

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Ethan Harris	Student ID number:	
Programme:	HNC/D MECHANICAL ENGINEERING		
Module:	ENGINEERING SCIENCE 1		
Module code:	M4X00385	Contribution to Overall Module Assessment (%):	30%
Lecturer:	Emily Nyathi	Internal Verifier:	Nigel Evans
Assignment Title:	PRACTICALS I & II (SIMPLE HARMONIC MOTION AND BENDING MOMENT)	Word count (or equivalent):	
Submission deadline:	13/01/2020	Return date of provisional marks & written feedback:	21/01/2020
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one-week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

STUDENT FEEDBACK FORM

This section details the extent to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

42%
NJE

APPENDIX GA36a

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Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
Your research work shows little evidence of wider reading and no referencing at all.	25	7
2. Knowledge and Understanding Skills		
You have demonstrated a basic understanding of the applications of some of the equations appropriate to the tasks given, however you need to proofread your work for errors. Labelling your Free Body Diagrams correctly, calculating your shear forces and drawing the correct Bending moment and Shear force Diagrams could have scored you more marks here.	30	14
3. Cognitive and Intellectual Skills		
You have presented your results using tables, graphs and diagrams, however you need to work on how you interpret your data and making sound arguments.	15	7
4. Practical Application Skills		
Giving real life applications of the SHM and BM applications in the Engineering Industry could have scored you more marks here.	25	12
5. Transferable Skills for Life and Professional Practice		
Demonstrates the basic skills for employment requiring the exercise of personal responsibility and decision-making. Mostly ordered presentation and structure in which relevant ideas / concepts are reasonably expressed, but needs to work on drawing sound conclusions.	5	2

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to 1 week late (40% Max)

Over 1 week late (0%)

42%

Bending moment in beams

Abstract

A test to visually see the extensive load of weight on a supported beam. A beam is placed with 3 weights in different places along the beam. The beam has a split in the middle and is held together via a spring. Using different calculations such as sum of the moment equals to $M_a = 0$ and sum of all forces in the F_y direction equal to forces in the F_x (vertical forces and vertical forces equal 0).

Introduction

The beam in the experiment is a length of metal, separated in the middle. The beam is held via two supports. The arranged loads and supports that are resting on the top of the beam must all equal 0. This is called the equilibrium. The bending moment in this experiment is the reaction about point R_3 . This is reaction point in the beam. The spring that is holding the beam together is a newton meter (shown in figure 2) and it helps shows the force taken to the bend the beam when it is under load. The readings are in newtons (N). A picture of the beam and the spring can be seen in the appendices section of the beam, (please see figure 1 in appendices section).

Theory/Research

The theory for this test is that the more weight added to the beam in the selected are more likely to bend the beam and give a reading to evaluate and consult. Equations used in this test are: -

→ You could have added applications of beam bending theory in To work out bending moment industry.

Bending moment = $D \times F$ or Distance multiplied by Force

To work out moments about point R_3

$$R_2 \times X_2 + R_4 \times X_3 + R_5 \times X_4 - R_6 \times X_6$$

$$MR_3 = 0$$

$$F_y = 0$$

Equilibrium of beams

When working out the direction of forces we will the formula: -

"Upward forces = downward forces"

When we are working out clockwise moments about a selected point on the beam the following equation will be used: -

"Clockwise moments about a point = anticlockwise moments about the same point."

References?

Methodology

The test carried out was to see if weights in chosen positions would impact a simply supported beam. The beam was split into two and was held together by a spring. As I said the beam then had weights in specific position to enable a noticeable bend in the beam. (see figure 1). The first stage was to measure all the points in which the weights were located, the overall length of the beam and the distance in which the spring was placed. To gain the position of the spring it was measured from the middle point of the beam to the centre of the spring. The spring was being measured via a newton meter (See figure 2). Before applying the load to then beam, the spring was checked to ensure that it was zeroed out. This allowed the results to become precise. The beam was also checked over by placing a rule on the top. This again ensured that the beam was straight and was in the correct order to start the test. Once all measurements were taken note of and the beam was zeroed out completely, the weights were then placed on the hangers. The weights used in the experiment are a 5N weight, a 19.6N weight and another 5N weight. Once this next stage was carried out measurements of the load were then carried out. The taken measurements were recorded and are now ready to put into equations. In order to receive accurate calculations, a conversion had to be made from "CM" to "MM". this was done as when it came to plotting figures into the table it would make reading it easier.

