Forces

Five buttons and gravity

Measurement of the acceleration due to gravity

You will need….

- ✓ five buttons or washers, all the same size and mass
- ✓ a piece of white thread (50 cm)
- ✓ a short length of glass tubing with smooth edges (6 cm long)

Background:

The weight of four buttons/washers provides the centripetal force required to maintain one button/washer in circular motion.

Follow these steps:

1. Ensure that the ends of the glass tube are very smooth.
2. Put the thread through the glass tube. Tie one button to one end and four to the other end of the thread. Mark the thread at a point 25 cm from the centre of the single button.
3. Holding the glass tube vertically, move it in a circular motion so that the single button moves around in a circle of radius about 25 cm. By varying the rate of rotation the radius of the orbit can be increased or decreased. Vary it until the 25 cm mark is exactly at the top of the glass tube and maintain a steady speed. Time 50 or 100 revolutions and calculate the time for one revolution (T).

So what happened?

The centripetal force is provided by the weight of the four buttons:

$$mr\omega^2 = 4mg$$

and

$$\omega = 2\pi / T$$

so

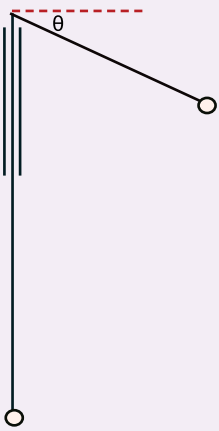
$$r(2\pi / T)^2 = 4g$$

or

$$g = r\pi^2 / T^2$$

If r = 25 cm then

$$g = 2.47 / T^2$$



What next?

1. The thread holding the button in orbit is not exactly horizontal; the angular dip depends on the motion. If the declination is θ then the radius of the orbit is not r but $rCos\theta$.
2. Because of the declination the centripetal force is reduced from $4mg$ to $4mgCos\theta$. The forces are now described by the equation: $mrCos\theta.\omega^2 = 4mg.Cos\theta$ Since $Cos\theta$ is the same on both sides, the equation is essentially the same as the first equation above.