

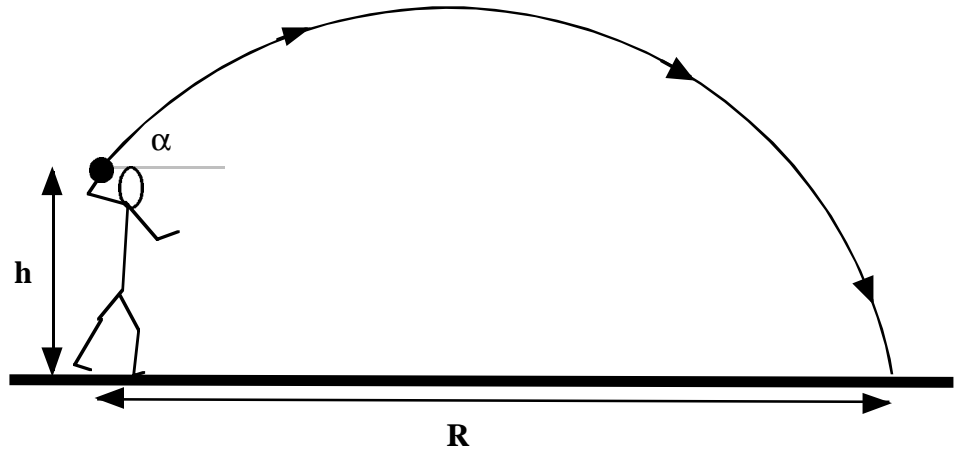
KINEMATICS IN TWO DIMENSIONS

ANSWER EACH OF THE FOLLOWING PROBLEMS! BE SURE TO SHOW ALL WORK CAREFULLY!

1. Suppose that a shot putter throws a 12 pound shot with a velocity of 39 ft/s at an angle of $\alpha = 38^\circ$ above the horizontal. At the time the shot is released the shot putter's hand is $h = 5.8$ feet above the ground.

[Remember that $g = 32.2 \text{ ft/sec}^2$]

- What will be the **horizontal** and **vertical** components of the velocity of the shot put as it leaves the putter's hand? [5 pts]
- How **long** will it take for this shot put to strike the ground? [5 pts]
- What will be the **velocity** of the shot put at the highest point? [5 pts]
- What will be the **maximum height** above the ground reached by the shot put? [5 pts]
- What will be the final **horizontal displacement** of the shot put? [5 pts]

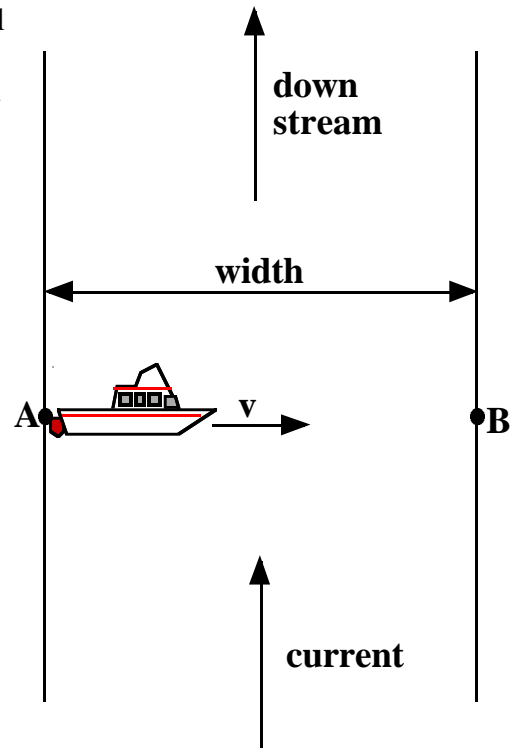


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2. A small boat has a maximum speed of 4.40 m/sec as it moves through still water. This boat is to head directly across a river which has a width of 880 meters and which has a current of 1.8 m/sec as shown in the diagram to the right.

