Flipping Measure Spoons

Key Stage: 3

Strand: Measures, Shape and Space

Learning Unit: Mensuration

Objective: Understand the applications of calculating volumes and lengths in industrial designs, with the consideration of appropriately chosen materials.

Prerequisite Knowledge:

(i) Basic concepts on calculating circumferences and the volume of a sphere

(ii) Understand and use the relationships between sides and volumes of similar figures

(iii) Imagine the 3-D objects from given 2-D representations

Relationship with other KLA(s) in STEM Education:

"Particle model for the three states of matter", "Corrosive nature of acids", and "Materials of the modern world" in Science (S1 – 3) Curriculum Framework 2016 (Provisional Final Draft) of Science Education KLA.

Resources Required:

1. Internet resources on the information of flipping measuring spoons and the physical and chemical properties of silicone.
2. Tablet computers with Internet connection.

Scenario:

A measuring spoon is an important utensil in cooking for a fairly accurate measurement of the amounts of ingredients during the preparation. Traditionally, one measuring spoon is used to measure one fixed amount (conventionally 1 cup, 1/2 cup, 1 tablespoon, 1/2 tablespoon, 1 teaspoon, 1/2 teaspoon, etc.). However, with the aid of extensible and flexible materials such as silicone rubber, a flippable measuring spoon can be designed so that when flipping, two fixed amount can be measured using the same measuring spoon (See the reference link below: *https://www.youtube.com/watch?v=yKTgaZnkaqc*)

This task is to discuss the industrial design of such flipping measuring spoons by applying students' mathematical knowledge in finding various measurements and scientific knowledge in explaining why a specific material is or is not suitable for making a piece of kitchen utensil.

Description of the Activity:

Preparatory Activity (Optional)

Students familiarise themselves in finding the radius of a hemisphere from given volume. For example, if the measure of a tablespoon is 15 cm^3, and assuming the shape of a measuring spoon is a hemisphere, students are requested to find the radius of the measuring spoons that can be used to measure one tablespoon and 1/2 tablespoon.

Teachers may suggest students to use the knowledge of similar figures in finding the ratio of the radii between the two measuring spoons by considering the ratio between their volumes.

Activity 1:

Teachers may play the video clip (link provided above) of the flipping measuring spoons to introduce the ideas behind the industrial design of the flipping measuring spoons which can measure two fixed volumes.

After the video, teachers may use the cross-section model of the flipping measuring spoons in Figure 1a and 1b to further facilitate students' understanding on the design:

Figure 1a

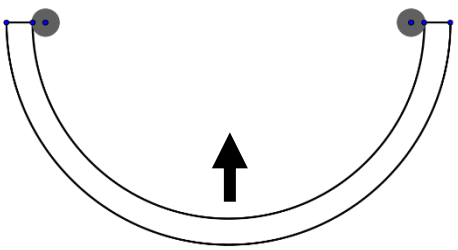
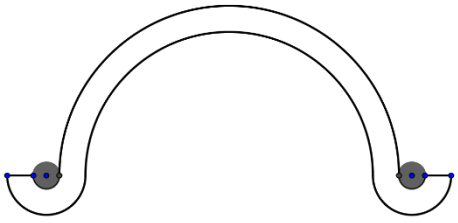


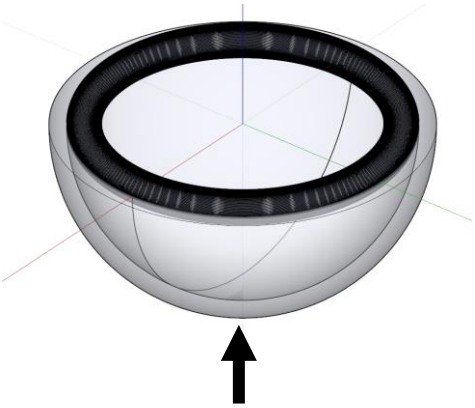
Figure 1b



The grey circles are the mount for fixing the flipping measuring spoon

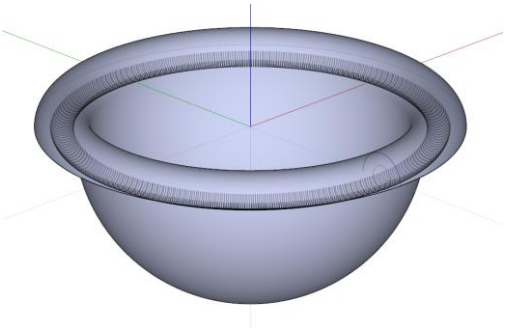
Remarks: Teachers can also use 3-D graphics software packages to illustrate the design of the measuring spoon if necessary (see Figure 2a and 2b):

Figure 2a



Push to flip and turn-over

Figure 2b



Questions for discussion:

1. If the flipping measuring spoon is designed to measure one tablespoon and 1/2 tablespoon of ingredients respectively, and assuming that in both cases the interior is a hemisphere, what should the radii of the two hemispheres be?
2. Let *t* be the thickness of the material for making the flipping measuring spoon and *r* be the radius of the circular mount, suggest one formula which links up the relationship between *t* and *r* such that the capacities of the two states of the measuring spoon are respectively one tablespoon and 1/2 tablespoon.
3. Teachers can discuss with students on the errors the assumption on hemispheres created, and how they could be reduced by varying *t* and *r*.

Activity 2:

Students are asked to search on the Internet on some physical and chemical properties of silicone, such as its melting point, durability, flexibility, conductivity, toxicity, chemical reactivity, acid resistance, and so on to critically analyse whether this material is good for making kitchen utensils. Teachers are encouraged to collaborating with Science teachers, to form a stronger linkage of the lesson to Science Education KLA. Related science topics in junior secondary includes “Particle model for the three states of matter”, “Corrosive nature of acids”, “Materials of the modern world”, etc.

Questions for discussion:

1. Why is considering the melting point of a matter important in choosing the material to make kitchen utensils? Besides the melting point, what are the other factors one should consider concerning temperature?
2. In order to make the design of the flipping measuring spoons possible, what important physical properties of silicone are featured? Are there any other matters which possess the same physical properties?

3. Compare silicone and plastic. Which materials should be preferred as the material for making kitchen utensils in considering its health impact and environmental impact?

This example mainly involves the following generic skills:

1. Critical thinking skills
   - Critically discuss the advantages and limitations of the design, and the materials used in the flipping measure spoon
   - Employ the ideas of mathematical modelling as a powerful tool to quantitatively simulate and solve the problems of practicability in designing the flipping measure spoon

2. Self-learning skills
   - Autonomously gather useful information on the materials used in the flipping measure spoon through various sources
   - Initiate own enquiry to modify and refine the designs for better purposes of the flipping measure spoon