MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Department of Physics

Physics 8.01 Fall 2000

EXAM 2
Friday, October 13, 2000

FAMILY (Last) NAME

GIVEN (First) NAME

Student ID Number

Your Recitation (check one) →

R01	MW 1:00	W. Bertozzi	
R02	MW 2:00	W. Bertozzi	
R03	MW 3:00	W. Bertozzi	
R12	TR 1:00	A. Bolton	
R18	TR 9:00	B. Burke	
R19	TR 10:00	B. Burke	
R20	TR 11:00	B. Burke	
R21	TR 2:00	M. Evans	
R22	TR 3:00	M. Evans	
R06	MW 2:00	M. Feld	
R07	MW 3:00	M. Feld	
R08	MW 4:00	M. Feld	
R16	TR 11:00	D. Fernie	
R15	TR 10:00	A.Guth	
R23	TR 11:00	J. Hager	
R24	TR 12:00	J. Hager	
R09	MW 1:00	P. Joss	
R10	MW 2:00	P. Joss	
R11	MW 3:00	P. Joss	
R26(M)	TR 3:00	McBride/Bove	
R17	TR 12:00	TA- Ribeiro	
R13	TR 2:00	J. Shelton	
R14	TR 3:00	J. Shelton	
R04	MW 1:00	G. Stephans	
R05	MW 2:00	G. Stephans	

Instructions:
1. SHOW ALL WORK. All work must be done in this booklet. Extra blank pages are provided.
2. This is a closed book exam.
3. CALCULATORS, BOOKS, and NOTES are NOT ALLOWED.
4. Do all FOUR (4) problems.
5. Exams will be collected 5 minutes before the hour.

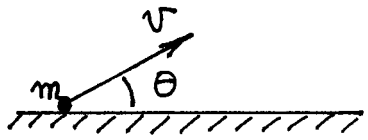
Problem	Maximum	Score	Grader
1	30		
2	25		
3	25		
4	20		
TOTAL	100		

Note: this exam included a 3-page formula sheet, which can be downloaded separately.

1. 30 points, 5 points each part, no partial credit.

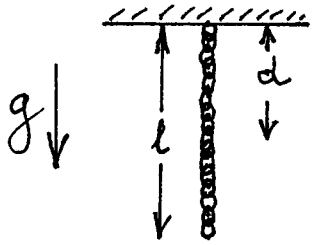
   a) A projectile of mass m is launched over level ground with an initial speed v at an angle θ to the horizontal. Neglecting air resistance,

      i) What is the kinetic energy just after launch?



      ii) What is its total energy at the top of its flight?

   b) A uniform chain of total mass m and total length ℓ is hanging from a nail. If the acceleration of gravity is g, what is the tension in the chain a distance d from the nail?

