Midterm Exam 2

Physics 7A, Spring 2012

Lecture 1: Herdman

April 2, 2012

Please do all your work in a bluebook. You will be graded on your *solutions* not just your *answers*. Show all work and thoroughly justify your solutions with figures, diagrams, equations, and words, as appropriate. Partial credit will be given to partially correct and/or partially complete solutions. No credit will be given to unjustified answers. Cross out any parts of solutions that you do not want to be graded.

There are 5 problems and 100 possible points on the exam. Please read all 5 problems carefully at the beginning of the exam and attempt all problems to maximize your partial credit. Make sure that your answers to questions that ask for a vector quantity are given in the form of vectors (i.e. have vector components, or a magnitude and direction). Where appropriate, clearly label the choice of axes you are using. You have two hours to complete the exam. This is a closed-book exam–you may use one double-sided $3'' \times 5''$ index card of notes. Calculators are not allowed.

On the front or your bluebook, write your:

- full name
- SID
- D/L section number
- GSI name
- signature

Do not open the exam until you are told to do so.

Good luck!!

1 Bullet & Blocks [20 pts]

A bullet (mass m_b) is fired horizontally with speed v_0 at two blocks sitting on a frictionless surface (see figure 1). The bullet passes through the first block (mass m_1) and and them embeds into block 2 (mass m_2). The bullet loses half its kinetic energy after passing through the first block. Find the final speeds of block 1, v_1, and block 2, v_2, in terms of given quantities (m_1, m_2, v_0) and any relevant constants.

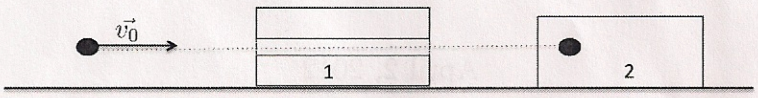

Figure 1: Problem 1

2 Box on a Ramp [20 pts]

A box of mass m, which begins instantaneously at rest, is pushed up a ramp by a person who applies an unknown, constant horizontal force to the box (see figure 2). There is a spring of spring constant k attached to the box, and it is initially stretched a length $\Delta\ell$ from its equilibrium length, ℓ_0. The coefficient of kinetic friction between the box and the ramp is μ_k and the ramp has an incline of angle $\theta < 45^o$. After it has travelled a distance d up the ramp, the box comes to rest for an instant.

(a) What is the net work done on the block?

$W_{net} = \Delta KE = KE_f - KE_i$

(b) How much work has the person done on the block?

Put all answers in terms of the given quantities (m, k, d, $\Delta\ell$, μ_k, θ) and relevant physical constants.

$\frac{1}{2}k\Delta\ell^2 - \frac{1}{2}k(d-\Delta\ell)^2$

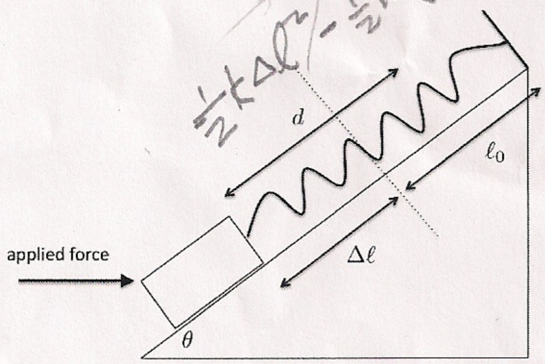

Figure 2: Problem 2

3 Ball & Block [20 pts]

A rubber ball of mass m is attached to a string of length ℓ and released from rest at an unknown angle to the vertical (see figure 3). When the string is vertical, the ball has a perfectly elastic collision with a block of mass $2m$ sitting at rest on a frictionless surface. The block is attached to a spring of spring constant k and the block comes to a rest after moving a distance d. Find the angle θ of the string to the vertical from which the ball was released in terms given quantities (m, k, ℓ, d) and relevant physical constants. You may solve for a trig function of θ rather than θ itself.

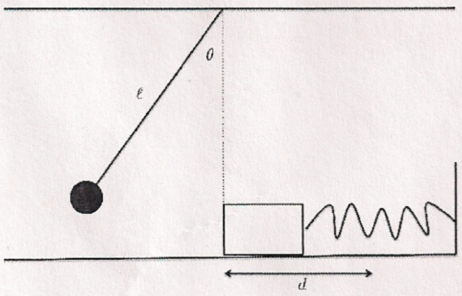

Figure 3: Problem 3

4 Approaching stars [20 pts]

Two stars, with masses m_1 and m_2 that are initially *very* far apart and at rest (and even farther from any other stars) are pulled together by their gravitational attraction. Find their relative speed when they are a distance d apart from one another. Put your answer in terms of given quantities (m_1, m_2, d) and any relevant physical quantities.

5 Cannon [20 pts]

A cannonball (mass m_b) is loaded into a short cannon (mass m_c) which can slide frictionlessly on the ground and is aimed at an angle θ to the horizontal (see figure 4). The cannon starts at rest and the cannonball is loaded a height h above the ground. The TNT provides and explosion of energy Δ and a fraction f of that energy is dissipated into heat and sound. Find the final speeds of the cannon and cannonball right before the cannonball lands in terms of the given quantities (m_b, m_c, θ, h, Δ, f) and relevant physical constants. Assume the cannon is short enough, and the ratio m_b/m_c small enough, that the initial velocity of the cannonball immediately after the cannon is fired makes an angle θ to the horizontal.

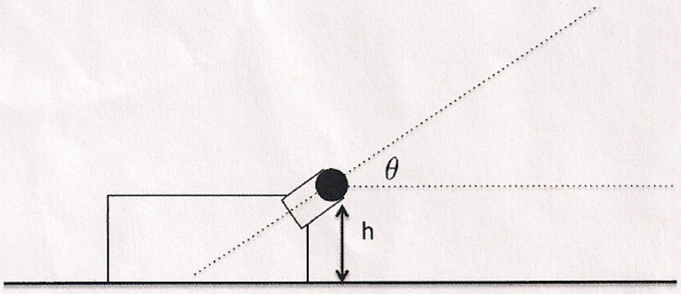

Figure 4: Problem 5