PHYS 100 Midterm examination #2 (vers. 2D)

Oct. 28, 2005 Name________________________________

Time: 50 minutes Student No.____________________________

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Please show complete solutions and explain your reasoning, stating any principles that you have used.

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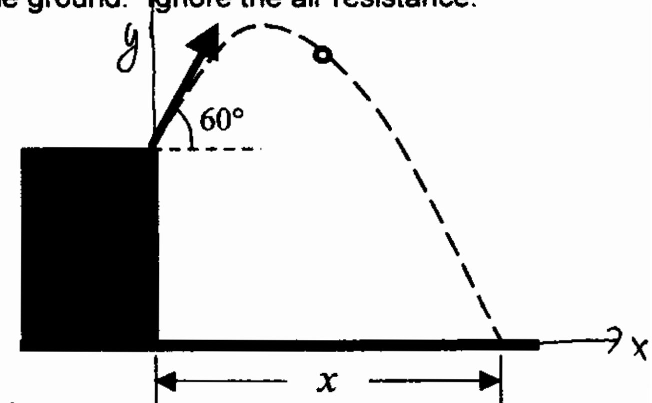
1 (5/20). A ball is thrown from the roof of a building at a 60° angle above the horizontal with a speed of 16 m/s. 5.0 seconds later, the ball hits the ground. Ignore the air resistance.

A) Determine height of the building.
B) Find the horizontal distance *x*.



[solution]. Set up $\overset{y}{\vdash} x$

1/5

Given: $v_0 = 16$ m/s, $\theta = 60°$

when $t = 0$, $x = x_0 = 0$

$y = y_0$ = height of building

when $t = 5.0$ sec, $y = 0$

2/5

A). $y = y_0 + v_0 \sin\theta \cdot t - \frac{1}{2} g t^2$

$0 = y_0 + v_0 \sin\theta \cdot 5 - \frac{1}{2} g 5^2$

$y_0 = \frac{1}{2} g t^2 - v_0 \sin\theta \cdot t$

$= \frac{1}{2} \times 9.8 \times 5^2 - 16 \times \sin 60° \times 5$

$= 53.2$ m

2/5

B). $x = v_0 \cdot \cos\theta \cdot t$

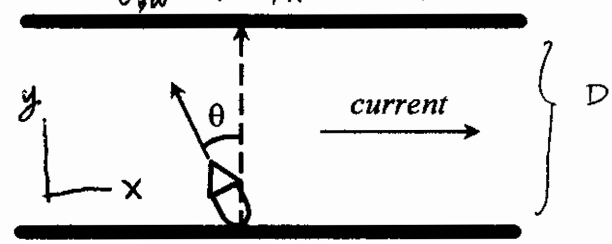
$= 16 \cdot \cos 60° \cdot 5$

$= 40$ m.

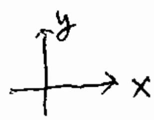
2(5/20). A river is 1.2 km wide and its current is flowing at 3 km/h. A man wants to drive a boat across the river to reach a point on the other bank directly opposite to his starting point. His boat is capable of travelling 5 km/h in still water.

A) At what angle upstream should the man point his boat (θ=?)?
B) How long does it take for him to cross the river?

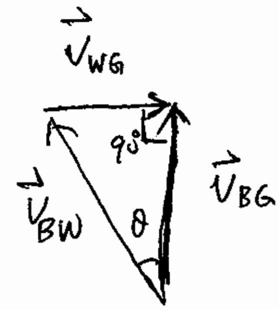
[solution]. Given: D = 1.2 Km. $V_{BW} = 5$ Km/h = m/s.
$V_{WG} = 3$ km/h = m/s



① /5 Set up coordinate system



$$\vec{V}_{BG} = \vec{V}_{BW} + \vec{V}_{WG}$$



② /5 A): $V_{BW} \sin\theta = V_{WG}$

$$\sin\theta = \frac{V_{WG}}{V_{BW}} = \frac{3 \text{ km/h}}{5 \text{ km/h}} = 0.6$$

$$\theta = \sin^{-1} 0.6 = 36.9°$$

② /5 B). ~~V_{BGy} =~~ $V_{BG} = V_{BGy} = V_{BW}\cos\theta = 4$ km/h.

