NAME_______________________________

Phys 631 Summer 2007 Quiz 2 Tuesday July 24, 2007
Instructor R. A. Lindgren
9:00 am – 12:00 am

Write your name legibly on the top right hand corner of this paper

No Books or Notes allowed
Calculator without access to formulas allowed.
Please sit in alternate seats.

Quiz 2 will have two parts.

The first part consists of a set of five numerical problems with subparts totaling 23 questions. The second part consists of 10 multiple-choice questions. There are a total of 33 questions. All questions are equally weighted.

Honor Pledge.
Please write on your exam
"I did not receive aid nor did I give aid" and sign it.

Problem 1:

An air track system has two carts A and B of mass m_A = 0.3 kg and m_B = 0.6 kg on a frictionless track. Cart A is moving at a speed of 0.5 m/s towards cart B, which is stationary. An elastic collision occurs. Answer the following questions.

a) Find the speed and direction of cart A after the collision.

b) Find the speed and direction of cart B after the above collision.

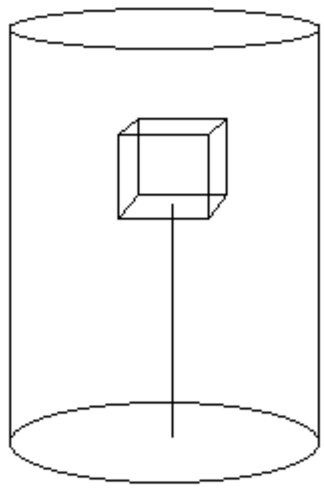
c) What is the kinetic energy of cart B after the collision?

d) What is the speed of the center of mass of the system?

e) Assuming cart A is in contact with cart B for 2.0 milliseconds, find the average force acting on cart A during the collision.

Problem 2:

An ice cube 5x5x5 cm^3 of density 0.9 g/cm^3 is placed in a cylindrical glass containing 500 cm^3 of salt water of density 1.2 g/cm^3. The ice cube is pushed down until the top of the cube is 5 cm below the surface of the water. A cord attached to the bottom of the glass prevents the cube from rising.



a) Draw a free body diagram of the forces acting on the ice cube.

b) Find the buoyant force in Newtons acting on the ice cube.

c) Find the tension in the cord in Newtons.

d) The cord is now cut. What is the speed of the cube when it reaches the surface? Neglect all drag forces between the ice cube and the water.

e) Assuming the cube comes to rest in static equilibrium at the surface, what volume of the ice cube lies below the surface in cm^3?

Problem 3:

A yo-yo has a rotational inertia of 1050 gcm^2 and a mass of 150 g. Its axle radius is 4 mm and its string is 150 cm long. The yo-yo rolls from rest down to the end of the string. This is similar to an object rolling down an inclined plane whose angle is 90 degrees and whose length is the same as the string.

a) What is the magnitude of the acceleration of the center of mass?

b) How long does it take to reach the end of the string?

c) As it reaches the end of the string, what is its linear speed?

d) As it reaches the end of the string, what is its rotational kinetic energy?

e) As it reaches the end of the string, what is its angular speed?

Problem 4:

A satellite of mass m = 3000kg orbits a planet of mass M = $9x10^{24}$kg in a circular orbit of radius r = $5x10^{6}$m.

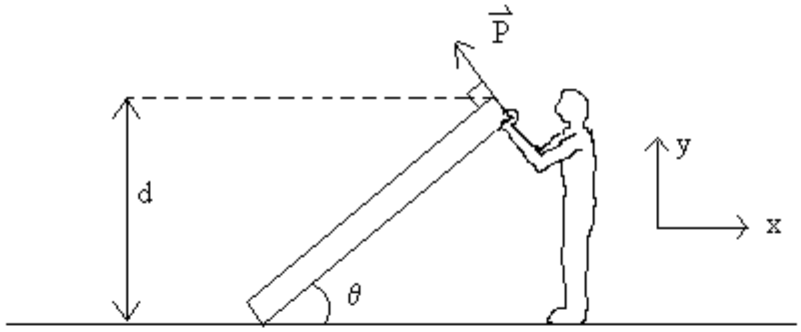
a) Find the period of the orbit.

b) Find the speed of the satellite.

c) Find the total mechanical energy of the satellite after the velocity change.

Problem 5:

A worker attempts to lift a beam of length 2.5m that weighs 500 N. At one instant the worker holds the beam up at one end to a height d = 1.5 m by exerting a force P perpendicular to the beam. The beam is in stable equilibrium.



a) Draw a free body diagram of all forces acting on the beam.

