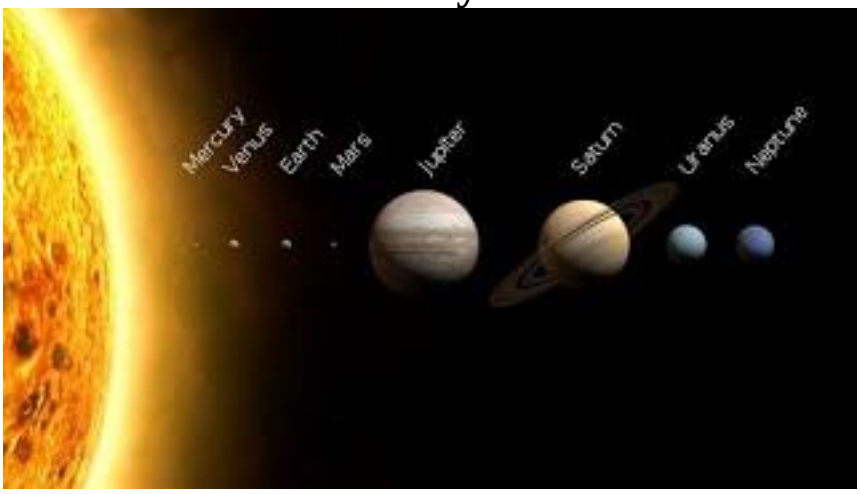
ILA- Nebula Knowledge Knockout Study Guide

Introduction

This study guide is designed to help you prepare for the Interstellar Trivia Tournament. It covers key topics related to space exploration, astronomy, and the contributions of notable individuals in the field. Use this guide to review the concepts and facts that will help you answer the multiple choice and long answer questions effectively. The tournament will consist of 40 multiple choice question and 7 long answer question. You will be in teams of 4 (all high school students or all junior high students). These resources maybe helpful for all sections: https://solarsystemscope.com/

https://science.nasa.gov/solar-system/

Section 1: The Solar System

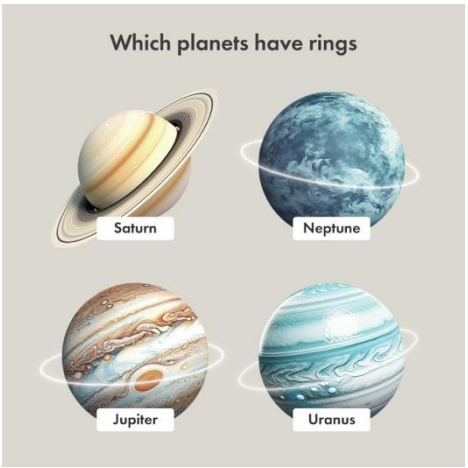


Planets and Moons

1. **Moons:** https://science.nasa.gov/jupiter/moons/
    - Jupiter has the most moons in the Solar System with 95 confirmed moons.
    - The four largest moons are known as the Galilean moons: Io, Europa, Ganymede, and Callisto.
    - Discovered by Galileo Galilei in 1610.
    - Ganymede, a moon of Jupiter, is the largest moon in the Solar System. It is even larger than mercury with a diameter of about 5,268 kilometers (3,273 miles).
    - Ganymede has a magnetic field, the only moon known to have one.
    - Europa is believed to have a subsurface ocean beneath its icy crust.

- Io is the most volcanically active body in the Solar System.

