CSUC Physics 204A

First Exam

EXAM PROTOCOL: 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) KINEMATIC BASICS:

(a) Define precisely what we mean by (1) (vector) displacement, (2) instantaneous vector velocity, and (3) instantaneous vector acceleration.

(b) Suppose you throw a ball straight up from ground level at initial speed $\mathbf{v}_o$.
Briefly (but carefully) sketch the *three graphs* specified below portraying (from the moment the ball leaves your hand until it returns) respectively:

(*1*) the ball's position versus time,
(*2*) the ball's velocity versus time, and
(*3*) the ball's acceleration versus time.

(c) Define what we mean by the scalar ("dot") product. You may employ **either** the geometric or component definitions as you wish. Be sure to specify what specific geometric concept is represented by this operation.

(d) Use the dot product to find the angle between the vectors (1,1,1) and (-1,-1,1)

2) CONSTANT VELOCITY 2-D KINEMATICS: A woman can row a boat at 6 mi/hr in still water. She must row directly across a 3 mile wide river whose current is 1.5 mi/hr.

(a) At what angle with respect to the shore should the axis of the boat be set if she wishes to reach a point on the opposite shore directly across from her starting point and

(b) how long will it take her?

3) 1-DIMENSIONAL CONSTANT ACCELERATION BALLISTICS: A bullet is fired horizontally with initial velocity $\mathbf{v}_o$. At a distance '**x**' downrange the bullet's velocity is now measured as $\mathbf{v}_1$. **Disregard gravity (i.e. 1-D MOTION)** and assume a constant acceleration for the bullet. In terms of the numbers { $\mathbf{v}_o$, $\mathbf{v}_1$, **x**} alone, *derive* expressions which will give:

(a) The time of flight over the distance x.

(b) The bullet's acceleration over the distance x.

4) 2-D BALLISTICS: Suppose we fire a sphere of mass *M* horizontally off a table top so that it lands on the floor some distance away - *exactly* as we did in lab. If the sphere is launched from a vertical height *H* above the floor and achieves a horizontal range *X*, *use the measured numbers {M,H,X, and g}* *alone*, plus what you know about falling bodies to:

(a) Derive from fundamental relations what its time of flight must have been.

(b) Derive from fundamental relations what its initial velocity must have been.

(c) Derive with what velocity it strikes the floor and with what speed is it traveling.

5) A KINEMATIC PROBLEM: A dog runs in the x-y plane with a velocity vector given by $\mathbf{v} = (a - bt^2 , ct)$. { a, b, c are constants where a = 2.4 m/s , b = 1.6 m/s^3 , c= 4 m/s^2}
If the dog is at the origin at t = 0:

(a) find the *position vector* as a function of time.

(b) find the *acceleration vector* as a function of time.