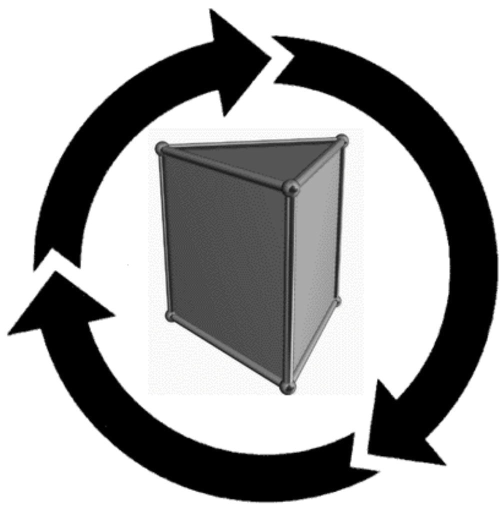
LEARNING CYCLE MODEL
FOR LEARNING SURFACE AREA OF TRIANGULAR PRISM



WORKSHOP ON DEVELOPING LEARNING MODEL
BASED ON REALISTIC MATHEMATICS EDUCATION APPROACH

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LEARNING CYCLE MODEL

I. RATIONALE

Realistic Mathematics Education was underlined by the idea of Hans Freudenthal that viewed mathematics as human activity, instead as subject matter that must be transferred from teachers to students (Freudenthal, 1973). Based on Freudenthal's idea, the teaching and learning process of mathematics should be connected to realistic problem. The term "reality" as the focus of Realistic Mathematics Education means that the problem situation must be experientially real for students. The main focus of the teaching and learning process is activities that lead to the process of mathematization.

There are five tenets of realistic mathematics education defined by Treffers (1987), namely:

1. Phenomenological exploration

   Contextual problems are used as the base and starting point for the teaching and learning process. The teaching and learning process is not started from formal level but from a situation that is experientially real for student.
2. Using models and symbols for progressive mathematization

   The aim of this tenet is bridging from concrete level to more formal level using models and symbols.
3. Using students' own construction

   The freedom for students to use their own strategies could direct to the emergence of various solutions that can be used to develop the next learning process. The students' strategies in the activities are discussed in the following class discussion to support students' acquisition of the formal level of mathematics concepts.
4. Interactivity

   The learning process of students is not merely an individual process, but it is also a social process. The learning process of students can be shortened when students communicate their works and thoughts in the social interaction emerged in classroom.

5. Intertwinement

   The activities used in the teaching and learning process do not merely support learning for a single mathematics topic, but they also should support the learning process of other mathematics topics or concepts.

Interactivity, as one of the five tenets of realistic mathematics education, emphasizes on the learners' social interaction to support the individual's learning process. This idea is in line with social constructivism that views an individual's cognitive development as a result of communication in social groups and it cannot be separated from social life. The learning process of learners is not merely an individual process, but it is also a social process, and these both perform simultaneously (Cooke & Buchholz, 2005 and Zack & Graves, 2002). Social interaction is a prerequisite to the individuals' cognitive development through internalization of ideas in the community. The learning process of learners can be shortened when they communicate their works and thoughts in the social interaction. However, social constructivism should not merely focus on the individual part and the social interaction the learning systems, but should also focus on the knowledge and skills to be learned as the social products.

Considering the importance of exploration, social interaction and knowledge development, as emphasized by RME and social constructivism, it is important to use a learning model that integrates these three components. One of learning model that is suitable for this objective is learning cycle model.

II. THEORETICAL REVIEW

Learning cycle model is a learning model that encourages students to develop their own understanding of a scientific concept, explore and deepen that understanding, and then apply the concept to new situations. There two types of learning cycle, the first type is the old learning cycle model and the second type is the new learning cycle model.

The old learning cycle model has three phases, namely: exploration, concept development and concept application.

a) Exploration

In the first phase, students work in small groups to explore the given problems and attempt to solve problems. The teacher acts as facilitator, posing questions and providing assistance as needed. Students have the opportunity to develop their own hypotheses and to test them through a hands-on experiment or observation.

b) Concept development

In the second phase of the learning cycle, the teacher leads the students through the introduction and development of the scientific concepts central to the lesson. This phase can be facilitated in a class discussion. The students may begin by sharing their observations and ideas from the exploration phase.

c) Concept application

The teacher now poses a new problem or situation for the students to solve based on their initial exploration and on the concepts they refined in the second phase. In this phase the students work individually or in small groups while the teacher acts as facilitator. The learning cycle may then begin again, as these hands-on activities become the starting point for the exploration and development of a related concept.

