Exam

FINAL

P201 Fall 2006,
Instructor: Prof. Abanov

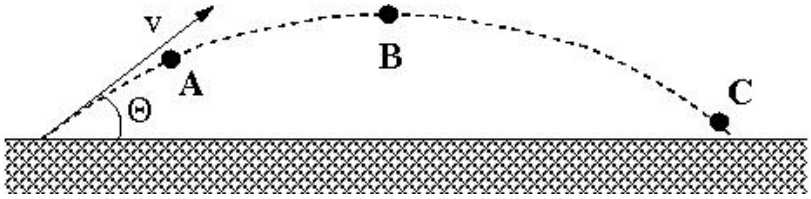
12/13/06

Name_____ Section_____

(print in **big** block letters)

Your grade:

Problem 1.



A ball has been thrown from the ground level with initial velocity $v = 20\text{m}/s$ at the initial angle $\Theta = 30°$. Point **B** is the top of the trajectory, point **C** is right before the ball hits the ground.

What is the ball's acceleration at points A, B, and C? A_____, B_____, C_____

What is horizontal component of the velocity at points B and C? B_____, C_____

What is vertical component of the velocity at points B and C? B_____, C_____

What time does it take for the ball to reach the points B and C? B_____, C_____

What is the height of the trajectory at the point B? _____

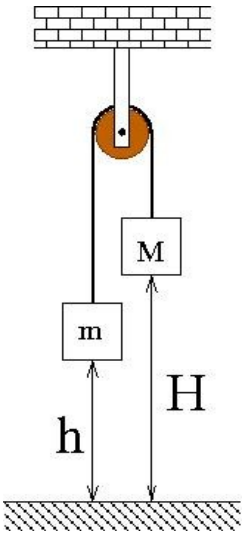
What is the distance from the initial point to the point C? _____

What would the hight of the trajectory at the point B be if you doubled the initial velocity?_____

What would the distance from the initial point to the point C be if you doubled the initial velocity?_____

Problem 2.

Two bricks with masses $M = 20\text{kg}$ and $m = 16\text{kg}$ are hanging at the hight $h = 2\text{m}$ and $H = 5\text{m}$ on a frictionless pulley as shown on the figure. At the initial moment everything is at rest



What is the acceleration of the bricks m and M? M_____, m_____

What is the tension T of the rope? _____

What is the initial energy of the system?_____

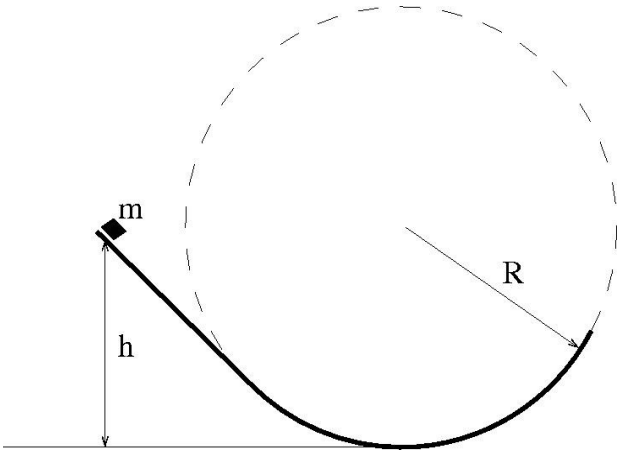
What is the potential energy of the system when the brick M hits the floor?_____

What is the velocity of the brick M right before it hits the floor?_____

What would be the velocity of the brick M right before it hits the floor, if 20 Joules of heat were produced in the block due to friction?_____

Problem 3.

A brick of mass $m = 5\text{kg}$ slides down a frictionless ramp from a hight $h = 2\text{m}$. The ramp at the end bends with radius $R = 2\text{m}$ as shown in the figure.

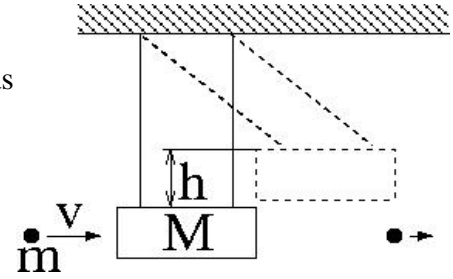


What is the velocity of the brick at the bottom of the ramp?_____

What is the magnitude of upright force which acts on the brick at the bottom of the ramp?_____

Problem 4.

A bullet of mass $m = 10\text{g}$ has an initial velocity $v = 300\text{m}/s$. It goes through a wooden brick of mass $M = 5\text{kg}$ which is hanging as shown in the figure. The speed of the bullet on the other side of the brick is half of its initial speed.



What is the initial momentum of the system?_____

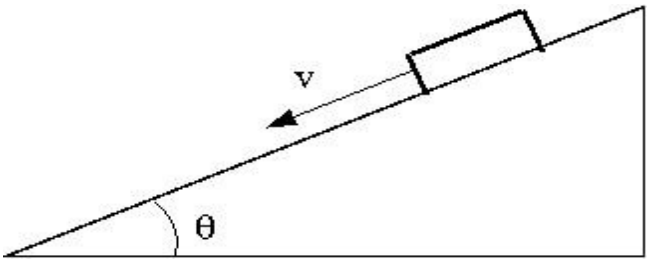
What is the maximum hight h the brick M will get to?_____

How much of the initial energy of the bullet were converted to heat? _____

Problem 5.