(OR: $V_{BG} = \sqrt{V_{BW}^2 - V_{WG}^2} = 4$ km/h)

$$\Delta t = \frac{\Delta y}{V_{BG}} = \frac{1.2 \text{ Km}}{4 \text{ km/h}} = 0.3 \text{ h}.$$

3 (5 marks). A Pendulum is a small bob swinging to and fro on a string, as shown in the figure below. The bob reaches the bottom A with a horizontal velocity of 2.0m/s to the right. 0.50s later, it reaches B with a velocity 0.40m/s at an angle of 30°. The length of the string is 1.25m.

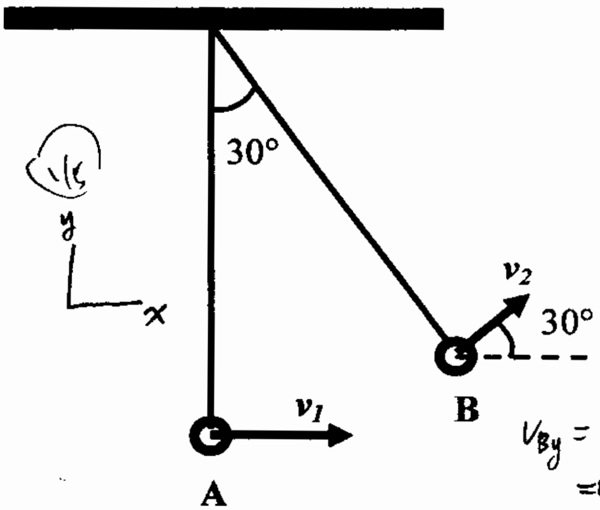
(a) Find the horizontal component of the velocity of the bob at B.

(b) Find the average acceleration of the bob over the time interval between A and B.

[solution]:

① Set up coordinate system

(1/5)



Given: when $t_i = 0$

$V_{Ax} = 2.0$ m/s

$V_{Ay} = 0$;

when $t_f = 0.50$ s,

$V_B = 0.40$ m/s

$\theta = 30°$

$V_{By} = V_B \sin\theta = 0.40 \sin 30° = 0.20$ m/s

(1/5) a) $V_{Bx} = V_B \cos\theta = 0.40 \text{ m/s} \cdot \cos 30° = 0.346$ m/s

(4/5) (b) $\vec{a}_{av} = \dfrac{\Delta \vec{V}}{\Delta t}$ ①,

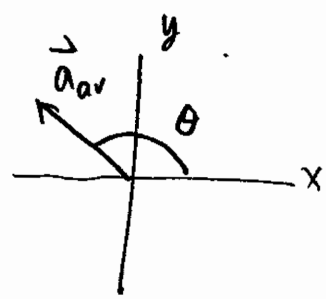
① $a_{avx} = \dfrac{\Delta V_x}{\Delta t} = \dfrac{V_{Bx} - V_{Ax}}{\Delta t} = \dfrac{0.346 - 2.0}{0.5} = -3.31 \text{ m/s}^2$

$a_{avy} = \dfrac{\Delta V_y}{\Delta t} = \dfrac{V_{By} - V_{Ay}}{\Delta t}$ ~~[illegible]~~