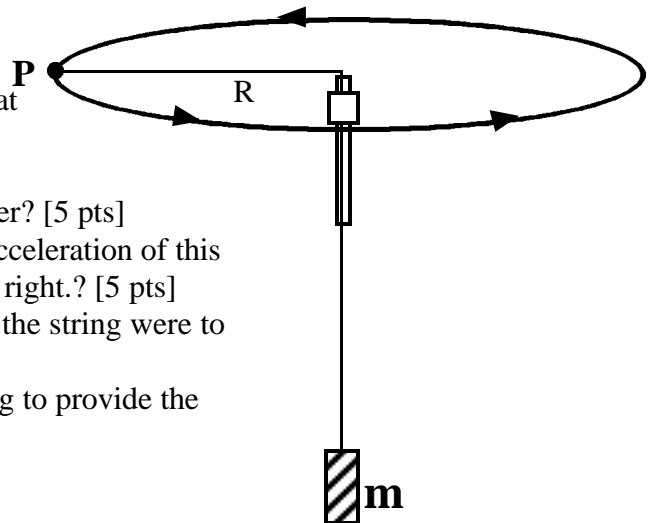
- a. How **long** will it take for the boat to reach the opposite shore? [5 pts]
- b. What will be the **velocity** of the boat as measured by an observer standing along the shore of the river? [5 pts]
- c. How far **downstream** will this boat reach the opposite shore? [5 pts]
- d. What will be the **final displacement** of the boat when it reaches the opposite shore? [5 pts]
- e. Suppose that the pilot of the boat would like to reach point B which is directly opposite the starting point A. In what **direction** [angle] should the pilot aim the boat? [5 pts]
- f. How **long** would it take for this boat to reach a point 250 meters upstream from point A and then return? [5 pts]



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3. You perform a lab where a rubber stopper, which has a mass of 12.5 ± 0.50 grams, is spun in a horizontal circle as shown to the right. The circle is measured to have a radius of 125 ± 2 centimeters. Your lab partner uses a stopwatch to measure that it takes 9.4 ± 0.3 seconds to make 12 complete revolutions.



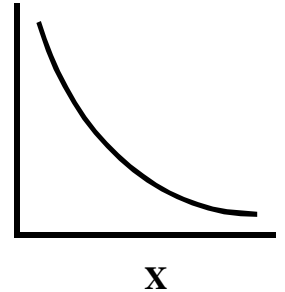
- What is the **average speed** of this rubber stopper? [5 pts]
- What would be the **error** on the speed of this rubber stopper? [5 pts]
- What are the **direction** and **magnitude** of the centripetal acceleration of this stopper when is the position P shown in the diagram to the right.? [5 pts]
- What will be the **resulting motion** of the rubber stopper if the string were to break when at point P in the diagram? [5 pts]
- How much mass **m** must be hanging on the end of the string to provide the needed centripetal force? [5 pts]

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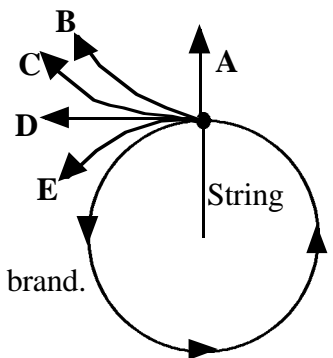
ANSWER EACH OF THE FOLLOWING PROBLEMS! BE SURE TO SHOW ALL WORK CAREFULLY!

FOR EACH OF THE FOLLOWING MULTIPLE CHOICE SELECT THE BEST ANSWER AND CIRCLE THE CORRESPONDING LETTER.