A brick of mass $M = 4\text{kg}$ on a slope of the angle $\theta = 20°$ initially has a velocity $v = 2\text{m}/s$

The friction coefficient between the brick and the slope is $\mu = 0.4$



What is the friction force which acts on the brick? F=_____ (show the direction on the figure)

What is the acceleration of the brick? _____

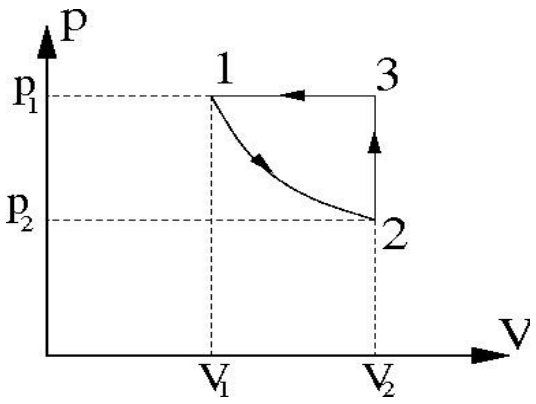
How much time will it take the brick to stop?_____

What distance will the brick move until it stops?_____

How much heat will be produced by the friction?_____

Problem 6.

One mole of an ideal gas has initial temperature 500K and initial volume 1m^3 (1). During an isothermal process its volume doubled (2). Then by a process at constant volume it was brought to the initial pressure (3). Finally, decreasing volume at constant pressure the gas was brought to the initial state.



What is the initial pressure p_1 ?_____

What are the volume V_2 , the pressure p_2 and the temperature T_2 at the state (2)?_____,_____,_____

What are the volume V_3 , the pressure p_3 and the temperature T_3 at the state (3)?_____,_____,_____

How much work had to be done on the gas during the process 2-3?_____

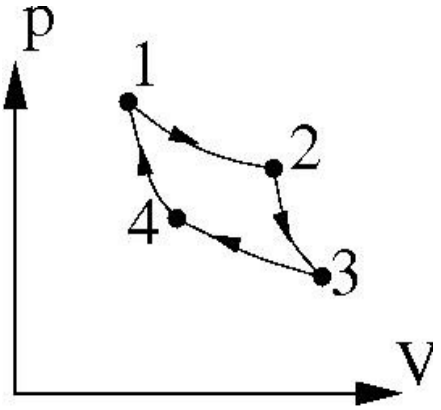
How much internal energy of the gas has changed during the process 2-3?_____

How much heat had to be supplied to the gas during the process 2-3?_____

How much heat had to be supplied to the gas during the process 3-1?_____

Problem 7.

One mole of an ideal gas goes around the Carnot cycle. The temperature of the hot heat bath is $T_H = 400\text{K}$, the temperature of the cold bath is $T_C = 350\text{K}$. During the process 1-2 the gas received 4J of heat.



What work is done by the gas during the process 2-3?_____

What work is done by the gas during the process 4-1?_____

How much work has been done by the gas during the process 1-2?_____

How much heat the gas transfered to the cold bath during the process 3-4?_____

How much work the gas has done during the process 3-4?_____

What is the thermal efficiency of this heat engine?_____

What is the change of entropy during the processes 1-2, 2-3, 3-4, 4-1?_____,_____,_____,_____

What is the net change of entropy during the cycle? Why?_____

Problem 8.

A wire with mass 50g is stretched so that its ends are tied down at points 70cm apart. The wire vibrates in its fundamental mode with frequency 170Hz and with an amplitude of 0.8cm at the antinodes.

What is the wavelength of the fundamental mode? _____

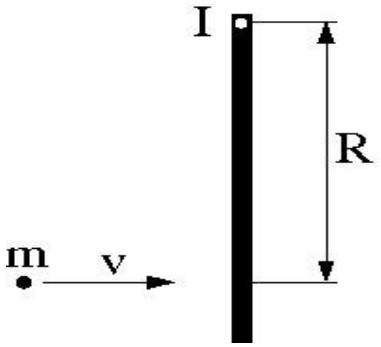
What is the speed of the wave?_____

What is the tension of the wire?_____

What are the frequency of the second harmonic?_____

Problem 9.

A bullet of mass $m = 10\text{g}$ and velocity $v = 300\text{m}/s$ hits a door at the distance $R = 1\text{m}$ (see figure) and gets stuck in it. The door is initially at rest. The door's moment of inertia is $I = 10\text{kg} \bullet m^2$.



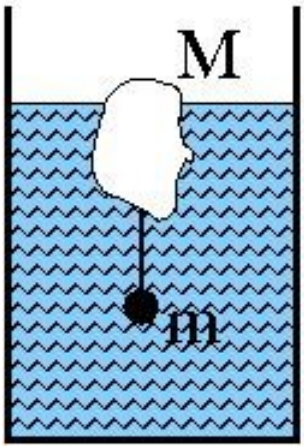
What is the initial angular momentum of the system?_____

What is initial energy of the system?_____

What is the final angular velocity of the door?_____

How much heat was produced during the collision?_____

Problem 10.



A piece of metal ($\rho_m = 10000\text{kg}/m^3$) of mass $m = 10\text{g}$ is attached by a rope to a chunk of ice ($\rho_I = 900\text{kg}/m^3$) of mass $M = 100\text{g}$ (see figure). The density of water is $\rho_w = 1000\text{kg}/m^3$.

What is the tension of the rope?_____

What volume of the ice sticks out of the water?_____