**Measuring force**

|  |  |
| --- | --- |
| **Equipment** | |
| * Force-meter | * Spring |
| * Newton balance | * 300 g mass |

Measure each force.

Draw a force-arrow on each picture to show the force (1 cm = 1 N).

|  |  |
| --- | --- |
| 1. Force to lift my pencil case | 1. Force to pull my pencil case along the desk |
| 1. Force to make a spring 10 cm longer | 1. Force of a 300 g mass on the ground |
| 1. Force to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | 1. Force to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

*Physics > Big idea PFM: Forces and motion > Topic PFM1: Forces > Key concept PFM1.2: Describing forces*

|  |
| --- |
| **Response activity** |
| **Measuring force** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Forces arise when two objects interact; the force on one object is always equal in size, and opposite in direction to the force on the other object; force arrows indicate the size, direction and location of each force. |
| Observable learning outcome: | * Represent the size and direction of a force with an appropriate force arrow. * Correctly position a force arrow to show how a particular force acts. |
| Activity type: | Response, practical - to practise using an idea |
| Key words: | Force, Newton, force meter, Newton meter, force-arrow |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: How big is the force?
* Diagnostic question: Where is the force?

**What does the research say?**

Terry *et al* (1985) found that many 11-14 year old students were quite ad hoc in their use of force arrows: they did not effectively start them from the point of action, use them to indicate the direction of force or change their length to indicate the size of the force. This may contribute, as Driver *et al* (1994) noted, to the difficulty that some students have in thinking of forces in terms of their magnitude and direction.

Drawing force-arrows to scale or interpreting relative sizes of forces from their lengths requires mathematical skills that some students will find difficult and which are not necessarily taught in mathematics lessons until age 12-13 (Boohan, 2016).

Measuring forces using force-meters and newton balances gives students experience of what different sizes of force feel like, and the opportunity to practise drawing accurate force arrows onto diagrams. Experiencing the forces first hand can help students understand how the size and position of a force-arrow represents a real force.

**Ways to use this activity**

This practical activity gives students the opportunity to practise measuring forces and applying their understanding of force arrows, and to clarify their thinking through discussion. To support this, students should complete the practical in pairs or small groups.

Listening to individual groups as they work often highlights any difficulties they might have. These can often be overcome, through a whole class clarification or redirection part way through the activity.

Two boxes on the student sheet have been left blank for the students to put in their own measurements.

*Differentiation*

Using the recording sheets can help some students organise their observations so they can more easily focus on the science. If some students are working with a teaching assistant, then a list of prompt questions for the TA could help to make this activity more purposeful. Some students may benefit from being challenged to plan and organise their own record keeping.

You may choose to use just 0-10 N force meters, or to give your students a choice of force-meter so they can measure a wider range of forces. This may require them to use a different scale for their force-arrows (other than 1cm = 1N).

**Equipment**

For each student/pair/group:

* Force-meter (0-10N)
* Spring (Hooke’s law spring)
* 300g hanging masses
* Access to string

For the class:

* Balance(s) that read in Newton
* Newton meters for measuring different ranges of force

**Technician notes**

Balances need to be set to read in Newton. One 300g hanging mass per balance is needed.

String may be necessary to make loops to attach the force meter to objects.

**Health and safety**

Hooke’s law springs can deform and flick into eyes if they are significantly over stretched. If this is a possibility with your class you should consider using safety glasses.

Students may select to measure forces that involve heavy objects that can fall, or opening of doors that can trap fingers.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

Typical forces are: lifting pencil case 5 N; dragging pencil case 1 N, stretching spring 2.5 N, 300g on balance 2.94 N (approx. 3 N)

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: UYSEG

**References**

Boohan, R. (2016) *The language of mathematics in science*, Association for Science Education, Hatfield, England.

Driver, R., Squires, A., Rushworth, P. and Wood-Robinson, V. (1994) Making sense of secondary science, research into children’s ideas, Routledge, London, England.

Terry, C., Jones, G. and Hurford, W. (1985) ‘Children’s conceptual understanding for force and equilibrium’, Physics Education 20(4): 162-5.