

Calculus in the Cosmos

Calculus · Answer Key · 10 Questions

1. Newton's Law of Universal Gravitation describes the force of attraction between two celestial bodies. If the distance between two planets doubles, by what factor does the gravitational force between them change?

- A) It doubles.
- B) It halves.
- C) It increases by a factor of 4.
- D) It decreases by a factor of 4.**

2. The orbital velocity of a satellite around a celestial body is inversely proportional to the square root of the orbital radius. If the orbital radius of a satellite is increased by a factor of 4, what happens to its orbital velocity?

- A) It increases by a factor of 4.
- B) It decreases by a factor of 2.**
- C) It increases by a factor of 2.
- D) It decreases by a factor of 4.

3. The escape velocity from a celestial body is the minimum speed needed for an object to break free from its gravitational influence. If a planet has twice the mass of another planet with the same radius, how does its escape velocity compare?

- A) It is half.
- B) It is the same.
- C) It is twice as large.**
- D) It is four times as large.

4. The luminosity of a star is the total amount of energy it emits per unit time. If a star's radius doubles and its surface temperature remains constant, by what factor does its luminosity change?

- A) It halves.
- B) It doubles.
- C) It quadruples.**
- D) It remains the same.

5. The angular momentum of a planet in orbit around the Sun is conserved. If the planet is closer to the Sun, its orbital speed is higher. If the planet's distance from the Sun doubles, and its angular momentum is to remain constant, what must happen to its orbital speed?

A) It doubles.

B) It halves.

C) It increases by a factor of 4.

D) It decreases by a factor of 2.

6. The rate of change of a planet's angular position with respect to time is known as its angular velocity. If a planet completes one orbit in 365 days, its average angular velocity is approximately 2π radians per 365 days. What is the approximate angular velocity of Earth in radians per second?

A) 7.29×10^{-5}

B) 1.99×10^{-7}

C) 1.67×10^{-4}

D) 3.14×10^{-6}

7. The surface area of a sphere is given by $4\pi r^2$, where r is the radius. If the radius of a spherical nebula increases at a constant rate, what can be said about the rate of change of its surface area?

A) It is constant.

B) It increases linearly with time.

C) It increases with the square of time.

D) It increases linearly with the radius.

8. The volume of a spherical planet is $\frac{4}{3}\pi r^3$. If the planet's radius is increasing, the rate of change of its volume is proportional to what?

A) The radius cubed.

B) The radius squared.

C) The radius.

D) The square root of the radius.

9. The acceleration due to gravity on the surface of a planet is proportional to its mass and inversely proportional to the square of its radius. If a planet has twice the mass and twice the radius of another planet, how does its surface gravity compare?

A) It is the same.

B) It is twice as large.

C) It is half as large.

D) It is four times as large.

10. The intensity of light from a distant star decreases with the square of the distance from the observer. If an observer moves twice as far away from a star, by what factor does the observed light intensity change?

- A) It doubles.
- B) It halves.
- C) It increases by a factor of 4.
- D) It decreases by a factor of 4.**