Problem Solving in Mathematics

Shape, Space, Measures

Hole in the Bucket

Rewarding Learning

Teacher Notes

Introduction

Pupils can work on this problem individually or with others.

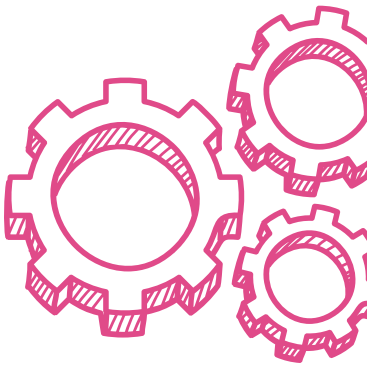
- They can discuss how to approach the problem and compare approaches.
- They will be using metric units and will need to know how to convert between different metric units.
- They can choose whether to work through the problem in millilitres or litres as shown in the Solution.
- In the Problem, it says that the paddling pool has been fixed. This is to avoid suggestions that Liza could move the paddling pool toward the outdoor tap. Pupils should also be mindful that 1 litre of water weighs 1 kilogram. Moving a paddling pool weighing hundreds of kilograms is not that easy.
- For the purpose of this problem, the rate at which water leaks from the hole is given as a **constant**. This will allow pupils to make straightforward calculations. They may however recognise that the rate would not be constant in real life!

This problem deals with a pupil's ability to calculate volume and capacity, convert metric units, and use their number skills.

What I know (think)

The pupils should know the following from the given problem:

- Liza has a fixed paddling pool.
- The paddling pool has an internal rectangular base measuring 1.2 m by 1 m and a height of 0.4 m.
- Liza does not have a garden house and needs to use a 12 litre bucket, which can be filled using an outdoor tap.
- The bucket has a hole at the bottom that leaks water at a rate of 150 ml every second.
- It takes Liza 10 seconds to carry a full bucket from the tap to the paddling pool.
- Liza will only carry **full** buckets.
- Liza wants the paddling pool to be at least three-quarters full.



What I need to know (identify)

Pupils need to identify:

- the fact that Liza cannot move the paddling pool closer to the tap as it is fixed;
- that the internal shape of the paddling pool is an open cuboid;
- how to calculate the volume of the cuboid;
- how to convert cm^3 or m^3 into ml or litres;
- how to calculate ¾ of the pool's capacity;
- how many millilitres or litres of water leaks from the bucket during the 10 seconds it takes for an initially full bucket to be taken to the paddling pool;
- that no water is lost from the bucket other than that which leaks during the 10 seconds to carry an initially full bucket from the tap to the paddling pool;
- how many litres of water Liza is able to empty into the paddling pool each time; and
- how many times Liza will need to fill the bucket in order for the pool to be at least ¾ full.

Hole in the Bucket (Continued)

What I need to do (employ)

Pupils should use the information they have been given and come up with appropriate steps to help them solve the problem. Pupils can work through the problem using millilitres and/or litres, and the Solution provides the calculations they may make as a result. They can choose their own approach, and the metric units that they feel most comfortable using. Using only litres requires less calculation, but the pupils will have to calculate using decimal numbers. If they use millilitres throughout instead, they can employ whole-number calculations.

For the capacity of the paddling pool, pupils could:

- Calculate the capacity of the pool in m^3 by multiplying the three given dimensions of the pool together.
- Multiply the three given dimensions by 100 first in order to convert m to cm (if calculating the capacity of the pool in cm^3).
- Convert cm^3 to ml or m^3 to litres using a given or known conversion.
- Multiply by 1000 to find the capacity of the pool in litres (if calculating in m^3).
- Divide by 1000 to find the pool capacity in litres (if calculating in ml).
- Calculate ¾ of the pool capacity, either by multiplying full capacity by 3 and dividing by 4, or multiplying full capacity by 0.75.

Please note, some pupils may recognise that they can initially calculate ¾ of the pool capacity in cm^3 or m^3 by finding ¾ of 0.4 m or 400 cm (the internal height of the pool) then proceed to convert to ml or litres.

To calculate how much water is in the bucket when Liza gets to the paddling pool, pupils could:

- Multiply 150 ml by 10 to find the amount of water lost due to the leak, if using millilitres.
- Multiply 12 litres by 1000 to find the capacity of the bucket in millilitres.
- Divide 150 ml by 1000, and then multiple by 10 to find the amount of water lost due to the leak, if using litres.
- Subtract the amount of water lost from the capacity of the bucket.

For the number of buckets needed, pupils could:

- Divide the ¾ pool capacity by how much water is in the bucket when Liza gets to the paddling pool.
- Round their answer up to the next whole number, as Liza wants the pool to be at least three-quarters full.

What I did (review)

Pupils will use self-assessment, peer assessment or teacher feedback to decide whether they have approached the problem as intended.

- Did they recognise that the paddling pool has a cuboid shape?
- Did they calculate the capacity of the paddling pool like they would calculate the volume of a cuboid?
- Did they know how to convert cm^3 to ml or m^3 to litres?
- Did they know how to convert millilitres to litres?
- Did they calculate what three quarters of the pool capacity was after finding the capacity of the pool? Or did they find three quarters of the height first?
- Did they calculate how much water was in the bucket due to the leak in the bottom when Liza emptied it into the paddling pool?
- Did they know to round their answer up in order to find the **least** amount of buckets Liza needs to fill?

Hole in the Bucket (Continued)

Curriculum Objectives

This problem should enable pupils to demonstrate their knowledge, understanding and skills through:

Developing pupils as Individuals	**Demonstrate an ability and willingness to develop logical arguments:** • Pupils will be able to work through the problem demonstrating how much water needs to be emptied into the paddling pool while also taking into account how much water is lost through the leak in the bucket.

Thinking Skills and Personal Capabilities

This problem can provide an opportunity for pupils to demonstrate a variety of the following Thinking Skills and Personal Capabilities:

Managing Information	• Ask focused questions • Plan and set goals and break task into sub-tasks
Thinking, Problem-Solving and Decision Making	• Make links between cause and effect • Justify methods, opinions and conclusions • Generate possible solutions, try out alternative approaches and evaluate outcomes
Being Creative	• Experiment with ideas and questions • Make ideas real by experimenting with different designs, actions and outcomes • Learn from and value other people's ideas
Working with Others	• Listen actively and share opinions • Suggest ways of improving their approach and working collaboratively
Self-Management	• Seek advice when necessary • Review learning and some aspect that might be improved • Compare their own approach with others' and in different contexts • Organise and plan how to go about a task

Cross-Curricular Skills

This problem should enable pupils to demonstrate a variety of the following Cross-Curriculum Skills:

Using Mathematics