4. Two variables, x and y, are plotted against one another and the resulting graph is shown to the right. What can you conclude is the most likely relationship between these variables? [5 pts]
- A. Y is proportional to X B. X is proportional to Y C. Y is constant
 D. Y is inversely proportional to X E. Y is proportional to the square of X



5. A rubber stopper is moving in a circular path at the end of a string as shown to the right when the string suddenly breaks. Which path in the diagram is the stopper most likely to follow after the string breaks? [5 pts]

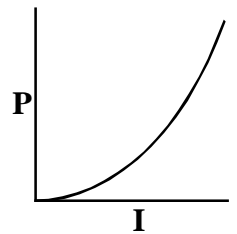


6. Which of the following would be an example of a controlled experiment? [5 pts]

- To find out which brand of sneaker is fastest in a race have;
- A. all team members of a track team run a race wearing the same brand.
 B. all team members of a track team run a race where each team member wears a different brand.
 C. all team members of a track team run a race where each team member wear one shoe from each of two different brands.
 D. the team members run several races. During each race have every team member wear the same brand.
 E. each team member wear the same brand throughout the entire track season.

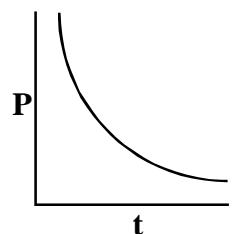
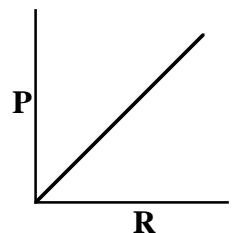
7. How is centripetal acceleration different from all other types of acceleration? [5 pts]

- A. In centripetal acceleration the velocity never changes.
 B. In centripetal acceleration the acceleration is always perpendicular to the velocity vector.
 C. In centripetal acceleration the magnitude of the velocity is always decreasing.
 D. In centripetal acceleration the direction of the velocity always remains constant.
 E. In centripetal acceleration the direction of motion is always increasing.



8. A controlled experiment is run and the three graphs to the right are plotted. Which of the following equations could reasonable been developed from these three graphs? [5 pts]

- A. $P = I \times t$ B. $P = (I \times t^3) / R$ C. $P = t^2 \times R / I$
 D. $P = (I^2 \times R) / t$ E. $P = (R \times t) / I^2$



LAB PHYSICS TEST - TWO DIMENSIONAL KINEMATICS 1998-99 D

1. $v_o := 39 \frac{\text{ft}}{\text{sec}}$ $\alpha := 38 \text{ deg}$ $g := 32.2 \frac{\text{ft}}{\text{sec}^2}$ $D_{ov} := 5.8 \text{ ft}$ $D_{fv} := 0 \text{ ft}$ $D_{oh} := 0 \text{ ft}$ $D_{fh} := 10 \text{ ft}$ $t := 1 \text{ sec}$

a. $v_{ov} := v_o \cdot \sin(\alpha)$ $v_{ov} = 24.0 \frac{\text{ft}}{\text{sec}}$ N := newton

1a. The components of the initial velocity. [5 pts]

$v_{oh} := v_o \cdot \cos(\alpha)$ $v_{oh} = 30.7 \frac{\text{ft}}{\text{sec}}$

b. Given $D_{fv} = \frac{1}{2} \cdot g \cdot t^2 + v_{ov} \cdot t + D_{ov}$ $t := \text{Find}(t)$ $t = 1.70 \text{ sec}$ **1b. Time for the shotput to strike the ground. [5 pts]**

c. $v_{\text{high}} := v_{oh}$ $v_{\text{high}} = 30.73 \frac{\text{ft}}{\text{sec}}$ **1c. The velocity at the high point will only be the unchanging horizontal velocity. [5 pts]**

d. $v_{fv} := 0 \cdot \frac{\text{ft}}{\text{sec}}$ $t_{\text{high}} := 1 \text{ sec}$

Given $v_{fv} = -g \cdot t_{\text{high}} + v_{ov}$ $t_{\text{high}} := \text{Find}(t_{\text{high}})$ $t_{\text{high}} = 0.746 \text{ sec}$

$D_{\text{fhigh}} := \frac{1}{2} \cdot g \cdot t_{\text{high}}^2 + v_{ov} \cdot t_{\text{high}} + D_{ov}$ $D_{\text{fhigh}} = 14.75 \text{ ft}$ **1d. The highest point reached by the shotput. [5 pts]**

e. $D_{fh} := v_{oh} \cdot t$ $D_{fh} = 52.33 \text{ ft}$ **1e. The final horizontal displacement. [5 pts]**

