

**Possibly Useful Information:**  $g = 9.80\text{m/s}^2$ ,  $G = 6.67 \times 10^{-11}\text{N}\cdot\text{m}^2/\text{kg}^2$ ,  $\alpha_{\text{steel}} = 11 \times 10^{-6}/\text{C}^\circ$ ,  $\beta_{\text{gasoline}} = 960 \times 10^{-6}/\text{C}^\circ$

**Problem 1** Short answer (2 points each)

Which of the following could be used to find the mass of Jupiter? Answer yes or no.

\_\_\_\_\_ (i) The speed and period of Europa, one of Jupiter's moons.

\_\_\_\_\_ (ii) The radius and speed of Jupiter's orbit about the sun.

A crazed physicist risks his life rotating on a frictionless stool. When he pulls his arms in he spins faster. Give the signs of the changes (as he moves his arms inward) in kinetic energy, angular momentum and angular velocity. Answer +, - or 0.

\_\_\_\_\_ [iii]  $\Delta K$       \_\_\_\_\_ [iv]  $\Delta L$       \_\_\_\_\_ [v]  $\Delta \omega$

**Problem 2**

(a) A 200 kg spherical mass is at the origin, an 800 kg spherical mass is at (3m,0) and a 500 kg mass is at (0,2m). What is the net force on the 200 kg mass? (7 points)

(b) If the 800 kg and 500 kg masses in part (a) are fixed in place then what is the smallest speed that the 200 kg mass must be given to escape the gravitational pull of the other two masses? (7 points)

(c) Neptune has a mass that is 17.2 times that of the earth and orbits the sun every 165 years. What is its distance from the sun in AU, where 1 AU is the earth-sun distance?

**Problem 3** (7 points each)

(a) A simple pendulum has a period of 8s on earth. What is the period of this pendulum on a planet with 5 times the earth's mass and twice its radius?

(b) A particle moves in simple harmonic motion with a frequency of 0.60 Hz and an amplitude of 10 cm. What are the speed and acceleration of the particle when it is at a point 6 cm from the equilibrium position?

(c) A string is wrapped many times around a frictionless pulley, which is a uniform disk of mass  $M$ . The string is connected to a hanging mass of mass  $m$ . What is the speed of the hanging mass after it falls a distance  $h$  from rest?

(d) A 30 gal steel container is filled to the brim with gasoline at  $15^{\circ}\text{C}$ . How much gasoline spills out when the temperature of *both* the gasoline and steel is increased to  $50^{\circ}\text{C}$

(e) A ceiling fan accelerates uniformly at a rate of  $3\text{rad/s}^2$  from rest. How long does it take for the acceleration of a point 1.2 m from the center to have a magnitude of  $6\text{m/s}^2$ .

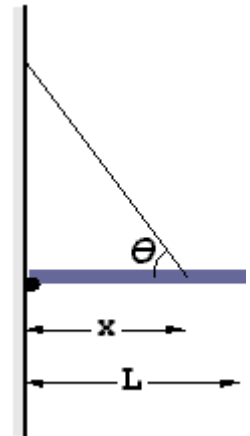
**Problem 4**

(a) Gold melts at 1338K. What is this in Fahrenheit? (6 points)

(b) A uniform disk with a 2m radius swings without friction about a nail through a hole 30cm from the rim. What is the period of small oscillations? (7 points)

**Problem 5** A uniform horizontal shelf of mass  $m$  and width  $L$  is held to a wall by a frictionless hinge and by a rope as shown. (7 points each)

(a) What is the tension in the rope?



(b) Suppose the rope is cut and the shelf swings without friction. What is the shelf's angular acceleration just after the rope is cut?

(c) If the rope is cut as in part (b) what is the speed of the far edge of the shelf just before it hits the wall?