PRODUCT WARS: PACKAGE DESIGN

These activities are designed for 60-minute lessons. You may need to adapt the materials for use in longer or shorter lessons.

INTRODUCTION

In this activity, pupils are invited to consider drinks packages before designing and making a container for their smoothie.

This activity is mainly paper based. It has been designed for use with pupils in a maths classroom equipped with a data projector and whiteboard. It is suggested that pupils work together in pairs or small groups to encourage appropriate levels of participation and discussion.

The activity contains 3 options offering varying degrees of challenge. Different pupil pairs or groups within a class can work at different options. Alternatively, you may prefer to ensure each group has a mix of pupils. This will help to create appropriate conditions for peer support.

These different options are as follows:

- **Option A:** Pupils are presented with a worksheet asking them to decide which diagrams are nets for a cuboid. The main activity asks them to design and make a cuboid container, calculating its volume in cubic millimetres and its capacity in millilitres. A sheet with the net of a cuboid is provided. This option is considered appropriate for learners working at **level 3 – level 4 of the National Curriculum**.

- **Option B:** Pupils are presented with a worksheet similar to that used in Option A but including nets for containers that are not cuboid. The main activity asks them to design and make a container that is not necessarily cuboid, calculating its volume in cubic millimetres and its capacity in millilitres. A sheet with the net of a container is provided. This option is considered appropriate for pupils working at **level 5 – level 6 of the National Curriculum**.

- **Option C:** Pupils are presented with a worksheet asking them to draw 3 nets for an equilateral triangular prism. The main activity asks them to design and make a container of any shape with a capacity of exactly 1 litre. This option is considered appropriate for learners working **at or above level 6 of the National Curriculum**.

LEARNING OBJECTIVES

Option A

By the end of the lesson, pupils will:
- match nets to cuboids;
- use a template to make a cuboid;
- create their own net to make a cuboid.

Option B

By the end of the lesson, pupils will:
- match nets to containers, only some of which are cuboid;
- use a template to make a container;
- create their own net to make a container.

Option C

By the end of the lesson, pupils will:
- match nets to containers which include cuboids and prisms;
- create their own net to make a container that will hold exactly 1 litre.

LEARNING OUTCOMES

Option A
Most pupils will:
- use given information to solve a problem;
- identify the nets of cuboids;
- construct nets of cuboids.

Option B
Most pupils will:
- use given information to solve a problem;
- identify the nets of a variety of solids;
- use ruler and compasses to construct nets of 3-D shapes.

Option C
Most pupils will:
- use given information to solve a problem;
- identify the nets of a variety of solids;
- use ruler and compasses to construct nets of 3-D shapes with a given volume.

NATIONAL CURRICULUM OBJECTIVES

Ma3 Shape, Space and Measures

Option A

Using and applying shape, space and measures
1. Pupils should be taught to:
   a) select problem-solving strategies and resources, including ICT, to use in geometrical work, and monitor their effectiveness.

Geometrical reasoning
2. Pupils should be taught to:
   k) use 2-D representations of 3-D shapes and analyse 3-D shapes through 2-D projections and cross-sections, including plan and elevation.

Options B and C

Using and applying shape, space and measures
1. Pupils should be taught to:
   a) select problem-solving strategies and resources, including ICT, to use in geometrical work, and monitor their effectiveness.

Geometrical reasoning
2. Pupils should be taught to:
   k) use 2-D representations of 3-D shapes and analyse 3-D shapes through 2-D projections and cross-sections, including plan and elevation.

Measures and construction

4. Pupils should be taught to:
   g) find volumes of cuboids, recalling the formula and understanding the connection to counting cubes and how it extends this approach; calculate volumes of right prisms and of shapes made from cubes and cuboids.

Links to the revised Programme of Study for introduction in 2008 include:

1 Key concepts

Competence

a) Applying suitable mathematics accurately within the classroom and beyond.
b) Communicating mathematics effectively.

Creativity

b) Using existing mathematical knowledge to create solutions to unfamiliar problems.

Applications and implications of mathematics

b) Understanding that mathematics is used as a tool in a wide range of contexts.

2 Key processes

Analysing

Pupils should be able to:
k) make accurate mathematical diagrams, graphs and constructions on paper and on screen.

3 Range and content

Geometry and measures

The study of mathematics should include:
a) properties of 2D and 3D shapes
b) constructions, loci and bearings
g) units, compound measures and conversions
h) perimeters, areas, surface areas and volumes.

4 Curriculum opportunities

The curriculum should provide opportunities for pupils to:
a) develop confidence in an increasing range of methods and techniques
d) work on problems that arise in other subjects and in contexts beyond the school
f) work collaboratively as well as independently in a range of contexts.

LESSON PREPARATION

- Familiarise yourself with the different options in order to identify the ones that will best address your pupils' needs.
- Set up the projector or interactive whiteboard to enable the whole class to view the initial briefing from Brad King.
- Pupils can work in pairs or small groups at a computer or the activity can be delivered via a single computer projected onto a whiteboard or screen.
- You may wish to create a certificate of achievement to award to pupils that perform well in the activity.

