Lab 1 Instructions: Fundamentals of Statics

Objectives

- Decomposition and addition of forces
- Introduction to pulleys and bearings

Introduction

This Lab involves using various weights, pulleys, string and bearings to investigate the decomposition and addition of forces. This lab investigates 8 different setups, and you'll be expected to record the forces on the experimental setup and perform calculations to determine the theoretical values.

It is recommended that you read this manual and review the associated lab recording in parallel. You may need to pause the recording and re-watch sections to help with your understanding and to record values.

When writing your Lab Report, be sure to review the "*Guideline for laboratory reports*" document. In your report, when you are asked to draw a free body diagram, unless otherwise stated, you only need to draw a diagram for one of the positions tested.

Experimental Apparatus

The experimental equipment comprises of an experimental board where various pieces of equipment such as cables, pulleys, bearings, dynamometers (for force measurements) and weights. The squares on the board are 50 mm x 50 mm. Different configurations are added to the board to investigate how forces can be added and the effect of pulleys and bearings.

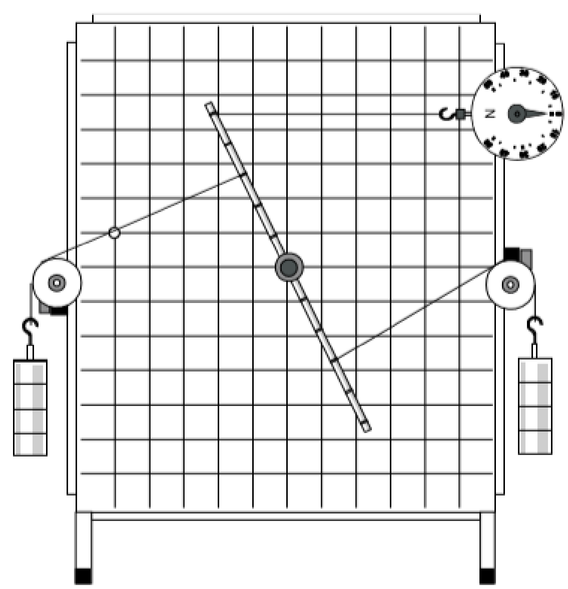

Figure 1*: The Experimental board, with weights, pulleys, rigid levers, bearing, string and dynamometer shown.*

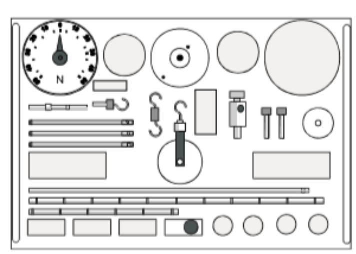

Figure 2: *Device components showing the variety of pulleys, dynamometers, levers and various attachment pieces*

Experimental Procedure and Required Analysis

Addition of vertical forces

Experimental Procedure I

1) Add a dynamometer to the top of the board with a string attached. See figure 3.
2) Attach the empty 5 weight hanger, record the dynamometer value.
3) Add 5N weights, record the dynamometer value for each additional 5 N up to 20 N.

Experimental Analysis I

1) Present a Table of the expected load and measured load
2) Draw a free body diagram of the load.

Questions: Do these forces:

- Have the same line of action? (Very briefly explain what this means)
- Have the same direction? (Very briefly explain what this means)

Introduction to Pulleys

Experimental Procedure II

1) Set up the experimental board as shown in Figure 4.
2) Record the dynamometer values.

Experimental Analysis II

1) Record the results in a table, showing the expected load and measured loads
2) Draw a free body diagram of the pulley and each dynamometer. Add the expected value of the Forces to the diagrams.