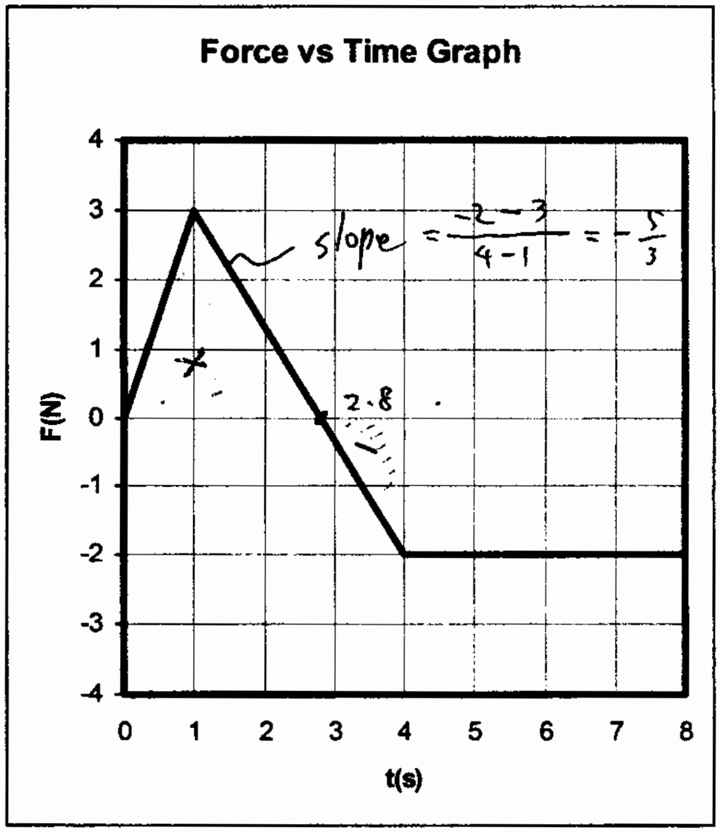
$= \dfrac{0.20 - 0}{0.5} = 0.40 \text{ m/s}^2$

① $a_{av} = \sqrt{a_{ax}^2 + a_{avy}^2} = 3.33 \text{ m/s}^2$.

$\theta = \tan^{-1} \dfrac{a_{avy}}{a_{avx}} = 173°$



4(5marks). The graph shows the x-component of the net force acting on a 5 kg block, as a function of time. At t=0 s, the block is moving along the negative x-direction with a speed of 6 m/s.
(a) What is the velocity of the block at t=4 s?
(b) What is its velocity at t=8 s?



[solution] $t=0$ $m = 5\text{ kg}$

$\vec{v}_0 \leftarrow$ □ → x, 0

$\frac{1}{5}$ When $t=0$, $v_0 = -6\text{ m/s}$.

$a = \frac{F}{m}$.

$\frac{2}{5}$ (a). area under $F \sim t$ curve. graph for $t=0$ to $t=4\text{s}$

(when $t = 2.8\text{ s}$, $F=0$)

$A_F = \frac{1}{2}(2.8)3 - \frac{1}{2}(1.2)2$

$= 3\text{ N}\cdot\text{s}$.

$F = -\frac{5}{3}t + b$. plug in (1, 3)

$3 = -\frac{5}{3} + b \Rightarrow b = 3 + \frac{5}{3} = \frac{14}{3}$

$F = -\frac{5}{3}t + \frac{14}{3}$.

when $F=0$: $0 = -5t + 14$

$t = \frac{14}{5} = 2.8$

Area under $a \sim t$ curve:

$A_a = \frac{A_F}{m} = \frac{3\text{ N}\cdot\text{S}}{5\text{ kg}} = 0.6\text{ m/s}$.

$= \Delta v = v_4 - v_0$

$v_4 = v_0 + A_a$.

$= -6\text{ m/s} + 0.6\text{ m/s} = -5.4\text{ m/s}$.

$\frac{2}{5}$ (b). Area under F-t curve from $t = 4\text{ s}$ to $t = 8\text{ s}$:

$A_F = -8\text{ N}\cdot\text{S}$.

Area under a-t curve:

$A_a = \frac{A_F}{m} = \frac{-8\text{ N}\cdot\text{S}}{5\text{ kg}} = -1.6\text{ m/s}$.

$v_8 = v_4 + A_a$

$= -5.4 - 1.6$

$= -7.0\text{ m/s}$.