The three phases of old learning cycle are developed into five phases in the new type of learning cycle model, namely: engagement, exploration, explanation, elaboration or extension, evaluation.

a) Engage

In this phase problem is used to stimulate students' interest and curiosity in the topic of study. However, there must be a connection between what students know and what students can do. Therefore, teacher needs to investigate students' pre knowledge before posing the problem. Students have a need to relate their pre knowledge to the given problem.

b) Explore

During this phase students should be given opportunities to work together. Teacher should act as facilitator and do not give direct instruction to help students solving the problem. In this stage students cooperate to explore, analyze and solve the problem. Students may do hands-on activities to solve the problem.

c) Explain

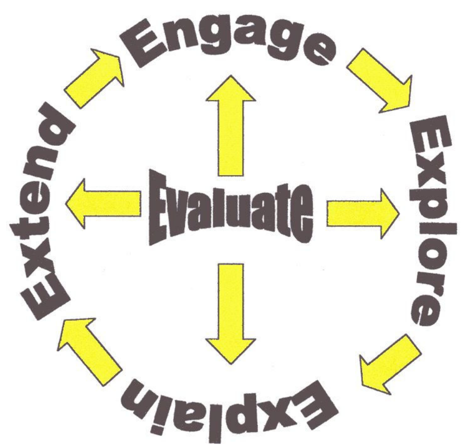
During this phase students have to present and explain concepts in their own words, provide evidence and clarification for their explanation, and listen critically to one another's explanation. At this phase teacher should bring students' ideas into more general and formal mathematical concept.

d) Extend

During this phase students should apply the learned concepts and skills in new (but similar) situations and use formal mathematical concept. Exploration phase may reapply here because students should be using the previous information to solve the new problem.

e) Evaluate

Teacher should observe students' knowledge and/or skills, application of new concepts and a change in thinking and students should assess their own learning. Teacher may pose open-ended questions that involve observation, evidence, and previously accepted explanations. Questions that would encourage future investigations are also important in this phase.



The implementation of the five phases of learning cycle model in mathematics teaching and learning can be formulated in the following sequence:

1. Teacher gives apperception

   Apperception is an initial step of engagement phase. There are two main aims of apperception, namely stimulating students' interest and investigating students' pre knowledge.

2. Teacher poses the problem and ask the students to think individually

   After knowing that students' already have required pre knowledge, teacher poses the problem and let students think individually. Students have a need to relate their pre knowledge to the given problem. Students are not asked to find the answer of the problem, but they are asked to analyze what the problem is and what kind of knowledge or strategies they need to solve the problem

3. Teacher makes group of four students and asks students to solve the problem in group

   This activity aims to facilitate the exploration phase of learning cycle model, namely giving students opportunities to work together. Students may do hands-on activities or other strategies to solve the problem. Students are asked to make conclusion.

4. Teacher conduct students' presentation and class discussion

   Students' presentation and class discussion aims to facilitate explanation phase of learning cycle. Students have to present and explain their work and listen critically to one another's explanation. Students' ideas should be bridged to the more general and formal mathematical concept.

5. Teacher gives new problems

   The new problems have to aims, namely providing students opportunities to extend and apply their knowledge in new situation and to evaluate students' achievement. When solving the new problems, students apply the learned concept and also do re-exploration process. Therefore, new cycle of learning begins.

III. OBJECTIVE

This document contains short description of Realistic Mathematics Education and Learning Cycle model, lesson plan and worksheets. This document is aimed to give examples of learning scenario for teaching and learning of the surface area of triangular prism by using learning cycle model.

References:

Bybee, R.W. et al. (1989). *Science and technology education for the elementary years: Frameworks for curriculum and instruction.* Washington, D.C.: The National Center for Improving Instruction.

Cooke, B.D. & Buchholz, D. (2005). Mathematical communication in the classroom: Teacher makes a difference. *Early Childhood Education Journal, Vol. 32 No. 6: 365 – 369*

Freudenthal, H. (1973). Mathematics as an Educational Task. Dordrecht: Reidel Publishing Company.

Treffers, A. (1987). *Three Dimensions. A Model of Goal and Theory Description in Mathematics Instruction – The Wiskobas Project*. Dordrecht, The Netherlands: Reidel Publishing Company

Zack, V. & Graves, B. (2001). Making mathematical meaning through dialogues: "Once you think of it the Z minus three seems pretty weird". *Educational studies in mathematics 46: 229-271*

LESSON PLAN

School unit : SMP …..