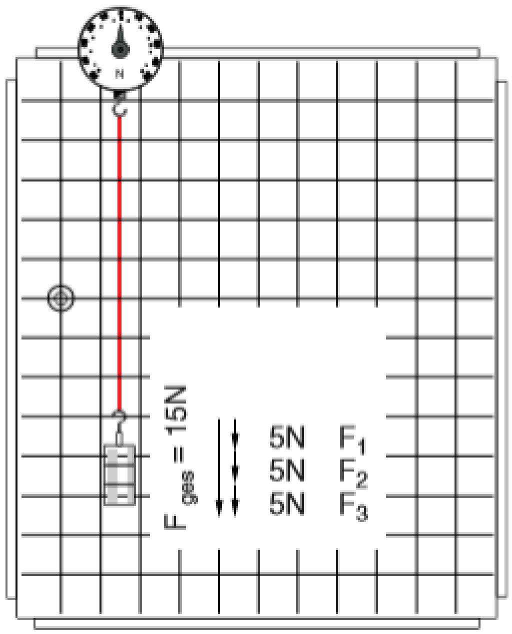

***Figure 3**: Addition of vertical forces*

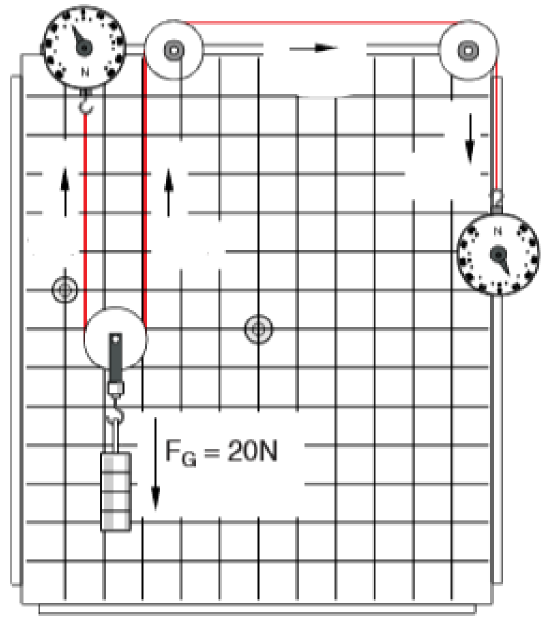

***Figure 4:** Introduction to pulleys*

A fixed pulley

Experimental Procedure III

1) Set up the experimental board as shown in Figure 5, with a 20N weight.
2) Record the dynamometer value
3) Move the dynamometer down 200 mm, record the new dynamometer value
4) Repeat step 3.

Experimental Analysis III

1) Record the results in the table, include the string angle, expected load and measured load.
2) Summarize your results in one sentence

Forces on a line

Experimental Procedure IV

1) Set up the experimental board as shown in Figure 6. Initially only add the 10 N weight and the string from the 10 N weight to the dynamometer. Record the dynamometer value.
2) Complete the setup by adding an additional line to the 10 N weight, pass it over both pulleys and add an additional 5 N weight to it. Record the dynamometer value.

Experimental Analysis IV

1) Record the results in a table, showing expected and measured values for the initial and final setup
2) Draw free body diagrams of the first and second setup.

Question: Would the system be in equilibrium if you removed the first string that goes to the dynamometer?

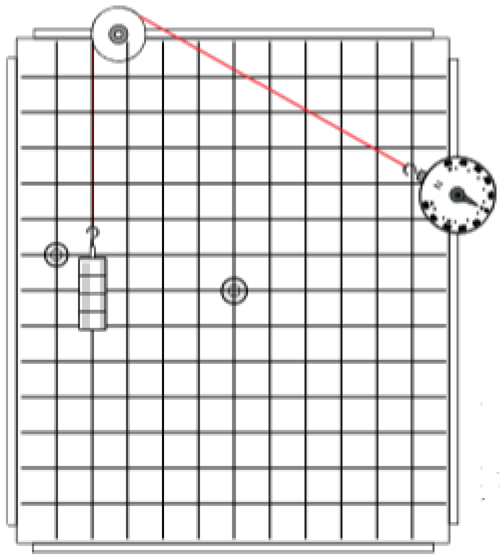

Figure 5: *A fixed pulley*

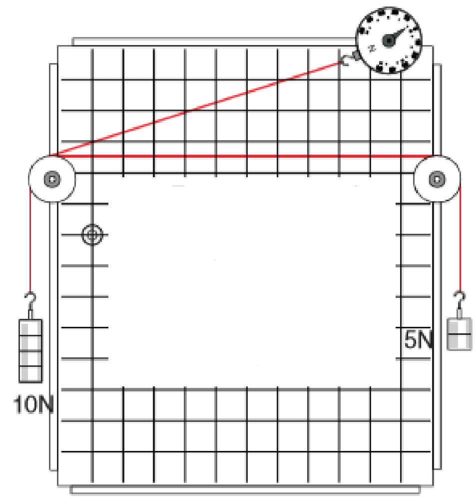

Figure 6: Forces on a line

Adding forces with different directions

Experimental Procedure V

1) Setup up the experimental board as shown in Figure 7

Experimental Analysis V

1) Record the dynamometer value
2) Draw a free body diagram of the end of the rod. Indicate the magnitude of all the forces in the string.

Resolution of Forces

Experimental Procedure VI

1) Setup the experimental board as shown in Figure 8, with 20 N.
2) Record the dynamometer values

Experimental Analysis VI

1) Tabulate your dynamometer results
2) Draw a free body diagram of the end of the rod. Show the magnitude and direction of the calculated forces