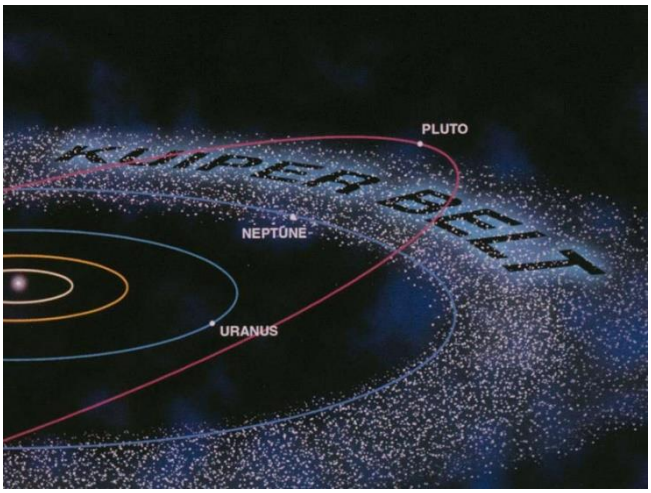
2. **Dwarf Planets:** https://science.nasa.gov/dwarf-planets/
    - Pluto, once considered the ninth planet, was reclassified as a dwarf planet in 2006 by the International Astronomical Union (IAU).
    - Eris, discovered in 2005, is slightly smaller than Pluto but more massive (dense).
    - Titan is not a dwarf planet; it is a moon of Saturn. Pluto, Eris, and Ceres are classified as dwarf planets.
    - Eris is located in the scattered disc, a distant area of the Solar System populated with icy bodies.
    - Ceres is the largest object in the asteroid belt between Mars and Jupiter and was discovered in 1801.
    - Pluto has five known moons: Charon, Styx, Nix, Kerberos, and Hydra.
3. **Light Travel Time from the Sun:** https://education.nationalgeographic.org/resource/sun/
    - It takes about 8 minutes for light to travel from the Sun to Earth, covering a distance of approximately 93 million miles (150 million kilometers).
    - Light travels at approximately 299,792 kilometers per second (186,282 miles per second).
    - Light takes about 3 minutes to travel from the Sun to Mercury.
    - Light takes about 5 hours and 30 minutes to reach Pluto.
    - The concept of "light-year" measures distance, not time, and is about 9.46 trillion kilometers (5.88 trillion miles).
    - The Sun's light takes about 43 minutes to reach Jupiter.
    - The light travel time to Neptune is about 4 hours and 15 minutes.
4. **Planetary Rings:** https://www.planetary.org/articles/rings-of-the-solar-system
    - Saturn is known for its prominent and extensive ring system, made primarily of ice particles, rocky debris, and dust.
    - The rings are divided into seven groups named alphabetically in the order they were discovered: D, C, B, A, F, G, and E.
    - Saturn's rings are primarily composed of water ice, with traces of rocky material.
    - Jupiter's rings are faint and composed mainly of dust particles ejected from its moons.
    - Uranus' rings were discovered in 1977 and are made of large, dark particles.
    - Four planets in the Solar System have rings: Jupiter, Saturn, Uranus, and Neptune.



- Uranus' rings are dark and faint, while Neptune's rings are made up of dust particles and are also relatively faint.
- Neptune’s rings were confirmed by the Voyager 2 spacecraft in 1989.
- Uranus’ rings are composed of a mix of ice and dark organic material.
- Saturn’s rings extend up to 282,000 kilometers from the planet but are as thin as 10 meters in some places.

5. **Day Length:** https://spaceplace.nasa.gov/days/en/
    - A day on Venus (one full rotation) is longer than a year on Venus (one full orbit around the Sun). Venus rotates on its axis in about 243 Earth days and orbits the Sun in about 225 Earth days.
    - Venus rotates in the opposite direction to most planets, a phenomenon called retrograde rotation.
    - Venus’s slow rotation causes extreme differences between its day and night temperatures.
    - Venus’s atmosphere is composed mostly of carbon dioxide, with clouds of sulfuric acid.
6. **Strongest Winds:** https://scijinks.gov/planetary-weather/
    - Neptune has the strongest winds in the Solar System, reaching speeds of up to 2,100 kilometers per hour.
    - The winds on Neptune are driven by its internal heat rather than sunlight.
    - Neptune’s largest storm, known as the Great Dark Spot, was observed by Voyager 2 in 1989.
    - Neptune’s winds are driven by its internal heat rather than sunlight, as it receives little solar energy due to its distance from the Sun.
    - The planet’s dynamic weather includes large-scale storms and high-altitude clouds of methane ice.
7. **Shortest Day:** https://spaceplace.nasa.gov/days/en/
    - Jupiter has the shortest day, completing one rotation in about 9 hours and 55 minutes.
    - Despite its rapid rotation, Jupiter's atmosphere experiences extreme weather patterns, including the Great Red Spot, a giant storm larger than Earth.
    - Jupiter’s rapid rotation causes it to have an oblate shape, meaning it is flattened at the poles and bulges at the equator.
    - The fast rotation contributes to Jupiter’s strong magnetic field.
    - Jupiter’s atmosphere is composed mostly of hydrogen and helium.
    - Jupiter's rotation axis is tilted just 3 degrees with respect to its orbital plane, so it does not experience significant seasonal changes.
8. **Kuiper Belt:** https://science.nasa.gov/solar-system/kuiper-belt/
    - The Kuiper Belt is a region beyond Neptune containing many small icy bodies, including dwarf planets like Pluto and Haumea.
    - It extends from about 30 to 55 astronomical units (AU) from the Sun.
    - The Kuiper Belt is home to many dwarf planets, including Pluto, Haumea, and Makemake.
    - It is similar to the asteroid belt but far larger, extending from about 30 to 55 AU from the Sun.