Subject : Mathematics

Grade/Semester : 8/2

Standard of competence : Understanding the characteristics of cube, cuboids, prism, pyramid and their parts with determined dimension

Basic competence : calculating the surface area and volume of cube, cuboids, prism, and pyramid

Indicators :
- Students are able to reinvent the formula to calculate the surface area of a triangular prism
- Student are able to calculate the surface area of a triangular prism

Time allocation : 2 x 40 minutes (1 meeting)

A. Learning objectives

1. Students are able to reinvent the formula of surface area of triangular prism.
2. Students are able to use the formula of surface area of triangular prism.
3. Students are able to use the formula of surface area of triangular prism to solve related problem in daily life.

B. Topics:

The surface area of triangular prism

C. Learning approach and model

1. Learning approach : Realistic Mathematics Education
2. Learning model : learning cycle

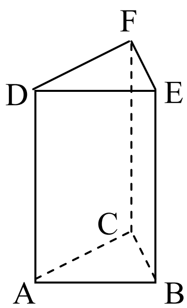
D. Teaching Materials

1. Sources/references:

   Marsigit ,2009 Mathematics 2 For Junior High School, Jakarta,Yudistira

2. Media: worksheet

E. Summary of material



A prism is a three dimensional shape in which each flat surface is a polygon, the across faces are congruent, and every two lateral faces intersects each other parallel lines.

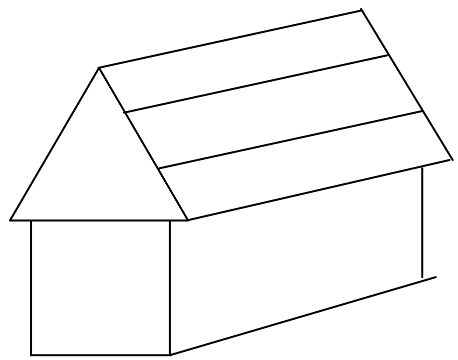
A triangular prism is a prism composed of triangular bases and three rectangular sides.

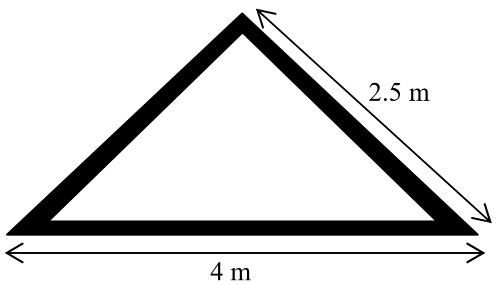
The elements of triangular prism are:

1. Face of prism, contains the base of prism (ABC), the top of prism (DEF) and lateral sides (ABED, BCFE, ACFD).
2. Lateral edges are intersect of lateral sides (AD, BE, CF) , base edges
3. Vertex (A, B, C, D, E, F,)

Surface area of the triangular prism is the sum of base area, top area and lateral sides area. The volume of a triangular prism is product of base area and the height of triangular prism.

F. Learning Activities

ACTIVITIES	CLASS DESIGN	SOURCE/ MEDIA	TIME
INTRODUCTION			
Apperception  Teacher shows a picture of house and asks the following question: a. *What geometrical shape is the roof of the house?* This question is aimed to recall students about triangular prism and its components and characteristics. b. *If students answer that the roof is a triangular prism, then teacher asks students to give the other examples of triangular prism in daily life.* This question is aimed to check students' understanding about the characteristics of a triangular prism by asking to give examples of triangular prism. c. *The dimension of living room is 3 m x 4 m. How many tiles do we need to buy if the*	Classroom activity (classical activities)		8'

	dimension of the tile is 20 cm x 20 cm? This question is used to stimulate students to recall the concept of area of a rectangle because the area of rectangle and triangle are the prerequisite to learn the surface area of triangular prism. *d. Teacher shows picture of a part of the roof and asks students calculate the height of the roof:*  This question aims to recall students about the concept of Pythagorean Theorem. The entire problem in this apperception is not only aimed to recall some mathematics concepts and to investigate students' pre-knowledge, but it also aimed to create a contextual-realistic learning atmosphere or situation. From contextual-realistic problem, it is expected that students do not only think about formula and other formal concept of mathematics. Instead, students are stimulated to analyze the problem and identify what mathematics concept they need to solve the contextual-realistic problem.			