2. $v_{\text{boat}} := 4.40 \frac{\text{m}}{\text{sec}}$ $v_{\text{river}} := 1.8 \frac{\text{m}}{\text{sec}}$ Width := 880 m

a. $t := \frac{\text{Width}}{v_{\text{boat}}}$ $t = 200 \text{ sec}$ **2a. Time to reach the opposite shore. [5 pts]**

b. $v := \sqrt{v_{\text{boat}}^2 + v_{\text{river}}^2}$ $v = 4.75 \frac{\text{m}}{\text{sec}}$ **2b. The velocity of the boat as observed from the shore. [5 pts]**

at $\alpha := \text{atan}\left(\frac{v_{\text{river}}}{v_{\text{boat}}}\right)$ $\alpha = 22.25 \text{ deg}$

c. $D_{\text{down}} := v_{\text{river}} \cdot t$ $D_{\text{down}} = 360 \text{ m}$ **2c. The distance downstream the boat will go. [5 pts]**

d. $D_{\text{final}} := v \cdot t$ $D_{\text{final}} = 951 \text{ m}$ at $\alpha = 22.25 \text{ deg}$ **2d. The final displacement of the boat. [5 pts]**

e. $\beta := \text{asin}\left(\frac{v_{\text{river}}}{v_{\text{boat}}}\right)$ $\beta = 24.15 \text{ deg}$ **2e. The angle upstream to aim the boat. [5 pts]**

f. $d := 250 \text{ m}$ $t_{\text{up}} := \frac{d}{v_{\text{boat}} - v_{\text{river}}}$ $t_{\text{up}} = 96.15 \text{ sec}$ $t_{\text{down}} := \frac{d}{v_{\text{boat}} + v_{\text{river}}}$ $t_{\text{down}} = 40.32 \text{ sec}$

$t_{\text{up,down}} := t_{\text{up}} + t_{\text{down}}$ $t_{\text{up,down}} = 136 \text{ sec}$ **2f. Time to go up and down the river. [5 pts]**

LAB PHYSICS TEST - TWO DIMENSIONAL KINEMATICS 1998-99 D

3. $m_{\text{stopper}} := 12.5 \cdot \text{gm}$ $R := 125 \cdot \text{cm}$ $\Delta R := 2 \cdot \text{cm}$ $T := 9.4 \cdot \text{sec}$ $\Delta T := 0.3 \cdot \text{sec}$ $n := 12$

a. $v_{\text{stopper}} := \frac{n \cdot 2 \cdot \pi \cdot R}{T}$ $v_{\text{stopper}} = 10.03 \frac{\text{m}}{\text{sec}}$ **3a. The speed of the stopper. [5 pts]**

b. $\Delta v_{\text{stopper}} := \frac{n \cdot 2 \cdot \pi \cdot (R + \Delta R)}{T - \Delta T} - v_{\text{stopper}}$ $\Delta v_{\text{stopper}} = 0.496 \frac{\text{m}}{\text{sec}}$ **3b. The error on the velocity. [5 pts]**

c. $a_c := \frac{v_{\text{stopper}}^2}{R}$ $a_c = 80.42 \frac{\text{m}}{\text{sec}^2}$ $\xrightarrow{a_c}$ **3c. The magnitude and direction of the centripetal acceleration. [5 pts]**

d. The stopper will move in a straight line out of the paper [or towards the bottom depending on perspective]. [5 pts]

$F_c := \frac{m_{\text{stopper}} \cdot v_{\text{stopper}}^2}{R}$ $F_c = 1.01 \text{ N}$

e. $g := 9.8 \frac{\text{m}}{\text{sec}^2}$ $m := \frac{\left(\frac{m_{\text{stopper}} \cdot v_{\text{stopper}}^2}{R} \right)}{g}$ $m = 0.103 \text{ kg}$ **3e. The total mass hanging down. [5 pts]**

4. D 5. D 6. D 7. B 8. D