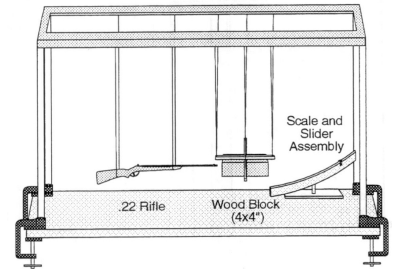


Physics 7A, Spring 2012, Sections 2 and 3, Instructor: Professor Adrian Lee
2nd Midterm Examination, Tuesday, April 3, 2012

Please do work in your greenbooks. Show your reasoning carefully so that we can be sure that you derived the answer rather than guessing it or relying on memory; in addition, this enables us to give partial credit. You may use one double-sided 3.5 x 5 index cards of notes. Test duration is 110 minutes. Calculators are not allowed.

1 Rifle Demo [25 pts. total]

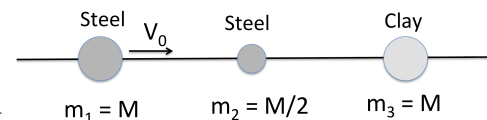
Consider the rifle demo from class. A rifle with mass m_R and a block of wood with mass m_W are suspended so that they can both swing freely. Initially, both the wood block and rifle are stationary. Then, the rifle fires a bullet with mass m_B and velocity v_B into the wood block.



- What is the velocity of the wood immediately after the bullet hits it? [5 pts.]
- At the peak of its swing what is the maximum change in height of the wood block? [10 pts.]
- What is the ratio of the maximum change in height of the wood block to that of the rifle? [5 pts.]
- Is any energy lost when the bullet hits the block? If yes, how much? [5 pts.]

2 Collisions [25 pts. total]

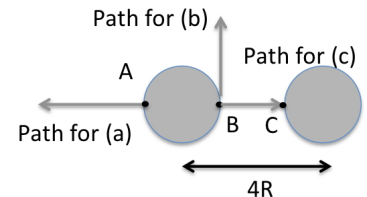
Consider three spheres lined up in a row along the x -axis with masses $m_1 = M$, $m_2 = M/2$, and $m_3 = M$. The sphere with $m = m_1$ has an initial velocity V_0 in the $+x$ direction, while the other two spheres are initially at rest. The sphere with $m = m_1$ has an elastic collision with m_2 and then m_2 collides and sticks to m_3 .



- Determine the velocities of m_1 and m_2 after the first collision. [10 pts.]
- Determine the velocities of m_2 and m_3 after the second collision. [5 pts.]
- After the second collision will m_1 collide with the m_2, m_3 combination? If they do not collide, for what values of m_3 would this collision occur? [10 pts.]

3 Twin Planets [25 pts. total]

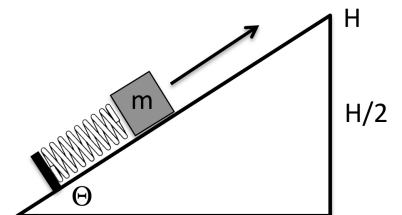
Consider a planetary system with two planets identical to earth with mass M and radius R which are separated with their centers a distance of $4R$ apart.



- Show that potential energy due to one planet and a mass m can be described by $-GMm/r$ for $r > R$. Consider a person at point A that wishes to fire a projectile from the far surface of one planet to reach very far away from the system. What is the minimum speed that she must fire the projectile? [10 pts.]
- Consider a similar situation at point B, on the near side of one of the planets. What is the minimum firing speed for a projectile to escape the planets? [5 pts.]
- Now consider if the person at point B only wants to fire her projectile from point B to point C on the next planet. What is the minimum firing speed required for this projectile? Draw a potential energy diagram for this path. [10 pts.]

4 Block Launcher [25 pts. total]

Consider a block launched from a wedge of height H and angle θ by a spring with spring constant k . The spring is compressed from its equilibrium by a distance d . A block with mass m is placed on the compressed spring half way on the incline of the wedge with a height $H/2$



- What is the velocity of the block as it leaves the hill? Include the effect of friction with coefficient of kinetic friction μ . Assume the spring is strong enough to launch the block from the wedge. [10 pts.]
- What is the velocity of the block when it falls back to a height $H/2$? [5 pts.]
- If at that point in part (b) the block breaks into two pieces with mass $1/3 m$ and $2/3 m$ such that the $1/3 m$ piece falls straight down with the same vertical velocity as before, how far apart will the two pieces be when they land? For the answer to this section, you do not have to plug in your values from parts (a) and (b). [10 pts.]