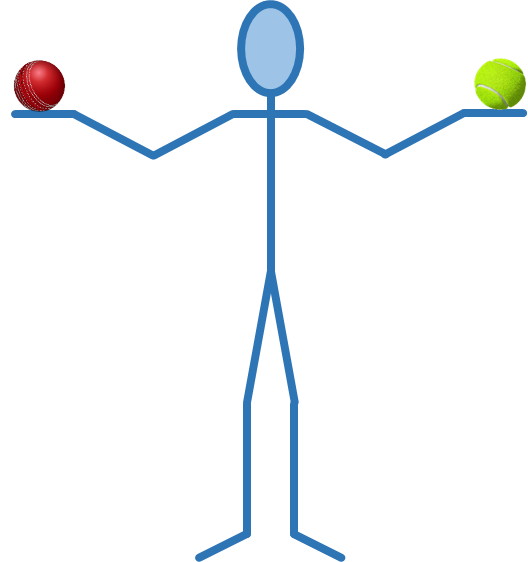
**Dropping forces**

Katherine drops two balls at the same time.



Red

Green

The red ball has twice the mass of the green one.

Describe what happens when the balls are dropped.

Pick ***one*** statement in each row to explain how.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | The force of gravity on the red ball is twice as big as it is on the green ball. | | The force of gravity is the same on both balls. | |
| 2 | The resultant force on the red ball is twice as big as it is on the green ball. | | The resultant force is the same on both balls. | |
| 3 | It is two times harder to accelerate the red ball. | It is two times harder to accelerate the green ball. | | It is equally hard to accelerate either ball. |
| 4 | The red ball accelerates faster. | The green ball accelerates faster. | | Both balls accelerate at the same rate. |
| 5 | The red ball hits the ground first. | The green ball hits the ground first. | | Both hit the ground at the same time. |

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*Physics > Big idea PFM: Forces and motion > Topic PFM6: Forces make things change > Key concept PFM6.2: Force, mass and acceleration*

|  |
| --- |
| **Response activity** |
| **Dropping forces** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The acceleration of an object is proportional to the resultant force acting on it and inversely proportional to its mass. An object accelerates in the direction of the resultant force acting on it. |
| Observable learning outcome: | Describe the effect of a resultant force on objects of different mass.  Describe the relationship between the resultant force on an object and its acceleration. |
| Activity type: | Explanation story |
| Key words: | Resultant force, acceleration, mass |

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

* Diagnostic question: Loaded lorry
* Drag race II

**What does the research say?**

Students struggle to understand forces and motion, and use a system of ‘gut dynamics’ based on everyday experience in their reasoning. Understanding motion in Newtonian terms is a major task for students, and students of all ages, including physics undergraduates, fail to understand Newtonian concepts of motion (Driver et al., 1994).

Students have intuitive theories about forces and motion that resemble mediaeval ‘impetus’ theory (McCloskey, 1983). They may not see force as an interaction between two objects but rather as something that resides in a single object. They may use the terms ‘energy’ and ‘force’ in an undifferentiated way (Twigger et al., 1994) and may use ideas about force in a way that resembles what a physicist means by momentum (Watts and Zylbersztajn, 1981). They may believe that a force is required to maintain motion at a constant velocity, and that a greater force is required to maintain motion at a greater velocity, so that force is seen as being proportional to velocity rather than to acceleration as in the Newtonian view.

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It is best done as a pencil and paper exercise.

Students should read the statements and follow the instructions on the worksheet. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in each group. For example, you may choose to select a student with strong prior knowledge as the scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | The force of gravity on the red ball is twice as big as it is on the green ball. | | The force of gravity is the same on both balls. | |
| 2 | The resultant force on the red ball is twice as big as it is on the green ball. | | The resultant force is the same on both balls. | |
| 3 | It is two times harder to accelerate the red ball. | It is two times harder to accelerate the green ball. | | It is equally hard to accelerate either ball. |
| 4 | The red ball accelerates faster. | The green ball accelerates faster. | | Both balls accelerate at the same rate. |
| 5 | The red ball hits the ground first. | The green ball hits the ground first. | | Both hit the ground at the same time. |

**Acknowledgments**

Developed by Simon Carson (UYSEG and Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG)

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