If the shoe fits: Teacher Notes

Summary

Shoes are one of the most important objects in our lives. There's a variety of different types, such as shoes for different sports, shoes for schools and work, and just about anything that we need. Typically, we never really think about what the shoes do for us, but they help with providing little or no friction to the surfaces we walk on. In this investigation, students will investigate different types of shoes on different types of surfaces to see how they'll vary, how they increase or decrease the frictional forces and find out what these differences mean.

Curriculum Outcomes: Victorian Curriculum F-10

Levels 7 and 8

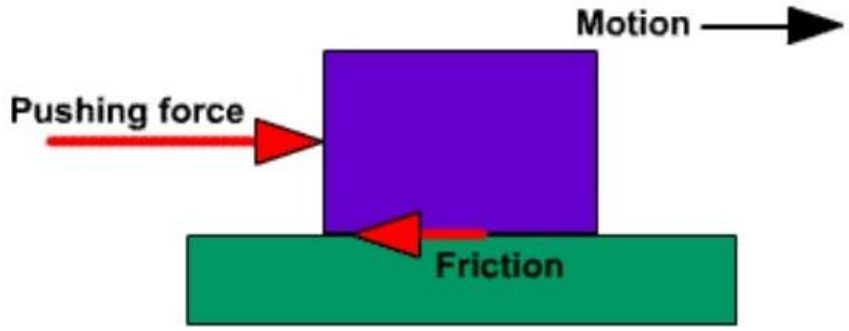
- Energy appears in different forms including movement (kinetic energy), heat, light, chemical energy and potential energy; devices can change energy from one form to another (VCSSU104)

Key Ideas

What is friction?

Friction is a force that opposes movement and is the reason things stay still or slow down. If friction did not exist, and if something was moving, it would never stop moving until another force acted upon it. Friction is created when two surfaces move or slide across each other. Keep in mind that air resistance is also friction; one of the surfaces just happens to be air.

Friction a force that is always in the opposite direction of motion of the object.



(Byju 2017)

The amount of friction, or the size of the force is dependent on the surface (coefficient of friction μs) and the normal force (the mass of the object × gravity). Which can be given by the equation:

$$F_f = \mu N$$

F_f = Force of friction

μ = Coefficient of friction for the two sliding surfaces

N = Normal force

(Serway 2017)

There are two types of friction coefficients, static and kinetic.

Static: when the sliding object is stationary.

Kinetic: when the sliding object is moving.

These forces can never happen at the same time and kinetic is always smaller than static for the same sliding surfaces.

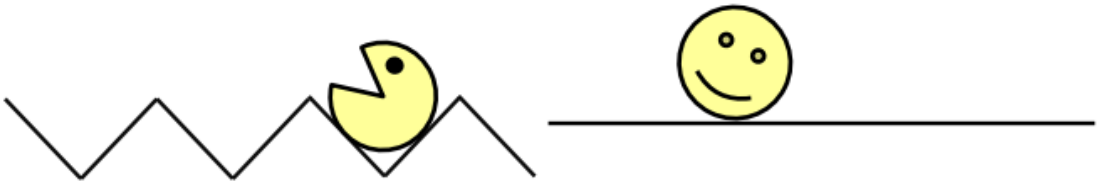
Useful information for this investigation

The sandbags add extra weight to the shoe and put a downward force onto the ground due to gravity. The ground opposes this force in equal magnitude, so no movement occurs.

Once the student pushes the shoe horizontally, when a force greater than the friction force is acting upon the shoe, it moves.

The different surfaces the students will use have different levels of imperfections. These involve crevices, troughs, ridges and peaks. The students can feel these imperfections and compare them to different materials and see which one has a smoother surface. The amount of imperfections determines the amount of friction, so those with more imperfections or courser have a higher frictional force.

The image on the left would have more friction than that of the right.



(ASELL 2018)

If you were to compare these two surfaces above the one on the right would require less force to move the same object.

Additionally, the more friction the higher the energy loss, through heat and sound, which means a higher force required to move an object. This is due to the law of conservation of energy.

Pedagogy

Inquiry

This is an inquiry activity that can be adjusted by the teacher to be as guided or as open-ended as desired. The student notes begin with specific directions, but later questions allow students to conduct more independent investigations. The teacher may, however, decide to provide close guidance and direction throughout the activity.

Extra notes

What could cause outliers?

- Some surfaces are hard to get a constant pull. For example, on grass it may be very rough, so a consistent force may be hard to acquire.
- The spring balance value may jump around a lot. Having someone pull the shoe is a rather inconsistent method. Therefore students could have varying data for the same surfaces. This could account for that variation.

Tips:

- Students should find as flat as surface as possible.
- If going outside, ensure there is no rain as rain would tend to lubricate the surfaces, and reduce friction effects.
- If students are worried about pulling strength not being constant, the teacher could inform them that we are trying to observe relative variations between shoes on average. Perfect pulling technique is not an issue.

Acknowledgement to Authors

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Louise Lopes and Karen Daniels were previous authors of the ASELL investigation “If the shoe fits”.

References

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