- The objects in the Kuiper Belt are thought to be remnants from the early Solar System.



Practice Questions: **Answers for the questions have to be researched by you!**

1. **Moons**:
Considering the unique characteristics of Jupiter's Galilean moons, describe how the geological activity on Io differs from the potential subsurface ocean on Europa.
2. **Dwarf Planets**:
Explain the criteria set by the International Astronomical Union (IAU) for classifying a celestial body as a dwarf planet and discuss why Titan does not meet these criteria despite its size.
3. **Light Travel Time from the Sun**:
Calculate the time it takes for light to travel from the Sun to Saturn, given that Saturn is approximately 1.4 billion kilometers from the Sun.
4. **Planetary Rings**:
Compare and contrast the ring systems of Saturn and Uranus in terms of composition, structure, and discovery history.
5. **Day Length**:
Analyze how the retrograde rotation of Venus impacts its atmospheric conditions and surface temperatures compared to Earth.

Studying Asteroids: https://science.nasa.gov/solar-system/asteroids/

1. **Scientific Benefits**
    - Understanding the Solar System's formation and the origins of life.
    - Asteroids are remnants from the early Solar System, providing clues about its initial conditions and processes.
    - Organic compounds found on some asteroids may offer clues about the origins of life on Earth.
2. **Practical Benefits**
    - Identifying resources (metals and minerals) and planetary defense.
    - Asteroids can contain valuable resources (metals and minerals), which could be mined for use in space missions or on Earth.
    - Studying and tracking asteroids is crucial for planetary defense, helping to identify potential impact threats to Earth.
3. **OSIRIS-Rex:** https://science.nasa.gov/mission/osiris-rex/

    - The OSIRIS-REx mission collected samples from asteroid Bennu to improve our understanding of asteroid dynamics, composition, and potential hazards.
    - Bennu is a carbonaceous asteroid, rich in organic material and water-bearing minerals.
    - Returned to earth in 2023 with 60g of material.

4. **Hayabusa2:** https://science.nasa.gov/mission/hayabusa-2/

    - The Hayabusa2 mission collected samples from asteroid Ryugu, enhancing our knowledge of surface and subsurface exploration and providing insights into the building blocks of life.
    - Hayabusa2 deployed small rovers and a lander to study Ryugu's surface up close.

Practice Questions: **Answers for the questions have to be researched by you!**

1. **Scientific Benefits**:

Discuss how studying organic compounds on asteroids can contribute to our understanding of the origins of life on Earth and the early conditions of the Solar System.

2. **Practical Benefits**:

Explain the significance of asteroid mining for future space missions and Earth's industries, and discuss the potential challenges associated with asteroid mining operations.

3. **OSIRIS-REx**:

Describe the scientific importance of the OSIRIS-REx mission's findings from asteroid Bennu and how these samples could improve our knowledge of asteroid composition and potential hazards.

4. **Hayabusa2**:

Compare the objectives and findings of the Hayabusa2 mission with those of OSIRIS-REx, focusing on the different asteroids studied and the specific insights gained from each mission.

5. **Planetary Defense**:

Evaluate the methods used to track and study potentially hazardous asteroids and discuss the strategies that could be implemented to prevent or mitigate the impact of an asteroid collision with Earth.

Osiris- REx

Hayabusa2

Studying Exoplanets: https://www.space.com/17738-exoplanets.html

Exoplanets: a planet that orbits a star outside the solar system.

1. **Habitable Zones**
    - Helps define the region where conditions might be right for liquid water to exist.
    - The habitable zone, or "Goldilocks zone," is the region around a star where conditions might be right for liquid water to exist on a planet's surface.

- Kepler-452b is an exoplanet located in the habitable zone of its star, Kepler-452.

2. **Atmospheric Composition**
    - Analyzing exoplanet atmospheres for potential biosignatures, such as water vapor, oxygen, methane, and carbon dioxide, helps scientists assess their habitability.
    - The presence of certain gases in an exoplanet's atmosphere can indicate biological activity.
    - Spectroscopy is used to analyze the light passing through or reflected by an exoplanet's atmosphere to determine its composition.
3. **Key Missions:** https://www.cosmos.esa.int/web/exoplanetsworkinggroup/missions
    - Kepler Mission and James Webb Space Telescope (JWST) play crucial roles in studying exoplanets.
    - The Kepler Mission has discovered thousands of exoplanets, many of which are in the habitable zones of their stars.
    - The James Webb Space Telescope (JWST) is expected to provide detailed observations of exoplanet atmospheres and surface conditions.
    - The Transiting Exoplanet Survey Satellite (TESS) continues to search for exoplanets around the brightest stars.