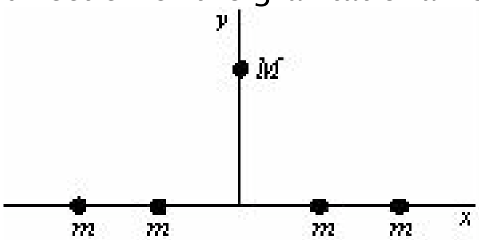
b) Find the angle q.

c) Sum the moments of the forces about the pivot point and find the magnitude of |P|.

d) What is the magnitude of the net force acting on the floor at the pivot point of the beam? Hint: Find the x-components and the y-components of the applied force P and the weight of the beam. Add the components and find the resultant.

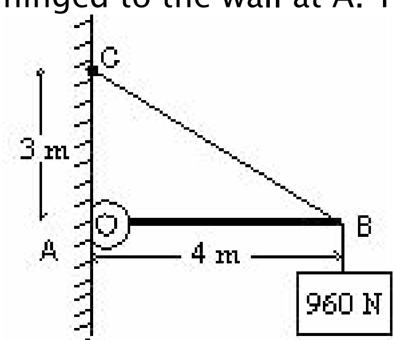
e) What is the minimum value of the force of friction at this instant? What is the normal force? What is the minimum value of coefficient of static friction in order to have the beam not slip at this instant?

6)
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:



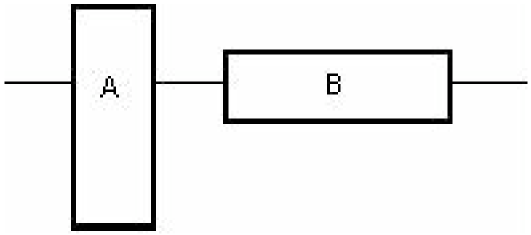
(_) to the left
(_) none of these directions
(_) downwards
(_) upwards
(_) to the right

7)
A 960 N block is suspended as shown. The beam AB is weightless and is hinged to the wall at A. The tension in the cable BC is:



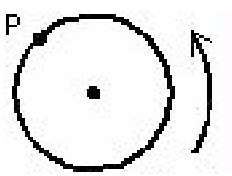
(_) 1280 N
(_) 1200 N
(_) 720 N
(_) none of these
(_) 1600 N

8)
Two identical blocks of ice float in water as shown. Then:



(_) block A displaces a greater volume of water since the pressure acts on a smaller bottom area
(_) block B displaces a greater volume of water since the pressure is less on its bottom
(_) block A displaces a greater volume of water since its submerged end is lower in the water
(_) Block B displaces a greater volume of water since its submerged end has a greater area
(_) the two blocks displace equal volumes of water since they have the same weight

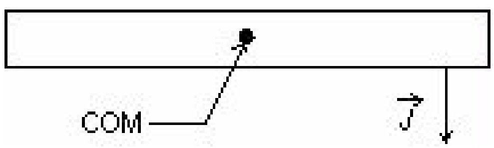
9)
The figure shows a cylinder of radius 0.7 m rotating about its axis at 10 rad/s. The speed of the point P is:



(_) 14 rad/s
(_) none of these
(_) 7.0 m/s
(_) 0.70 m/s
(_) 7 rad/s

10)
A disk with a rotational inertia of 5.0 kg m2 and a radius of 0.25 m rotates on a frictionless fixed axis perpendicular to the disk and through its center. A force of 8.0 N is applied tangentially to the rim. If the disk starts at rest, then after it has turned through half a revolution its angular velocity is:
(_) 0.80 rad/s
(_) 0.57 rad/s
(_) 0.64 rad/s
(_) 3.2 rad/s
(_) 1.6 rad/s

11)
A uniform narrow bar, resting on ice, is given a transverse horizontal impulse J at one end as shown. The center of mass of the bar COM will then:



(_) move in a straight line
(_) remain at rest
(_) move in a parabola
(_) move in a circle
(_) move along some other curve

12)
A projectile in flight explodes into several fragments. The total momentum of the fragments immediately after this explosion:

(_) is the same as the momentum of the projectile immediately before the explosion
(_) is more than the momentum of the projectile immediately before the explosion
(_) is less than the momentum of the projectile immediately before the explosion
(_) has been changed into radiant energy
(_) has been changed into kinetic energy of the fragments

13)
For a completely inelastic two-body collision the kinetic energy retained by the objects is the same as:

(_) the kinetic energy of the less massive body before the collision

(_) the difference in the kinetic energies of the objects before the collision

(_) the kinetic energy of the more massive body before the collision

(_) the total kinetic energy before the collision

(_) 1/2Mv2com, where M is the total mass and vcom is the velocity of the center of mass

14)
The law of conservation of momentum applies to a system of colliding objects only if:

