

Cosmic Calculations: Advanced Math in Space

Basic Math · Answer Key · 10 Questions

1. The gravitational constant, G , is approximately $6.674 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$. If two objects with masses of 1 kg each are separated by 1 meter, what is the approximate gravitational force between them?

- A) $6.674 \times 10^{-11} \text{ N}$
- B) $6.674 \times 10^{-9} \text{ N}$
- C) $6.674 \times 10^{-13} \text{ N}$
- D) 1 N

2. Earth's approximate equatorial diameter is 12,756 km. If the Moon's diameter is roughly 3,474 km, what is the ratio of Earth's diameter to the Moon's diameter, rounded to two decimal places?

- A) 3.67
- B) 0.27
- C) 4.00
- D) 2.50

3. The average distance from Earth to the Sun is about 149.6 million kilometers (1 Astronomical Unit). Light travels at approximately 300,000 km/s. How many seconds does it take for sunlight to reach Earth?

- A) 498.7 seconds
- B) 4987 seconds
- C) 49.87 seconds
- D) 49870 seconds

4. Jupiter's mass is approximately $1.898 \times 10^{27} \text{ kg}$, and Saturn's mass is approximately $5.683 \times 10^{26} \text{ kg}$. What is the ratio of Jupiter's mass to Saturn's mass, rounded to one decimal place?

- A) 3.3
- B) 0.3
- C) 10.5
- D) 5.7

5. The surface temperature of the Sun's photosphere is approximately 5,778 Kelvin. If we consider this a blackbody radiator, and using Wien's displacement law ($\lambda_{\text{max}} = b/T$, where $b = 2.898 \times 10^{-3} \text{ m}\cdot\text{K}$), what is the approximate peak wavelength of the Sun's radiation in nanometers?

- A) 500 nm
- B) 200 nm
- C) 5000 nm
- D) 50 nm

6. The speed of light in a vacuum is approximately 299,792 kilometers per second. Proxima Centauri, the closest star to our Sun, is about 4.24 light-years away. How many kilometers is this distance (using 1 light-year = $9.461 \times 10^{12} \text{ km}$)?

- A) $4.01 \times 10^{13} \text{ km}$
- B) $4.01 \times 10^{10} \text{ km}$
- C) $4.01 \times 10^{16} \text{ km}$
- D) $4.01 \times 10^{12} \text{ km}$

7. If the observable universe has an estimated diameter of about 93 billion light-years, and this is represented by a sphere, what is the approximate volume of the observable universe in cubic light-years (using $V = \frac{4}{3} \pi r^3$)?

- A) $4.19 \times 10^{32} \text{ cubic light-years}$
- B) $1.39 \times 10^{33} \text{ cubic light-years}$
- C) $3.14 \times 10^{33} \text{ cubic light-years}$
- D) $1.05 \times 10^{32} \text{ cubic light-years}$

8. Mars has an average orbital radius of approximately 228 million kilometers. If its orbital speed is about 24.13 km/s, what is the approximate orbital period of Mars in days (consider 1 day = 86,400 seconds)?

- A) 687 days
- B) 365 days
- C) 400 days
- D) 500 days

9. The average density of water is 1000 kg/m^3 . The average density of Jupiter is approximately 1326 kg/m^3 . What is the ratio of Jupiter's density to water's density, rounded to two decimal places?

- A) 1.33
- B) 0.75
- C) 2.33
- D) 1000.00

10. The escape velocity from Earth's surface is approximately 11.2 km/s. If a spacecraft needs to achieve this velocity, and its current velocity is 5.6 km/s, by what factor would its current kinetic energy ($KE \propto v^2$) need to increase to reach escape velocity?

- A) 4 times
- B) 2 times
- C) 2 times
- D) 1/2 times