The barricade at the end of a subway line has a large spring designed to compress 2.00 m when stopping a 2.05x105 kg train moving at 0.690 m/s. a. Can you solve the problem using the: (a) Kinematics equations ? and why? Ans: No we cannot use the kinematic equations. Force is not constant hence the acceleration is not constant. (b) Conservation of energy ? and why? Ans: Yes, the spring force is conservative. b. What is the force constant of the spring? Ans: 24400 N/m c. 0+.5*k*x^2 = KE, solve for k

What speed would the train be going if it only compressed the spring 0.760 m? Ans: 0.262 m/s

.5*k*x^2 = .5*m*v^2

d. What is the magnitude of the force that the spring exerts when compressed 0.760 m? Ans: 18544 N

Kx = f, solve for f

Two lightweight rods d = 22 cm are mounted perpendicular to an axle and at 180° to each other. At the end of each rod is a 700 g mass (masses do not have shape). The axle rotates at 30 rad/s. What is the component of the total angular momentum along the axle? Ans: 2.03 kg.m2 /s.

r = .22, m = .7, I = 2*.22^2*.7 = .0676 * w(30) = 2.03

A sphere completely submerged in water is hung with a string. The tension in the string is one-half the weight of the sphere. What is the density of the sphere? [hint: use the buoyant force, and mass volume density] Ans: 2000 kg/m, Fnet = Fb - W - T, Fb = dens_w*V*g, Fnet = 0, T = mg/2, M = Dens*V, Dens sphere = ⅔ Dens Water

) A horizontal platform in the shape of a circular disk rotates freely in a horizontal plane about a frictionless vertical axle. The platform has a mass M = 100.0 kg and a diameter D=2.0 m. A girl whose mass is m=50.0 kg walks from the center towards the rim of the disk. If the angular speed of the system is +4.0 rad/s when the girl is at the center. What is the angular velocity (ωr) as she reaches the rim? Ans: +2 rad/s. 4(100*.5*1^2) = 200, 200 = (Im + Ig) wf, wf = 2

(follow-up from the previous problem) From the rim, with the platform in rotational motion with an angular velocity (ωf) the girl (m = 50.0kg) starts running on the rim of the disk in circular motion with a speed of 3m/s with respect to the platform. Write down the equation of the final angular speed of the platform (ωf) after the girl starts running; and then find its value? Ans: +1rad/s. Ig + Im = 200, Ig (v = rw)

(follow-up from the previous problem) Is it possible that the girl stops the merry-go-round without applying external force to the whole system (made of platform + girl) and how? Ig*wf(gir)l = 200, v = rw, wf =4, v = 4*1 = 4 (She should run same direction as merry go round)

Complete the following statement: Momentum is conserved in a two-body collision only if Ans: the net external force acting on the two-body system is zero

2. A runaway train car that has a mass of 1400 kg travels at a speed of 3 m/s down a track. Calculate the magnitude of the force's impulse needed to bring the car to rest? Ans: 4200 kg*m/s 3. 1400*3 = 4200

Squids rely on jet propulsion, a versatile technique to move around in water. A 2.10 kg squid at rest suddenly expels 0.10 kg of water backward to quickly get itself moving forward at 4.0 m/s. If other forces (such as the drag force) are ignored, what is the speed with which the squid expels water? Ans: 80.0 m/s
2.0(4) - .10(x), x = 80

A uniform disk turns at 5 rev/s around a frictionless spindle. A nonrotating rod, of the same mass as the disk and length equal to the disk's diameter, is dropped onto the freely spinning disk. They then turn together around the spindle with their centers superposed. What is the angular velocity (in rad/s) of the combination? Ans: 18.9 rad/s.

Divers change their body position in midair while rotating about their center of mass. In one dive, the diver leaves the board with her body nearly straight, then tucks into a somersault position. If the moment of inertia of the diver in a straight position is 14 kg∗m 2 and in a tucked position is 7.0 kg∗m 2 . What is the ratio of the diver's angular velocity when tucked to the diver's angular velocity when straight? Ans: 2.00

A = max, v = 0, a = max,   A = 0, v = max, a = 0

6. Which one of the following statements is true concerning an object executing simple harmonic motion?

   Ans: The object's velocity is zero when its acceleration is a maximum

7. Ellen says that whenever the acceleration is directly proportional to the displacement of an object from its equilibrium position, the motion of the object is simple harmonic motion. Mary says this is true only if the acceleration is opposite in direction to the displacement. Which one, if either, is correct?

