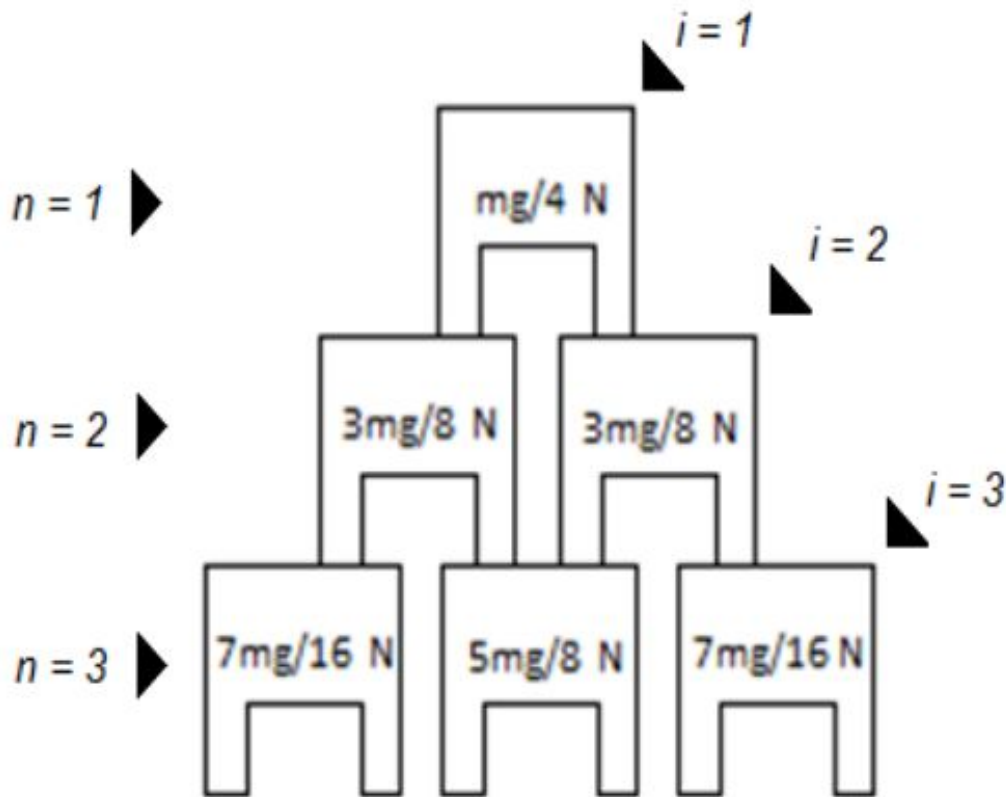


The model for a perfect human pyramid

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A diagram of the arrangement of a human pyramid. Each ‘leg’ shown represents an arm and a leg. The force on each limb is displayed at each position in the pyramid, assuming a uniform mass of individuals. Lines of constant n and i are displayed. Lines of constant i are diagonal and each n value corresponds to a tier in the pyramid. Credit: *Journal of Physics Special Topics*

Physics students from the University of Leicester have calculated the

formula for a perfect human pyramid – and have found that the best suited candidates are groups of men, women and children rather than formations of the same age and sex.

The human pyramid is a popular party game as well as a formation used in cheerleading and gymnastics. It involves participants kneeling together to form a row, forming a base for another tier of participants who kneel or stand on their shoulders, backs or thighs.

In a student paper presented in the *Journal of Physics Special Topics*, a peer-reviewed student journal run by the University of Leicester's Department of Physics and Astronomy, Hayley Allison, Jordan Penney, Roger Leyser and Giles Lipscombe investigated the science behind the human pyramid, using basic calculations to try to work out the best formula for constructing the tallest pyramid possible.

Student Hayley Allison said: "As [students](#), the *Physics Special Topics* module allows for us to come up with thought experiments that challenge us to apply the knowledge we learn in the classroom to fun theoretical situations. We were interested in the possible height a human pyramid could reach and found that a pyramid of men, women and children is likely to stand taller than one made of any group of similarly aged or same-sex individuals."

The students observed that the people in the centre of the bottom row have to support the most weight, meaning it is likely that this is the location where the pyramid will eventually falter and come tumbling down after being subjected to too much weight from above.

With this in mind, the students calculated that the largest pyramid must consist of men, women and children in order to distribute the weight efficiently – and a pyramid of this kind would in theory be able to reach a height of six tiers.

In comparison, a male-only pyramid would only be able to reach a height of four tiers if the men involved were of the weight of an average male, 83.6 kg. This is because similar-weighted individuals would put too much strain on the people at the bottom of the pyramid – and an average male would not be able to hold the weight of more than four-tiers worth of people before the pyramid would come crashing down.

The calculations are based on the assumption that all those involved have perfect balance and are of typical strength for an average male.

The calculations also assume that all those involved are of average weight, which is 83.6 kg for adult males, 70.2 kg for adult females and 32.2 kg for children.

The students also suggest that if the individuals located in the centre of the bottom row are stronger than average, then a male-only pyramid could in theory reach five tiers of people.

Human pyramids such as those made by the Castellers de Vilafranca, a group from Catalonia who specialise in building human towers, often exceed seven tiers in height through a slightly different variation of the human pyramid.

The world record for a human pyramid was a nine-level pyramid of 43.79 feet, about the height of a five storey building, created by the Jai Jawan Govinda Mandal in August 2012.

However, in this formation those involved stand on the shoulders of one another to try and build the tallest tower, which allows them to build much taller towers than is possible in the typical human pyramid formation. This is because legs are capable of supporting a greater weight than arms - meaning that in the traditional human pyramid formation arm strength is the limiting factor.

The students presented their findings in a paper entitled 'Pyramid of Geezers' for the *Journal of Physics Special Topics*, a peer-reviewed student journal run by the University's Department of Physics and Astronomy. The student-run journal is designed to give students practical experience of writing, editing, publishing and reviewing scientific papers.

Course tutor, Dr Mervyn Roy, a lecturer in the University of Leicester's Department of Physics and Astronomy, said: "The aim of the module is for the students to learn about peer review and scientific publishing. The students are encouraged to be imaginative with their topics, and find ways to apply basic physics to the weird, the wonderful and the everyday."

More information: The student paper 'Pyramid of Geezers' is available here: physics.le.ac.uk/journals/index.php/jps/article/view/754/545

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