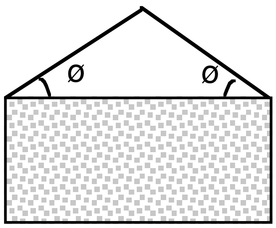
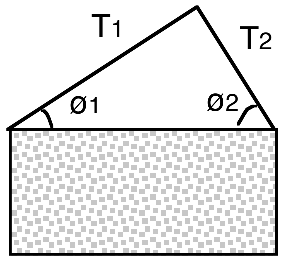
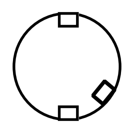
More Semester 1 Exam Review

1. A 20 kg sign hangs from wire as shown.
a. Determine the mass and weight of the sign
b. Determine the tension in the string if ø = 30°.
c. Determine T1 & T2 if the angles change to 30° and 60°





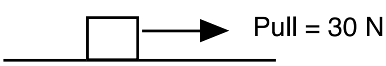
2. A 50 kg girl rides a roller coaster rolls around a vertical loop of radius 20m at a speed of 20 m/s.

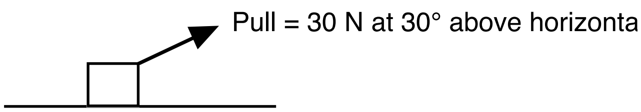


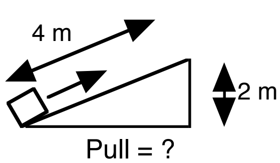
a. Determine the acceleration of the coaster.
b. Determine the support force when the car is at the bottom of the loop
c. Determine the minimum speed needed to prevent the passengers from falling out when the car is <u>moving</u> (upside down) at the top of the loop.

3. An astronaut weighing 500 N on Earth, travels to a planet that has twice the mass of the Earth and half the radius of the Earth ($R_E = 6 \times 10^6$ m).
a. Determine the acceleration of objects dropped near the surface of this planet.
b. Determine the weight of the astronaut on this planet.
c. If this planet has no atmosphere, an object can be put in circular orbit at what velocity?
d. What is the period of this orbit?

4. Determine the total work done in moving a 20 kg block a distance of 4 meters at a <u>constant speed</u> in the cases below: (friction is present in a and b)

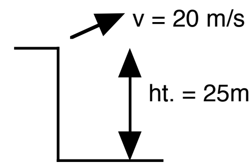
a. 

b. 

c. 

(no friction here

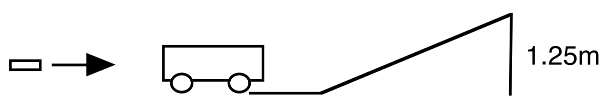
5. A 0.100 kg ball is shot at a speed of 20 m/s from a window 25 meters above the ground.



a. Determine the speed of the ball when it hits the ground.
b. If the ball does 40 J of work against air resistance as it falls, determine the final speed when it reaches the ground.

6. A 2,000 kg car moving East at 10 m/s collides <u>and sticks</u> to a 1,000 kg car moving at 8 m/s West. The collision lasts 0.1 sec.
a. Determine the final velocity of the connected cars after the collision.
b. Determine the impulse acting on <u>each</u> car.
c. Determine the average force on <u>each</u> car.
d. The two connected cars slide to a stop in 20 meters. Determine the force of friction.
e. If instead of colliding inelastically, the cars collide <u>perfectly elastically</u>. Determine the final velocity of <u>each</u> car.

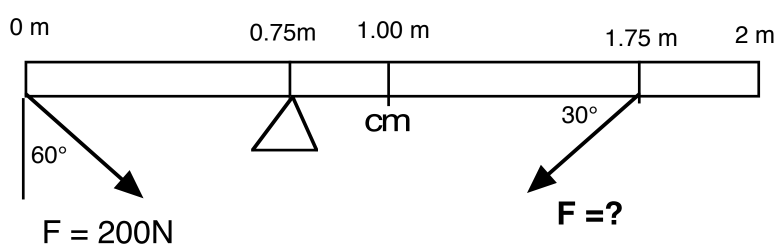
7. A 0.01 kg bullet hits and lodges in a 1.99 kg block of wood at rest on frictionless wheels. After the collision, the block (with the bullet lodged inside) rises up an incline a height of 1.25 m before coming to rest.



