

ANSWER

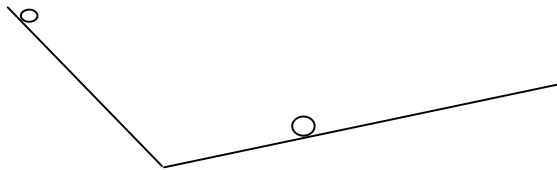
BALLS COLLIDE

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

($v_i = 0$)

	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

Distance1 up ramp D_1 _____
(measurements)

*Acceleration1 A_1 _____ (from measurements)

*Time1 down ramp T_1 _____

Ramp2

*Acceleration2 A_2 _____ (from

*Time1 down ramp $T_2 = T_1$ (same as

*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

$$A_1 = 2(2)/.6^2 = 11.11 \text{ m/s}^2$$

Second ramp is also 2 meters long to start, has a time of 1.2 seconds so its acceleration is $A_2 = 2(2)/(1.2)^2 = 2.78 \text{ m/s}^2 \dots$

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

$$D_2 = 1/2A_2T^2 \text{ or } D_2 = 1/2 * 2.78 * (.6)^2 = 0.5 \text{ meters}$$

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

$$D = 1/2AT^2$$

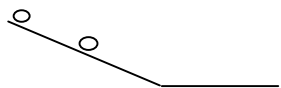
$$V_i = 0$$

$$D = 1/2AT^2$$

RAMP (fixed angle) LENGTH

$$V_f^2 = 2AD \quad D_{\text{after}} = V_f * T_{\text{after}}$$

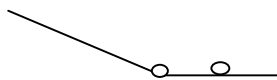
TIME



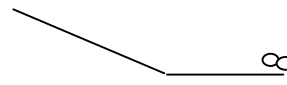
t=0



t=t2



t=t1



t=tafter + t3

* = calculations

BALL1:

MEASURE :Length of ramp: ___ 2m

MEASURE: Time1 down ramp ___ .6 sec

*Acceleration of ramp $A = 2D_1/T_1^2 = 2*2/(.6^2) = 11.11 \text{ m/s}^2$

BALL2: (first down ramp)

Length down ramp (half of ball one) ___ $D_2 = 1/2 * D_1 = 1\text{m}$

*Acceleration of ramp (same as ball1) $A = 11.11 \text{ m/s}^2$

*Time₂ down ramp ___ $T_2 = \text{SQRT}(2D_2/A) = \text{SQRT}(2*1/11.11) = .424 \text{ sec}$

*Velocity₁ at bottom of ramp ___ $V_{f1} = \text{SQRT}(2AD_1)$

$$V_{f1} = 2 \text{ Vavg} = 2 D_1/T_1 = 2(2)/.6 = 6.667 \text{ m/s}$$

*Velocity₂ at bottom of ramp $V_{f2} = \text{SQRT}(2AD_2) = 2 \text{ Vavg} = 2(1/.424)$

$$V_{f2} = 4.714 \text{ m/s}$$

*Time difference (Time along floor before ball1) $TD = (T_1 - T_2) = (.6 - .424) = .1754 \text{ sec}$

Distance along floor = Velocity₁ * Time after ramp

Distance along floor = Velocity₂ * (Time after ramp + Time difference)

$$D? = V_1 * T?$$

$$D? = V_2 (T? + TD)$$

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 $A_1 = 2(2)/.6^2 = 11.11 \text{ m/s}^2$. Its velocity at the end of the ramp is $V_1 = 2 \text{ Vavg} = 2*2/.6 = 6.67 \text{ m/s}$. 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 $T^2 = 2 D/A = 2/11.11 = .42426 \text{ seconds} = T_2$. Its velocity at the end of the ramp is $V_2 = 2 \text{ Vavg} = 2 * 1/.42426 = 4.714 \text{ m/s}$. It spends a longer amount of time on the floor by the time difference $T_1 - T_2$ or $.6 - .42426 \text{ seconds} = .17574 \text{ seconds}$. So its distance along the floor is $D = V_2 * (T + TD) = 4.714 (T + .1754)$

Since they collide $D = D$ or

$$6.67 T = 4.714 (T + .1754)$$

$$T = .82844 / (1.956) = .423537 \text{ sec}$$

$$D = 2.82499 \text{ meters}$$

ALGEBRA:

BALL1:

MEASURE :Length of ramp: $\frac{D_1}{2}$

MEASURE: Time1 down ramp T_1

*Acceleration of ramp $A=2D_1/T_1^2$

*Velocity1 at bottom of ramp $V_{f1}=\text{SQRT}(2AD_1)$

$$V_{f1} = 2 D_1/T_1$$

BALL2: (first down ramp)

Length down ramp (half of ball one) $D_2 = \frac{1}{2}D_1$

*Acceleration of ramp (same as ball1) A

*Time2 down ramp $T_2=\text{SQRT}(2D_2/A)=T_1/(\text{SQRT}(2))$

*Velocity2 at bottom of ramp $V_{f2}=\text{SQRT}(2AD_2)=\text{SQRT}(AD_1)=\text{SQRT}(2)*D_1/T_1$

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

Distance along floor=Velocity1 * Time after ramp

Distance along floor=Velocity2 * (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

$$\text{SQRT}(2AD_1) * T$$

$$\text{SQRT}(2(2D_1/T_1^2)D_1) * T$$

$$\text{SQRT}(4D_1^2/T_1^2) * T$$

$$2 D_1/T_1 * T$$

$$= \text{SQRT}(2A \frac{1}{2}D_1) * (T+(T_1-T_2))$$

$$= \text{SQRT}(A D_1) * (T+(T_1-T_2))$$

$$= \text{SQRT}((2D_1/T_1^2)D_1) * (T+(T_1-T_2))$$

$$= \text{SQRT}(2) * D_1/T_1 * (T + T_1 - \text{SQRT}(2 * \frac{1}{2}D_1/A))$$

$$= \text{SQRT}(2) * D_1/T_1 * (T + T_1 - \text{SQRT}(D_1/A))$$

$$= \text{SQRT}(2) * D_1/T_1 * (T + T_1 - \text{SQRT}(D_1/(2D_1/T_1^2)))$$

$$= \text{SQRT}(2) * D_1/T_1 * (T + T_1 - T_1/\text{SQRT}(2))$$

$$= \text{SQRT}(2) * D_1/T_1 * (T) + \text{SQRT}(2) * D_1/T_1 * T_1 - \text{SQRT}(2) * D_1/T_1 * T_1/\text{SQRT}(2)$$

$$2 D_1/T_1 * T = \text{SQRT}(2) * D_1/T_1 * (T) + \text{SQRT}(2) * D_1 - D_1$$

$$2 D_1/T_1 * T - \text{SQRT}(2) * D_1/T_1 * (T) = + \text{SQRT}(2) * D_1 - D_1$$

$$(2 - \text{SQRT}(2)) * D_1/T_1 * (T) = + (\text{SQRT}(2)-1) * D_1$$

$$T = T_1 * ((\text{SQRT}(2)-1)) / (2-\text{SQRT}(2))$$

$$T = T_1 / (\text{SQRT}(2))$$

$$D = (2 D_1/T_1) * (T_1 / (\text{SQRT}(2)))$$

$$D = \text{SQRT}(2) * D_1$$