Free report on experiment 8

Centripetal force

PHY 2091-01

Introduction

The purpose for this experiment was to determine the centripetal force acting on a metal bob revolving on a Beck centripetal force apparatus. The mass, radius, and time for completing one rotation were measured and used to calculate the centripetal force. Weight of masses hanged on the metal bob was calculated and used to determine the static centripetal force. Calculated centripetal force and static centripetal force were then compared.

Data

The results obtained from the experiment are shown below:

Data analysis

The calculations are as shown below:

Percent error in radius

Percent error in radius (%σr) = (0. 005/0. 18)* 100 = 2. 78%

Frequency

Frequency (f) = N/T. Using the first measurement;

f = 10/5. 26 = 1. 90

Average frequency (f) = (sum of the six frequency measurements)/6

= (1. 90+1. 92+1. 90+1. 86+1. 88+1. 84)/6

= 1. 88h

Standard deviation of frequency (σf)

σf = √[∑(fx-f¯)2/(n-1)] where fx is the value of a frequency measurement, f¯ is the average frequency, and n is the total number of measurements.

σf =√(0. 00535178/6-1) = √ 0. 00107= 0. 03

%error of frequency (%σf):

%σf = σf/f¯*100 = 0. 03271628/ 1. 878408781*100

= 1. 74%

Error in the bob's mass (σm)(kg):

σm = 0. 1/1000

= 0. 0001kg

Percent error in bob's mass:

%σm = σm/mav*100 = 0. 0001/0. 377*100 = 0. 027%

Static Equivalent Centripetal Force (Fst. eq.(C)):

Force = total hanging mass*gravitational field strength (g)

Force= 0. 7205*9. 792 = 7. 06N

Error in static equivalent centripetal force (Fst. eq.(C)).

σFst. eq.(C) = 9. 792*σm = 9. 792*0. 0001 = 0. 0009792 = 0. 001

Percent error in static equivalent centripetal force;

%σ Fst. eq.(C) = σ Fst. eq.(C)/Fst. eq.(C)*100 = 0. 0009792

/ 7. 055136*100 = 0. 0139 %

Square of the average frequency:

Square of the average frequency (f2) = 1. 9*1. 9 = 3. 5284h2

Percent error in square of average frequency:

%σf2 = %σf*2 = 1. 74*2 = 3. 48%

Experimental value for centripetal force (FCex):

FCex = 4π2mrf2 = 4*3. 141592*0. 377*0. 18*1. 882

FCex = 9. 5 N

Percent error in centripetal force (%σFCex):

%σFCex = √[(%σm)2+ (%σr)2 + (%σf2)2] =√(0. 0272+2. 782+3. 482)

%σFCex = √0. 000703586+7. 716049383 +12. 13410375= √19. 850856719

= 4. 45543003%

When rounded off to the nearest 2d. p. %σFCex = 4. 46%

Absolute error of centripetal force;

σFCex = %σFCex*FCex/100 = 4. 45543003*9. 452639122/100 = 0. 4

Difference (d):

d= theoretical value (Fst. eq.(C)) – experimental value (FCex) = Fst. eq.(C)-

FCex = 9. 45 – 7. 06 = 2. 39

Error in the difference (σd).

σd = √[(σFst. eq.(C)))2+(σFCex)2]

σd=√(0. 0012+0. 42) = √0. 0000009588+0. 17736586=√0. 1773668188 =

0. 4

Discussion

Summary of results obtained from the experiment are shown in the table below:

The measured quantity with the highest error in the experiment is the radius of the circular path of the metal bob. This accounted for most of the total error. The error in measuring the mass of the bob is negligible.

The errors met in this experiment were caused by the following: inaccurate reading of the radius, mass of the bob, and time taken for the bob to cover ten revolutions due to the limitations of the instruments used; changes in elasticity of the spring while the masses hanged on the bob were being measured; and unconscious bias in setting up the apparatus. All these errors are classified under intrinsic random errors. These can be detected by taking several measurements. The errors can either increase or decrease the values of both calculated centripetal force and static equivalent centripetal force.

Question

The value of calculated centripetal force and static equivalent centripetal force do not agree within the limits of experimental error. The difference is greater than the error of the difference. This can be attributed to ignoring a systematic error. For instance, the instruments used to measure the mass may have been one unit greater than actual measurements and this may have not been detected. This tends to increase the values of masses measured by similar percentage.

Given that the two values compared do not agree within the limits of experimental error, the experiment is not completely successful.

Conclusion

The original aim of the experiment was achieved since the centripetal force of the metal bob was determined. Besides, the students learnt much from the experiment.

References

Breithaupt, Jim. New Understanding Physics for Advanced Level.

Cheltenham: Stanley Thornes, 2000. Print.

Den, Hartog J. P. Mechanics. New York: Dover Publications, 1961. Print.