Vocabulary

Net design, cuboid, prism, triangular prism

Materials required

For each option, you will need the following:

- Internet access or a downloaded version of this case study
- glue sticks
- scissors
- rulers
- protractors
- Microsoft PowerPoint
- a suite of computers or a computer, projector and whiteboard.
- copies of the appropriate template sheet (optional for Option C)
- copies of the appropriate extension sheet.

In addition, for Option A you will need:

- a selection of cuboid-shaped boxes that you can cut up
- some A3 card or stiff paper (could be cm squared)

For Option B and Option C you will need:

- a selection of boxes and containers that you can cut up
- some A3 or A2 card or stiff paper

Prior knowledge required

- Pupils working at Option A should have some experience of finding the volume of a cuboid.
- Pupils working at Option B and Option C pupils should have experience of finding the volumes of cuboids and prisms.

LESSON DETAILS

Before the starter, play the video of Brad King introducing the task to the whole class.

Ensure that pupils are clear on what they will need to do in the lesson.

Starter

Option A

Whole-class activity

- Show pupils a selection of cuboid-shaped boxes one at a time.
- Ask them to sketch the shape that will fold up to make each box.
- Compare their sketches. Have they all drawn the same shape?
- Cut the first box along some of its edges so that it can be opened flat to show its net.
- Ask pupils if any of them had drawn this shape.
- Cut the second box along different edges and open it flat.
- Repeat for the rest of the boxes to demonstrate that there are a number of different ways to draw the 2-D shape to fold into a cuboid.
- Introduce the word ‘net’ for the 2-D shape if they have not met it before.

Option B and Option C

Whole-class activity

- Show pupils a selection of containers one at a time.
- Ask them to sketch the net of each container.
- Ask pupils to compare their sketches. Have they all drawn the same shape?
- Discuss the number of nets that could be drawn for each container.
- Cut each container along some of its edges so that it can be opened out flat to show its net.
- Discuss the criteria that manufacturers might use in deciding on a net for a container, e.g. how economical it would be to use a particular net when a number of them are cut from a large sheet of card.

Main

Option A

- As a whole class activity, project the Option A presentation onto a whiteboard or screen.
- Pupils are presented with a net and a selection of cuboid packages.
- Ask selected pupils to match each net to one of the 4 different packages that are shown.
- Once ready, distribute the template sheet, scissors and glue sticks to each group.
- Ask pupils within each group to cut out and fold the net to make a cuboid.
- Ask pupils how to find the volume of a cuboid. You may need to remind them that the volume is the area of the base x the height.
- Ask pupils to find the volume of the cuboid that they have made and to write the answer on it (96 cm^3).
- One of the nutrition labels from the Ultimate Smoothie activity could be printed out and pasted on to the cuboid.
- Pupils should now be asked to draw a net of their own on A3 paper/card, using their own measurements, to make a cuboid.
- Discuss the shape that pupils need for a container to hold a smoothie. Get them to think about how easy it will be to hold, how it will stack on shop shelves, how it will open, etc.
- Discuss the need for accuracy. Remind pupils that all the angles must be right angles. Also remind them not to forget the tabs for the glue.
- Once the container is made, pupils should measure its length, width and height and calculate its volume. The volume should be recorded on the container. A nutrition label from the Ultimate Smoothie activity should be pasted on to the container and the name of their smoothie added.

Option B

- As a whole class activity, project the Option B presentation onto a whiteboard or screen.
- Pupils are presented with a net and a selection of both cuboid and non-cuboid packages.
- Ask selected pupils to match each net to one of the 6 different packages that are shown.
- Once ready, distribute the template sheet, scissors and glue sticks to each group.
- Ask pupils within each group to cut out and fold the net to make a container.
- Ask pupils to consider how likely it is that this container would be completely filled with smoothie, e.g. it is likely that the smoothie will just come to the top of the cuboid base and not go into the pyramidal top.
- Ask pupils how to find the volume of a cuboid. You may need to remind them that the volume is the area of the base x the height.

- Ask them to find the volume of the cuboid part of the one they have made and to write the answer on it (360 cm^3).
- One of the nutrition labels from the Ultimate Smoothie activity should be printed out and pasted on to the container
- Pupils should now be asked to draw a net of their own on A3 paper/card, using their own measurements, to make a container.
- Discuss the shape that they could use for a container to hold a smoothie. Get them to think about how easy it will be to hold, how it will stack on shop shelves, how it will open etc.
- Discuss the need for accuracy. Remind them that all the angles in particular must be carefully measured. Also remind them not to forget the tabs for the glue.
- Once the container is made, pupils should measure the necessary lengths and calculate the volume. The volume should be recorded on the container. A nutrition label from the Ultimate Smoothie activity could be pasted on to the container and the name of their smoothie added.

