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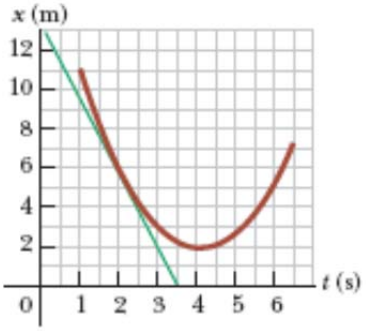
General Physics I, Midterm 1
PHYS10000AA, AB, AC, Class year 107
10-25-2017

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 6 problems, 110%)



1. **Position, Time and velocity:** (20%) A position-time graph for a particle moving along the x axis is shown in the figure to the right. (a) Find the average velocity in the time interval $t = 1.50$ s to $t = 4.00$ s. (b) Determine the instantaneous velocity at $t = 2.00$ s by measuring the slope of the tangent line shown in the graph. (c) At what value of t is the velocity zero?
2. **Kinematics:** (20%) The front 1.20 m of a 1 400-kg car is designed as a "crumple zone" that collapses to absorb the shock of a collision. If a car traveling 25.0 m/s stops uniformly in 1.20 m, (a) how long does the collision last, (b) what is the magnitude of the average force on the car, and (c) what is the acceleration of the car? Express the acceleration as a multiple of the acceleration due to gravity.
3. **Lennard-Jones Potential:** (25%) 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%)

   This problem is from Page 201 (Example 7.9) of text book; in lecture notes p8-4
4. **Linear momentum conservation:** (15%) Two masses are in a collision course with mass $\mathbf{M_1}$, $\mathbf{M_2}$ and velocities $\mathbf{V_1}$ and $\mathbf{V_2}$, respectively. Using Newton's third law, derive (or prove) the conservation of linear momentum in an isolated system.
5. **Moment of Inertia:** (20%) What is the moment of inertia of a solid annular cylinder with total mass M, with outer radius R2, and Inner radius R1, rotating about any of its central axis?
6. **Solid sphere rolling down an inclined plan: (20%)** A sphere rolls without sliding down an inclined plane making an angle θ with the horizon. The solid sphere has a total mass M, radius R and rotational moment of inertia I_{CM}; the inclined plane has a length L, and its height is H. (a) What is its kinetic energy when it is rolling down from top with angular velocity ω? (b) What is its translational velocity of the center of mass (V_{CM}) in terms of parameters given?