Results, Analysis, Evaluation and Errors.

As mentioned in the brief-the point in the experiment was to see if the added weight would have an impact on the beam, find below my working out and results.

Results

Distances

Point	CM	M
R1-R2	10.5	0.105
R1-R3	16	0.16
R1-R4	30.5	0.305
R1-R5	65.5	0.655
R1-R6	84	0.84
R1-R7	96	0.96
R1-R8	100	1

Show / label your weights and support reactions
clearly e.g. W_1 $W_2 \dots$ then R_A & R_B for
your support reactions

Bending moment with no weight-15cm @ 100g=0.1kg

Bending moment with weight-15cm @ 200g=0.2kg

*multiply by 9.81 m/sec²
spring force to get*

6. Moment @ cut = $F_c \times 0.15$

Finding moment about point R3

$$+ R2 \times X2 = 5N \times 0.106M = 0.53$$

$$+ R4 \times X3 = 19.6N \times 0.145M = 2.842$$

$$+ R5 \times X4 = 1.96N \times 0.495M = 0.97$$

$$- R6 \times X6 = ? \times 0.8$$

$$R2 \times X2 + R4 \times X3 + R5 \times X4 - R6 \times X6$$

$$0.53 + 2.842 + 0.97 = 4.342$$

$$4.342 - R \times 0.8 \text{ then turns to } R = 3.342 \div 0.8$$

$$4.342 \div 0.8 = 5.4275$$

$$R = 5.4275$$

CHECK

$$4.342 - (5.4275 \times 0.8) = 4.342$$

$$4.342 - 4.342 = 0$$

Finding vertical points F_y

$$R_A + R_B = 5N + 19.6N + 5N = 29.6$$

$$29.6 - 4.342 = 25.258$$

$$R_A = 25.258$$

CHECK

$$25.258 + 4.342 = 29.6$$

$$R_A + R_B = 29.6$$

(see figure 3 for a labelled diagram)

Finding the bending moment about the cut point.

Taking moment about cut point. (M_c)

