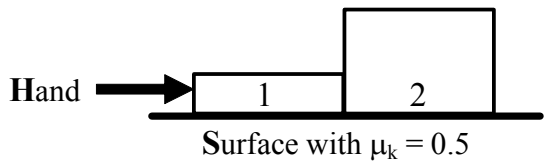


Homework Handout #5: Work and Energy (Phys 207, Fall 2005) DUE 10/17

Problem #1: Convert external work to Kinetic Energy

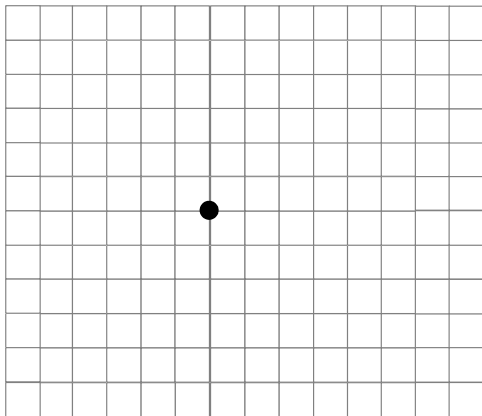
Block #1 (1 kg) and block #2 (3 kg) are being accelerated to the right at 5 m/s^2 by a hand pushing on block #1. The **initial velocity** of the two blocks is 4 m/s . The coefficient of kinetic friction between the blocks and the surface is $\mu_k = 0.5$.

(a) Draw the **free body diagrams** for both blocks using the two subscript notation, and draw the **net force** on each block. (assume $g = 10 \text{ m/s}^2$)

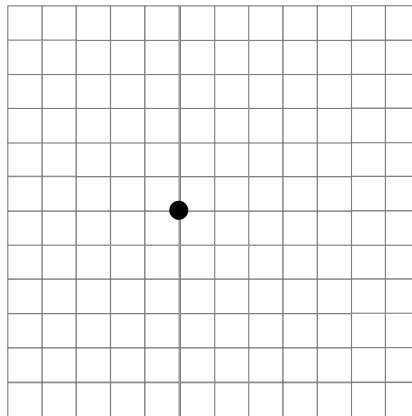


Block #1 FBD

Block #2 FBD

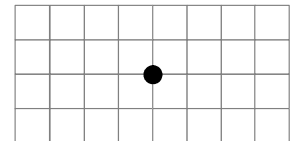


1 div = 5 N

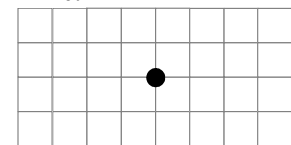


1 div = 5 N

F_{1net}



F_{2net}



1 div = 5 N

(b) Find the **initial** kinetic energies K_{1i} and K_{2i} for blocks #1 and #2, respectively.

(c) If the blocks travel a **distance of 2 m**, find the **change** in kinetic energies ΔK_1 and ΔK_2 for blocks #1 and #2, respectively. Hint: Use the Net Work-Kinetic Energy theorem.

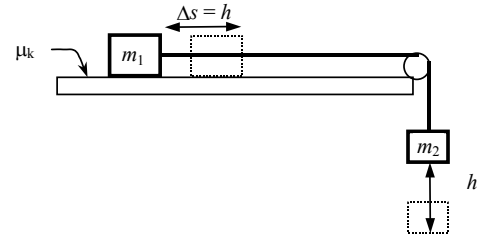
(d) Find the **final** kinetic energies K_{1f} and K_{2f} for blocks #1 and #2, respectively.

Name: _____ “Alphabetic” Student No.:



Problem #2: Convert U_G to Heat and K

Blocks #1 and #2 are attached as shown, where block #1 is on a **rough, horizontal surface** with kinetic coefficient of friction μ_k . Block #2 will **fall a height h** in this problem, converting its gravitational potential energy into kinetic energy of the blocks and lost heat due to block #1 sliding on the surface with friction. Assume that the gravitational energy of block #2 is zero after it has fallen the distance h .



- Redraw a **picture** of the problem and label the distance variables (h and Δs , where $\Delta s = h$).
- Using the Work-Energy Theorem #2, find an **algebraic expression** for the velocity v of the blocks after block #2 falls a distance h in terms of the other variables (m_1 , m_2 , h , μ_k). If the height h is **tripled**, how does the velocity v change?
- Find the **numerical value** of the **velocity v** given the following: $m_1 = 2$ kg, $m_2 = 4$ kg, $h = 4$ m, $\mu_k = 0.5$. Use $g = 10$ m/s².
- Find the following **numerical energy values** using values from part (c): 1) **initial potential** energy of block #2, 2) energy **dissipated** by block #1, and 3) total **final kinetic** energy of both blocks. Use $g = 10$ m/s² and round to the nearest Joule. Check that the initial potential energy of block #2 equals the dissipated energy plus the final total kinetic energy.

Problem #3: Convert U_G and K to U_s

A block of mass m is thrown vertically **UPWARDS** with an **initial vertical velocity v_1** . It is located at a **height h** (position #1) above the **top** of a “sponge cylinder”. Assume that this cylinder is composed of a material such that when a mass pushes down on it, **potential energy** is stored and given by $U = Cx^3$, where C is a constant and x is the distance that the mass has compressed the cylinder. After being thrown, the block eventually comes into contact with the sponge cylinder and slows down, **compressing** the cylinder an **amount x** (position #2). Assume that the **gravitational** potential energy of the block is **zero** when it has compressed the spring by x .

- Draw a **picture** of the block and spring for the **initial** and **final** positions of the block and label the relevant **distances** (h , x).
- Using the Work-Energy Theorem #2, find an **algebraic expression** for the **velocity v_2** of the block (position #2) after it compresses the cylinder by an amount x .
- Find an **algebraic expression** for the **compression distance x** of the spring (in terms of v_1 and v_2). To **simplify** solving for x , **ASSUME** that the height h is **MUCH greater** than x , i.e. $h + x \sim h$.
- Find the **numerical value** of the **maximum compression distance x** using part (c) and the following values: $m = 2$ kg, $h = 5$ m, $v_1 = 3$ m/s, $C = 5000$ N/m². Use $g = 10$ m/s². Check that x is much smaller than h .
- Find the following **numerical energy values**: 1) **initial** energy of the block (gravitational potential and kinetic), and 2) **final** spring potential energy of the block using x value from part (d). Use $g = 10$ m/s² and round to the nearest Joule. Compare the initial and final energies to check if they are within 1%.

Problem #4: Convert U_G to Heat and U_s

A block starts from rest and slides down a **frictionless ramp** of height h . The block then slides a total distance Δs on a **rough horizontal surface** with kinetic coefficient of friction μ_k . At the end of its travel, the block **compresses a horizontal spring** with force constant k by a distance x . (Note: The distance x is included in the total distance Δs on the rough surface.)

- Draw a **picture** of the problem and label the distance variables (h , Δs , x).
- Using the Work-Energy Theorem #2, find an **algebraic expression** for the spring compression **distance x** in terms of the other variables (m , h , μ_k , Δs , k).
- Find the **numerical value** of the compression **distance x** given the following: $m = 4$ kg, $h = 4$ m, $\mu_k = 0.5$, $\Delta s = 2$ m, and $k = 1000$ N/m. Use $g = 10$ m/s².
- Find the following **numerical energy values**: 1) **initial** gravitational potential energy, 2) energy **dissipated** by heat, and 3) **final** spring potential energy. Use $g = 10$ m/s² and round to the nearest Joule. Check that the initial gravitational potential energy equals the dissipated energy plus the final spring potential energy.