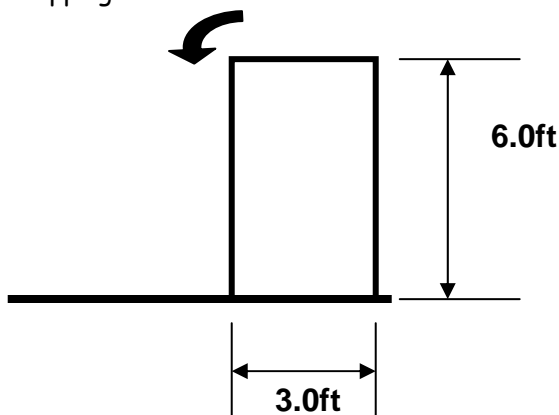


## Conceptual Questions: Statics and Gravitation

- One can apply a force of 9N and 4N to counter the action of a force of
  - 20N
  - 11N
  - 7N
  - none of the above
- When applying the condition for rotational equilibrium on a body, one sums the torques about an axis
  - passing through the center of mass of the body.
  - passing through the geometrical center of the body.
  - passing through the line of action of the forces.
  - passing through any point on the body.
  - none of these.

- A box is on a horizontal surface as shown below. What is the maximum angle that the box (in the orientation shown) can be tilted to avoid tipping over?

- 26.6°
- 30.0°
- 45.0°
- 57.6°
- 63.3°



- Suppose the box in the above problem is placed in the back of a pick up truck. What is the greatest acceleration that the truck can have without tipping over the box (you may assume that the box begins to tip over before it begins to slide)?
  - 4.9m/s<sup>2</sup>
  - 4.4m/s<sup>2</sup>
  - 3.2m/s<sup>2</sup>
  - 2.6m/s<sup>2</sup>
- Consider the following statement: The center of gravity is always at the geometric center of an object. This statement is
  - True
  - False
- Consider the following statement: An object is in equilibrium only if the sum of the forces acting on it is zero. This statement is
  - True
  - False

7. A steel cable suspends a mass vertically. If the cable is replaced with one with twice the diameter then,
  - A. Young's modulus is doubled.
  - B. The strain decreases by a factor of 4.
  - C. The stress goes up by a factor of 4.
  - D. The length of the cable doubles.
  - E. The length of the cable decreases by a factor of 4.
  
8. An aluminum wire and steel wire of the same length and diameter are joined to form a wire twice their original length. The wire is fastened to the roof and a weight  $W$  is attached to the other end. Neglecting the mass of the wires, which of the following is true?
  - A. The aluminum portion of the wire will stretch by the same amount as the steel wire.
  - B. The tensions in both portions of the wire are the same.
  - C. None of the above statements is true.
  
9. You're on a diet. You step on a scale to determine your weight. As a result of the Earth's rotation, the value read off the scale is
  - A. less than your true weight.
  - B. greater than your true weight.
  - C. is equal to your true weight only if you're at the equator.
  - D. is equal to your weight at the poles of the Earth.
  - E. A and D are true
  - F. B and C are true
  - G. B and D are true
  
10. The gravitational field at the center of the Earth is
  - A. zero
  - B.  $GM_E/R_E^2$
  - C. infinite
  
11. For a planet orbiting the sun, which of the following physical quantities is conserved?
  - A. Energy
  - B. Linear Momentum
  - C. Angular Momentum
  - D. Energy and Linear Momentum
  - E. Energy and Angular Momentum
  
12. If the radius of the Moon's orbit around the Earth were suddenly increased four-fold its orbital period would
  - A. increase by two-fold
  - B. decrease by two-fold
  - C. increase by four-fold
  - D. increase by eight-fold
  - E. decrease by 64-fold.

