Telematic Schools Project

2022 SUBJECT WORKBOOK
Grade 12

$a+b=c$ MATHEMATICAL LITERACY

A joint initiative between the Western Cape Education Department and Stellenbosch University.

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BROADCAST SESSIONS

GRADE 12 **BMI**

GRADE 12 MODELS

Session	Date	Time	Topic
1	**04/05/2022**	**15:00 – 16:00**	**BMI**
2	26/07/2022	15:00 – 16:00	Models

INTRODUCTION AND TOPICS

BMI
For every adult, there is a relationship between the persons height and weight, and it is called the persons body mass index. In short BMI.

Models
The following must be investigated:

- The most cost-effective and convenient way to pack cans or boxes.
- The packaging must be such that the space is optimally utilized.
- The use of models to solve problems.

Topics	Description
BMI	To determine a persons body mass index and to make predictions on a persons state of health.
Models	The concepts and skills that will be mainly focused on are: • packaging of a rectangular box and cylindrical can in a rectangular container / large box • to use models to solve problems

TERMINOLOGY

Term	Definition
Body mass index (BMI)	A number calculated from an adult's weight and height, expressed in units of kg/m^2
Height	The measurement between two points, in a straight line, e.g., from the top of a persons head to the floor on which the person is standing
Measure	Using an instrument to determine size, weight etc.
Weight	An indication of how heavy an object is.

SUMMARY

WHAT YOU SHOULD KNOW

The learner should know how to determine the height and weight of a person. Must also be able to do conversions between different units.

BODY MASS INDEX (BMI)

A. What is Body Mass Index (BMI)?

- Body Mass Index (BMI) is a number calculated from an **adult's weight** and **height and** is expressed in units of **kg/m²**.
- **BMI** is used for **adults** to determine whether the adult is of **normal weight**, **underweight**, **overweight** or **obese**.
- This weight status is used by health practitioners to provide appropriate advice.
- Note, for **children and teenagers' growth charts** are used to determine their **weight status**.

B. How is BMI calculated?

BMI is calculated by the following formula:

$$\text{BMI} = \frac{\text{Mass/Weight in kg}}{(\text{Length/Height in m})^2}$$

C. How is the weight status determined from the BMI value?

The following BMI-Weight Status table is used to determine the weight status of a person.

BMI - WEIGHT STATUS TABLE	
BMI	**Weight Status**
Below 18,5	Underweight (**U**)
18,5 – 24,9	Normal (**N**)
25 – 29,9	Overweight (**OW**)
30 and more	Obese (**O**)

24,22 is in grey row 18,5 – 24,9.
Weight Status: **Normal(N)**

WORKSHEET

EXAMPLES:

The table is used to calculate the values to confirm the correctness of it and the weight status of Learner 4:

Learner	Mass in kg	length in m	BMI	Weight status
4	70	1.70	24.22	**N**

- Work through all the examples with your calculator.
- You must get the same answers and then you know that you used the calculator correctly.

1. How to determine BMI

$$\textbf{BMI} = \frac{\textbf{Weight in kg}}{\textbf{(Length in m)}^2}$$

$$\text{BMI} = \frac{70\text{ kg}}{(1{,}7\text{ m})^2}$$

= **24,22**

Weight Status – Go to the BMI-weight status table to determine in which row **24,22** fall. In this case it is in the 'grey' row 18,5 – 24,9.

So, the weight status is **Normal (N)**

2. How to determine the length

$$\textbf{Length in m} = \sqrt{\frac{\textbf{Weight in kg}}{\textbf{BMI}}}$$

$$\text{length in m} = \sqrt{\frac{70\text{ kg}}{24{,}22}}$$

= 1,70

3. How to determine the weight

Weight in kg = BMI × (length in m)²

Learner 4: Weight in kg = $24{,}22 \times 1.7^2$

≈ 70 kg

CLASS DISCUSSIONS

ACTIVITY

(BMI – BODY MASS INDEX)

During the health week a group of persons were selected to take their Body Mass Index (BMI). The information is shown below:

Person	Mass in kg	length in m	BMI	Weight status
1	56	1.56	**(A)**	N
2	60	1.63	**(B)**	N
3	44	1.55	**(C)**	**(D)**
4	70	1.70	24.22	N
5	52	**(E)**	22.51	N
6	60	**(F)**	23.73	N
7	45	1.30	26.63	**(I)**
8	**(G)**	1.55	25.39	OW
9	**(H)**	1.60	23.83	N
10	57	1.68	20.20	N

