<u>Physics TAS I</u>

Date: 8th Oct, 2004
Title: Measurement of centripetal force required for circular motion
Objective: To measure the centripetal force required for a mass whirling around a horizontal circle and compare the result obtained with the theoretical value $F=mw^2r$.
Apparatus: 1 rubber bung, 1 glass tube, screw nuts, 1 nylon string, 1 paper marker, I metre rule, 1 stop watch, 1 balance
Set-up:

Procedure:
1. The centripetal force apparatus should be constructed as shown in the above diagram.
2. The length of the nylon string that was under investigation was measured (e.g. 0.3 m) from the **centre of the rubber bung** to the glass tube and the particular length L was marked with a paper marker.
3. The mass of the rubber bung and the screw nuts was weighed with a balance.
4. The glass tube was held vertically and the rubber bung was whirled around in a horizontal circle, the paper mark should be just below the glass tube.
5. The time for 50 revolution was recorded using a stop watch.
6. Step 1-5 should be repeated with different length of string.

Precaution:
1. The paper mark should not be in contact with the glass tube when whirling the rubber bung, i.e. there was no friction between the glass tube and the rubber bung.
2. A uniform whirling speed should also be maintained throughout the experiment.
3. A certain distance will be kept from your partner when whirling the rubber bung.
4. The time should be counted after the circular motion of the rubber bung became steady.
5. A reasonable range of length of the string should be selected.

Theories:
When the rubber bung is whirling around a circle with a radius r equals to $L\sin\theta$, where θ is the angle between the glass tube and the string, the centripetal force F required for circular motion of the rubber bung is provided by the tension T of the string.

$\because F = T\sin\theta$

$= mw^2 r$

$= mw^2 L\sin\theta$

$\therefore T = mw^2 L$, regardless of the angle θ.

Measurement:

Mass of rubber bung: 0.0115 ±0.00005kg

Mass of screw nuts: 0.0215 ±0.00005kg

Tension in string T=Mg= 0.0215x9.8N =0.2107N

Length of string L/m	0.2	0.3	0.4	0.5
Time for 50 revolution 50t/s	33.42	38.48	43.51	49.51
Angular velocity $w=2\pi/t$ /rads^{-1}	9.4	8.16	7.22	6.34
mw^2L/N	0.197	0.222	0.232	0.224

Mean mw^2L=

(0.197+0.222+.0232+0.224)/4=0.218N

Errors discussion:

The measured value T is smaller than the theoretical value mw^2L, this may be due to

1. w(measured)>w(true): The time recorded was shorter than the actual value, as the time recorder might have already stopped the stop watch before the rubber bung had finished its 50th cycle.
2. L(measured)>L(true):The edge of the glass tube was rough, hence the measured length might not be accurate, in such case L might be larger than the actual value.
3. m(measured)>m(true): This might be due to the reading error when using the balance.
4. M(measured)<M(true): This might be due to the reading error when obtaining the weight of the screw nuts.

Suggestions for a higher accuracy:

1. A certain position should be marked when the stop watch started to count and the same position should be reached when the stop watch was stopped.
2. A glass rod of smooth edge should be used.
3. Instead of a balance, an electronic balance might be used.

Percentage error:

Conclusion:

The centripetal force measured in this experiment is slightly smaller than the theoretical value.