What was the original velocity of the bullet?

8. A 1 kg ball moving at 10 m/s (N30°W) and a 2 kg ball moving at 6 m/s (N60°E) collide inelastically and stick together. Determine the final velocity of the balls.

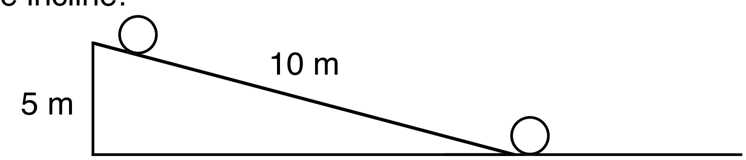
9. A 2 meter long rod has a mass of 20 kg.
a. Determine the force "F" needed to keep the rod in equilibrium.
b. Determine the upward force exerted by the fulcrum (ie: pivot point) on the rod.



10. A bike wheel with a 0.5 m radius spinning at 1 rad/s is accelerated at a constant rate of 2 rad/s/s for 4 seconds.
a. Determine the final angular velocity of the wheel at 4 seconds.
b. Determine the angle through with the wheel spins in 4 seconds.
c. Determine the tangential velocity of a point on the outside of the wheel at 4 seconds.

11. A bike wheel accelerates from 6 rad/s/s to 12 rad/s/s in 2 seconds
a. What is the angular acceleration of the wheel?
b. If the wheel has an angular inertia (also called moment of inertia) of 0.2 kgm^2, how much torque is needed to give the wheel this angular acceleration?
c. If the wheel has a radius of 0.5 m, what is the tangential acceleration of a point on the outside of the wheel?

Challenge:
A ring of radius 0.5m and mass 2 kg statrs from rest and rolls down a 5m high, 10m long incline, as shown. Determine the linear velocity of the ring when it reaches the bottom of the incline!



HINTS:
Rotational inertia for a ring = mR^2
Linear KE = 1/2 mv^2
Rotational KE = 1/2$□^2$
PE = mgh
□ = v/ r

Answers: ***(Warning! I did the solutions VERY QUICKLY, so there may be errors!)***
1.
a. mass = 20 kg
weight = 200N
b. T = T2 = 200N
c. T1 = 100N
T2 = 173 N

2.
a. 20 m/s/s
b. at bottom: N = 1500 N upward
c. v = 14.14 m/s

3.

a. 80 m/s/s
b. 4,000 N
c. v = 15492 m/s
d. T = 1217 sec

4.
a. 120 J
b. 103.9 J
c. 400 J

5.
a. 30 m/s/s
b. 10 m/s

6.
a. 4 m/s east
b. +/- 12,000Ns
c. +/- 120,000N
d. -1200N
e. (try this on your own!)

7.
v = 1,000 m/s

8.
vel = 5.2 m/s [N20.2°E]

9.
a. F = 50N
b. upward force = 325N

10.
a. (chg. in ang. vel.) = (ang. accel.)(time) = (2)(4) = 8 rad/sec
(final ang. vel.) = (initial ang vel.) + (chg. in ang. vel.) = 1+8 = **9 rad/s**
b. (change in angle) = (avg ang. vel.)(time)= (5)(4) = **20 rad**
c. v = (ang. vel)(R) = (9)(.5) =**4.5 m/s**

11.
a. (ang. accel.) = (chg. in ang. vel) / time = 6/2 = **3 rad/s/s**
b. (torque) = (moment of inertia)(ang. accel) = (0.2)(3) = **0.6Nm**
c. (linear accel.) = (ang. accel)(R) = (3)(.5) = **1.5 m/s/s**

Challenge:
PE = lin KE + rot KE
$mgh = (1/2)(m)v^2 + \mathbf{(1/2)(I)w^2}$
$mgh = (1/2)(m)v^2 + (1/2)(\mathbf{mR^2})w^2$
$mgh = (1/2)(m)v^2 + (1/2)(mR^2)\mathbf{(v/R)^2}$
$mgh = (1/2)(m)v^2 + (1/2)(m)v^2$
$mgh = (m)v^2$
$v^2 = gh$ $v^2 = 50$ **v = 7.07 m/s**
7.07 m/s instead of the 10 m/s if it slide friction free down the incline!... 30% slower!