BMI-WEIGHT STATUS TABLE	
BMI	**Weight Status**
Below 18,5	Underweight (**U**)
18,5 – 24,9	Normal (**N**)
25 – 29,9	Overweight (**OW**)
30 and more	Obese (**O**)
BMI = $\frac{\text{Mass in kg}}{(\text{Length in m})^2}$	1 pound = 0,4536 kg 1 inch = 2,54 cm

1. Determine the BMI - value (**A)** and (**B).**
2. Determine the BMI-value of (**C)** and (**D)**, the weight status of Person 3 as well as that of Person 7, **(I)**
3. Determine the lengths in m of Persons 5 and 6, the values of (**E)** and (**F)**.
4. Determine the mass in kg, the value of **(G)** and **(H)** of Persons 8 and 9.
5. An American exchange student said that they use the following formula:

$$\text{BMI} = 703 \times \frac{\text{Mass in pound}}{(\text{Length in inches})^2}$$

Use the information of Person 10 to calculate the BMI to show that the formula is correct.

2. Mr and Mrs Bush's domestic worker Phelo and her daughter Thuli, stay with them. Thuli and her friend Busi are worried about their weight. Study the growth chart on **THE NEXT PAGE** and answer the following questions.

2.1 Determine Thuli's BMI (Body Mass Index). She is 17 years old and her BMI places her in the 75th percentile.

2.2 Busi is 18 years old and she is 1,74 m tall. She has a weight of 96 000 g. TABLE 1 shows the relationship between BMI and weight status.