Option C

- As a whole class activity, project the Option C presentation onto a whiteboard or screen.
- Pupils are presented with a net and a selection of both cuboid and non-cuboid packages.
- Ask selected pupils to match each net to one of the 8 different packages that are shown.
- Once ready, distribute the worksheet (optional), scissors, glue sticks, rulers, compasses and protractors to each group.
- If you are not using the worksheet tell groups that their task is to design a smoothie container that will hold exactly 1 litre.
- Remind pupils of the connection between capacity, volume and mass for water, i.e. for water 1 litre = 1000 ml = 1000 cm^3 = 1000 g (1 kg).
- Discuss the dimensions of the container if it is a cuboid (length x width x height = 1000 cm^3).
- Ask pupils how to find the volume of a prism (area of base x height).
- Discuss the dimensions of the container if it is a triangular prism (area of triangle x height = 1000 cm^3).
- Challenge your pupils to design an interesting container that will hold 1 litre of smoothie.
- Discuss the shape that they could use. Get them to think about how easy it will be to hold, how it will stack on shop shelves, how it will open etc.
- Discuss the need for accuracy. Remind them that all the angles in particular must be carefully constructed or measured. Also remind them not to forget the tabs for the glue
- Once the container is made, pupils should measure the necessary lengths and calculate the volume. The volume should be recorded on the container. A nutrition label from the Ultimate Smoothie activity could be pasted on to the container and the name of their smoothie added.

Plenary

Option A and Option B

- Ask individual pupils to show their container and to explain why they chose that shape.
- Ask the following questions:
    - What is the volume of the container?
    - How did they calculate the volume?
    - How would the container be opened?
    - Will it have a straw/stopper?
    - How it would stack on shop shelves?

Option C

- Ask individual pupils to show their container and to explain why they chose that shape.
- Ask the following questions:
    - What difficulties did they have in finding the measurements to end up with a capacity of 1 litre?
    - How did they resolve the difficulties?
    - How would the container be opened?
    - Will it have a straw/stopper?
    - How it would stack on shop shelves?

Extension Activities

Option A

An activity where pupils are asked to decide which of the diagrams on the sheet would fold up to make a cuboid before cutting them out to check. The correct nets should then be pasted into their notebooks.

Option B

Again, an activity where pupils are asked to decide which of the diagrams on the sheet would fold up to make a solid before cutting them out to check. The correct nets should then be pasted into their notebooks.

Option C

Pupils are asked to accurately draw three nets that will make an equilateral triangular prism of given dimensions.

Homework

Pupils could be asked to produce a packaging display based on examples of packaging collected at home. This should include the dimensions and volumes of the packages used.

Alternatively, pupils could be asked to prepare for their presentations next lesson (see below).

Final Presentation Activity

Extend the Product Wars case study by allowing additional lesson time for pupils to create a detailed presentation of their findings across all three activities. Pupils should be directed to deliver their presentations as if to Brad King himself, using mathematical reasoning to present their cases.

Introduce the presentation activity and encourage pupils to identify the success criteria that they think are relevant. These could include, for example, appropriate use of data.

Pupils will need to refer back to their records from each activity in order to produce their group reports or displays. Pupils should be encouraged to develop their results:

- calculating any summary statistics
- describing and attempting to explain the patterns within the results, and
- presenting the data using appropriate construction techniques.

Groups could then be asked to present their report or display to the rest of the class. Other pupils could then be invited to peer-evaluate the reports or displays offering suggestions on how they could still be improved relative to the success criteria identified earlier.

TECHNICAL SUPPORT

Throughout all the activities and support notes you will be asked to open various files in Flash or in Adobe PDF. You may also wish to use Microsoft PowerPoint for presentations. To use these, you will need to have the minimum specification installed. This recommendations list can be found below.

The latest **Adobe Flash Player** (previously know as the Macromedia Flash Player) can be downloaded free from the Adobe website. Support and Help can also be found on this site:

http://www.adobe.com/shockwave/download/download.cgi?P1_Prod_Version=ShockwaveFlash

You will be using a version of **Adobe Reader** or Distiller to view these Teacher Notes. If you would like help or to download a newer version, you can find information at Adobe's website:

http://www.adobe.com/products/reader/

Training, templates and Product information on **Microsoft PowerPoint** can be found on the Microsoft website for PowerPoint:

http://office.microsoft.com/en-gb/powerpoint/default.aspx

Minimum Machine and Software Specifications

PC

P3 800MHz; 128MB RAM; Windows 2000
Screen resolution 1024x768
Browser: Microsoft Internet Explorer 5.5; Firefox 1; Netscape 7; or Opera 7
Microsoft Excel 2000
Microsoft PowerPoint 2000
Macromedia Flash Player 7
Adobe Reader 7

Mac

G3 500MHz; 128MB RAM; OS X 10.2
Browser: Safari 1; Firefox 1; Netscape 7; or Opera 6.2
Screen resolution 1024x768
Macromedia Flash Player 7
Adobe Reader 7