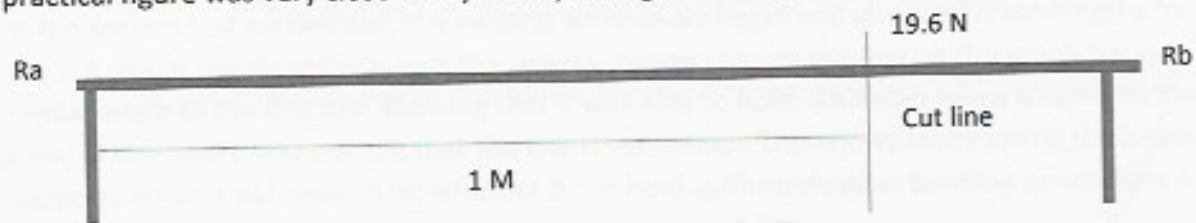
$$M_c = W a (L - a) \div L$$

$$1.692 (0.855 / 0.655) \div 1 = 0.338$$

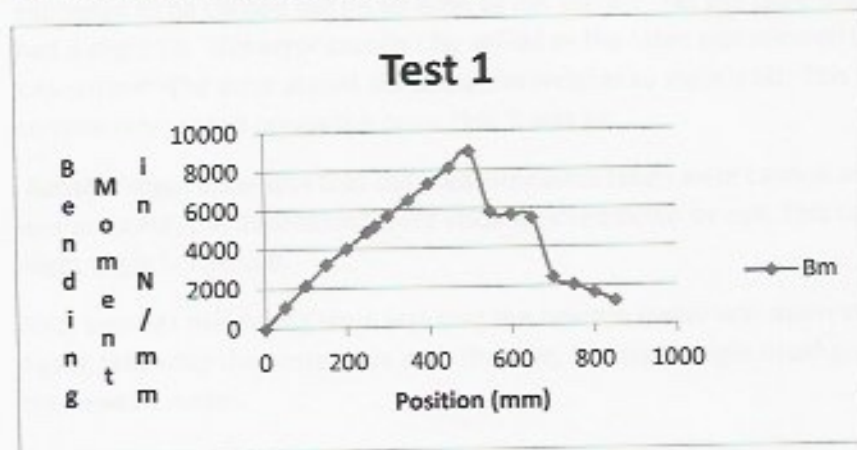
$$3 \times 0.15 = 0.45$$

To get my percentage error I will get $0.338 \div 0.45 = 0.075 \%$

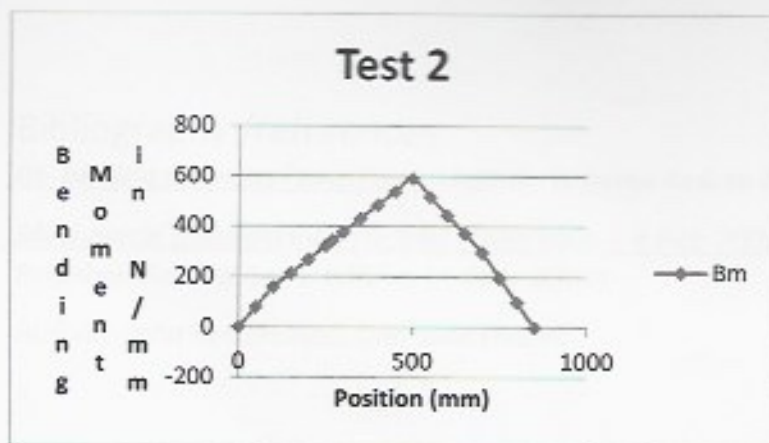
If you look at my values you can see that they are not very far apart. This tells me that my practical figure was very close to my theory telling me that I proved my theory correct



When all the figures were gathered such as the used weights and the lengths, they were inserted into an excel spread. In order to get these results to attained figures were multiplied by 9.81. This being the unit for gravity. From here, graphs were made in order to visually present the bending moments. Below I will show examples of the graphs and then go on to explain what is happening.



The first test carried was a success substituting the human errors. Looking at the graph above it shows a clear point in which the beam couldn't handle the weight that was allocated along the support. Around 500 mm into the beam, it shows that the beam was under pressure, yet the beam held itself until around 9000 N/M of force. Once the bend occurring, the graph shows that there may have been movement when the bending occurred due to the slow fall of the figures. As a reminder the weights located on the beam were 5N, 19.6N and another 5N weight.



In the second test carried out, the weights were re-arranged and given different lengths to see if it would significantly change the results. As you can see the line on the graph has a similar angle to the first test showing that it was able to hold. Although when it came to the bend of the beam, you can see that the line is very steep. This shows that moving the beam supports around will depend on whether it can hold sufficiently after bending or whether it will collapse.

Errors

The measuring equipment and the beam were measured as accurately as possible. Although it was done to correct as much as probable, some errors were hard to eliminate. For example, this test is supposed to be carried out on an even or flat surface. Yet the table that the beam was placed was had a slight tilt. This error couldn't be solved as the table was secured to the floor and no adjustment. The error stated did cause the weights to slightly tilt. This meant that the weight wasn't consistently spread across the point that it was on.

Another slight issue was that the measurements taken were carried out by a rule. Although the rule was accurate, the dimensions were visually noted down by eye. This could be affected even by a slight angle in the rule.

Also, another measuring issue was that the newton meter was again visually noted down by eye. Again, following the same issue with the rule, any slight angle could give an inaccurate result from the newton meter.

Conclusion

In conclusion I think the recorded results have shown to prove my theory. It is true that the more weight added to a simply supported beam will show a significant amount of stress within the beam. This can be evidently proven via the provided graphs that I have created. I am happy with how the test went although some human errors were made. I now know that if I ever do this type of testing again I look back on this report and try to eliminate or try to reduce the human errors from this test.