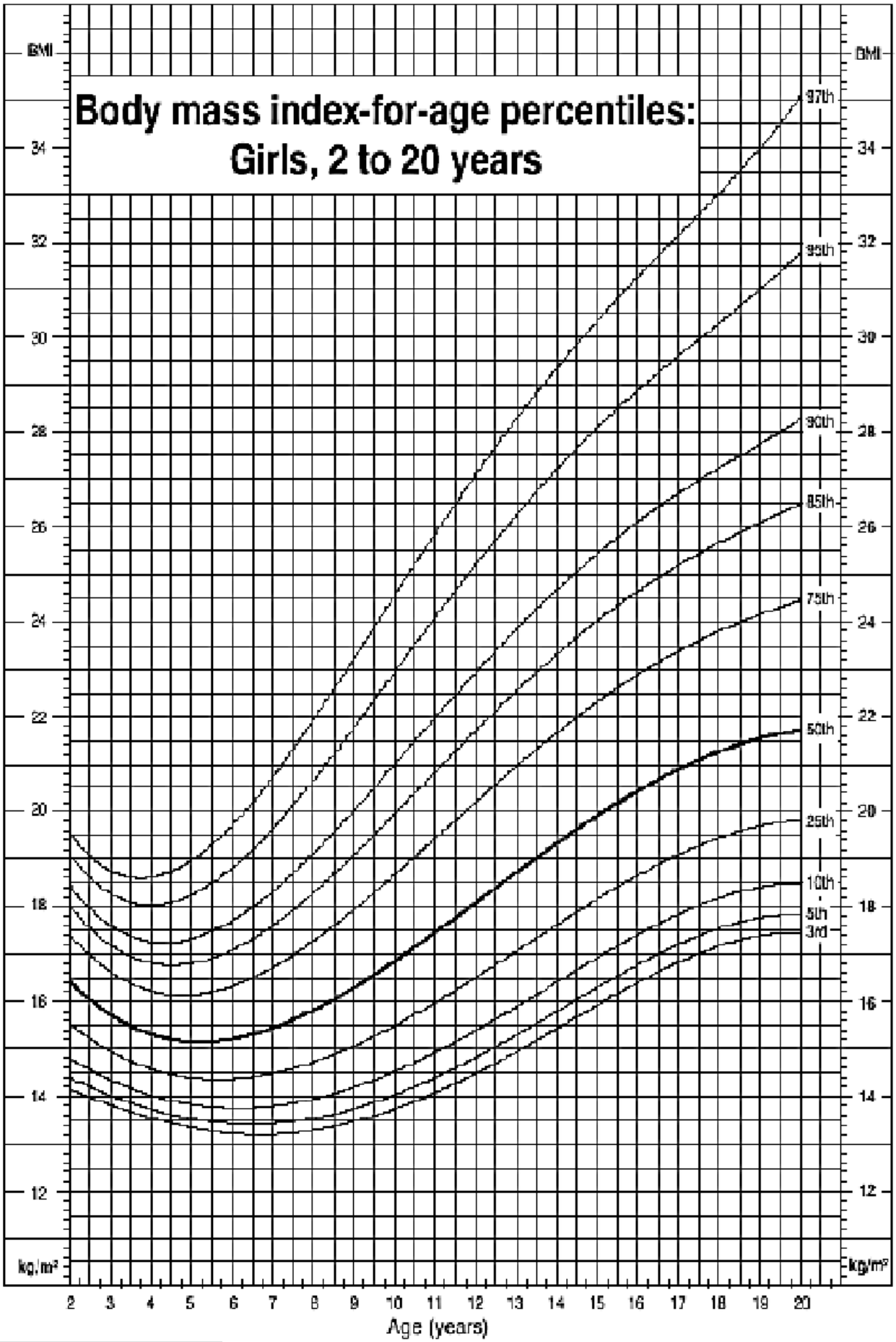
TABLE 1: WEIGHT STATUS TABEL

BMI for age Percentile range	Weight status
< 5th percentile	Underweight
5th to < 85th percentile	Healthy
85th to < 95th percentile	Risk of overweight
≥95th percentile	Overweight

2.2.1 Determine her weight status using TABLE 1 and the given formula:

$$\text{BMI} = \frac{\text{Weight in kg}}{(\text{Length in m})^2}$$

2.2.2 What advice should Mrs Bush give Busi's parents?


Body mass index-for-age percentiles:
Girls, 2 to 20 years
BMI
BMI
34
32
30
28
26
24
22
20
18
16
14
12
kg/m²
kg/m²
97th
95th
90th
85th
75th
50th
25th
10th
5th
3rd
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Age (years)

Term	Definition
Breadth	How wide something is. From the word “broad”.
Diameter	A straight line passing through the centre of a circle and touching the circle at both ends, thus dividing the circle into two equal halves.
Length	The measurement between two points, in a straight line, e.g. the length of a room.
Radius	The distance from the centre of the circle to any point on the circumference of the circle.

SUMMARY

WHAT YOU SHOULD KNOW

Prior knowledge of the 3 - dimensional figures especially the identification of length, width and height; rounding; ratio between radius and diameter, calculator skills and logical reasoning are knowledge and skills that come in handy for the topic that actually contains a strong practical component.

Packing a rectangular box in a rectangular container/large box:

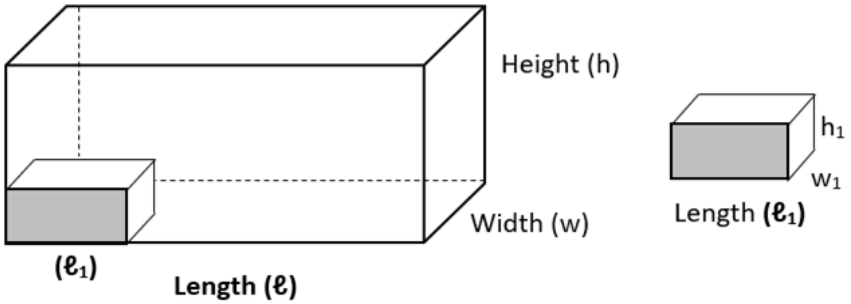
PACKAGING METHOD 1:

Length - wise: The LENGTH of the small box is packed along the LENGTH of the LARGE CONTAINER / BOX.

CALCULATION:

The number of small boxes that can be packed along length =

Length (ℓ) of large container / box ÷ length ($ℓ_1$) of small box

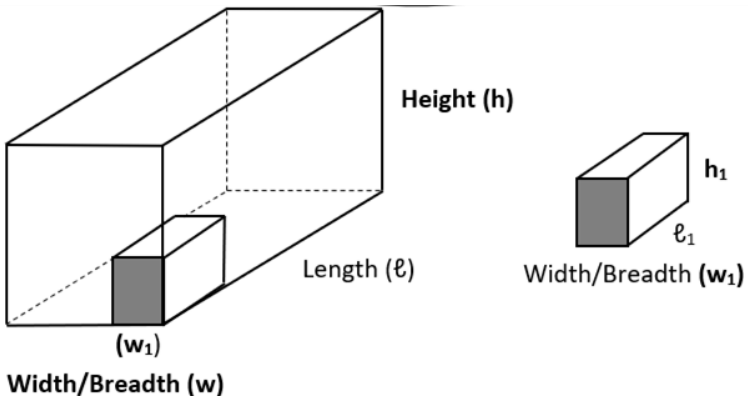


Width -wise: The WIDTH of the small box is packed along the WIDTH / BREADTH of the LARGE CONTAINER / BOX.

