CSUC Practice Test

Physics 204A sections 8 and 9 Third Exam

Please complete the following problems on the blank sheets provided using one side only. Please begin each new problem on a new blank sheet to provide good problem separation. Show all your work clearly and don't dwell too long on any one problem. Rather, complete first those that you understand better and return to any remaining problems at the end. Each problem is worth 20 points. Be sure to work from fundamental equations only and indicate your derivations clearly. When you are done please label , initial, and number each sheet, then staple them all together in order and place them in the box provided. **No calculators and no notes of any kind are to be used. Please complete all your reasoning symbolically and express your solution as an algebraic expression available for numerical evaluation.**

1) A moving particle of mass m_1 and initial speed v_1 collides head on with an initially stationary particle of mass m_2. The collision is elastic and the motion remains 1-dimensional.
(a) Define (in symbols) what we mean by the center of mass of this system and state – in detail! – what the motion of the center of mass of this system is throughout the collision.
(b) What does this collision *look like* from the *center of mass* reference frame?
(c) Work from *basic conservation laws* to derive the resulting final velocity of each mass *as it appears in the center of mass frame* .
(d) What are the final particle velocities in the original lab frame of reference?

2) A hunting rifle fires a bullet of mass 0.012kg with a muzzle velocity of 600 m/s. The rifle has a mass of 4kg.
(a) What is the recoil velocity of the rifle as the bullet leaves the barrel ?
(b) If the rifle is stopped by the hunter's shoulder in a distance of 2.5 cm, what is the average force on the hunter's shoulder ?
(c) In this case, then, how much time is required to stop the rifle?
(d) If the hunter were to brace his shoulder so the recoil distance were shorter, how would your answers to the above change ?

3) A block of mass m starts from rest and slides down a rough plane inclined at angle α . If the coefficient of kinetic friction is μ, what will be the speed of the mass after having traveled a distance **s** along the incline ?

4) Imagine that a variable force $\vec{\mathbf{F}}$ is applied to a mass m which is moving on a **given** *curved* path.
a) Write down an expression for the total work done by $\vec{\mathbf{F}}$ on m between any two points of the path.
b) The usefulness of the concept *kinetic energy* rests on the Work-Energy theorem. State the theorem carefully for the general **3-D** case.
c) How do you know if a given force is conservative (what explicit experiments would you have to conduct)?
d) Carefully explain how you would go about defining a potential function for a given conservative force (be sure to explain briefly the significance of the choice of reference point).

5) Newton's second law is best stated in terms of ***momentum*** :
a) State the law in that form.
b) Now show how the statement of *conservation of momentum* for two interacting particles derives from Newton's third law.
c) Now, as was done in class and in the text, apply parts **a)** and **b)** to find the increment of velocity gained by a rocket of mass M when it expels a chunk of mass dM at exhaust speed v_{ex}.