

Name: _____ Date: _____

1. An artificial satellite of Earth releases a bomb. Neglecting air resistance, the bomb will:
 - A) strike Earth under the satellite at the instant of release
 - B) strike Earth under the satellite at the instant of impact
 - C) strike Earth ahead of the satellite at the instant of impact
 - D) strike Earth behind the satellite at the instant of impact
 - E) never strike Earth

2. A spherical shell has inner radius R_1 , outer radius R_2 , and mass M , distributed uniformly throughout the shell. The magnitude of the gravitational force exerted on the shell by a point mass particle of m , located a distance d from the center, inside the inner radius, is:
 - A) 0
 - B) GMm/R_1^2
 - C) GMm/d^2
 - D) $GMm/(R_2^2-d^2)$
 - E) $GMm/(R_1-d)^2$

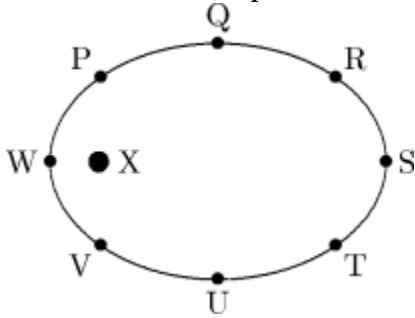
3. The mass of a hypothetical planet is 1/100 that of Earth and its radius is 1/4 that of Earth. If a person weighs 600 N on Earth, what would he weigh on this planet?
 - A) 24 N
 - B) 48 N
 - C) 96 N
 - D) 192 N
 - E) 600 N

4. To measure the mass of a planet with the same radius as Earth, an astronaut drops an object from rest (relative to the planet) from an altitude of one radius above the surface. When the object hits its speed is 4 times what it would be if the same experiment were carried out for Earth. In units of Earth masses, the mass of the planet is:
 - A) 2
 - B) 4
 - C) 8
 - D) 16
 - E) 32

Write the letter for the correct answer on the answer sheet. Write clearly.

5. A spherical shell has inner radius R_1 , outer radius R_2 , and mass M , distributed uniformly throughout the shell. The magnitude of the gravitational force exerted on the shell by a point particle of mass m located a distance d from the center, outside the inner radius and inside the outer radius, is:
- A) 0
 - B) GMm/d^2
 - C) $GMm/(R_2^3 - d^3)$
 - D) $GMm(d^3 - R_1^3)/d^2(R_2^3 - R_1^3)$
 - E) $GMm/(d^3 - R_1^3)$
6. Neglecting air resistance, a 1.0-kg projectile has an escape velocity of about 11 km/s at the surface of Earth. The corresponding escape velocity for a 2.0 kg projectile is:
- A) 3.5 km/s
 - B) 5.5 km/s
 - C) 7.1 km/s
 - D) 10 km/s
 - E) 11 km/s
7. The gravitational constant G has the derived units:
- A) $\text{N} \cdot \text{m}$
 - B) $\text{N} \cdot \text{m}/\text{kg}$
 - C) $\text{N} \cdot \text{kg}/\text{m}$
 - D) $\text{N} \cdot \text{m}^2/\text{kg}^2$
 - E) $\text{N} \cdot \text{kg}^2/\text{m}^2$
8. An object is raised from the surface of Earth to a height of two Earth radii above Earth. Then:
- A) its mass increases and its weight remains constant
 - B) both its mass and weight remain constant
 - C) its mass remains constant and its weight decreases
 - D) both its mass and its weight decrease
 - E) its mass remains constant and its weight increases

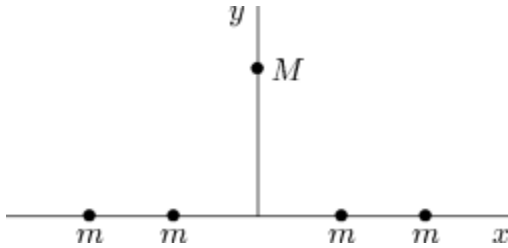
9. A planet travels in an elliptical orbit about a star X as shown. The magnitude of the acceleration of the planet is:



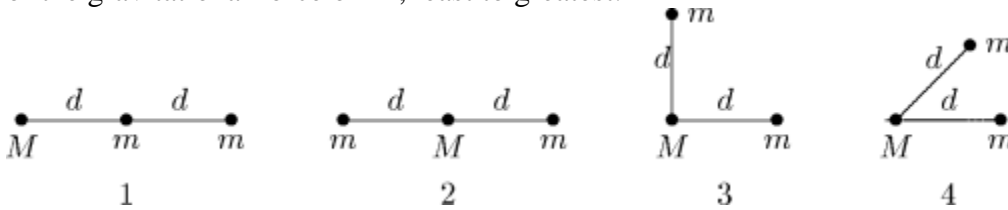
- A) greatest at point Q
 B) greatest at point S
 C) greatest at point U
 D) greatest at point W
 E) the same at all points
10. The magnitude of the acceleration of a planet in orbit around the Sun is proportional to:
- A) the mass of the planet
 B) the mass of the Sun
 C) the distance between the planet and the Sun
 D) the reciprocal of the distance between the planet and the Sun
 E) the product of the mass of the planet and the mass of the Sun
11. A rocket ship is coasting toward a planet. Its captain wishes to know the value of g at the surface of the planet. This may be inferred by:
- A) measuring the apparent weight of one of the crew
 B) measuring the apparent weight of an object of known mass in the ship
 C) measuring the diameter of the planet
 D) measuring the density of the planet
 E) observing the ship's acceleration and correcting for the distance from the center of the planet.
12. If Earth were to rotate only 100 times per year about its axis:
- A) airplanes flying W to E would make better time
 B) we would fly off Earth's surface
 C) our apparent weight would slightly increase
 D) Earth's atmosphere would float into outer space
 E) our apparent weight would slightly decrease