(_) there is no change in kinetic energy of the system

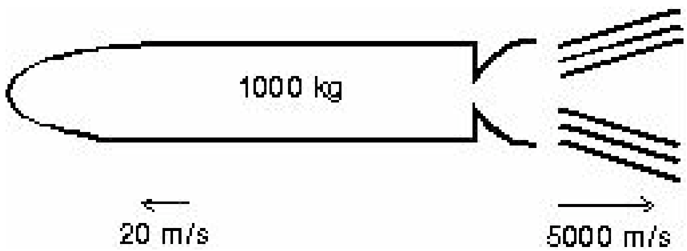
(_) the coefficient of restitution is one

(_) the net external impulse is zero

(_) the coefficient of restitution is zero

(_) the collisions are all elastic

15)
A 1000 kg space probe is motionless in space. To start moving, its main engine is fired for 5 s during which time it ejects exhaust gases at 5000 m/s. At the end of this process it is moving at 20 m/s. The approximate mass of the ejected gas is:



(_) 4 kg
(_) 20 kg
(_) 0.8 kg
(_) 25 kg
(_) 5 kg

$$\sin\theta = \frac{opp}{hyp}$$

$$\cos\theta = \frac{adj}{hyp}$$

$$\tan\theta = \frac{opp}{adj}$$

$$G = 6.7 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$$

$$g = 9.8 \frac{m}{s}$$

$$v = v_o + at$$

$$v_{avg} = \frac{1}{2}(v_o + v)$$

$$x = v_{avg} t$$

$$x = v_o t + \frac{1}{2} a t^2$$

$$v^2 = v_o{}^2 + 2ax$$

$$a_c = \frac{v^2}{r}$$

$$D = \frac{1}{2} C \rho A v^2$$

$$F_{net} = ma$$

$$f_s(\max) = \mu_s N$$

$$f_k = \mu_k N$$

$$x - x_0 = (v_0 \cos\theta_0) t$$

$$y - y_0 = (v_0 \sin\theta_0) t - \tfrac{1}{2} g t^2$$

$$v_y = v_0 \sin\theta_0 - gt$$

$$v_y^2 = (v_0 \sin\theta_0)^2 - 2g(y - y_0)$$

$$v_x = v_0 \cos\theta_0$$

$$s = r\theta$$

$$v = \omega r$$

$$a_t = r\alpha$$

(for α =constant)

$$W = F \cdot x$$

$$F_s = -kx$$

$$Power = \frac{dW}{dt}$$

$$K = \frac{1}{2} m v^2$$

$$U = mgh$$

$$U_s = \frac{1}{2} k x^2$$

$$F = -\frac{dU}{dx}$$

$$p = mv$$

$$F = \frac{dp}{dt}$$

V$_{cm}$ = Total momentum/Total mass

$$v_{1f} = \frac{(m_1 - m_2)}{(m_1 + m_2)} v_{1i}$$

$$v_{2f} = \frac{2m_1}{(m_1 + m_2)} v_{1i}$$

$$R v_{rel} = Ma$$

$$v_f - v_i = v_{rel} \ln(\frac{M_i}{M_f})$$

$$J = F_{avg} \Delta t$$

$$\omega = \omega_o + \alpha t$$

$$\omega_{avg} = \frac{1}{2}(\omega_o + \omega)$$

$$\theta = \omega_{avg} t$$

$$\theta = \omega_o t + \frac{1}{2} \alpha t^2$$

$$\omega^2 = \omega_o{}^2 + 2\alpha\theta$$

$P = \tau\omega$

$I = \frac{1}{3}ML^2$

(Moment of inertia for a rod of length L rotating about one end)

$I = I_{cm} + Mr^2$

$K = \frac{1}{2}I\omega^2$

$\tau = I\alpha$

$\tau = r \times F$

$\tau = dL/dt$

$L = r \times p$

$L = I\omega$

$$a_{com} = \frac{-g\sin\theta}{(1 + I_{com}/MR^2)}$$

$$\frac{F}{A} = E\frac{\Delta L}{L}$$

(E=Young's Modulus)

$$\frac{F}{A} = G\frac{\Delta x}{L}$$

(G=Shear Modulus)

$$p = B\frac{\Delta V}{V}$$

(B=Bulk Modulus)

$$F = \frac{GmM}{r^2}$$

$$U = \frac{-GmM}{r^2}$$

$$E = \frac{-GmM}{2r}$$

$$T^2 = \frac{4\pi^2}{GM}r^3$$

$$E = \frac{-GmM}{2a}$$

(a=semi-major axes of an elliptical orbit)

$F_{buoy} = \rho Vg$

Apparent weight = weight - F_{buoy}

$A_1v_1 = A_2v_2$

$\rho Av = constant$