CALCULATION:

The number of small boxes that can be packed along WIDTH =

Width (w) of large container / box ÷ width (w_1) of the small box



Height - wise: How many boxes can be packed along the HEIGHT of the

BIG BOX / CONTAINER?

CALCULATION:

The number of small boxes that can be packed along the HEIGHT =

Height (h) of large container / box ÷ Height (h_1) of the box

What aspects of PACKAGING are important to us?
What is packed? Rectangular boxes and cylindrical cans/tins
What is it packed into? Rectangular Containers / Boxes
How is it packed? There are different packaging ways e.g., packaging methods 1 and 2 but optimal use of space and cost-effectiveness must also be taken into account.

OPTIMAL / MAXIMUM USE OF SPACE:
The boxes or cans should be packed in such a way that it fits the largest number of boxes/cans/tins in a container/box.

COST EFFICIENCY:
Packaging materials are expensive. The smallest container may need to be used for packaging of a certain number of boxes /tins /cans.

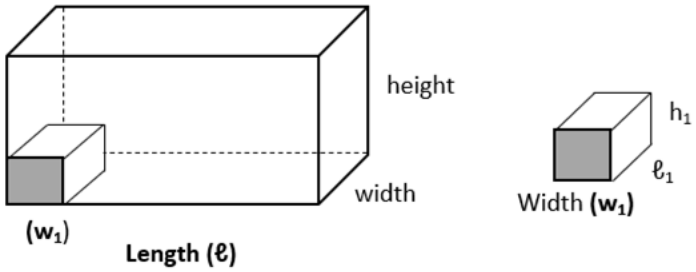
PACKAGING METHOD 2:

Length-wise: The width of the small box is packed along the LENGTH of the large container / box.

CALCULATION:

The number of small boxes packed along the length =

Length (ℓ) of large container / box ÷ width (b_1) of the small box

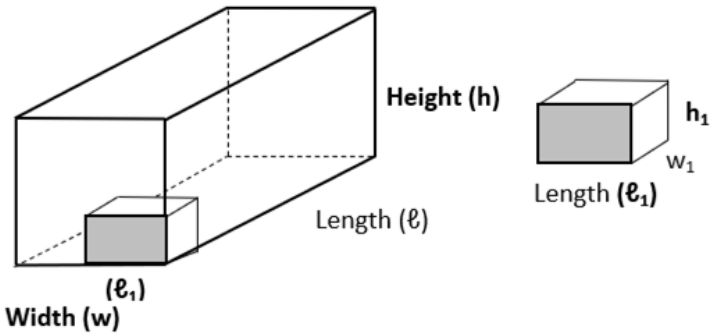


Width - wise: The LENGTH of the small box is packed along the WIDTH of the large container / box.

CALCULATION:

The number of small boxes that can be packed along the WIDTH =

Width (w) of large container / box ÷ length (ℓ_1) of the small box



Height - wise: How many boxes can be packed along the height?

CALCULATION:

The number of small boxes that can be packed next to HEIGHT

= Height (h) of large container / box ÷ Height (h_1) of the small box

EXAMPLE 1:

PROBLEM:

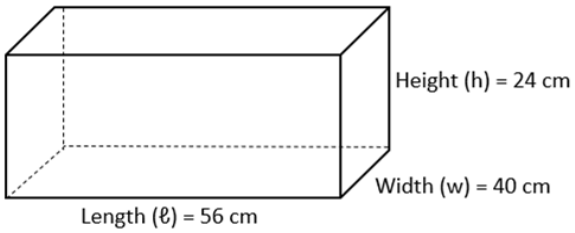
The small boxes must be packed in the big box.

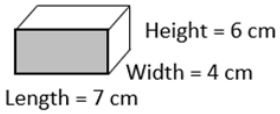
Verify which of the following packaging options will be the most cost effective:

Option 1: The length of the small box along the length of the large box/container

Option 2: The width of the small box along the length of the large box/container

Show all calculations to justify your answer.