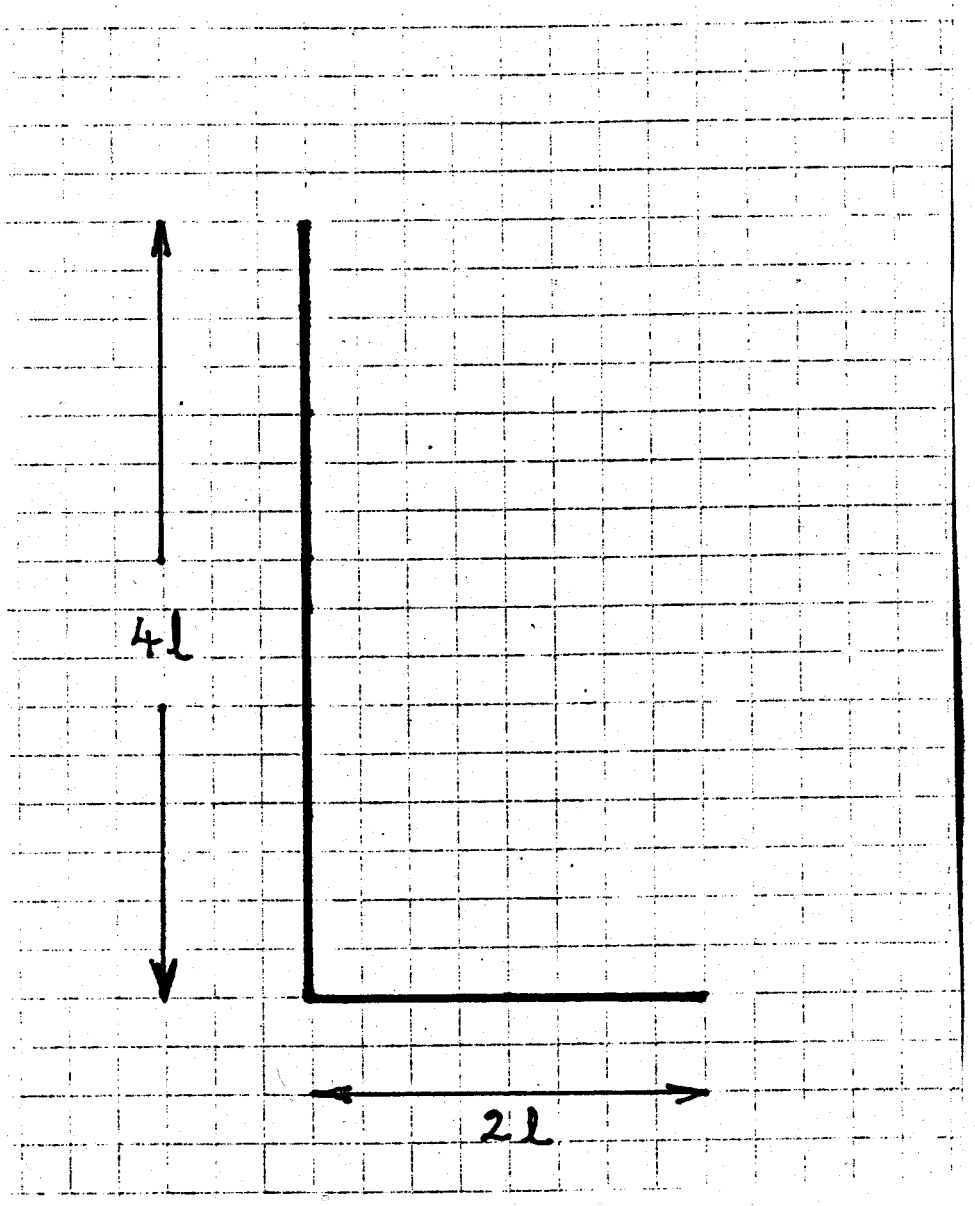


   c) A book with mass m is lying on a table.

      i) On the diagram below, indicate <u>all</u> the forces acting on the book. Label each force.

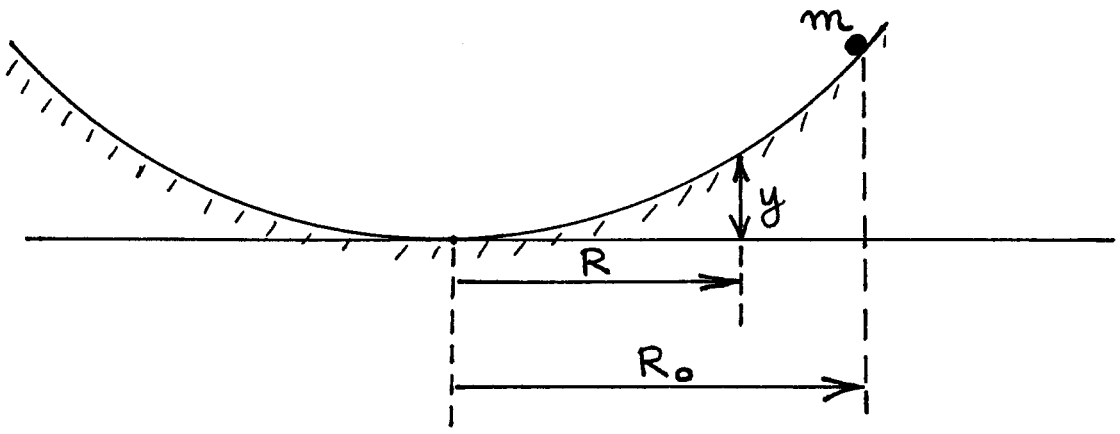
      ii) For each force above, list the corresponding force which is equal and opposite by Newton's third law.

d) The diagram below shows two rods, one of length 4ℓ and mass $4m$ the other of length 2ℓ and mass $2m$, joined at right angles. Indicate with a cross the position of the center of mass.



2. (25 points)

A parabolic mirror is placed on a table such that, at a horizontal distance R from the center of the mirror, the inside surface of the mirror is a vertical distance y above the center, given by: $y = \dfrac{R^2}{4a}$



A stationary small object of mass m is released from a position $R = R_0$. Assuming the surface of the mirror is so smooth that there are no frictional losses,

a) Derive an expression for the magnitude of the velocity of the object when it is at position R.

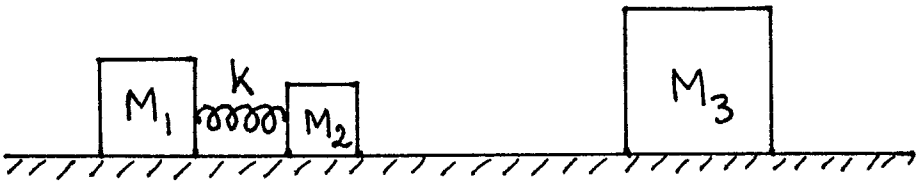
b) During the motion of the object from R_0 to R,

i) How much work does the normal force do on the object?

ii) What fraction of the work on the object is done by gravity?

Give your answers in term of only R, R_0, a, m and g.

3. (25 points). Two stationary masses M_1 and M_2 are placed on a horizontal sheet of ice. A massless ideal spring of constant k is compressed by a distance x and placed between the two masses, as shown. The spring is not attached to the masses. After the spring is released, M_2 slides with no frictional losses toward a stationary child of mass M_3. The child catches M_2 and holds it stationary relative to herself. Derive an expression in terms of only M_1, M_2, M_3, k and x, for the magnitude of the velocity of the child as she slides after catching M_2.



4. (20 points)

Over a short stretch of a roller-coaster the potential energy of a cart of mass m is given by $u(x) = a + bx^2$

i) At what value of x would the cart be in equilibrium?

ii) The cart is displaced slightly from equilibrium and let go from rest. How long will it take for the cart to reach the point of equilibrium (for the first time)? Assume no friction.