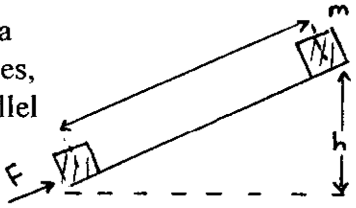
Physics 103 July 1 , 1996
Final Exam Time: 8:00 a.m.

Name:____

I.D. no.____

10 marks

1. A block of mass m = 11.7 kg is to be pushed a distance of S = 4.65 m along an incline (see figure below) so that it is raised a distance of h = 2.86 m in the process. Assuming fricitonless surfaces, calculate how much work you would do if you applied a force parallel to the incline to push the block up at constant speed.



10 marks

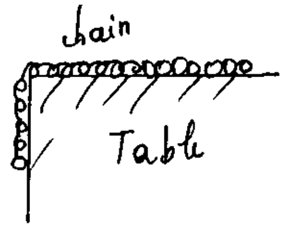
2. A child pulls a 5.6-kg sled a distance of S = 12 m along a horizontal at a constant speed. What work does the child do on the sled if the coefficient of Kinetic friction μ_k is 0.2 and the cord makes an angle of $\phi = 45^o$ with the horizontal.

10 marks

3. A 0.15 kg ball is moving at a speed of 40 m/s when it is struck by a bat that reverses its direction and gives it a speed of 6 m/s. What average force was exerted by the bat if it was in contact with the ball for 5.0 ms.

10 marks

4. A chain of mass m and length L is held on a frictionless table with one fifth of its length over the edge. Find the work required to pull the hanging part back on the table.



10 marks

5. An object of 2.0 kg mass makes an elastic collision with another object at rest and continues to move in the orginal direction but one-fourth of its original speed. What is the mass of the struck object ?

10 marks

6. A passenger of mass 72.2 kg is riding in an elevator while standing on a platform scale.
What does the scale read when the elevator cab is

a- descending with constant velocity.
b- ascending with acceleration 3.2 m/s^2 ?

10 marks

7. Two solid cylinders, each of mass M and radius R, are welded together along a line tangent to their length.

Find an expression for the moment of inertia of the system for rotation about the lines that joins the cylinders.

15 marks

8. A soccer player kicks a ball at an angle of 37^{o} above the horizontal with an initial speed of 15 m/s. Assuming that the ball moves in a vertical plane,

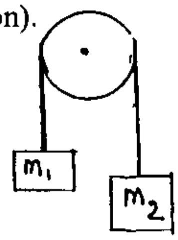
a- find the time at which the ball reaches the highest point of its trajectory.

b- find its maximum hight.

15 marks

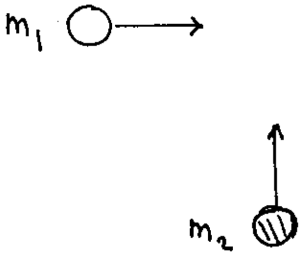
9. Consider two unequal masses connected by a string that passes over an ideal pulley (whose mass is negligible and whose axle rotates with negligible friction).
Let m_2 be greater than m_1. Find
a-the tension in the string and

b-the acceleration of the masses.



20 marks

10. Two skaters collide and embrace in a completely inelastic collision. That is they stick together after impact. One whose mass m_1, is 70-kg, is initially moving east at 6.0 km/h while the other, whose mass m_2 is 50 kg is initially moving north at 8.0 km/h
Calculate



a- the final velocity of the couple

b- the initial kinetic energy of the skaters

c- the final energy of the skaters.

d- the fraction of the kinetic energy of the skaters lost because of the collision.

<u>15 marks</u>

11. A uniform disk rotates about a fixed axis, starting from rest and accelerating with a constant angular acceleration. At one time it is rotating at 12 rev/s. After completing 80 more complete revolutions its angular speed is 16 rev/s. Calculate

a- its angular acceration in rev/s^2.

b- the time required to complete the 80 revolutions

c- the time required from the start to attain the 12 rev/s angular speed.