OPTION 1:

The length of the small box along
the length of the large box / container

Length - wise:
The number of small boxes that can be packed along the LENGTH
= length of large box ÷ length of small box
= 56 ÷ 7 = 8 boxes

Width - wise:
The number of small boxes that can be packed along the WIDTH
= width of large box ÷ width of small box
= 40 ÷ 4 = 10 boxes

Height - wise:
The number of small boxes that can be packed along the HEIGHT
= Height of big box ÷ Height of small box
= 24 ÷ 6 = 4 boxes

TOTAL BOXES PACKED
= Number at length × Number at width × Number at height
= 8 × 10 × 4
= 320 boxes

OPTION 2:
The width of the small box along the length of the large box / container.

Length-wise:
The number of small boxes packed along the LENGTH
= Length of large box ÷ width of small box
= 56 ÷ 4 = 14 boxes

Width - wise:
The number of small boxes that can be packed along the WIDTH
= Width of large box ÷ length of small box
= 40 ÷ 7 = 5.7 ≈ 5

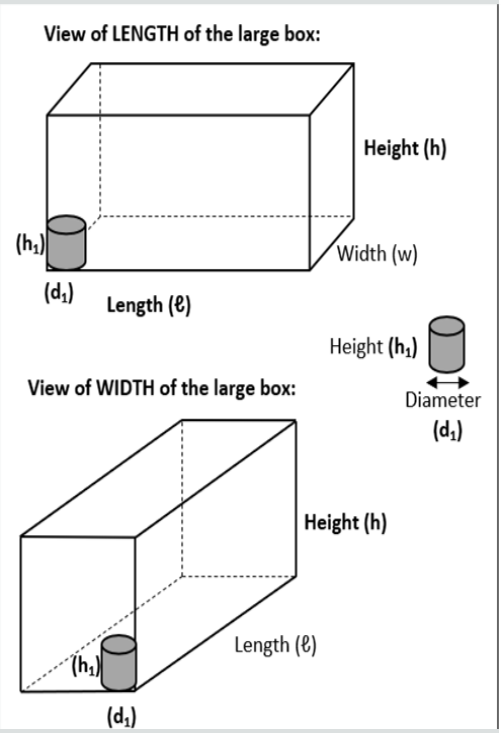
Height:
The number of small boxes that can be packed along the HEIGHT
= Height of big box ÷ Height of small box
= 24 ÷ 6 = 4 boxes

TOTAL BOXES PACKED
= Number on length × Number on width × Number on height
= 14 × 5 × 4
= 280 boxes

Conclusion:
Option 1
(More boxes can be packed, and it will be more compact)

ANSWERING TECHNIQUES:

Make sure all units of measurement are exactly the same
Use headings e.g., **Length - wise** etc.
Write down your formula, which indicates exactly which values you need to use.
Use only the **Natural Numbers;** ignore decimals.
Use your calculator correctly for calculations.



DETERMINING THE NUMBER OF CYLINDRICAL TINS/CANS IN A RECTANGULAR CONTAINER / LARGE BOX:

Length - wise: The DIAMETER of the tin is packed along the LENGTH of the large container / box.

CALCULATION:

The number of tins that can be packed along the LENGTH =

Length (ℓ) of large container / box ÷ diameter (d_1) of the tin

Width - wise: The DIAMETER of the tin packed along the WIDTH of the large container / box.

CALCULATION:

The number of tins that can be packed along the WIDTH =

Width (w) of large container / box ÷ diameter (d_1) of the tin

Height-wise: How many tins can be packed along the height?

CALCULATION:

The number of tins that can be packed along the HEIGHT

= **Height (h) of large container / box ÷ Height (h_1) of the tin**

TOTAL TINS/CANS PACKED

= number at length × number at width × number at height

NUMBER OF TINS/CANS PACKED ON BASIS = number at length × number at width

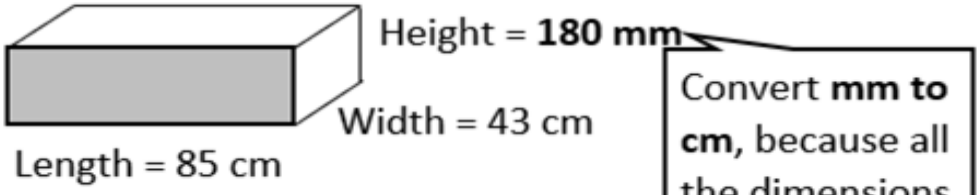
NB: Diameter = 2 × radius

EXAMPLE 2:

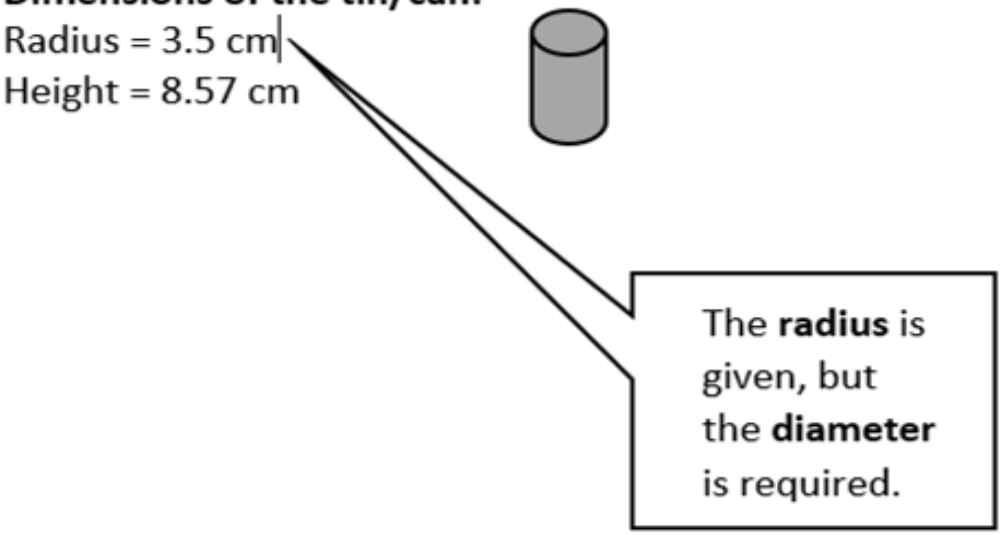
PROBLEM

Determine how many cans/tins can be packed in the box. Show all calculations.

Box dimensions:



Dimensions of the tin/can:



SOLUTION:

Diameter = 3.5 × 2 = 7 cm

Conversion: Height = 180 mm ÷ 10 = 18 cm

Length - wise:

The number of cans/tins that can be packed along the LENGTH

= Length of large box ÷ diameter of the tin

= 85 ÷ 7

= 12,14 ≈ **12 cans/tins**

Width - wise:

The number of cans/tins that can be packed along the WIDTH

= Width of large container / box ÷ diameter of the tin

= 43 ÷ 7

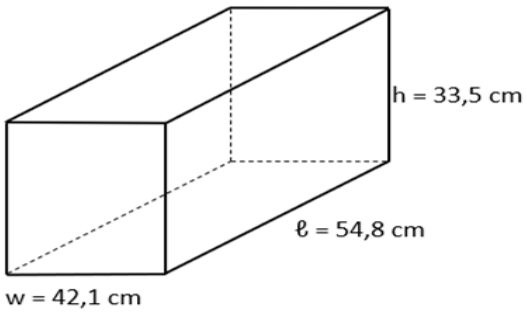
= 6,14 ≈ **6 cans/tins**

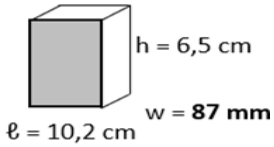
Height - wise:
The number of cans/tins that can be packed next to HEIGHT
= Height of large container / box ÷ Height of the tin
= 18 ÷ 8.57
= 2,1 ≈ **2 (cans/tins/layers)**
TOTAL CANS/TINS PACKED
= number at length × number at width × number at height
= 12 × 6 × 2
= **144 tins**

TOTAL TINS/CANS PACKED = number at length × number at width × number at height
NUMBER OF TINS/CANS PACKED ON BASIS = number at length × number at width

ACTIVITY ON PACKAGING:

1. Calculate the number of small boxes that can be packed in the large container/box if the length (ℓ) of the small box is packed along the width(w) of the container / box.