Practice Questions: **Answers for the questions have to be researched by you!**

1. **Habitable Zones**:

Define the concept of the "habitable zone" and explain why Kepler-452b is considered significant in the study of potentially habitable exoplanets.

2. **Atmospheric Composition**:

Describe the role of spectroscopy in analyzing exoplanet atmospheres and discuss how the presence of gases like oxygen and methane could be indicative of biological activity.

3. **Key Missions**:

Compare the objectives and achievements of the Kepler Mission and the James Webb Space Telescope (JWST) in the context of exoplanet discovery and characterization.

4. **Biosignatures**:

Discuss the importance of finding biosignatures such as water vapor, methane, and carbon dioxide in exoplanet atmospheres and how these findings contribute to our understanding of exoplanet habitability.

5. **TESS Mission**:

Evaluate the contributions of the Transiting Exoplanet Survey Satellite (TESS) to exoplanet research and explain how its focus on the brightest stars aids in the discovery of new exoplanets.

Stars and Phenomena

1. **First Artificial Satellite**
    - Sputnik 1, launched by the Soviet Union in 1957, was the first artificial satellite to orbit Earth. It marked the beginning of the space age and the U.S.-Soviet space race.
2. **Supernova Outcomes:** https://www.space.com/6638-supernova.html

A supernova is the colossal explosion of a star.

- A supernova can result in a black hole if the remaining core is massive enough.
- Alternatively, a supernova can leave behind a neutron star if the core is not massive enough to form a black hole.
- The Crab Nebula is the remnant of a supernova observed in 1054 AD.
- Supernovae distribute heavy elements, such as iron and gold, throughout the galaxy.

3. **Northern and Southern Lights**
   - These phenomena are caused by the interaction of solar wind with Earth's magnetosphere.
   - The Northern and Southern Lights are also known as auroras. Aurora borealis and Aurora Australis respectively. These lights are most commonly seen near the polar regions.
4. **Closest Star**
   - Proxima Centauri is the closest star to Earth, other than the Sun. It is part of the Alpha Centauri star system and is located about 4.24 light-years away.
   - It is a red dwarf star, much smaller and cooler than our Sun.
   - Proxima Centauri has at least one known exoplanet, Proxima Centauri b, which is located in its habitable zone.
5. **Gravitational Lensing:** https://esahubble.org/wordbank/gravitational-lensing/#:~:text=Gravitational%20lensing%20occurs%20when%20a,accordingly%20called%20a%20gravitational%20lens.
   - Gravitational lensing occurs due to the curvature of spacetime around massive objects, bending the path of light from distant sources. This phenomenon can magnify and distort the images of background galaxies.
   - It was first predicted by Albert Einstein's theory of general relativity.
   - Strong gravitational lensing can create multiple images of a single distant object.
6. **Schwarzschild Radius:** https://study.com/academy/lesson/black-holes-the-event-horizon-and-schwarzschild-radius.html#:~:text=The%20Schwarzschild%20radius%20is%20the,significant%20characteristic%20of%20black%20holes.
   - The Schwarzschild radius for an object with a mass three times that of the Sun is approximately 9 kilometers. This radius defines the event horizon of a black hole, beyond which nothing can escape its gravitational pull.
   - The concept is named after Karl Schwarzschild, who provided the first exact solution to the equations of general relativity.

Practice Questions: **Answers for the questions have to be researched by you!**

1.First Artificial Satellite:
Discuss the significance of Sputnik 1's launch in 1957 and its impact on the subsequent space race between the United States and the Soviet Union.

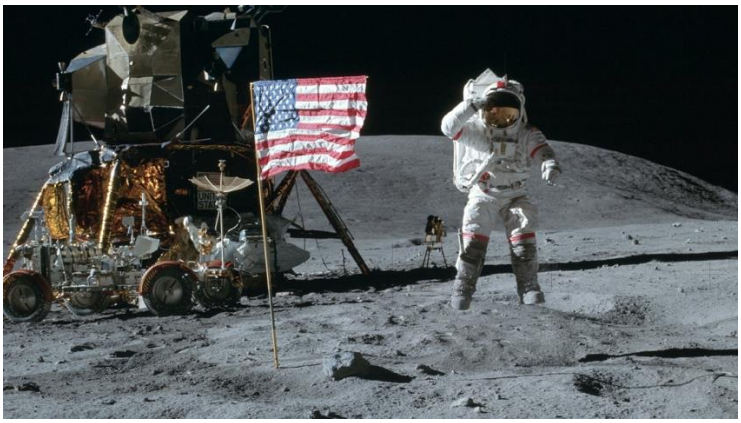
2. Supernova Outcomes:
Explain the process that determines whether a supernova will result in the formation of a black hole or a neutron star, using the Crab Nebula as a case study for supernova remnants.