13. Kepler's 2<sup>nd</sup> Law is a direct consequence of
- A. Angular Momentum Conservation
  - B. Newton's Law of Gravitation
  - C. Newton's 2<sup>nd</sup> Law
  - D. Chasles' Theorem
  - E. Pascal's Law
14. At the surface of the Earth, the acceleration due to gravity is  $g$ . At a distance from the center of the Earth equal to three times the radius of the Earth the acceleration due to gravity is
- A.  $g/9$
  - B.  $g/3$
  - C.  $g$
  - D.  $3g$
  - E.  $9g$

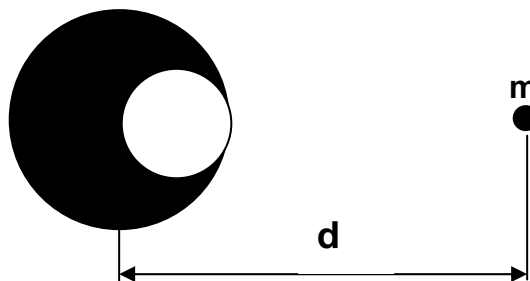
A satellite is orbiting the Earth in a circular orbit of radius  $r_1$ . Answer the following six questions regarding the satellite.

15. If the satellite orbit is changed to  $r_2 > r_1$ , then the speed of the satellite must
- A. increase.
  - B. decrease.
  - C. remain the same.
16. If the satellite orbit is changed to  $r_2 > r_1$ , then the mechanical energy of the satellite must
- A. increase
  - B. decrease
  - C. remain the same
17. If the satellite orbit is changed to  $r_2 > r_1$ , then the work done on the satellite is
- A. positive
  - B. negative
  - C. zero
18. If the satellite orbit is changed to  $r_2 > r_1$ , then the total energy of the satellite must
- A. increase
  - B. decrease
  - C. remain the same
19. How would the answers to the previous four questions change if the satellite is changed to an elliptical orbit with semi-minor axis  $r_2 > r_1$ ?
- A. The answers would be the opposite of those of the previous four questions.
  - B. They would be the same.
20. Can the satellite move to  $r_2 > r_1$  by simply speeding up?
- A. Yes
  - B. No

21. An electron orbits a proton in a hydrogen atom. The atom absorbs energy from a laser. As a result, the electron jumps to a larger orbit, and the energy of the electron
- increases
  - decreases
  - remains the same

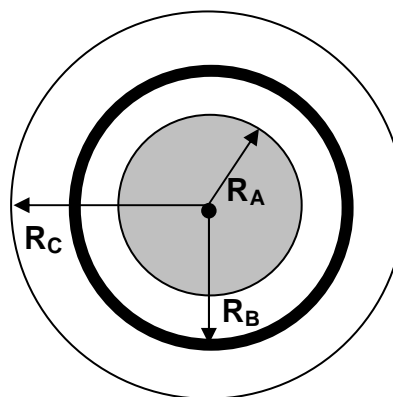
22. A sphere of radius  $R$  has a hollow cavity of radius  $R/2$  as shown. The mass of the sphere was  $M$  before it was hollowed. Calculate the force on a point mass  $m$  a distance  $d$  from the center of the sphere.

- $\frac{GMm}{d^2} \left[ 1 - \frac{1}{8(1 - (R/2d)^2)} \right]$
- $\frac{3GMm}{4d^2}$
- $\frac{GMm}{d^2} \left[ 1 - \frac{1}{4(1 - (R/d)^2)} \right]$
- $\frac{5GMm}{8d^2}$



23. A uniform solid sphere of mass  $m_A$  and radius  $R_A$  is inside and concentric with spherical shells of mass  $m_B$  and outer radius  $R_B$ , and mass  $m_C$  and radius  $R_C$ . The magnitude of the gravitational field at the surface of the sphere of radius  $R_B$  is

- $\frac{G(m_A m_b)}{(R_A + R_B)^2}$
- $\frac{G(m_A + m_b - m_C)}{(R_A + R_B - R_C)^2}$
- $\frac{G(m_A + m_b)}{R_B^2}$
- $\frac{G(m_A + m_B - m_C)}{R_B^2}$
- $\frac{G(m_A m_B m_C)}{(R_A + R_B + R_C)^2}$



24. When does the Earth move fastest around the Sun?
- when it is at its minimum distance (perihelion distance) from the Sun
  - when it is at its maximum distance (aphelion distance) from the Sun