For Teachers

Am I being Cheated in the Market Place?

Teacher's Guide

This teaching material is intended to

a) draw attention to the fact that measuring instruments can be unreliable
b) introduce the principle of moments
c) appreciate that simple instruments can be accurate if used well, based on a common standard.

Lesson learning outcomes

Lesson 1

At the end of this lesson, students are expected to be able to:

- Recognise that balances may appear good, but can give false readings
- It is important to learn the principle behind the working of a balance
- Make and use a 2 pan balance.

Lesson 2

At the end of this lesson, students are expected to be able to:

- Create a 1 pan balance
- Use a 1 pan balance to determine the weight of various materials
- Derive the principle of moments

Lesson 3

At the end of this lesson, students are expected to be able to:

- Appreciate that weight and mass are two different entities
- Recognise that the principle of moments is based on massing
- Compare the readings using the 1 pan balance and a spring balance
- Explain why a spring balance determines weight (not mass)
- Appreciate that weight is mass x gravity

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Lesson 4

At the end of this lesson, students are expected to be able to:

- Explain that mass is measured in grams
- Explain that weight is measured in Newtons (or grams wt.)
- To justify, with sound arguments, whether the accuracy of balances is a problem for society.

Suggested Teaching Strategy

1. This activity material is designed to be largely self learning for students and should need only occasional guidance from the teacher. The initial motivation of students will play a crucial role in ensuring the success of this activity.
2. The experiments are intended to lead to the principle of moments and hence an understanding of the way different balances work. But this information is of little value if we cannot put it to good use in being able to discuss the accuracy or misuse of balances in the market place or elsewhere.
3. The teacher may begin by demonstrating a false balance in which one arm is shorter then the other but pans are fixed at the ends of each arm. Use the balance to pose the following puzzle:
   - It seems the balance is unbalanced. How do we correct it?
     Expected Answer: By a compensatory weight.
     The teacher proceeds to correct the balance in this way.
   - Now if we put a 100 gm weight in each of the pans should the scales balance?
     Expected Answer: Yes, it should.
     The teacher demonstrates that in practice this does not happen.

   The observation is intended to be puzzling enough to motivate the children to do the following activities and experiments.
4. Students are guided to make their own balances, in groups, using locally available materials. It is recommended that the balance be of the hand-held type with the string tied to the centre of a piece of wood (length 50-100 cm) so that they do not rely on a flat surface to work. They can be hand-held by being suspended by a piece of string. The balance is balanced when the arm is horizontal (as inspected by eye). The students undertake the experiments and competition is to find out which group is the most accurate in their weighing.
5. To ensure understanding of the experiments with the one-pan balance (moving weight balance) the students are asked to formulate their own conclusions in terms of moments. The teacher can introduce some additional imaginary numerical problems for student to tackle if the teacher is

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unsure that students understand the concept (these can also be verified by experiment if necessary).

6. Having established the principle of moments ($m_1d_1 = m_2d_2$ or $w_1d_1 = w_2d_2$), the students can now be introduced to another type of balance – the spring balance.
7. It is recommended to use an actual sprig balance (rather than students making their own because home made spring balances will need to be calibrated).
8. If the spring balance records in Newtons, then the values obtained for the weight of different objects or weights added will differ by a constant (the value for the acceleration due to gravity which is approximate 10 m s^{-2}). Students can try to establish this relationship for themselves and also understand the meaning of the difference. This will lead to distinguishing between mass and weight and to an appreciation that the spring balance measures the force whereas the other balances measure mass.
6. Students discuss in groups how their findings relate to the balances in use in the market place or elsewhere and hence to their accuracy. They will realise that the accuracy depends among other things on the accuracy of the weights. This leads to the question of whether there is a standard weight and if so, where is it. Students are given the project to find out (they should determine that the standard kilo is kept in France since Napoleonic times).

Achieving the learning Outcomes

LEARNING OUTCOMES	This is achieved by
1. To put forward a point of view, with sound arguments, whether the accuracy of balances is a problem for society.	*discussing within the groups and recording their decision with justification.*
2. To construct a set of weights and different balances using locally available materials and tools.	*carrying out the activities as put forward.*
3. Co-operate as a member of a group	*participating actively with members of the group in undertaking the experiments and in discussing outcomes.*
4. Communicate in oral and written forms.	*participating in the experimental group work and in recording findings and conclusions.*
5. To derive empirically the principle of moments.	*interpreting the results of experiments*
6. To apply the principle of moments	*carrying out the experiments on the balances.*
7. To explain why a 1-pan balance determines mass whereas a spring balance determines weight	*undertaking a comparison of the 2 balances and the values obtained*

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For Students

Am I being Cheated in the Market Place ?

Student Activities

Scenario

The one or two-pan balance (scales) continues to be a crucial instrument in buying vegetables and other foodstuffs in the market which involve weighing. The suspicion that we are being cheated by people using faulty balances, or false weights often troubles us. But how do we find out whether a pair of scales is true or false? Does it suffice to check that the arms balance with empty pans, and if they don't, then does only a compensatory weight need to be added to obtain correct weighing? Even after this initial balancing, how many people realise that the scales may still be faulty?

To understand this we need to investigate the principles behind different types of balances and determine factors which can affect the weighing.

Your Tasks

1. Describe the different types of balances in use in the marketplace and the reason for the use of different types.
2. Construct your own, hand-held, 2-pan balance using simple materials. Hold the balance using a short length of string which is tied to the middle of a length of wood 50-100cm in length. Attach pans at each end using string and make sure the length of wood is horizontal when the balance is held by the string. If it is not, then move the place where the string is tied to the wood until you find the balance point and the length of wood is horizontal Weights can be made using marbles, stones, plastic, sand, etc. in polythene bags or small bottles or whatever. You are encouraged to explore and suggest better materials. Learn to operate the balance quickly and effectively. Record the weights of the objects you use.
3. Now construct a 1-pan balance, where weights are fixed in place of the other pan at different distances from the balance point (the fulcrum) where the hand-held string is attached). Again establish the balance point by moving the place where the string is tied to the length of wood.
4. Use this balance to carry out a series of experiments to see what happens if weights are placed in the pan (on the lefthand side) and then different weights are attached at different distances from the fulcrum (on the righthand side). Complete the following table:

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Left Hand Side of Fulcrum			Right Hand Side of Fulcrum		
Weight attached (g wt)	Distance of pan from the fulcrum (cm)	Weight x Distance (g wt x cm)	Weight needed to balance(g wt)	Distance from fulcrum (cm)	Weight x Distance (g wt x cm)

5. The weight x distance is called the moment of a balance Now express your conclusions from the table in terms of moments of the left hand side versus the moments of the right hand side.
6. Use a spring balance and compare the value of a series of weights with the corresponding reading on the spring balance. Record your results and draw any conclusion between the reading on the spring balance (written in Newtons) and the value of the weight.
6. Comparing the balances you have constructed, which type of balance do you consider easier to use and/or which is more accurate. Which type is more appropriate for use in the market ?
7. To check the weights used in the market it is necessary to use a standard. Find out about standard weights. Weight is the absolute standard kept?
8. In groups discuss the potential for cheating using the different types of balances and decide whether you feel there is too great a potential for people to be cheated when shopping in marketplaces.

Questions to answer

1. What is the relationship between Newtons and the weights used on other balances ?
2. Are the weights used on 2-pan or 1-pan balances actually recording weight or mass ? What is the difference ?
3. Comment on the readings obtained when weighing an object on the moon using a 1-pan balance and a spring balance.

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