3. Northern and Southern Lights:
Describe the physical mechanisms behind the auroras (Aurora Borealis and Aurora Australis) and explain why these phenomena are predominantly observed near Earth's polar regions.

4. Gravitational Lensing:
Define gravitational lensing and discuss its significance in the field of astronomy, particularly in the context of studying distant galaxies and verifying Einstein's theory of general relativity.

5. Schwarzschild Radius:
Calculate the Schwarzschild radius for an object with twice the mass of the Sun and explain the implications of this radius in the context of black hole event horizons.

Space Missions and Technology: https://www.nasa.gov/missions/



1. **First Moon Landing**
    - Apollo 11 was the spacecraft that successfully landed humans on the Moon in 1969.
    - Apollo 11 was the spacecraft that successfully landed humans on the Moon in 1969. Astronauts Neil Armstrong and Edwin "Buzz" Aldrin became the first humans to walk on the lunar surface.
    - Armstrong and Aldrin spent about 21 hours on the lunar surface.
    - The mission returned 21.5 kilograms (47.5 pounds) of lunar material to Earth.
2. **First Mars Landing**
    - Viking 1 was the first spacecraft to successfully land on Mars in 1976. it conducted experiments to search for signs of life and studied the Martian surface and atmosphere.

- Viking 1 operated on Mars for over six years, far exceeding its expected lifespan.

3. **Huygens Probe on Titan**
   - The Cassini spacecraft successfully landed the Huygens probe on Saturn's moon Titan in 2005. Huygens provided detailed images and data about Titan's surface and atmosphere.
   - Huygens discovered evidence of liquid hydrocarbon lakes and rivers on Titan.
4. **First Flyby of Pluto**
   - The New Horizons spacecraft conducted the first flyby of Pluto in July 2015. It provided detailed images and data about Pluto's surface, atmosphere, and moons.
   - The spacecraft discovered that Pluto has a heart-shaped glacier made of nitrogen ice.
   - New Horizons continues its mission, exploring objects in the Kuiper Belt.

5. **First Woman in Space**
   - Valentina Tereshkova, a Soviet cosmonaut, was the first woman to travel to space in 1963. She orbited the Earth 48 times aboard the Vostok 6 spacecraft.
6. **Reusable Rocket Technology**
   - The development of reusable rocket technology has significantly reduced costs, increased accessibility (launch frequency), and spurred the growth of the commercial space industry.
   - The development of reusable rocket technology, such as SpaceX's Falcon 9, has significantly reduced launch costs, increased launch frequency, and spurred the growth of the commercial space industry.

Practice Questions: **Answers for the questions have to be researched by you!**

1. First Moon Landing:
Analyze the scientific and technological achievements of the Apollo 11 mission and discuss its long-term impact on human space exploration.
2. First Mars Landing:

Evaluate the contributions of the Viking 1 mission to our understanding of Mars, particularly in terms of its experiments searching for signs of life and its study of the Martian surface and atmosphere.

3. Huygens Probe on Titan:

Explain the significance of the Huygens probe's discoveries on Titan, focusing on the evidence of liquid hydrocarbon lakes and rivers and how these findings contribute to our knowledge of this moon's potential for supporting life.

4. First Flyby of Pluto:

Discuss the scientific importance of the New Horizons mission's flyby of Pluto, highlighting the key discoveries about Pluto's surface, atmosphere, and moons, and the ongoing contributions of the mission as it explores the Kuiper Belt.

5. Reusable Rocket Technology:

Assess the impact of reusable rocket technology on the space industry, particularly focusing on the economic and operational benefits brought by advancements such as SpaceX's Falcon 9.

