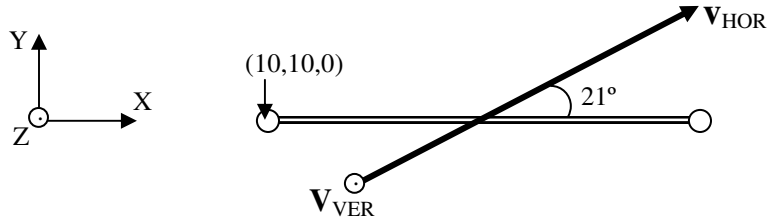
SPME430
SAMPLE PROBLEMS -- TEST #1

1. At the instant that he releases the pole, the center of gravity of a pole vaulter has a positive or upward vertical velocity of 5.0 m/s and the magnitude of the horizontal velocity vector of the c.g. is 3.1 m/s. From an overhead view, the horizontal velocity vector makes an angle of 21° with the bar (see sketch). If the position of the c.g. at the peak of his jump is (10.423, 10.012, 5.97) m. Answer the following questions.



   a. What was the vaulter's position at the instant of takeoff (i.e., his X, Y and Z coordinates)?

   b. What were the values of the velocities in the X and Y directions at the instant of takeoff?

   c. What was the time between the instant of takeoff and the instant the vaulter's c.g. reached its maximum height?

   d. What was the time between the instant of takeoff and the instant that the c.g. was directly over the bar?

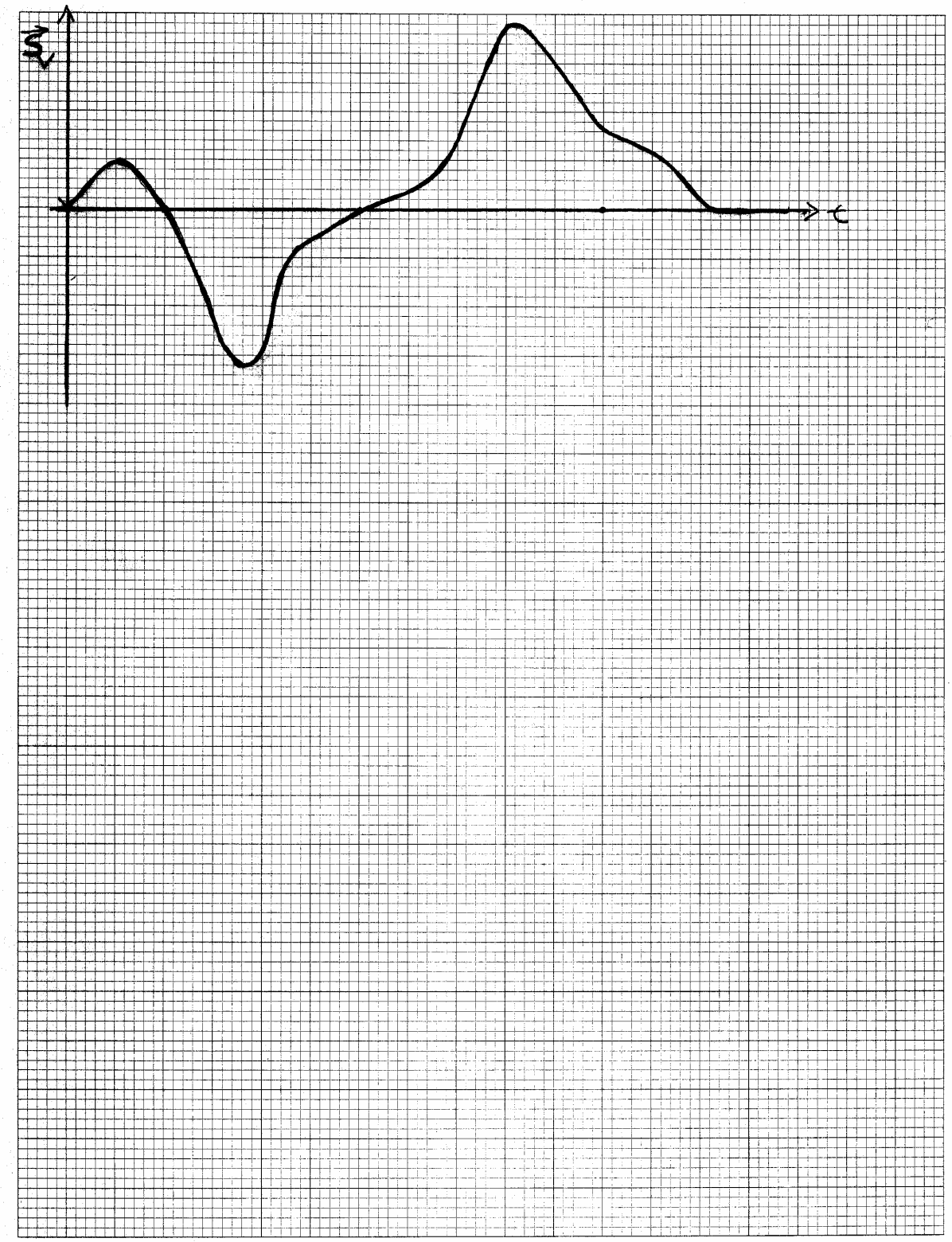
   e. If from the peak of his jump the c.g. had to fall 5.5 m before the vaulter landed in the pit how long would it take from the instant of takeoff until the instant the vaulter lands?

