ANSWER

BALLS COLLIDE

Where to make them collide? (Same Place, Same Time)

You are given two ramps at different slope facing one another. (A short ramp at a steep angle, and a long ramp at a shallower angle) You are given a ball. You will roll the ball down each ramp and make measurements. Then the balls will be taken away from you. Using only your information and formulas, predict where to put TWO balls, one on each ramp, so they will collide at the bottom. Have teacher verify results

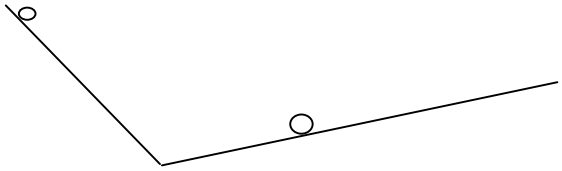
(Vi = 0)

RAMP1 LENGTH TIME $A_1 = 2D_1/T_1^2$

$D=1/2AT^2$

RAMP2 LENGTH TIME $A_2 = 2D_2/T_2^2$

$D=1/2AT^2$



Ramp1 ***Ramp2***

Distance1 up ramp__D_1_____ ****Acceleration2__A_2_____ (from measurements)***

****Acceleration1___A_1_____(from measurements)*** ****Time1 down ramp ___T_2=T_1_ (same as ramp1)***

****Time1 down ramp__T_1_____*** ****Distance up ramp2___ D_2=1/2A_2T^2***

sample numbers: first ramp is 2 meters long, has a time of .6 seconds, so its acceleration is

A_1= 2(2)/.6^2=11.11 m/s^2

Second ramp is also 2 meters long to start, has a time of 1.2 seconds so its acceleration is A_2= 2(2)/(1.2)^2= 2.78 m/s^2….

To place the ball on ramp 2 so it hits at the same time as ramp 1….

D_2=1/2A_2T^2 or D_2 = ½* 2.78 * (.6)^2 = 0.5 meters

SAMPLE ANSWERS

Where will they collide?

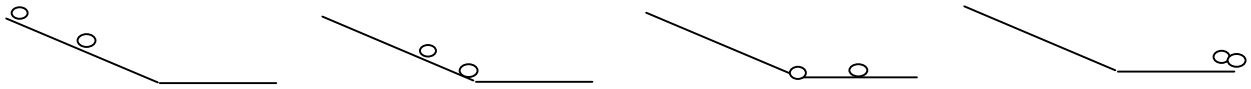
Where will they collide???? (Same Place Same time)

You are given one ball and a ramp. You will roll the ball down the ramp and make measurements. THEN, you will be given a second ball. BEFORE you are given the second ball, you will be asked to predict where a ball from the top and the middle of the ramp will collide along the floor, if at all. Show your work and calculations. (HINT: you can use algebra, calculus, or the good old graphing method. Assume that the ball after the ramp goes a constant speed). Have teacher verify results

$D=1/2AT^2$

Vi=0 RAMP (fixed angle) LENGTH TIME

$D=1/2AT^2$ $Vf^2=2AD$ $D^{after}=Vf*T_{after}$



t= 0 t=t2 t = t1 t=tafter + t3

* = calculations

BALL1: ***BALL2: (first down ramp)***

MEASURE :Length of ramp:__ ___ 2m ***Length down ramp (half of ball one)__ _ $D_2 = ½*D_1=1m$***

MEASURE: Time1 down ramp__ .6 sec_ ****Acceleration of ramp (same as ball1)_A_=11.11_m/s²_***

****Acceleration of ramp_A=$2D_1/T1^2$ =2*2/(.6²)=11.11_m/s²_*** ****Time$_2$ down ramp__T_2=SQRT(2D_2/A)= SQRT(2*1/11.11)=.424 sec***

****Velocity1 at bottom of ramp__ _ Vf_1=SQRT (2AD_1)*** ****Velocity$_2$ at bottom of ramp Vf_2=SQRT(2AD_2)=2Vavg=2(1/.424)***

Vf_1 =2 Vavg= 2 D_1/T_1 = 2(2)/.6=6.667m/s ***Vf_2=4.714 m/s***

****Time difference(Time along floor before ball1)TD=(T_1 - T_2)= (.6-.424) =.1754 sec***

Distance along floor=Velocity$_1$ * Time after ramp

Distance along floor=Velocity$_2$ *(Time after ramp + Time difference)