   Ans: Mary, because the second derivative of an oscillatory function like sin(ωt) or cos(ωt) is always the negative of the original function

8. Complete the following statement: In order to decrease the frequency of the simple harmonic motion of a spring-mass system, one would have to:

   Ans: decrease the spring constant

The position of an object moving with simple harmonic motion is given by x = 4 cos (6πt), where x is in meters and t is in seconds. What is the period of the oscillating system? Ans: 0.33 s
T = 2pi/w, 2pi/6pi = ⅓, ⅓ = .33

After landing on an unfamiliar planet, an alien explorer constructs a simple pendulum of length 48.5cm. The explorer finds that the pendulum completes 10 full swing cycles in a time of 14s. What is the magnitude of the gravitational acceleration on this planet? Ans: 9.8 m/s2
T = 14/10 = 1.4, 1.4 = 2pisqrt(l/g) solve for g = 9.8

Astronauts measure their mass by measuring the period of oscillation when sitting in a chair connected to a spring. The Body Mass Measurement Device on Skylab, a 1970s space station, had a spring constant of 100 N/m. The empty chair oscillated with a period of 3.14s. What is the mass of an astronaut who oscillates with a period of 6.28 s when sitting in the chair? Ans: 75 kg
3.14 = 2pisqrt(mass of chair/k), mass of chair = 25, 6.28 = spisqrt(mass of A + C/k) C + A = 100, so A = 75

. At what displacement from equilibrium is the energy of a Simple Harmonic Oscillator one-fourth KE (Kinetic Energy) and three-fourths PE (Elastic Potential Energy)? (Answer the question as a function of the amplitude A) Ans: A *sqrt(¾)

If one oscillation has 9 times the energy of a second one of equal frequency, but the first's spring constant k is three times as large as the second's, how do their amplitudes compare (Amplitude(1st oscillator)/Amplitude(2nd oscillator))? Ans: 1.73
9(½ kA^2) = (½ * 3k*A^2) cancel x and k and ½, 9A^2 = 3A^2, A = sqrt(9/3)

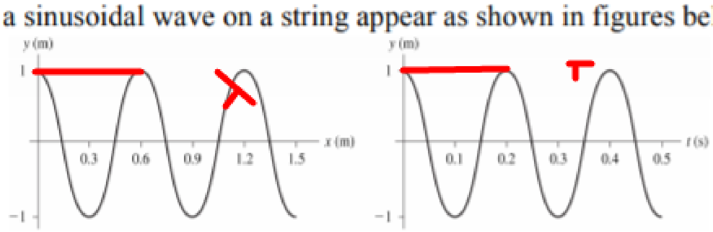
. A 12 cm long tendon was found to stretch 4.0 mm by a force of 16 N. The tendon was approximately round with an average diameter of 8 mm. Calculate Young's modulus of this tendon. Ans: 9.6*106 N/m2
Lo = .12, ChangeL = .004, r = .004, F = 16, plug in, (pi r^2)

. Which one of the following statements concerning waves is false? Ans: A transverse wave is one in which the disturbance is parallel to the direction of travel

. A sound wave is modeled as ΔP = 1.4 Pa sin(2.5 m−1 x − 5000 s−1 t). What is the speed of the sound wave? Ans: 2000 m/s
Wavelength = w/k = 5000/2.5 = 2000

A snapshot and a history graph for a sinusoidal wave on a string appear as shown in figures below. What is the speed of the wave?

Ans: 3.0 m/s



uids

The magnitude of the buoyant force is equal to the weight of the amount of fluid that has the same total volume as the object. Under what circumstances is this statement true? Ans: for an object completely submerged in a fluid

19. Two blocks of identical size are fully submerged in water but did not hit the bottom. One is made of lead (heavy), the other of aluminum (light). Upon which is the buoyant force greater? Ans: They both experience the same buoyant force

20. Consider the portion of a flow tube shown in the figure. Point 1 and point 2 are at the same height. An ideal fluid enters the flow tube at point 1 and moves steadily toward point 2 [Hint: since the fluid is moving from point 1 to point 2, then there is a clear relation between pressure at point 1 and the one at point 2]. What can you say about the fluid's velocity at point 2? The fluid's velocity at point 2 is: Ans: bigger than the fluid's velocity at point 1