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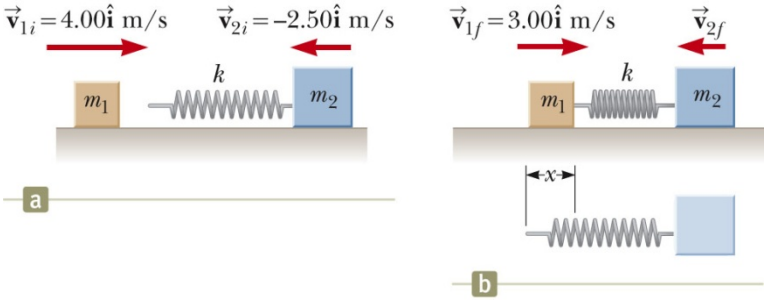
General Physics I, Midterm 1
PHYS10400, Class year 100
10-27-2011

SN:_____, Name:_____

*Note: You can use pencil or any pen in answering the problems. dictionary, calculators and mathematics tables **are** allowed. Please hand in both solution and this problem sheet. ABSOLUTELY NO CHEATING!*

Problems (total 5 problems, 100%)

1. **Lennard-Jones Potenetial:** The potential energy associated with the force between two neutral atoms in a molecule can be modeled by the Lennard-Jones potential as $U(x) = 4\varepsilon\left[(\frac{\sigma}{x})^{12} - (\frac{\sigma}{x})^{6}\right]$, where **x** is the separation of the atoms. (a)What is the most likely distance between the two atoms? (10%) (b) Given **σ**=0.263 nm, and **ε**=1.51×10^{-22}J are two typical constants in a molecule, what is the atom separation in a typical chemical bond? (5%) (c) Draw the potential curve qualitatively (5%) (d)When the two atoms are separated at a distance of 4.5×10^{-10} m, the two atoms are subject to a restoration or repelling force? (5%), (e) Explain you answer in (d) (5%)



2. **Two-body collision with a spring:** Using the figure on the right, A block of mass m_1=1.6 kg initially moving to the right with a speed of 4.00 m/s on a frictionless, horizontal track collides with a light spring attached to a second block of mass m_2=2.10kg initially moving to the left with a speed of 2.50 m/s as shown in the figure (a). The spring constant is 600 N/m. (a) Find the velocities of the two blocks after the collision.(10%) (b) Determine the velocity of block 2 during the collision, at the instant block 1 is moving to the right with a velocity of 3.00 m/s as shown in figure (b). (10%)

3. **Work and Energy Conservation:** How much work is required to raise a 100 g block to a height of 200 cm and simultaneously give it a velocity of 300 cm/sec?(15%).

4. **Dynamic:** A man holds a ball of weight **w**=0.25 lb at rest in his hand. He then throws the ball vertically upward. In this process, his hand moves up 2 ft (feet) and the ball leaves his hand with an upward velocity of 48 ft/sec. What is the force **F** with which the man pushes on the ball? Note, you can use **g**=32 ft/s^2 in calculation. (15%)

5. **Terminal Velocity:** In one of our home work, we asked why a cat has better chance of survival compared to a man. The key is on the terminal velocity. Now we work on a different question. A ball bearing is released from rest and drops through a viscous medium. The retarding force acting n the ball bearing has magnitude ***kv***, where ***k*** is a constant depending on the radius of the ball and the viscosity of the medium, and ***v*** is the all bearing's velocity. (a) What is the terminal velocity of the ball bearing and (b) the time it takes to reach the speed of half of the terminal velocity? Note to calculate the (b) part, you need some calculus. The following is something you can use without proof. (20%)

$\int \frac{dx}{x} = \ln x$, where x is the natural log; and $\int \frac{dx}{ax+b} = \frac{1}{a}\ln(ax+b)$