LETTER BALANCE

TEACHER/TUTOR NOTES & WORKSHEETS

The project will take probably three sessions for assembly and test.

BACKGROUND

- One of the first things people want to know when we are born is our weight and throughout our life it will be used to tell how well we are.
- The history of weight measurement is very long and started in Mesopotamia more than 5000 years ago where a machine like a yoke for carrying weights was used to compare the weight of corn or grain against standard weights in the shapes of different animals cast in bronze.
- The Latin for a balance is “libra” , the zodiac sign, and is the origin of our abbreviation for pounds “ lb “.
- In the middle ages there were enormous arguments over the actual weights of commodities sold in the markets until after standardization of the pound over the whole country or kilogram now over the whole world.
- Any weighing machine either compares the weight of the object against a standard like the Mesopotamian yoke or measures the gravitational force the object exerts on the weighing machine. A spring balance is an example of the latter. Electronic balances are just strain gauged spring balances with an electronic display. We are going to make the first or comparative type.
- The turning force of each arm of the comparative balance exerts a bending force or moment on the balance beam and is in equilibrium when these are equal. The bending moment is the product of the force and distance to the pivot point. In a conventional balance the distances between the pivot to the points where the force or weight acts are equal. However we are making a comparative balance called a steelyard where the moment on one side of the pivot is adjusted to be equal that of the other.

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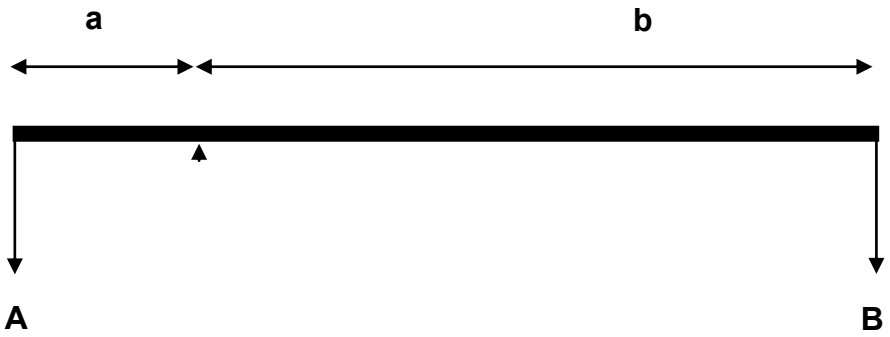
The balance gives a very good example of a mathematical equation where the moments on each arm are equal so :-



Aa = Bb

In our model a and B are kept constant and b is varied to balance A

To make the balance work, we have to obtain equilibrium when there is nothing on the scale pan and the jockey weight is in the zero position (ie. close to the pivot) and this position is then marked on the paper scale. The 100 gram position is then marked on the scale using 14 two penny pieces which weigh almost exactly 100 grams.

Measure the distance between the zero and the 100gram mark and then divide by 5 and marking the beam with 4 equidistant marks to give the 20, 40, 60, and 80 gram positions.

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KIT CONSTRUCTION:

Session 1

Blackboard

1. Two different types of weighing machine - spring balance (or strain-gauged spring) and beam balance.
2. See-saw with weights at different distances from the pivot is practical example of beam balance.
3. Concept of 'moment' that is weight x distance from the pivot.
   The beam balance is in equilibrium when the moments are the same.
4. Analogy with mathematical equations - both sides of the equation are equal when in balance.
5. Decimals - the beam chould be divided into tenths between the gram divisions.

Practical

1. Check parts
2. Fit the pivot bearings using the 6mm setscrew, washers and nut.
3. Worksheet.

Session 2

Blackboard

1. Revision of session 1
2. Pivots - these must be sharp and sit on the steel washers to allow free movement.

Practical

1. Assemble the base, its struts and the link. A bit of trial and error is necessary to get the wires through the struts and link. When the wire is in both struts and link use the plugs to stop the wires from coming out.
2. Fit beam to the base struts.
3. Fit the struts to the letter pan

Session 3

Blackboard

1. Revision of session 1.
2. Calibration - use of standards - reference to the National Physical Laboratory standard.

Practical

1. Turn the balance upside down with the letter pan facing downwards and assemble to the beam.
2. Insert the wire into the letter pan struts and link and finish by fitting the plugs to prevent the wire from coming out.
3. Fit the scale paper, mark the zero and 100gram positions..
4. Divide the spaces between the 20 gram divisions and mark with pencil.
5. Test weigh small objects.
6. Competition for most accurate balance.

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WORKSHEET

1. How many grams in a kilogram? .....

2. What other units are used for measuring weight?

   ……..

3. What is the difference between Weight and Force ?

   .....……

4. Draw a picture of a balance so that next year's class can see how it goes together.

5. What other ways can you measure weight?

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6. Invent a new kind of weighing machine and make a drawing of it.

7. Write a story about someone who had a weighing machine which did not work.