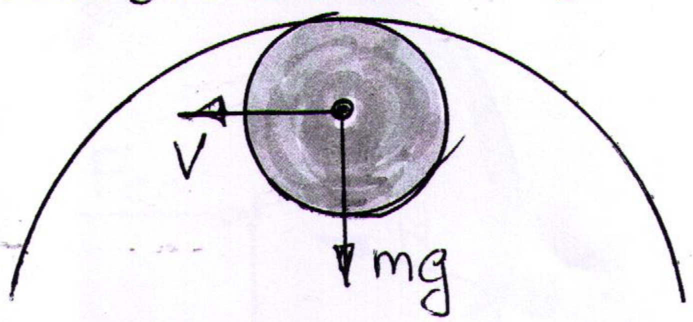
HOW FAST MUST THE BALL BE GOING TO LOOP THE LOOP ?

- from MOTION Q2

Physics says the centripetal force (the force that any object going in a circle experiences) must be equal or greater than the gravitational force acting on the ball at the top of the loop.



The equations are:

Centripetal Force $Fc = \frac{mv^2}{r}$ where m=mass, v= velocity

r= radius of the curve.

Gravitational Force $Fg = mg$ and g=9.8

Since these must be equal at the top of the loop you can write

$$\frac{mv^2}{r} = mg$$

This can be simplified to:

$$V = \sqrt{rg}$$

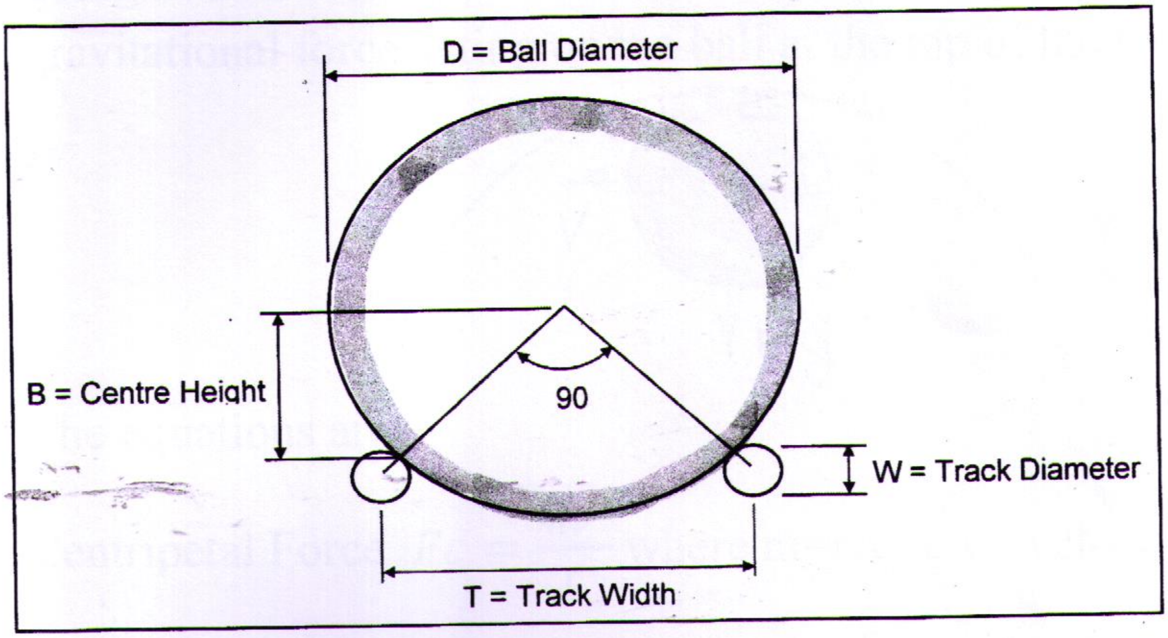
In our case this is about 1.7 m/sec for a radius of about 0.3m

(quite slow as 50 km/hr is 14 m/sec)

BALL TRACK GEOMETRY *(1)*

- from MOTION Q3

How wide does the track have to be to allow the balls to run correctly?