Bibliography /references

04- Bending moments PowerPoint, - Author- Dr Rabya Kadhimi & Emily Nyathi

Mechanical Engineering Principles Paperback – 4 Feb 2002 –

Publisher- Routledge; 1 edition (4 Feb. 2002)

Author- John Bird (Author), Carl Ross (Author)

} Put these references in text

Appendices

Figure 1 (beam)

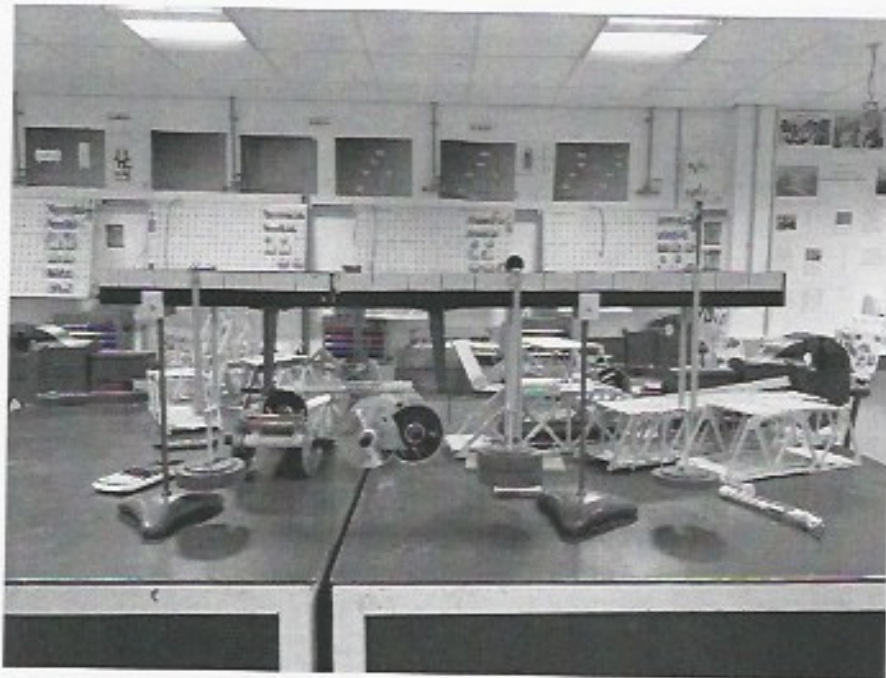


Figure 2 (spring)

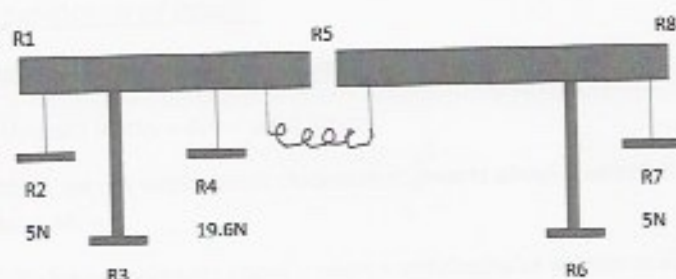


Figure 3 (beam diagram)

Part B)

- i) In the experiment carried out the first recorded measurement of the spring that was holding the beam together was very accurate. To counter balance this issue the spring was set at a figure of 100 N/M of force. When the weights were applied to the beam, it did in fact bend as the results record went from 100 N/m of force to 200 N/m of force. Although, in the second test carried out it did not bend due to the change of position with the beam supports. This shows that positioning of supports is crucial for structural stabilisation.

