**ACTIVITY: Measuring foot pressure**

**Activity idea**

In this activity, students collect measurements that will enable them to calculate the pressure exerted by each foot when standing normally. SI units, derived units and prefixes will be used throughout.

By the end of this activity, students should be able to:

* use graph paper to measure the area presented by each foot when standing normally
* convert a kilogram body mass measure into body weight in newtons (N)
* convert area units in cm2 to m2
* calculate pressure by dividing body weight by foot area
* apply the knowledge gained to footwear such as stiletto heels and snowshoes.

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**Introduction/background**

Every measurement consists of two parts: a number and a unit. In this activity, students will measure the area presented by each foot when standing normally as well as their body weight. These measures will then be used to calculate the pressure exerted by each foot when standing normally.

Adherence to the SI system of units, derived units and prefixes will be maintained, with the final answer being reported in the unit kilopascal.

The scientific definition of pressure is force per unit area: *P* = *F*/*A*.

To measure foot pressure when standing normally, two measures need to be made:

* Body weight in newtons – this becomes the *F* in the equation above.
* Foot area in square metres – this becomes the *A* in the equation above.

Body weight can be calculated from body mass in the following way:

* Body weight (N) = body mass (kg) x 9.8

Effective foot area can be measured by carefully placing a wet foot on a piece of graph paper. The wet imprint can be outlined with a pencil and the cm2 squares enclosed counted.

To convert the measured area in cm2 into m2, divide by 10,000.

Foot pressure is then obtained by dividing body weight (N) by foot area (m2). The unit N/m2 is known as the pascal (Pa).

**What you need**

* Copies of the student worksheet: [Stilettos and snow shoes](#stilleto)
* Bathroom scales
* Graph paper
* Pencil
* Shallow tray of water (big enough to hold an adolescent foot)
* Towel or bathmat
* Calculator
* Shoe with a stiletto heel
* Tennis racquet (this will act as the snow shoe)

**What to do**

1. Hand out copies of the student worksheet: [Stilettos and snow shoes](#stilleto) and assist students to complete it as necessary. Compare and discuss the results.

**Discussion questions**

* By what factor is normal foot pressure increased by wearing stiletto heels? (Assume that total body weight is acting over the area of one stiletto heel.)
* On the basis of your calculated stiletto heel pressure, should such footwear be permitted in buildings such as a school gym with wooden floors?
* By what factor is normal foot pressure reduced by wearing snow shoes?
* Why is it preferable to wear snow shoes or snow skis rather than boots when tramping over wilderness areas covered in deep snow?
* Given that standard air pressure is 100 kPa, how does your foot pressure compare with this?

**Stilettos and snow shoes**

1. Use bathroom scales to determine your fully clothed body mass and calculate your weight in newtons.

Body mass = \_\_\_\_\_\_ kg

Body weight = body mass x 9.8

 = \_\_\_\_\_\_ kg x 9.8

 = \_\_\_\_\_\_ N

1. Put an piece of A4 graph paper beside the water tray. Put one bare foot in the water tray to wet the foot surface then put the foot firmly onto the graph paper to make an imprint.
2. Using a pencil, carefully outline the area of the foot imprinted on the graph paper. Count the number of full (1 cm2)squares in the outlined area, and estimate the number of whole squares that the part squares add up to.

Foot area = whole squares + estimated no. of whole squares from part squares

 = \_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 = \_\_\_\_\_\_\_\_\_\_\_ cm2 (To convert to m2, divide by 10,000.)

 = \_\_\_\_\_\_\_\_\_\_\_ m2

1. Use the graph paper to estimate the area of a stiletto heel and a ‘snow shoe’ (tennis racquet) – you will need to tape several sheets of paper together for the snow shoe.

Stiletto heel area = \_\_\_\_\_\_\_\_\_\_\_ cm2 (To convert to m2, divide by 10,000.)

 = \_\_\_\_\_\_\_\_\_\_\_ m2

Snow shoe area = \_\_\_\_\_\_\_\_\_\_\_ cm2 (To convert to m2, divide by 10,000.)

 = \_\_\_\_\_\_\_\_\_\_\_ m2

1. Use the figures above to calculate foot pressure for one foot for different footwear:

Effective foot pressure = body weight/foot area

 = \_\_\_\_\_\_\_ N/ \_\_\_\_\_\_\_m2

 = \_\_\_\_\_\_\_ N/m2

 = \_\_\_\_\_\_\_ Pa

 = \_\_\_\_\_\_\_ kPa

Stiletto heel pressure = body weight/stiletto heel area

 = \_\_\_\_\_\_\_ N/ \_\_\_\_\_\_\_m2

 = \_\_\_\_\_\_\_ N/m2

 = \_\_\_\_\_\_\_ Pa

 = \_\_\_\_\_\_\_ kPa

Snow shoe pressure = body weight/snow shoe area

 = \_\_\_\_\_\_\_ N/ \_\_\_\_\_\_\_m2

 = \_\_\_\_\_\_\_ N/m2

 = \_\_\_\_\_\_\_ Pa

 = \_\_\_\_\_\_\_ kPa

1. Standing on two feet, effective foot pressure = \_\_\_\_\_\_\_\_Pa