

Your Name: \_\_\_\_\_

PHY203  
Final Exam  
12/14/07

# Solutions

For problems 1-3, Let  $\mathbf{A} = 6\mathbf{i} - 5\mathbf{j}$ ,  $\mathbf{B} = -7\mathbf{i} + 10\mathbf{j}$ ,  $\mathbf{C} = 3\mathbf{A} - 2\mathbf{B}$

1. Write the vector,  $\mathbf{C}$ , in vector notation:

- a.  $4\mathbf{i} - 5\mathbf{j}$                        $\mathbf{C} = 3(6\mathbf{i} - 5\mathbf{j}) - 2(-7\mathbf{i} + 10\mathbf{j}) = 32\mathbf{i} - 35\mathbf{j}$   
 b.  $4\mathbf{i} + 5\mathbf{j}$   
 c.  $32\mathbf{i} + 5\mathbf{j}$   
 d.  **$32\mathbf{i} - 35\mathbf{j}$**   
 e. None of the above

2. Find the magnitude of the vector  $\mathbf{B}$ :

- a. 3.0                       $B = ((-7)^2 + (10)^2)^{1/2} = 12.2$   
 b. 7.1  
 c. **12.2**  
 d. 17.0  
 e. None of the above

3. Find the angle that vector  $\mathbf{A}$  makes with the positive x-axis (measured in a counterclockwise direction from the positive x-axis):

- a.  $40^\circ$                        $\theta = 360^\circ - \tan^{-1}(5/6) = 320^\circ$   
 b.  $50^\circ$   
 c.  $310^\circ$   
 d.  **$320^\circ$**   
 e. None of the above

4. A bike rider starts from rest with an acceleration of  $0.066 \text{ m/s}^2$ . Find how long it takes the bike rider to ride 1.0 km:

- a. **2.9 min.**                       $1000\text{m} = 1/2(0.066)(t)^2$   
 b. 5.5 min.                       $t = 174\text{s}/60 = 2.9 \text{ min.}$   
 c. 5.8 min.  
 d. 253 min.  
 e. None of the above

5. Consider two trains running in the same direction on parallel tracks. Train 1 passes the station at time,  $t = 0$ , with a constant speed of 5 m/s. Train 2 passes the station 30 seconds later than train 1 at a constant speed of 6 m/s. Find the time,  $t$ , at which the trains are exactly side-by-side:

- a. 16.4 sec.                       $x_1 = 5t$  ;  $x_2 = 6(t-30)$   
 b. 150 sec.                       $x_1 = x_2$  :  $5t = 6t - 180$   
 c. **180 sec.**                       $t = 180 \text{ sec.}$   
 d. 210 sec.  
 e. None of the above

6. A police officer gives a burst of the car's siren as the car is traveling towards a wall at a speed of 100 m/s. The officer hears the siren sound reflected from the wall 1.0 sec. later. Find the distance the car was at the time the siren was sounded. (Use 343 m/s as the speed of sound in air):

- a. 172 m                                       $t = 1.0\text{s} = d/343\text{m/s} + (d-100\text{m/s}(1\text{s}))/343\text{m/s}$   
 b. **221.5 m**                                     $343 = d + d-100 = 2d - 100 ; d = 221.5\text{m}$   
 c. 243 m  
 d. 343 m  
 e. None of the above



For problems 7-10, refer to the plot above:

7. Find the average speed from points C-G:

- a. -8.3 m/s                                      average speed = distance/time = 500m / 60 s = 8.33 m/s  
 b. -1.7 m/s  
 c. 1.7 m/s  
 d. **8.3 m/s**  
 e. None of the above

8. Find the average velocity from points A-G:

- a. -8.9 m/s                                       $Dv_{\text{avg}} = (x_2 - x_1) / Dt = (-200\text{m} - 0) / 90\text{s}$   
 b. **-2.2 m/s**                                       $= -200\text{m} / 90\text{s} = -2.22\text{ m/s}$   
 c. 2.2 m/s  
 d. 8.9 m/s  
 e. None of the above

9. Find the instantaneous velocity at point D:

- a. 0                                                 $v_{\text{inst.}} = \text{slope} = -300\text{m} / 30\text{ s} = -10\text{ m/s}$   
 b. -6.7 m/s  
 c. -5 m/s  
 d. -2.2 m/s  
 e. **None of the above**

10. Find the instantaneous acceleration at point F:

- a. -6.67 m/s<sup>2</sup>                                     $a_{\text{inst.}} = \text{slope of } v \text{ vs. } t = 0$   
 b. -5 m/s<sup>2</sup>  
 c. -2.22 m/s<sup>2</sup>  
 d. **0**  
 e. None of the above

11. A boy who is standing on top of a 30m tall building throws a ball at a nearby building that is 100m tall. The initial velocity in the x-direction given to the ball is 30 m/s. When the ball lands on the roof of the second building it is traveling *only* in the horizontal direction. **Show your work.** (Note: use  $g = 9.81\text{ m/s}^2$ ).



a. Calculate the initial velocity of the ball in the y-direction.

$$0 = (v_{y0})^2 - 2(9.81 \text{ m/s}^2)(100\text{m} - 30\text{m})$$

$$v_{y0} = + 37 \text{ m/s}$$

b. Calculate the initial speed of the ball *and* the angle the ball made initially with respect to the horizontal (x-) direction.

$$v = (30^2 + 37^2)^{1/2} = 47.7 \text{ m/s}$$

$$q = \tan^{-1}(37/30) = 51^\circ$$

c. Calculate the time it takes for the ball to reach the roof of the second building.

$$0 = 37 \text{ m/s} - (9.81 \text{ m/s}^2)(t)$$

$$t = 3.8\text{s}$$

d. Write the velocity of the ball just as it is hitting the roof in vector notation using the coordinate system given above.

$$\mathbf{v} = 30 \text{ m/s } \mathbf{i}$$

e. *If the second building were not in the way*, calculate how long it would take for the ball to hit the ground.

$$0 = 30\text{m} + 37 \text{ m/s } t + 1/2(-9.81 \text{ m/s}^2)t^2$$

$$t = 8.3\text{s}$$

### PHY203 Crib Sheet Chapters 1-3

$$\text{speed } \Delta V = (\text{total distance traveled})/Dt$$

$$D\mathbf{x} = \mathbf{x}_2 - \mathbf{x}_1 \text{ (displacement)}$$

$$v_{AV} = D\mathbf{x}/Dt$$

$$a_{AV} = Dv/Dt$$

$$v_{Inst} = dx/dt$$

$$a_{Inst} = dv/dt$$

For constant acceleration:

$$x_f = x_0 + v_0 t + (1/2)at^2$$

$$v_f = v_0 + at$$

$$v_f^2 = v_0^2 + 2a(x_f - x_0)$$

$g = 9.81 \text{ m/s}^2$ , the acceleration due to gravity (on Earth), unless otherwise directed

For a vector **A** with magnitude  $A$  and direction  $q$  (measured counterclockwise with respect to the x-axis):

$$A_x = A \cos(q)$$

$$A_y = A \sin(q)$$

$$A = (A_x^2 + A_y^2)^{1/2}$$

$$\tan(q) = A_y/A_x$$

quadratic eq. sol.: If  $ax^2 + bx + c = 0$ ; then  $x = [-b \pm (b^2 - 4ac)^{1/2}] / (2a)$