- ii) Compute the average figure which expresses the comparison between the experimental and theoretical bending moments (use either ratio or a percentage error).

$$0.1 \times 9.81 \times 0.15 = 0.1475$$

$$0.2 \times 9.81 \times 0.15 = 0.2943$$

My difference generated from these figures is 0.1475 I will then divide this by 2 to give me my average $0.1475 \div 2 = 0.073575$

$$\text{I will also divide my theoretical by 2} = 2141.5 \div 2 = 1070.75$$

Then to find my error margin as a percentage I will divide my experimental value by my theoretical = $0.073575 \div 1070.75 \times 100 = 0.00687135\%$ will be my margin of error.

iii) The theory generated for this test was the following: -

The theory for this test is that the more weight added to the beam in the selected are more likely to bend the beam and give a reading to evaluate and consult. Equations used in this test are: -

To work out bending moment

Bending moment = $D \times F$ or Distance multiplied by Force

To work out moments about point R3

$$R2 \times X2 + R4 \times X3 + R5 \times X4 - R6 \times X6$$

$$MR_3 = 0$$

$$F_y = 0$$

Equilibrium of beams

When working out the direction of forces we will use the formula: -

"Upward forces = downward forces"

When we are working out clockwise moments about a selected point on the beam the following equation will be used: -

"Clockwise moments about a point = anticlockwise moments about the same point."

Through this test and the research conducted, it is confirmed that the more weight added to the simply supported beam will in fact have an effect. This can be proven graphically and numerically via equations and other examples.

Experiment 1: Simple Harmonic Motion

Abstract

A report on the investigation of harmonic motion using a simple pendulum. Connected to the pendulum is a piece of string and a weight. The swinging motion of these two objects allow the user to gather a type of frequency. The test is to determine how many oscillations can be achieved by swinging different weights that are connected to string and a test tube holder. The first variant carried out is to increase the weight in each test to see if a visible pattern develops. Another variant was introduced, and this was to change the length of string and again see if the other variant will have a visible effect on the theory. A second test was also carried out by using springs.

Introduction

The test carried out is to see how long it takes for a weight connected to a length of string to complete 10 oscillations. The test is being accomplished by connecting a piece of string to a test tube holder. In the test, a total of two variants and carried out a total of six tests in each individual trial. The first variant was to see if the change in length would create different results and if a change in weight would influence the outcomes. As stated, the test is being undertaken to see if the trials undertaken will influence our theory. The second test carried out as mentioned was done by using springs.

Theory/Research

Aim Our theory for this test is to see if the length of string effects the time taken for 10 oscillations. Our results will hopefully prove this theory.

Methodology

I will now go on to explain how we carried out these tests and the apparatus we used to find and gather our results.

The first step is to gather the test weights and the length of string needed. Other items such as the test tube Holder, (the apparatus we used to suspend the rope and weights from) and clamps (a tool that is attached to the stand that helps us reduce the risk of hitting the test tube holder). The first test carried out was to change the length in increments of 0.5. Increasing the amount is reasonable as any additional weight could potentially ruin the overall outcome. The second step carried out was to then attach the rope to the clamp and then attaching the rope to the weight. After that step the weights were attached. Once the required weights were securely attached, the setting upstage was completed, and testing can now start. Lastly, measuring equipment and a stop watch was also gathered to enable to record the findings of the experiment. The measuring equipment gathered was a protractor to enable a visual angle to be seen and recorded. Once the required angle was ready, the test weight was dropped and at the same time the stop watch was started. For one oscillation, the weight needed to return to its position in which it was dropped from. Once one test was completed the test was then repeated in the same process another five times to give a total of six recordings.

The second test was then carried out but there was a variant changed. This time instead of the string length being changed it was made that the string would stay a constant of 30cm. the variant this time was to increase the weight by 0.50g every test. Again, a total of 6 test were carried out altogether repeating the same as last.

Results, Analysis, Evaluation and Errors.

Presented below will be two tables both. One will contain the one variable and the second table another.

Length (M)	Angle (°)	Mass (M)	Time for 10 oscillations	Period ÷ 10 (S)	Theoretical period
0.25	40	100	12.30	1.23	1
0.30	40	100	12.82	1.282	1.099
0.35	40	100	13.77	1.377	1.187
0.40	40	100	14.31	1.431	1.269
0.45	40	100	15.58	1.558	1.346
0.50	40	100	15.88	1.588	1.418

Length (M)	Angle (°)	Mass (M)	Time for 10 oscillations	Period ÷ 10 (S)	Theoretical period
0.25	40	50	13.10	1.310	1
0.30	40	100	13.27	1.327	1.099
0.35	40	150	13.31	1.331	1.187
0.40	40	200	13.42	1.342	1.269
0.45	40	250	13.47	1.347	1.346
0.50	40	300	13.47	1.347	1.418

You could have tried varying the angle here.

