

Physics 218 Honors; Secs. 201,202,203; Exam 1, Fall-10

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

Section No: \_\_\_\_\_

NOTE: Each problem is worth 20 pts

1. In the product  $\vec{F} = q\vec{V} \times \vec{B}$ , take  $q = 2$ ,  
 $\vec{V} = 2.0\hat{i} + 4.0\hat{j} + 6.0\hat{k}$  and  $\vec{F} = 4.0\hat{i} - 20\hat{j} + 12\hat{k}$   
 What then is  $\vec{B}$  in unit-vector notation if  $B_x = B_y$

let's compute  $\vec{V} \times \vec{B}$

$$\vec{V} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ V_x & V_y & V_z \\ B_x & B_x & B_z \end{vmatrix} = \hat{i}(V_y B_z - V_z B_x) + \hat{j}(V_z B_x - V_x B_z) + \hat{k}(V_x B_x - V_y B_x)$$

$$\therefore \vec{V} \times \vec{B} = \hat{i}(4B_z - 6B_x) + \hat{j}(6B_x - 2B_z) + \hat{k}(2B_x - 4B_x)$$

$$\therefore \vec{F} = 2(\vec{V} \times \vec{B})$$

$$4.0\hat{i} - 20\hat{j} + 12\hat{k} = \hat{i}(8B_z - 12B_x) + \hat{j}(12B_x - 4B_z) + \hat{k}(-2B_x)$$

$$\therefore -4B_x = 12$$

$$\boxed{B_x = -3}$$

$$12B_x - 4B_z = -20$$

$$-36 - 4B_z = -20$$

$$-4B_z = 16$$

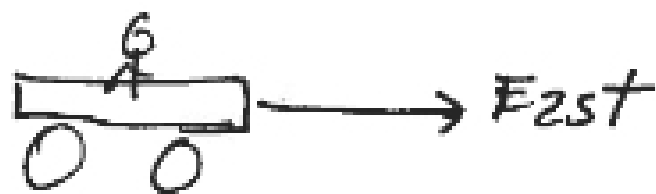
$$\boxed{B_z = -4}$$

$$\therefore \vec{B} = -3\hat{i} - 3\hat{j} - 4\hat{k}$$

2. A motorcyclist who is moving along an x axis directed toward the east has an acceleration given by  $a = (6.1 - 1.2t) \text{ m/s}^2$ , for  $0 \leq t \leq 6.0 \text{ s}$ . At  $t = 0$ , the velocity and position of the cyclist are  $2.7 \text{ m/s}$  and  $7.3 \text{ m}$  respectively.

a) What is the maximum speed achieved by the cyclist?

b) What total distance does the cyclist travel between  $t = 0$  and  $t = 6.0 \text{ s}$ ?



$$2) \quad a = (6.1 - 1.2t) \text{ m/s}^2 \quad \forall 0 \leq t \leq 6.0$$

$$a = \frac{dv}{dt} = 6.1 - 1.2t, \quad v = 6.1t - \frac{1.2t^2}{2} + C$$

$$v(0) = 2.7 = C \quad \therefore v = 6.1t - 0.6t^2 + 2.7$$

$$v = \frac{dx}{dt} = 6.1t - 0.6t^2 + 2.7$$

$$x = \frac{6.1t^2}{2} - \frac{0.6t^3}{3} + 2.7t + C$$

$$x(0) = 7.3 = C$$

$$\therefore x = \frac{6.1t^2}{2} - \frac{0.2t^3}{3} + 2.7t + 7.3$$

Max speed attained when  $a = 0 = \frac{dv}{dt}$

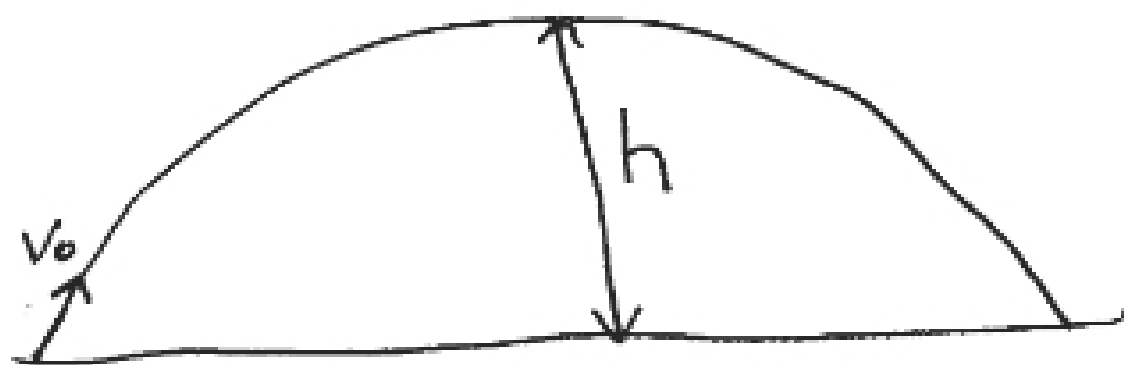
$$\therefore t = \frac{6.1}{1.2} \text{ s} = \underline{5.08 \text{ s}}$$

$$v_{\text{max}} = 19.2 \text{ m/s}$$

$$b) \quad \Delta x = x_f - x_i = 3.05t^2 - 0.067t^3 + 2.7t$$

$$\Delta x = 83.8 \text{ m}$$

3. Let  $h$  be the maximum height attained by an object projected into the air, such as a baseball, football, or soccer ball and let  $t$  be the total time of flight of the object in seconds. Obtain an expression for  $h$  in terms of  $t$  and  $g$ . Hint: your result should not depend on the initial velocity of the object nor the angle it was launched at.



$$v_{fy} = v_{iy} - gt_h \Rightarrow t_h = \text{time to reach } h.$$

$$v_{fy} = 0 \therefore t_h = \frac{v_{iy}}{g}$$

$$\therefore h = v_{iy}t_h - \frac{1}{2}gt_h^2$$

$$h = \frac{v_{iy}^2}{g} - \frac{g}{2} \frac{v_{iy}^2}{g^2} = \frac{v_{iy}^2}{2g}$$

$$\text{Also } y = v_{iy}t - \frac{1}{2}gt^2$$

$$\text{Now } y=0 \text{ when } t=0 \text{ and } 0 = v_{iy} - \frac{gt}{2}$$

where  $t = \text{total flight time.}$

$$\therefore t = \frac{2v_{iy}}{g}$$

$$\text{or } v_{iy} = \frac{gt}{2}$$

$$\text{Now } h = \frac{v_{iy}^2}{2g} = \frac{g^2 t^2}{8g} = \frac{gt^2}{8}$$