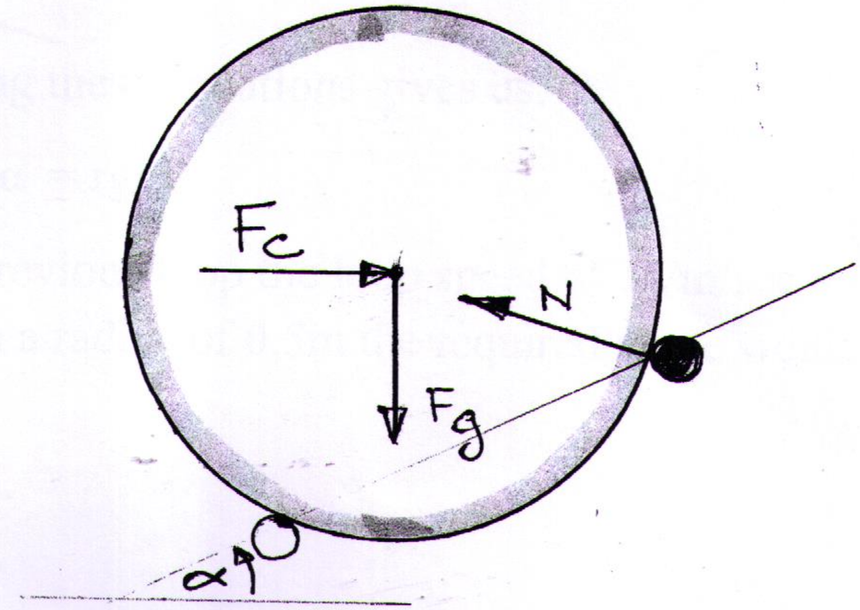
In the above diagram the Ball Diameter is 114mm and the track is 8mm. This gives us an equilateral triangle with the sides equal to the sum of the radius of both the ball and the track. Since we know that the sides of an equilateral triangle are in the ratio of 1 to √2

The track width (T) is √2 x (4 + 57) = 86mm

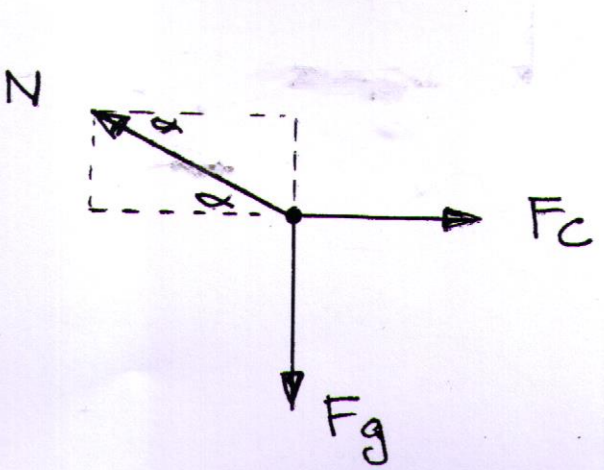
BALL TRACK GEOMETRY *(2)*

- from MOTION Q4

If the ball is running at 1.7 m/sec around a curved track how much must we bank the track to keep the ball from flying off ?



Look at the forces on the ball when it is about to tip off the track. All the weight of the ball will be on the outside track. The normal force off the track will be balanced by a gravitational force holding the ball down with a centrifugal force trying to tip the ball up over the outside track.



Since the vector sum of N must equal F g plus F c we can write the following equations:

F g = mg = N sin α and Fc = $\frac{mv^2}{r}$ = N cos α

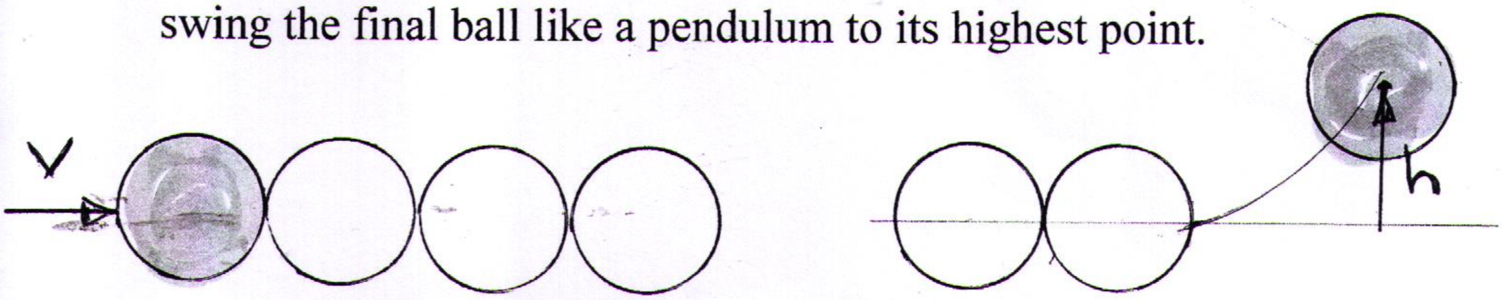
Combining these equations gives us:

Tan α = rg/v2

For our previous loop the loop speed of 1.7m/sec and a tight bend with a radius of 0.5m the required angle would be 30 degrees.

NEWTON'S CRADLE

How does physics apply to Newton,s Cradle ?. His laws about the conservation of momentum combined with the fundamental principle the conservation of energy both apply. Consider the two scenarios sketched below. The first just before impact of our delivery ball, the other after it's impact (and Newton,s law about the conservation of momentum) has caused all the balls to swing the final ball like a pendulum to its highest point.



Can we calculate the impact speed of our delivery ball. The initial kinetic energy has all been converted into potential gravitational energy with the swinging ball. Thus:

$$E\,k = \frac{mv^2}{2} = Eg = mgh$$

This can be rearranged for $v = \sqrt{2}gh$

For our cradle this is about the same as our loop the loop calculation: 1.4m/sec

Have fun!