<u>15 marks</u>

12. A 0.80 kg pendulum bob is supported by a 1.5 m long string from a fixed point. The bob is pulled to one side, so that the string makes an angle of 30° with vertical, an then released from rest. Find:

a- the speed of the bob at the lowest point of its swing.

b- the instantaneous angular velocity of the pendulum at that point of its swing.

c- the tension in the string at that moment.

<u>15 marks</u>

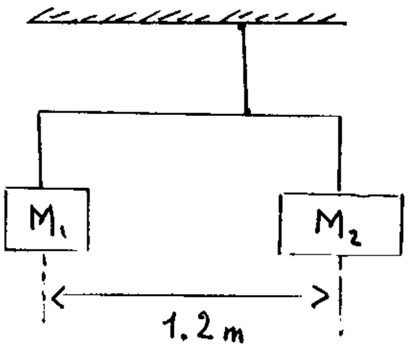
13. A 600 kg satellite is placed into orbit 1.5×10^6 m above the surface of the earth. (the radius of the earth is 6.37×10^6 m). Determine the period of this satellite and the energy that had to be expended to place it into orbit. (Neglect the kinetic energy of the satellite while at rest on the surface of the earth due to the rotation of the earth about its axis.

<u>15 marks</u>

14. Two masses $m_1 = 1.60$ kg and $m_2 = 2.00$ kg are suspended from the ends of a very thin(effectively massless) aluminum rod whose length is 1.20 m Figure below. The rod itself is supported by a string from the ceiling.
Find

a- the position on the rod at which the string should be attached so that the rod will be horizontal, and

b-the tension in the supporting string.



20 marks

15. A merry-go-round at a playground consists of a circular piece of wood 8.0 cm thick and4.00 m in diameter. The disk has a mass of 200 kg. Initially, lthe merry-go-round is at rest. Four children, each having a mass of 30.0 kg, push tangentially along its circumference, running along with the merry-go-round as it turns until they are running at a speed of 15.0 km/h when they jump onto the disk. Assume that each pushes with a constant force of 20.0 N.

    a- What is the angular acceleration of the merry-go-round?

    b- How far does each child run before jumping abroad?

    c- How much work has each child done?

    d- What is the kinetic energy of the system after the children have jumped abroad?

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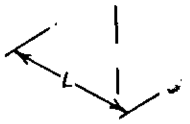
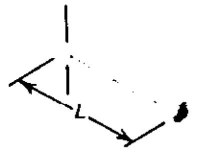
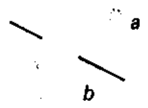
9.1

Table 9.1

Cylindrical shell about axis		$I = MR^2$
Solid cylinder about axis		$I = \frac{1}{2}MR^2$
Thin rod about perpendicular line through center		$I = \frac{1}{12}ML^2$
Thin rod about perpendicular line through one end		$I = \frac{1}{3}ML^2$
Thin spherical shell about diameter		$I = \frac{2}{3}MR^2$
Solid sphere about diameter		$I = \frac{2}{5}MR^2$
Solid rectangular parallelepiped about axis through center perpendicular to face		$I = \frac{1}{12}M(a^2 + b^2)$

and the total moment of inertia of the object about AA' is

$$I = \sum_i \Delta I_i = \sum_i \Delta m_i r_i^2 \tag{9.13}$$

It is this summation that may pose difficulties. We shall not carry out such calculation here, but give the moments of inertia of some simple geometrical objects in Table 9.1.

The fact that the elemental moments of inertia ΔI_i depend on the distances r_i of the masses Δm_i from the rotation axis means that *the moment of inertia of an object is not a fixed quantity but depends on the location of the axis about which the moment of inertia is calculated.* A particular object does have a unique mass; it does *not* have a unique moment of inertia. Its moment of inertia depends not only on its total mass and the distribution of that mass in space—that is, the shape of the object—but also on the orientation and position of the axis of rotation.