13. In the formula $F^{\text{grav}} = Gm_1m_2/r^2$, the quantity G :
- A) depends on the local value of g
 - B) is used only when Earth is one of the two masses
 - C) is greatest at the surface of Earth
 - D) is a universal constant of nature
 - E) is related to the Sun in the same way that g is related to Earth
14. Of the following where would the weight of an object be the least?
- A) 2000 miles above Earth's surface
 - B) At the north pole
 - C) At the equator
 - D) At the center of Earth
 - E) At the south pole
15. An object is dropped from an altitude of one Earth radius above Earth's surface. If M is the mass of Earth and R is its radius the speed of the object just before it hits Earth is given by:
- A) $\sqrt{GM/R}$
 - B) $\sqrt{GM/2R}$
 - C) $\sqrt{2GM/R}$
 - D) $\sqrt{GM/R^2}$
 - E) $\sqrt{GM/2R^2}$

16. Four particles, each with mass m , are arranged symmetrically about the origin on the x axis. A fifth particle, with mass M , is on the y axis. The direction of the gravitational force on M is:



- A) \uparrow
 B) \downarrow
 C) \leftarrow
 D) \rightarrow
 E) none of these directions
17. Three particles, two with mass m and one with mass M , might be arranged in any of the four configurations known below. Rank the configurations according to the magnitude of the gravitational force on M , least to greatest.



- A) 1, 2, 3, 4
 B) 2, 1, 3, 4
 C) 2, 1, 4, 3
 D) 2, 3, 4, 2
 E) 2, 3, 2, 4
18. Let M denote the mass of Earth and let R denote its radius. The ratio g/G at Earth's surface is:

- A) R^2/M
 B) M/R^2
 C) MR^2
 D) M/R
 E) R/M

19. Two particles, each of mass m , are a distance d apart. To bring a third particle, with mass $2m$, from far away to a resting point midway between the two particles the work done by an external agent is given by:
- A) $4Gm^2/d$
 - B) $-4Gm^2/d$
 - C) $8Gm^2/d^2$
 - D) $-8Gm^2/d^2$
 - E) zero
20. The mass of an object:
- A) is slightly different at different locations on Earth
 - B) is a vector
 - C) is independent of the acceleration due to gravity
 - D) is the same for all objects of the same size and shape
 - E) can be measured directly and accurately on a spring scale
21. Suppose you have a pendulum clock that keeps correct time on Earth (acceleration due to gravity = 9.8 m/s^2). Without changing the clock, you take it to the Moon (acceleration due to gravity = 1.6 m/s^2). For every hour interval (on Earth) the Moon clock will record:
- A) $(9.8/1.6) \text{ h}$
 - B) 1 h
 - C) $\sqrt{9.8/1.6} \text{ h}$
 - D) $(1.6/9.8) \text{ h}$
 - E) $\sqrt{1.6/9.8} \text{ h}$
22. A spherical shell has inner radius R_1 , outer radius R_2 , and mass M , distributed uniformly throughout the shell. The magnitude of the gravitational force exerted on the shell by a point mass m , located a distance d from the center, outside the outer radius, is:
- A) 0
 - B) GMm/R_1^2
 - C) GMm/d^2
 - D) $GMm/(R_2^2-d^2)$
 - E) $GMm/(R_1-d)^2$

- 23.** Neglecting air resistance, the escape speed from a certain planet for an empty space vehicle is 1.12×10^4 m/s. What is the corresponding escape speed for the fully loaded vehicle, which has triple the mass of the empty one?
- A) 3.73×10^3 m/s
 - B) 1.12×10^4 m/s
 - C) 3.36×10^4 m/s
 - D) 9.98×10^4 m/s
 - E) 1.40×10^{12} m/s
- 24.** A spring scale, calibrated in newtons, is used to weigh sugar. If it were possible to weigh sugar at the following locations, where will the buyer get the most sugar to a newton?
- A) At the north pole
 - B) At the equator
 - C) At the center of Earth
 - D) On the Moon
 - E) On Jupiter
- 25.** The approximate value of g at an altitude above Earth equal to one Earth diameter is:
- A) 9.8 N/kg
 - B) 4.9 N/kg
 - C) 2.5 N/kg
 - D) 1.9 N/kg
 - E) 1.1 N/kg

Answer Key

1. E
2. A
3. C
4. D
5. D
6. E
7. D
8. C
9. D
10. B
11. E
12. C
13. D
14. D
15. A
16. B
17. B
18. B
19. D
20. C
21. E
22. C
23. B
24. C
25. E