1. A horizontal meter stick supported at the 50-cm mark has a mass of 0.50 kg hanging from it at the 20-cm mark and a 0.30 kg mass hanging from it at the 60-cm mark. Determine the position on the meter stick at which one would hang a third mass of 0.60 kg to keep the meter stick balanced.
   a. 74 cm
   b. 70 cm
   c. 65 cm
   d. 68 cm
   e. 62 cm

2. The figure shows a uniform, horizontal beam (length = 10 m, mass = 25 kg) that is pivoted at the wall, with its far end supported by a cable that makes an angle of 51° with the horizontal. If a person (mass = 60 kg) stands 3.0 m from the pivot, what is the tension in the cable?

   ![Diagram of a beam with a person standing on it](image)

   a. 0.83 kN
   b. 0.50 kN
   c. 0.39 kN
   d. 0.22 kN
   e. 3.0 kN
3. A 25-ft long crane supported at its lower end by a pin is elevated by a horizontal cable as shown in the figure. A 250-lb load is suspended from the outer end of the crane. The center of gravity of the crane is 10 ft from the pin, and the crane weighs 200 lb. What is the tension in the horizontal cable?

a. 610 lb
b. 540 lb
c. 640 lb
d. 570 lb
e. 200 0 lb

4. A square of side \( \frac{L}{2} \) is removed from one corner of a square sandwich that has sides of length \( L \). The center of mass of the remainder of the sandwich moves from \( C \) to \( C' \). The displacement of the \( y \) coordinate of the center of mass (from \( C \) to \( C' \) ) is

a. \( \frac{1}{12} L \)
b. \( \frac{\sqrt{2}}{12} L \)
c. \( \frac{1}{6} L \)
d. \( \frac{1}{8} L \)
e. \( \frac{\sqrt{2}}{8} L \)
5. Pairs of forces of equal magnitude act on identical cylinders as shown in the figures. In which example is the cylinder in translational and rotational equilibrium?

(a) \hspace{1cm} (b) \hspace{1cm} (c)

(d) \hspace{1cm} (e)

6. A 50-kg satellite circles planet Cruton every 5.6 h in an orbit with a radius of $12 \times 10^6$ m. What is the magnitude of the gravitational force on the satellite by planet Cruton?
   a. 66 N  
   b. 58 N  
   c. 68 N  
   d. 73 N  
   e. 50 N  

7. Planet Zero has a mass of $5.0 \times 10^{22}$ kg and a radius of $2.0 \times 10^6$ m. A space probe is launched vertically from the surface of Zero with an initial speed of 4.0 km/s. What is the speed of the probe when it is $3.0 \times 10^6$ m from Zero's center?
   a. 3.0 km/s  
   b. 2.2 km/s  
   c. 1.6 km/s  
   d. 3.7 km/s  
   e. 5.9 km/s  

8. The figure below shows a planet traveling in a clockwise direction on an elliptical path around a star located at one focus of the ellipse. When the planet is at point A,

   a. its speed is constant.  
   b. its speed is increasing.  
   c. its speed is decreasing.  
   d. its speed is a maximum.  
   e. its speed is a minimum.
9. A body oscillates with simple harmonic motion along the x axis. Its displacement varies with time according to the equation \( x = 5.0 \sin (\pi t + \pi 3) \). The velocity (in m/s) of the body at \( t = 1.0 \) s is

a. \(-8.0\)
b. \(-8.0\)
c. \(-14\)
d. \(-14\)
e. \(-5.0\)

10. The figure shows a uniform rod (length \( L = 1.0 \) m, mass = 2.0 kg) suspended from a pivot a distance \( d = 0.25 \) m above its center of mass. The angular frequency (in rad/s) for small oscillations is approximately

![Diagram of a rod suspended from a pivot]

a. 1.0
b. 2.5
c. 1.5
d. 4.1
e. 3.5

11. Three pendulums with strings of the same length and bobs of the same mass are pulled out to angles \( \theta_1, \theta_2, \) and \( \theta_3 \) respectively and released. The approximation \( \sin \theta = \theta \) holds for all three angles, with \( \theta_3 \geq \theta_2 \geq \theta_1 \). How do the angular frequencies of the three pendulums compare?

a. \( \omega_3 \geq \omega_2 \geq \omega_1 \)
b. Need to know amplitudes to answer this question.
c. Need to know \( \sqrt{g/L} \) to answer this question.
d. \( \omega_3 \geq \omega_2 \geq \omega_1 \)
e. \( \omega_3 = \omega_2 = \omega_1 \)
12. An object of mass $m$ is attached to a string of length $L$. When it is released from point A, the object oscillates between points A and B. Which statement about the system consisting of the pendulum and the Earth is correct?

a. The gravitational potential energy of the system is greatest at A and B.
b. The kinetic energy of mass $m$ is greatest at point O.
c. The greatest rate of change of momentum occurs at A and B.
d. All of the above are correct.
e. Only (a) and (b) above are correct.

13. A graph of position versus time for an object oscillating at the free end of a horizontal spring is shown below. The point at which the object has negative velocity and zero acceleration is

a. A
b. B
c. C
d. D
e. E