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

Developer: Kamal Mahendroo Edited by: Jack Holbrook, Amitabha Mukherjee and Vijaya S. Varma
Institution: International Council of Associations for Science Education (ICASE)
Country: India

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

Developer: Kamal Mahendroo Edited by: Jack Holbrook, Amitabha Mukherjee and Vijaya S. Varma
Institution: International Council of Associations for Science Education (ICASE)
Country: India

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*

Developer: Kamal Mahendroo Edited by: Jack Holbrook, Amitabha Mukherjee and Vijaya S. Varma
Institution: International Council of Associations for Science Education (ICASE)
Country: India

Developer: Kamal Mahendroo Edited by: Jack Holbrook, Amitabha Mukherjee and Vijaya S. Varma
Institution: International Council of Associations for Science Education (ICASE)
Country: India