Black Holes and Theoretical Physics

1. **Reissner-Nordström Black Hole:** https://jila.colorado.edu/~ajsh/insidebh/rn.html
    - A Reissner-Nordström black hole is characterized by its mass and electric charge, but no angular momentum. It is a solution to the Einstein-Maxwell equations in general relativity.
    - It differs from a Schwarzschild black hole, which has no charge or angular momentum.
    - The solution describes the spacetime geometry around a charged, non-rotating black hole.
2. **M-Theory Dimensions:**
   https://www.ctc.cam.ac.uk/outreach/origins/quantum_cosmology_four.php
    - M-theory unifies the five different string theories, suggesting that strings are one-dimensional objects vibrating in a higher-dimensional space.
    - M-theory proposes that there are 11 dimensions in total: 10 spatial dimensions and 1 temporal dimension. It is a theory in physics that unifies all consistent versions of superstring theory.
3. **Dark Matter Explanation:** https://www.space.com/20930-dark-matter.html
    - The most accepted explanation for the nature of dark matter is that it consists of weakly interacting massive particles (WIMPs). Dark matter accounts for about 27% of the universe's mass-energy content.
    - Its presence is inferred from gravitational effects on visible matter, radiation, and the large-scale structure of the universe.

Exoplanets and Habitability: https://science.nasa.gov/exoplanets/habitable-zone/

1. **Habitable Zones**
    - Kepler-452b is an exoplanet located in the habitable zone of its star, Kepler-452. It is about 1.6 times the size of Earth and orbits a star similar to our Sun.

- Kepler-452b is located in the habitable zone of its star, about 1,400 light-years from Earth.
- It has a 385-day orbit around a star similar to our Sun.
- Kepler-452b's size suggests it is likely to be rocky, but its actual composition remains unknown.

2. **Studying Exoplanets**
   - Missions like the Kepler Mission and the James Webb Space Telescope (JWST) help scientists study exoplanets and assess their potential habitability. JWST, in particular, will provide detailed observations of exoplanet atmospheres.
   - The Kepler Mission discovered over 2,600 confirmed exoplanets during its operational period.
   - The James Webb Space Telescope (JWST) will study exoplanet atmospheres and search for signs of habitability.
   - Missions like TESS (Transiting Exoplanet Survey Satellite) continue to discover new exoplanets around nearby stars.

Practice Questions: **Answers for the questions have to be researched by you!**

1. **Reissner-Nordström Black Hole**:
Describe the characteristics and significance of a Reissner-Nordström black hole and compare it with a Schwarzschild black hole in terms of charge and angular momentum.
2. **M-Theory Dimensions**:
Explain the concept of M-theory and its proposal of 11 dimensions. Discuss how this theory unifies the different string theories and its implications for our understanding of the universe.
3. **Dark Matter Explanation**:
Discuss the role of weakly interacting massive particles (WIMPs) in the current understanding of dark matter and describe how dark matter is inferred from its gravitational effects on visible matter and radiation.
4**. Kepler-452b and Habitability**:
Evaluate the significance of Kepler-452b being located in the habitable zone of its star. Discuss the factors that contribute to its potential habitability and the challenges in determining its actual composition.
5. Studying Exoplanets with JWST:
Analyze the contributions of the James Webb Space Telescope (JWST) in the study of exoplanets. Explain how JWST's observations can enhance our understanding of exoplanet atmospheres and their potential to support life.

Section 2: Notable Individuals in Space Exploration

https://www.nasa.gov/history/honoring-black-astronauts-during-black-history-month-2023/

1. **Jeanette Epps**
   - Jeanette Epps' expertise in conducting experiments on the psychological effects of long-term space travel is valuable for missions to Mars.
   - Background: Aerospace engineer and former CIA technical intelligence officer.

2. **Charles Bolden**
    - Charles Bolden's STS-31 mission was significant for deploying the Hubble Space Telescope.
    - Role: Former NASA Administrator, contributed to the development of the Space Launch System.
3. **Ronald McNair**
    - Ronald McNair was known for his pioneering research in high-energy laser applications and laser spectroscopy.
    - One of the astronauts lost in the Challenger disaster.
4. **Mae Jemison**
    - Mae Jemison was a medical doctor and engineer, providing her with a diverse skill set beneficial for conducting scientific research in space.
    - Background: Medical doctor and engineer, performed scientific experiments in space.
5. **Bernard Harris**
    - Bernard Harris' spacewalk during STS-63 was primarily to test new space suit designs, and he conducted significant research on the effects of microgravity on insulin and glucose regulation.
6. **Leland Melvin**
    - Leland Melvin's background as a former NFL football player contributed to his role as an astronaut and his efforts in promoting STEM education.

Practice Questions: **Answers for the questions have to be researched by you!**

1. Jeanette Epps' expertise is particularly valuable for missions to Mars because she has conducted experiments on the psychological effects of long-term space travel. What is her professional background?

