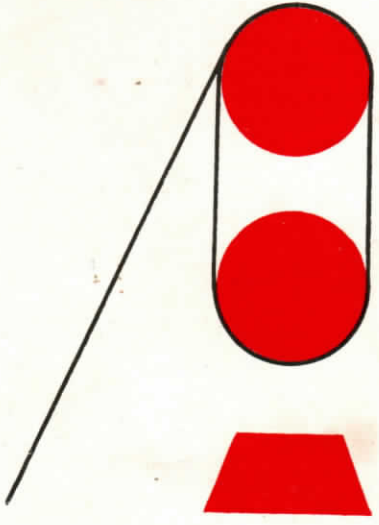
Pulleys, Gears and Levers Study Kit

Notes and Suggestions for Teachers



Educational Productions Ltd.

Produced in collaboration with Meccano Ltd.

Introduction

This kit deals with friction, pulleys, gears and levers. The experiments, however, have not been planned to give children a systematic scientific knowledge. The cards are designed to help children acquire a way of working and to arouse their curiosity. Less able pupils will gain much from working with the cards; and the more able ones may be stimulated to study the topics at a deeper level.

At all stages, children should be guided to look at their environment to see how the topics on the cards are related to it.

Approximate metric equivalents are given in brackets on the cards. However, since work on the cards is concerned with relationships rather than precise calculations it is not necessary to follow these equivalents. It is in any case expected that children will wish to experiment with weights and measurements beyond those specified on the cards.

Discovery Card 1. Friction Slope

Friction plays an important part in our lives. This card could lead to:

a. Shooting stars and the heat shield on a space capsule.
b. Use of lubricants.
c. Brake linings; stopping distances as shown in the Highway Code.
d. Sledging and Ski-ing.
e. The use of a Clutch.

It is interesting to note that the Olympic Games Committee in 1968 banned the use of a liquid which, when released along the hull of a boat, decreases friction and increases speed.

In the experiments suggested on the card, if a suitable surface is used the effects of oil and other lubricants can be explored.

Notes

A. When the object moves up the slope with uniform velocity, the force of friction is exactly balanced by the force acting parallel to the slope.
B. Where possible only a single piece of sand paper should be used for each experiment. Sand paper should be checked to see if it needs replacing.
C. When different materials are used on the slope, these must be fastened firmly and smoothly.
D. Possible alternatives to card would be hardboard or formica.

Discovery Card 2. Bogie Slope

The tape measure required should be the kind used for athletics field events. A suitable alternative would be the normal tape measure with a long piece of string. Pupils could decide if the string could be fastened to the bogie.

The first runs should be done without oil on the axles. As the weight increases, friction increases until the addition of more weight has no effect on the distance run. If oil is then applied to the axles a remarkable difference in the distance run will be obtained.

Teacher's Own Notes

Discovery Card 3. Bogie Slope (2)

The angle is best measured by means of a large cardboard protractor which will have to be specially made.
As an angle increases, the change in direction at the bottom of the slope becomes too great for the bogie to negotiate and it will bounce, losing energy.

Teacher's Own Notes

Discovery Card 4. Pulleys

This card is to show that with the aid of pulleys a heavy load can be lifted by a lighter effort than usual. Because of friction, it is unlikely that an accurate relationship of load to effort will be obtained. No mention has been made on the card of the fact that each string bears an equal amount of the weight to be lifted so that on a 3-string system the effort will be $\frac{1}{3}$ of the load. From this children can be led to deduce that the velocity ratio of this system is equal to the number of loads between the two pulleys.

Discovery Cards 5, 6 and 7. Gear Systems

An easy method of checking rotation is to mark a tooth on each cog with a piece of white paper, Sellotape or chalk. If the marks on each cog start together it is easy to see what happens when one cog is turned.
The relationship of the cogs in the kit is 2, 3 and 4. This means that if the large cog is turned once, it will turn the small cog twice and the medium cog $1\frac{1}{3}$ turns. In Card 6 the framework holding the cog wheels has not been made rigid so that it can be seen that if the framework is moved off square, it has no effect on the way the cogs work.
These cards can lead on to the study of gears used on bicycles; the gear box of a car; the working of a mechanical clock, etc.

Discovery Card 8. Extension of an elastic band

It will be seen from a graph of the results of loading the band that a point is reached when a small amount of additional weight produces a great increase in stretch. At this point the band is at breaking point.

The breaking of the band can lead on to finding out the breaking strain of various fibres and materials such as cotton and rayon. This could be further linked to hobbies such as fishing.

The final task on this card is to make an elastic band balance. This is used for Cards 9 and 10.

The dangers of calibrating the balance up to the breaking strain should be drawn from the children. When the children have calibrated their balance it would be useful to make a copy of the calibration which can then easily act as an adjustable scale.

Teacher's Own Notes

Discovery Cards 9, 10 and 11. Levers

The same rubber band should be used for both discovery cards 9 and 10. Setting up the apparatus on Cards 9 and 10 without the weight pan eliminates adjusting the scale each time the weight pan is moved. Some children may note that the weight of the pan has to be taken into account.

Card 11 could lead to a study of the history of weighing, particularly the steelyard. Children could make their own balances for weighing light objects.

If L.2. is four times as long as L.1., then an $\frac{1}{8}$oz. object will be balanced by $\frac{1}{2}$oz.

$$W \times L.2. = W \times L.1.$$

With the weight in the object pan and the weight of the pan itself. Similarly with the weight in the weight pan and the weight of the pan itself.

Teacher's Own Notes