Errors

Looking back in hindsight of the test a couple of mistakes were made that could've easily disrupted or given inaccurate results. One mistake made we should've attached the string and weights and then measured to overall length potentially giving us a more accurate reading for our overall results.

Again, we made some human error here as we examined the angle by eye and wasn't completely accurate, potentially again causing slightly off results.

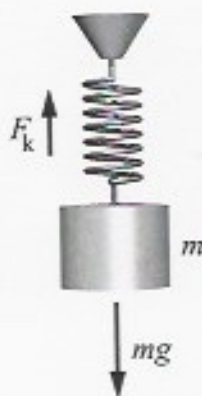
Pendulum conclusion

A pendulum is a length of string that is located and fixed to a certain point of an elevated platform. When the string has a certain weight connected to the string you must pull back the string and lose it go. This will then simulate one oscillation. This movement is caused by gravity. Once the string has done one complete oscillation this is where you get your one period from. A period is when the string returns to its original position from where it was lifted. This swing itself is affected due to gravity (9.81). The results found by doing these tests shows that the change in the length of string that is in the fixed point will have a considerable effect on the time taken. It will make the swing slower causing acceleration to be affected. When the tests were carried out the calculation for gravity was used. This formula was $M/S^2 - 1$. The figure you attain from carrying out this formula is dependent on how accurate the test carried out was. The swing overtime will slow down not only due to gravity but will slow down due to the point where the string is fixated. Because of the swinging action rubbing on the point it will lose acceleration from the moment it was dropped from the elevated point. *was about mass?*

Simple Spring test

In order to test the load of spring a simple test must be carried out. Below will be the findings of a test carried out on a 45mm long spring.

For the load a test a simple strut was used to hold the spring accompanied by the weight. The Spring had to loops on either end with the one hoop being placed on the hook at the top of the strut. The spring then had another hook paled on the lower hoop to hold the weight. To measure the overall stretch of the spring I used a rule and measured from the datum point (288mm). I then placed on the selected weight to the spring a recorded what I found. Once I gathered the stretch of the one weight, another 3 more weights were then added on to give a nice variation. Once the final weight was added the spring went into its plasticity point in which the spring did not return to its original form. Once the weights were recorded they were all divided by 1000 to give the weight in newtons as they were in kilograms. The conversion was applied due to the formula Mass multiplied by acceleration.



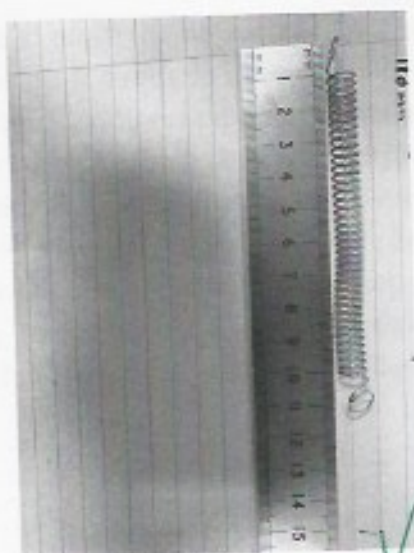
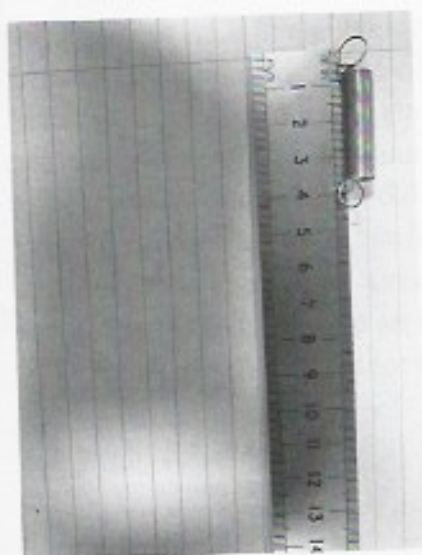
Results

Original spring length = 45mm

Load (N)	5	10	15	20
Extension of spring (MM)	22	52	97	212

When the 20 N weight was added to the spring, it did not return to its original form. The spring now measured at 110mm meaning it stretched 65mm.