A. Astrophysicist and former FBI agent

B. Aerospace engineer and former CIA technical intelligence officer

C. Medical doctor and former Air Force pilot

D. Chemist and former NASA flight director

2. **What was Charles Bolden's significant contribution during the STS-31 mission?**

A. First spacewalk by an African American astronaut

B. Deployment of the Hubble Space Telescope

C. Landing the first rover on Mars

D. Launching the International Space Station

3. **Ronald McNair was known for his pioneering research in which field?**

A. Quantum mechanics

B. High-energy laser applications and laser spectroscopy

C. Genetic engineering

D. Space suit design

4. **Mae Jemison's diverse background includes being a medical doctor and engineer. Which of the following best describes her contributions in space?**

A. Conducted experiments on plant growth in microgravity

B. Performed scientific experiments related to human health and medicine

C. Led the construction of the International Space Station

D. Discovered a new element in space

5. **What was the primary objective of Bernard Harris' spacewalk during the STS-63 mission?**

A. Repairing the Hubble Space Telescope

B. Testing new space suit designs

C. Collecting samples from the Moon

D. Conducting experiments on the effects of radiation in space

Section 3: Space technologies, international collaboration, Robotics and AI

Everyday Technologies from Space Research

https://www.nasa.gov/wp-content/uploads/2015/05/167752main_fs_spinoffs508c.pdf

1. **Memory Foam**
    - Developed for aircraft cushions, now used in mattresses and pillows.

    - Origin: Developed for aircraft cushions to improve crash protection.
2. **Scratch-Resistant Lenses**
    - Developed for astronaut helmet visors to withstand space conditions.
    - Now used in eyeglasses to make them more durable.
3. **Cordless Tools**
    - Developed for use on the Moon during apollo missions
    - Now common in household and industrial applications.
4. **Water Purification Systems**
    - Developed for space missions for clean water in space.
    - Now used to provide clean water in remote areas and disaster zones.
5. **Insulin Pumps**
    - Developed from technology used to monitor astronauts' health in space.
    - Now used by diabetics. Revolutionized diabetes management by allowing continuous insulin delivery.

International Collaboration in Space Exploration

1. **International Space Station (ISS)**
    - A collaborative effort involving NASA, Roscosmos, ESA, JAXA, and CSA. Key achievements include long-term human spaceflight research and material science advancements.
2. **Mars Exploration**
    - The ExoMars program by ESA and Roscosmos aims to search for signs of past life on Mars. NASA's Mars missions have international contributions for instruments and technology.
3. **Hubble Space Telescope**
    - A NASA-ESA project that has led to ground-breaking data on the universe, including the rate of expansion and the presence of dark energy.

Reusable Rocket Technology

1. **Cost Reduction**
    - Reusable rockets significantly lower the cost of launching payloads into space.
    - Example: SpaceX’s Falcon 9 rocket.
2. **Increased Accessibility**
    - Higher launch frequency and reduced costs make space exploration more accessible.
    - Example: Companies and research institutions can launch payloads more affordably.
3. **Commercial Space Industry Growth**
    - Companies like SpaceX have driven the growth of the commercial space industry.
    - Example: Companies like SpaceX and Blue Origin have expanded the possibilities for space tourism and commercial payload launches.

Challenges and Solutions for Mars Missions

1. **Life Support Systems**
    - Challenge: Providing adequate oxygen, water, food, and waste management for long duration missions.
    - Solution: In-Situ Resource Utilization (ISRU) technologies to produce essential resources on Mars.
2. **Radiation Protection**
    - Challenge: Mars lacks a global magnetic field and has a thin atmosphere providing little protection form cosmic radiation.
    - Solution: Building habitats underground or using Martian regolith as shielding material to protect astronauts from radiation.

Robotics and AI in Space Exploration

1. **Mars Rovers (Curiosity and Perseverance)**
    - Use AI for autonomous navigation and scientific analysis.
    - AI Usage: Autonomous navigation and scientific analysis to conduct research without direct human intervention.
    - Achievements: Discovery of organic molecules and assessment of past habitability.
2. **InSight Lander**
    - Robotics Usage: Deployed scientific instruments on Mars to study the planet's interior.
    - Achievements: Provided data on Mars' seismic activity and internal structure.
3. **Hayabusa2**
    - Utilized robotics for sample collection on asteroid Ryugu.
    - Robotics Usage: Collected samples from asteroid Ryugu using advanced robotic systems.
    - Achievements: Returned samples to Earth, providing insights into the composition of primitive asteroids.