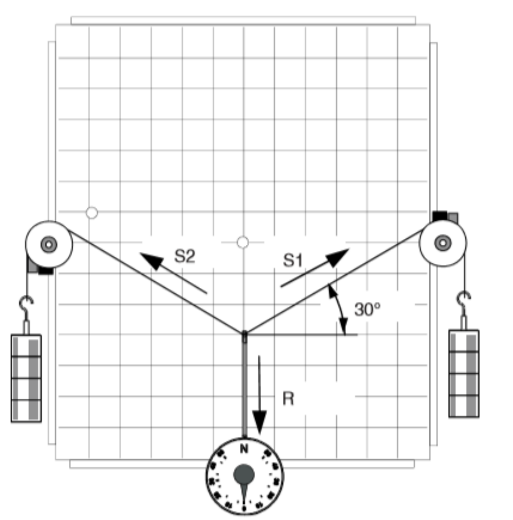

Figure 7: Adding forces with different directions

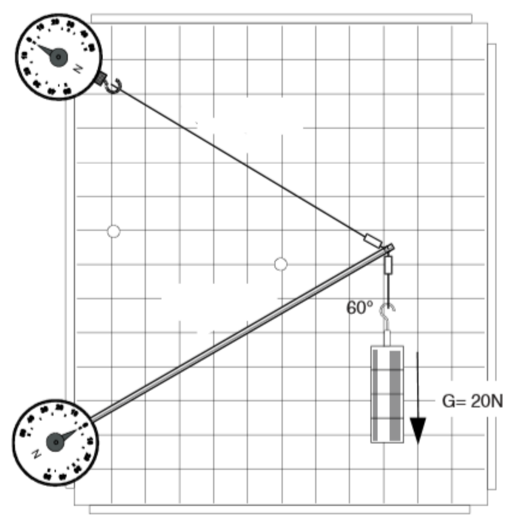

Figure 8: Resolution of forces

Simple levers

Experimental Procedure VII

1) Setup the experimental board as shown in Figure 9
2) Move the weight to multiple positions. Note the dynamometer values and the distance s_1 and s_2. Recall that one square of the experimental board is 50 mm x 50 mm.
3) Adjust the dynamometer to the setup shown in Figure 10.
4) Record the dynamometer value.

Experimental Analysis VII

1) Record the values obtained in the first part of the experiment in a table.
2) Draw a free body diagram of the lever. Add the theoretical forces to the diagram (including magnitude and direction)
3) Draw a free body diagram of the lever for the second part o the experiment. Add the theoretical forces to the diagram (including magnitude and direction).
4) Comment on any difference between the theoretical and measured force.

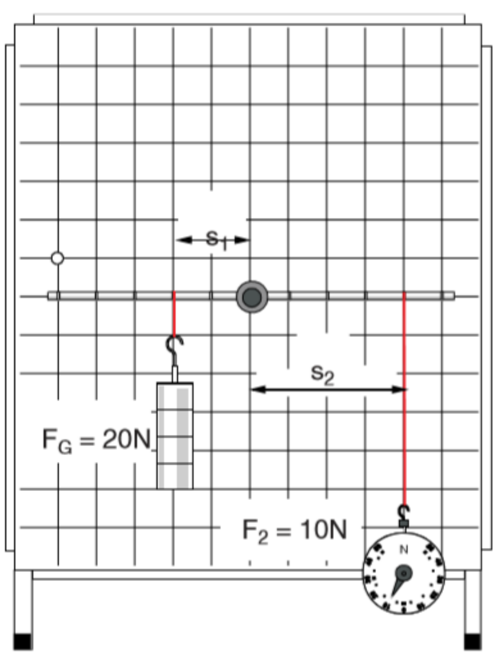

Figure 9: *Simple levers*

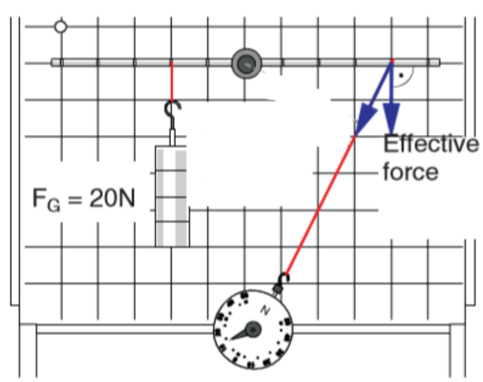

Figure 10: *Simple levels II*

Reaction Forces

Experimental Procedure VIII

1) Setup the experimental board as shown in Figure 11
2) Position the 20 N weights 15 cm from Dynamometer A. Record the forces.
3) Position an additional 15 N weight, 10 cm from Dynamometer B. Record the forces.

Experimental Analysis VIII

1) Tabulate the results, showing recorded and theoretical results.
2) Draw a free body diagram of the rod with both weights attached.
3) Calculate the theoretical forces on the dynamometers. Show your working in your Report appendix (may be handwritten).

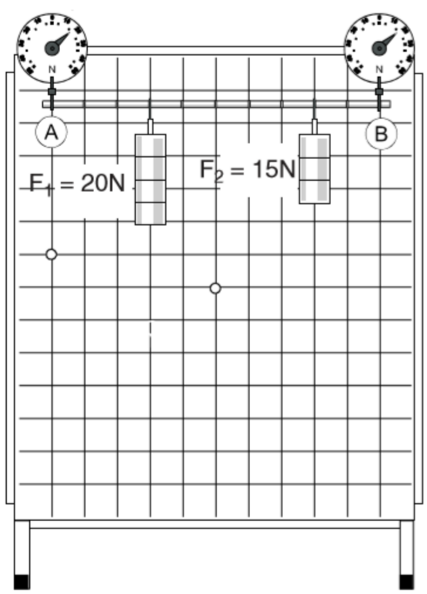

Figure 11: *Reaction forces*