Find below images of spring in original form and stretched form



Simple spring test conclusion

When an object is in equilibrium and you use force to move the object it ~~will not simply~~ ^{tends to return} move away ^{to its state of equilibrium} due to a force keeping it in the same place. If it returns to the equilibrium after it has been moved then it is classed harmonic motion. An important point to make about the two tests carried out (pendulum swing and spring test) is that they are measured in seconds. Like when the pendulum returns to its original position from which it was swing is classed as one oscillation. Harmonic motion is when a weight is added to spring and once returned after the weight is removed is also classed as one oscillation. When you swing a mass, the speed is decided on the length of string. To decrease the speed, the string will need to be lengthened. As for a spring to ensure that it becomes stiffer you will need to increase its strength.

Experiment 1, task B

1. The period of oscillation of an ideal simple pendulum depends on length, L of the pendulum and the acceleration of gravity g and is given by the following equation: $T = 2\pi \sqrt{\frac{L}{g}}$

Once rearranged

$$g = \frac{4\pi^2 L}{T^2}$$

2. Is the period of a simple pendulum dependant on the mass?

Through-out my research I have found that a pendulum in fact does not rely on the mass of an object. It in fact relies on a length and a form of acceleration. This is due to gravity.

3. How long must a simple pendulum be to have a period of 1 second?

The length of a simple pendulum must be 1M. The answer is 1M because one swing would take around 2 seconds to achieve one single oscillation.

4. Assuming you are safely located on the moon, and are provided with a simple pendulum, stopwatch and a metre rule, is it possible to determine the acceleration due to gravity on the moon using only these three items?

With the apparatus listed in the question it will allow me to carry out a simple test. By having a pendulum with multiple masses, it will allow me to gather an array of test results to see what speeds I will need in order to land in an area where gravity is non-existent like the moon. To carry out the following test I will get the pendulum, attach the spring to the pendulum and then from the string attach a mass. I will then lift the weight to a certain height and before I drop the weight, I will record the height with the metre stick.

For example, if my calculated period was 1.5 seconds and the length of string that I used was 0.15 metres it will give me the following:

(rearrange the formula for gravity (G))

$$G = \frac{4\pi^2 L}{T^2}$$

This calculation will now help me attain the acceleration for this test.

NOTE: Time(T)= 1.5 seconds and Length(L)= 0.15 metres

$$G = \frac{4\pi^2(0.15m)}{(1.5s)^2}$$

Giving me

$$G = \frac{5.92m}{2.25s^2}$$

Finally giving the answer of 2.6m/s². The actual gravity on the moon is 1.6 M/S². So, from the calculations carried out it shows that the answer attained is 1 off the actual gravity on the moon. Therefore, multiple test should be carried out to attain more accurate figures. For example, if the length and mass was less it may have been closer to the actual figure for the gravity on the moon. ✓

5. Consider your T² against the Length in the graph, what are the slope values? Show that the slope is,

Pendulum equation is $T = \frac{4(\pi)^2 L}{g}$ Meaning that t² is proportional the length in the graph. This can then be found by using a straight-line graph. The equation for a straight line is $y = mx + c$. In the graph the slopes will be $4(\pi)^2$. In this case y will equal to y². M will equal $\frac{(2)}{g}$, x will equal length and B will equal to 0.

References-

use academic references → books, journals etc.
and stick to Harvard Referencing style.

https://www.google.com/search?q=gravity+on+the+moon&rlz=1C1GCEA_enGB824GB824&oq=gravity+on+the+moon+&ags=chrome.0.0l8.6718j1j7&sourceid=chrome&ie=UTF-8

http://www.pstcc.edu/departments/natural_behavioral_sciences/Web%20Physics/Experiment%2004web.htm

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