Practice Questions: **Answers for the questions have to be researched by you!**

1. Memory foam was initially developed for:

    A. Astronaut helmets

    B. Aircraft cushions

    C. Space shuttle seats

    D. Space station sleeping quarters

2. Scratch-resistant lenses were first developed for:

A. Astronaut helmet visors

B. Space telescope lenses

C. Space station windows

D. Spacewalking gloves

3. Cordless tools were originally developed for use:

A. On the Moon during Apollo missions

B. Inside space shuttles

C. On the International Space Station (ISS)

D. During Mars rover missions

4. Water purification systems developed for space missions are now used primarily in:

A. Rural communities

B. Urban areas

C. Coastal regions

D. Desert environments

5. Insulin pumps were derived from technology used to:

A. Monitor astronaut health in space

B. Study planetary atmospheres

C. Analyze asteroid samples

D. Develop lunar habitats

Conclusion

Review this guide thoroughly to prepare for the tournament. Understanding these key concepts and facts will help you perform well in both the multiple choice and long answer sections of the competition. Good luck!

Practice Questions

1. **Which planet has the most confirmed moons in the Solar System?**

    A. Saturn

    B. Jupiter

    C. Neptune

    D. Uranus

2. **What significant feature does Ganymede possess?**

    A. Volcanic activity

    B. Subsurface ocean

    C. Magnetic field

    D. Methane lakes

3. **What reclassification did Pluto undergo in 2006?**

    A. Moon to planet

    B. Asteroid to planet

    C. Planet to dwarf planet

    D. Dwarf planet to moon

4. **Which of the following is not a dwarf planet?**

    A. Pluto

    B. Eris

    C. Ceres

    D. Titan

5. **How long does it take light to travel from the Sun to Earth?**

    A. 3 minutes

    B. 5 hours 30 minutes

C. 8 minutes

D. 43 seconds

6. **Which region contains many small icy bodies beyond Neptune?**

A. Asteroid Belt

B. Kuiper Belt

C. Oort Cloud

D. Scattered Disc

7. **What practical benefit does studying asteroids provide?**

A. Understanding Solar System formation

B. Discovering new planets

C. Identifying valuable resources

D. Observing black holes

8. **What is the habitable zone around a star also known as?**

A. Black Hole Zone

B. Dark Zone

C. Goldilocks Zone

D. Ice Zone

9. **Which telescope is expected to provide detailed observations of exoplanet atmospheres?**

A. Hubble Space Telescope

B. Kepler Mission

C. James Webb Space Telescope

D. Transiting Exoplanet Survey Satellite

10. **Which mission was the first to land humans on the Moon?**

A. Viking 1

B. Apollo 11

C. New Horizons

D. Huygens

11. **Which spacecraft conducted the first flyby of Pluto in 2015?**

A. Voyager 2

B. Cassini

C. New Horizons

D. Hubble Space Telescope

12. **Who was the first person to walk on the lunar surface?**

A. Yuri Gagarin

B. Buzz Aldrin

C. Neil Armstrong

D. Alan Shepard

13. **What everyday technology was developed for astronaut helmet visors?**

A. Cordless tools

B. Memory foam

C. Scratch-resistant lenses

D. Insulin pumps

14. **Which international collaboration involves NASA, Roscosmos, ESA, JAXA, and CSA?**

A. Mars Exploration

B. Hubble Space Telescope

C. International Space Station

D. ExoMars Program

15. **What technology significantly reduces the cost of launching payloads into space?**

A. Nuclear propulsion

B. Solar sails

C. Reusable rockets

D. Ion thrusters

16. **Which Mars rover uses AI for autonomous navigation?**

A. Spirit

B. Opportunity

C. Curiosity

D. Viking 1

17. **What is the significance of the habitable zone around a star?**

A. It is the region where stars are born

B. It is the region where conditions might be right for liquid water

C. It is the region where black holes are found

D. It is the region where galaxies form

18. **What can a supernova result in if the remaining core is massive enough?**

A. White dwarf

B. Neutron star

C. Black hole

D. Planet

Answers:

1. A. Saturn

2. C. Magnetic field
3. C. Planet to dwarf planet
4. D. Titan
5. C. 8 minutes
6. B. Kuiper Belt
7. C. Identifying valuable resources
8. C. Goldilocks Zone
9. C. James Webb Space Telescope
10. B. Apollo 11
11. C. New Horizons
12. C. Neil Armstrong
13. C. Scratch-resistant lenses
14. C. International Space Station
15. C. Reusable rockets
16. C. Curiosity
17. B. It is the region where conditions might be right for liquid water
18. C. Black hole