

Algebraic Principles in Astrophysics

Mathematics · Practice Test · 15 Questions

- 1. If the orbital period T of a planet is proportional to the $3/2$ power of its semi-major axis a ($T = ka^{3/2}$), and a dwarf planet has a semi-major axis 4 times that of Earth, what is its orbital period in Earth years?**

 - A) 4 years
 - B) 8 years
 - C) 16 years
 - D) 32 years
- 2. The apparent magnitude m and absolute magnitude M of a star are related by $m - M = 5\log_{10}(d) - 5$, where d is the distance in parsecs. If a star has $m=5$ and $M=0$, what is its distance d in parsecs?**

 - A) 10 pc
 - B) 50 pc
 - C) 100 pc
 - D) 500 pc
- 3. The Schwarzschild radius R_s of a black hole is calculated by $R_s = 2GM/c^2$. If mass M is doubled, by what factor does the radius R_s increase?**

 - A) 0.5
 - B) 1
 - C) 2
 - D) 4
- 4. The Stefan-Boltzmann law states luminosity $L = A\sigma T^4$. If a star's radius is doubled while its surface temperature T remains constant, by what factor does its luminosity L increase?**

 - A) 2
 - B) 4
 - C) 8
 - D) 16
- 5. Escape velocity v is proportional to the square root of the mass M of a planet ($v = k\sqrt{M}$). If planet A has 9 times the mass of planet B, how many times greater is the escape velocity of A compared to B?**

 - A) 3
 - B) 6
 - C) 9
 - D) 81

6. Using the equation $d = vt$, if a radio signal travels at 300,000 km/s and takes 500 seconds to reach Earth from the Sun, what is the distance in kilometers expressed in scientific notation?

- A) 1.5×10^7 km
- B) 1.5×10^8 km
- C) 3.0×10^8 km
- D) 1.5×10^9 km

7. The orbital velocity v of a satellite is given by $v = \sqrt{GM/r}$. If the distance r from the center of the planet is increased by a factor of 4, what happens to the orbital velocity v ?

- A) It decreases by half
- B) It decreases by a quarter
- C) It increases by half
- D) It remains the same

8. The gravitational force F between two bodies is $F = G(m_1 m_2)/r^2$. If the distance r between two planets is tripled, the gravitational force F changes by what factor?

- A) $1/3$
- B) $1/6$
- C) $1/9$
- D) 9

9. If a galaxy's redshift z is related to its recessional velocity v by $v = cz$, and c is 300,000 km/s, what is the velocity of a galaxy with a redshift of 0.05?

- A) 1,500 km/s
- B) 15,000 km/s
- C) 30,000 km/s
- D) 150,000 km/s

10. The total energy E of a photon is $E = hc/\lambda$. If the wavelength λ is halved, what happens to the energy E of the photon?

- A) It is halved
- B) It remains the same
- C) It doubles
- D) It quadruples

11. The density ρ of a planet is M/V . Given $V = (4/3)\pi r^3$, if the radius r of a planet is doubled while keeping mass M constant, the density ρ changes by what factor?

- A) $1/8$
- B) $1/4$
- C) $1/2$
- D) 2

12. Using the formula for the circumference of an orbit $C = 2\pi r$, if the average distance of Mars from the Sun is 228 million km, approximately how far does it travel in one complete circular orbit?

- A) 716 million km
- B) 1.43 billion km
- C) 2.86 billion km
- D) 4.56 billion km

13. The time dilation factor γ is $1/\sqrt{1 - v^2/c^2}$. If $v = 0.6c$, what is the value of γ ?

- A) 1.25
- B) 1.33
- C) 1.5
- D) 2.0

14. If the brightness of a star follows the inverse-square law $B = L/(4\pi d^2)$, and distance d is increased by a factor of 10, how does the brightness B change?

- A) It becomes $1/10$
- B) It becomes $1/20$
- C) It becomes $1/50$
- D) It becomes $1/100$

15. Using the formula for kinetic energy $KE = 1/2mv^2$, if an asteroid's velocity v is tripled, what happens to its kinetic energy?

- A) It increases by 3 times
- B) It increases by 6 times
- C) It increases by 9 times
- D) It increases by 27 times