   f. What would the vertical velocity of the vaulter's c.g. be at the instant he contacts the pit?

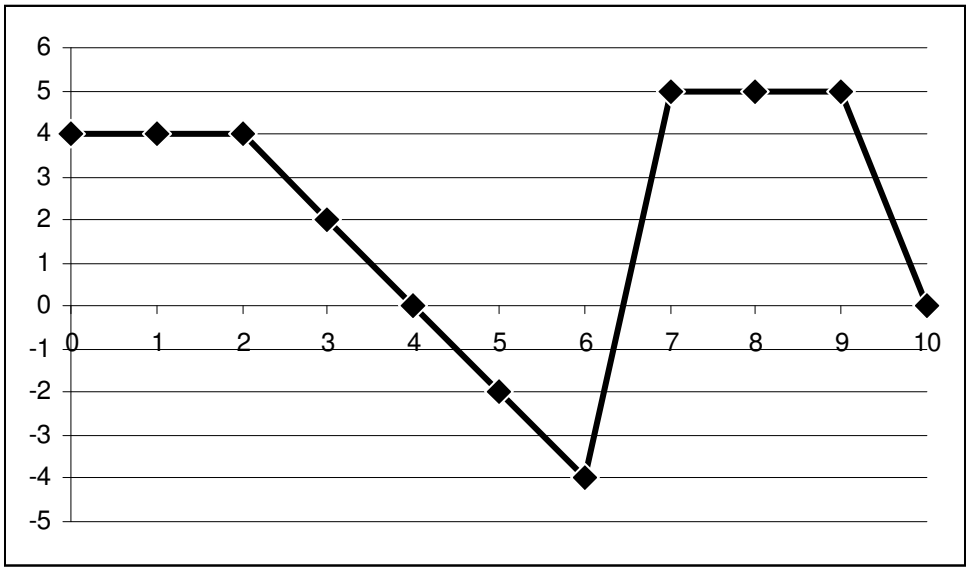
2. Shown on the following page is a plot of vertical displacement versus time for the c.g. during the hypothetical sports activity.

   a. Make a plot of vertical velocity of the c.g. versus time

   b. Make a plot of vertical acceleration of the c.g. versus time


ξ
t

3. The graph below indicates the velocity of a football player in the horizontal direction versus time during a run.



a. What were his horizontal accelerations during the intervals: 0-2, 2-4, 4-6, 6-7, 7-9 and 9-10 seconds

b. Plot horizontal acceleration versus time.

c. What were the changes in his horizontal displacement during the intervals: 0-2, 2-4, 4-6, 6-7, 7-9 and 9-10 seconds

d. What was his horizontal displacement at time = 0, 2, 4, 6, 7, 9 and 10 seconds if his displacement at time = 0.0 s was 10 m.

e. Plot horizontal displacement versus time.

4. A soccer player running across the field (name = Gus, mass = 90 kg, velocity = 7 m/s in the horizontal direction) collides with a cheerleader (name = Buffy, mass = 40 kg) who is standing still on the sidelines. Gus makes a constant force of 800 N in the positive X direction on Buffy for 3 seconds during the course of the collision. (Assume that the linear accelerations of Gus and Buffy in the Y direction are equal to 0 m/s^2 throughout the collision.)

   a. Make a free-body diagram of Gus at any instant during the collision.

   b. Make a free-body diagram of Buffy at any instant during the collision.

   c. What was the linear momentum of Gus before the collision?

   d. What was the linear momentum of Buffy before the collision?

   e. What was the linear momentum of the combined Gus and Buffy system before the collision?

   f. What was the net horizontal impulse exerted on Buffy by Gus during the collision?

   g. What was the net horizontal impulse exerted on Gus by Buffy during the collision?

   i. What was the linear acceleration of Gus during the collision?

   j. What was the linear acceleration of Buffy during the collision?

   k. If Buffy and Gus stuck together after the collision (i.e., they combined their masses to form 1 body), what is the horizontal velocity of the combined Buffy-plus-Gus system?

   l. What is the linear momentum of the Buffy-plus-Gus system before the impact?

   m. What is the linear momentum of the Buffy-plus-Gus system after the impact?