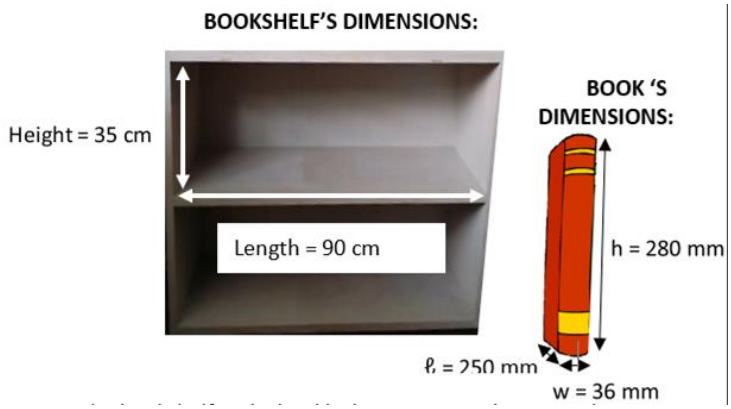




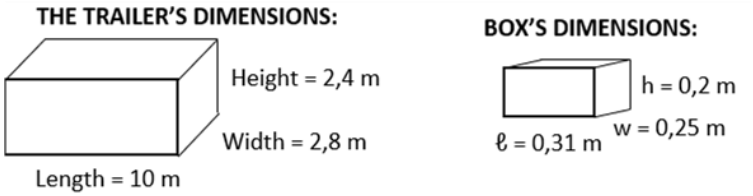
2. A box of 24 cans of Diet Coke is displayed.

The radius of a can of Diet Coke is 3.5 cm.
The cans are packed as in the picture.
Calculate the minimum length and minimum width of the box to contain the 24 cans of Diet Coke.

3. Use the bookshelf and a book's dimensions to determine how many books can be packed into the TWO shelves if the books are packed in its width (w) along the length of the bookshelf.



4. Use the following diagrams to answer the question that follows:



Verify which of the following packaging options will be the most cost-effective:

Option 1: The length (ℓ) of the box along the length of the trailer

Option 2: The width (w) of the box along the length of the trailer

NB: **Show all calculations to justify your answer.**

ANSWERS: ACTIVITY ON PACKAGING

1. The length of the box is packed along the width of the container/box:

Conversion of box width = 87 mm ÷ 10 = 8,7 cm

Width - wise:
The number of boxes that can be packed along the WIDTH
= **Width of large box ÷ length of small box**
= 42.1 ÷ 10.2
= 4,127 ≈ **4 boxes**

Length - wise:
The number of small boxes packed along the LENGTH
= **Length of large box ÷ width of small box**
= 54.8 ÷ 8.7
= 6,298 ≈ **6 boxes**

Height - wise:
The number of small boxes that can be packed along the HEIGHT
= Height of big box ÷ Height of small box
= 33.5 ÷ 6.5
= 5,153 ≈ **5 boxes / layers**

TOTAL BOXES PACKED = number at height × number at width × number at height
= 4 × 6 × 5
= **120 boxes**

2. **Diameter** = 2 × 3,5 = 7

Minimum length = 7 × 6
= 42 cm

Minimum width = 7 × 4
= 28 cm

3. **Conversion** of width of book = 36 mm ÷ 10 = 3.6 cm

Number of books on 1 shelf = 90 ÷ 3.6
= 25 books

Number of books on 2 shelves = 25 × 2
= **50 books**

4. **OPTION 1:**
The length of the box along the length of the trailer.

Length - wise:
The number that can be packed along the LENGTH
= length of trailer ÷ length of the box
= 10 ÷ 0.31
= 32.25
≈ **32 boxes**

Width - wise:
The number of boxes that can be packed along the WIDTH
= width of trailer ÷ width of the box
= 2.8 ÷ 0.25
= 11.2 ≈ **11 boxes**

Height - wise:
The number of boxes that can be packed along the HEIGHT
= Height of trailer ÷ height of the box
= 2.4 ÷ 0.2
= **12 boxes**

TOTAL BOXES PACKED
= number at height × number at width × number at height
= 32 × 11 × 12
= **4 224 boxes**

OPTION 2:
The width of the boxes along the length of the trailer

Length - wise:
The number of boxes packed along the length
= Length of trailer ÷ width of the box
= 10 ÷ 0.25
= **40 boxes**

Width - wise:
The number of boxes that can be packed along the WIDTH
= Width of trailer ÷ length of the box
= 2.8 ÷ 0.31
= 9.03 ≈ **9 boxes**

Height - wise:
The number of boxes that can be packed along the HEIGHT
= Height of trailer ÷ height of the box
= 2.4 ÷ 0.2 = **12 boxes**

TOTAL BOXES PACKED
= number at height × number at width × number at height
= 40 × 9 × 12
= **4 320 boxes**

Conclusion:
Option 2
(More boxes can be packed, and it will be more compact)