D? = V1 * T? ***D? = V2 (T? + TD)***

two equations, two unknowns, solve for distance after ramp. Only known numbers are D_1,T_1

Sample numbers : Distance = 2 meters, Time = .6 seconds… … Ball 1 is at 2 meters, its acceleration is A_1= 2(2)/.6²=11.11 m/s² . Its velocity at the end of the ramp is V_1= 2 Vavg = 2*2/.6 = 6.67 m/s . Its distance along the floor is D= 6.67 * T (T is time along the floor).

Ball 2 is at 1 meter, its acceleration is also 11.11 . Its time on the ramp is T²= 2 D/A = 2/11.11 = .42426 seconds = T_2 . Its velocity at the end of the ramp is V_2 =2 Vavg = 2 * 1/.42426 = 4.714 m/s . It spends a longer amount of time on the floor by the time difference T_1-T_2 or .6-.42426 seconds = .17574 seconds. So its distance along the floor is D= V_2* (T+TD) = 4.714 (T+.1754)

Since they collide D=D or 6.67 T = 4.714 (T + .1754) T= .82844/ (1.956) = .423537 sec

D = 2.82499 meters

ALGEBRA:

BALL1:

MEASURE :Length of ramp:__ ___ D_1

MEASURE: Time1 down ramp__ T_1__

**Acceleration of ramp_A=$2D_1/T1^2$ __*

**Velocity1 at bottom of ramp__ _ Vf_1=SQRT (2AD_1)*

$Vf_1 = 2\ D_1/T_1$

BALL2: (first down ramp)

Length down ramp (half of ball one)__ _ $D_2 = ½*D_1$

**Acceleration of ramp (same as ball1)_A_ __*

**Time$_2$ down ramp__T_2=SQRT(2D_2/A)= T_1/(SQRT(2))*

**Velocity$_2$ at bottom of ramp Vf_2=SQRT(2AD_2)=SQRT (AD_1)=SQRT(2)*D_1/T_1*

**Time difference(Time along floor before ball1)TD=(T_1 - T_2)*

*Distance along floor=Velocity$_1$ * Time after ramp*

*Distance along floor=Velocity$_2$ *(Time after ramp + Time difference)*

*D? = V1 * T?* *D? = V2 (T? + TD)*

two equations, two unknowns, solve for distance after ramp. Only known numbers are D_1,T_1

*SQRT (2AD_1) * T = SQRT (2A ½*D_1) * (T+(T_1-T_2))*

*SQRT (2 (2D_1/T_1^2)D_1) * T = SQRT (A D_1) * (T+(T_1-T_2))*

*SQRT(4 D_1^2/T_1^2) * T = SQRT ((2D_1/T_1^2)D_1) * (T+(T_1-T_2))*

*2 D_1/T_1 * T = SQRT(2) * D_1/T_1 * (T + T1 – SQRT (2 *½*D_1/A))*

*= SQRT (2) * D_1/T_1 * (T + T1 – SQRT (D_1/A))*

*= SQRT (2) * D_1/T_1 * (T + T1 – SQRT (D_1/(2D_1/T_1^2)))*

*= SQRT (2) * D_1/T_1 * (T + T1 –* T_1/ SQRT (2))*

*= SQRT (2) * D_1/T_1 * (T) + SQRT (2) * D_1/T_1 * T1 – SQRT (2) * D_1/T_1 *T_1/ SQRT (2)*

*2 D_1/T_1 * T = SQRT (2) * D_1/T_1 * (T) + SQRT (2) * D_1–D_1*

*2 D_1/T_1 * T - SQRT (2) * D_1/T_1 * (T) = + SQRT (2) * D_1–D_1*

*(2 - SQRT (2)) * D_1/T_1)* (T) = + (SQRT (2)–1) * D_1*

T = T_1((SQRT(2)-1))) / (2-SQRT(2))*

T = T_1/(SQRT(2))

*D = (2 D_1/T_1) * (T_1/(SQRT(2)))*

*D = SQRT(2) *D_1*