	Note: For time efficiency, teacher can give the problem above by displaying on LCD screen, instead of storytelling. Other alternative is that teacher gives the problem in a hand out and asks students to work on the hand out.			
MAIN ACTIVITY				
	1. Teacher poses the problem and asks students to think individually (note: the problem is problem number 1 on worksheet A). Students are not asked to find the answer of the problem, but they are asked to analyze what the problem is and what kind of knowledge or strategies they need to solve the problem. Problem number 1 is the most important problem that will be used as the base for the formation of mathematics concepts (i.e. surface area of a triangular prism). Consequently, teacher should encourage students to give extra consideration to this problem. 2. Teacher makes groups of 4 students and asks students to share their individual ideas and solve the problem. After students understand the problem, then they start solving the problem in groups. Students' individual ideas are shared and developed to solve the problem. Students may do hands-on activity or make drawings to solve the problem. Teacher facilitates the group discussion (i.e. provides guidance, etc) During group discussion, teacher should clarify students' idea and also scaffold students in solving the problem.	Classroom activity (classical activities) and group activity		5' 30'

	Note: Teacher may provide some teaching aids/materials that can be used by students when working on hands-on activities. Teacher may provide a model of triangular prism as the representation of the tent and a roll of tape as the representation of the cloth/fabric. Students may cut the tape and glue it on the model of triangular prism when determining they cloth needed to make the tent.			
	3. Teacher conducts presentation or class discussion. Several groups of students are asked to present their work. Teacher should bring and bridge students' idea to the more general and formal mathematical concepts by posing question or other guidance. There are two possible alternative of facilitating the explanation phase: - Teacher selects some interesting work of students to be presented in the classroom discussion. (Note: interesting does not only mean correct solution, but any solution that will contribute to the formation of mathematics concepts). - Teacher asks all group to display or hang their work on the wall, then they can visit, observe and discuss the others' work. Students can record their question and then pose it in the classroom discussion.			

	4. Teacher gives new problems (see Task 1) Note: if the time is not enough, the problems can be used for the next meeting This activity aims to : – provide students opportunities to extend and apply their knowledge in new situation. – stimulate students to do new exploration to solve the problem and, therefore, the new cycle of learning begins. – evaluate students' achievement	Classroom activity		30'
CLOSING				
	– Teacher and students make a summary and conclusion about the learned topic – Teacher gives homework			7'

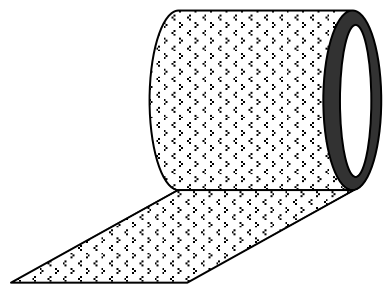
G. Assessment

1. The technical assessment : written test
2. Instrument :
   - Homework

     Homework is used to assess individual's achievement
   - Task 1

     Task 1 is used to stimulate students to do re-exploration to develop new concept (i.e. the concept of volume)

WORKSHEET A



Solve the following problems by using your own strategies and use drawing if it is needed.

1. For the next Pramuka camping, our scout team will make our own tent. The dimension of the tent will be 4 meters long, 3 meters wide and 2 meters high. How long do we need to buy the cloth/fabric to make our tent?

   Note: the wide of the special cloth to make the tenth is 1 meter.
2. If we would also like to make the base of our tent from the same cloth/fabric, how long do we need to buy the cloth/fabric for our tent? How many meter of cloth/fabric we need in total (for the tent and its base)?
3. All members of the scout team agree to express their creativity by making the tent colorful. If a bottle of paint is enough to paint 4 m^2 of cloth/fabric, how many bottles of paint do we need to buy to paint the tent and its base?
4. A tailor is asked to make the tent. Can you help the tailor draw the pattern of the tent?
5. Find the formula to calculate the surface area of a triangular prism

Time allocation: 40 minutes.

To help you manage your time, you can follow the following guide:

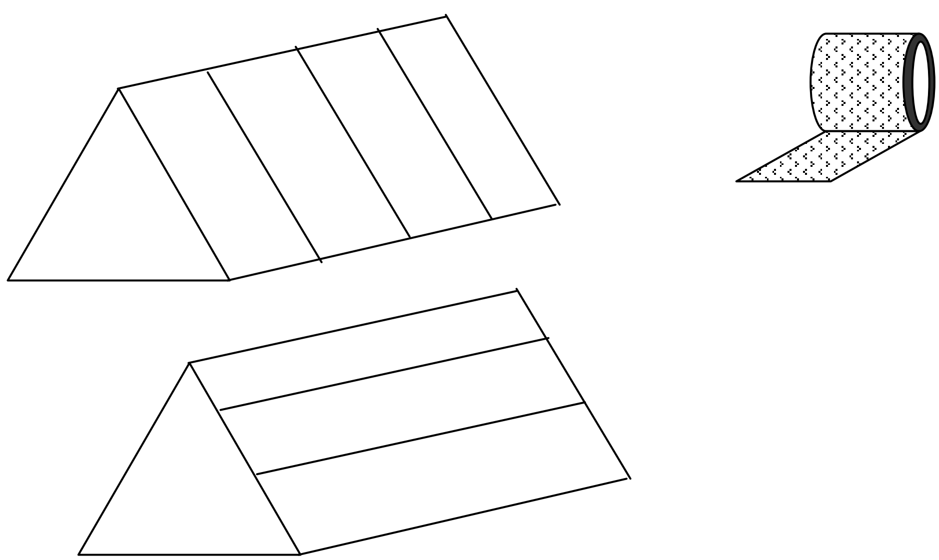
Problem 1 and problem 3: approximately you need 10 minutes for each problem

Problem 2: approximately you need 10 minutes

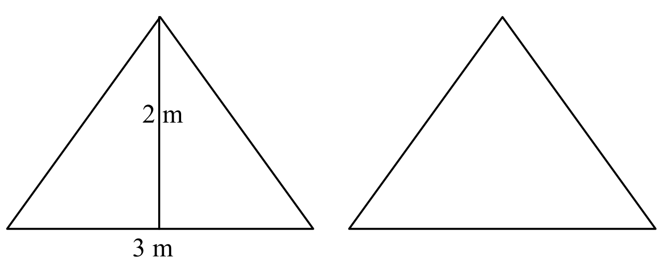
Problem 4 and 5: approximately you need 15 minutes for both problems

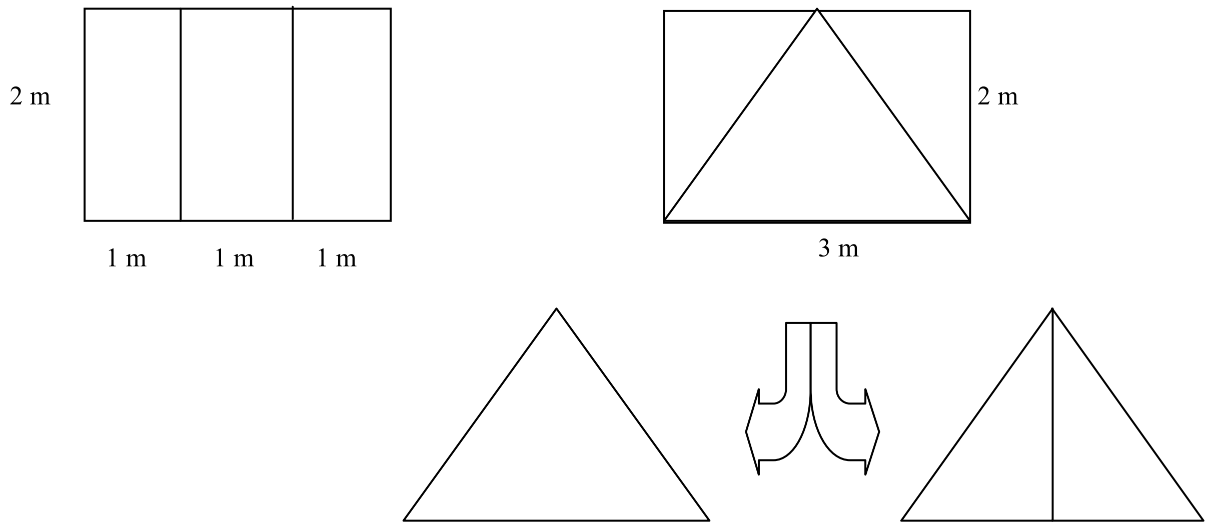
Note for teacher about the worksheet:

- Problem (1) involves two tenets of Realistic Mathematics Education, namely: phenomenological exploration and intertwinement. The phenomenological exploration is reflected from the use of contextual/realistic problem and the intertwinement is reflected how students to use the Pythagorean Theorem and the concept of area to solve the problem.
- Problem (1) and (2) is aimed to stimulate students' sense of surface area of triangular prism. When we discuss three dimensional objects, a question about their capacity or content is related to the concept of volume and a question about materials needed to make non-solid objects or a question about the amount of paint to paint the surface of the object is related to the concept of surface area. Therefore, the amount of cloth/fabric that is needed to make the tent (and its base) is related to the surface area of a triangular prism. Students may use hands-on activities and various strategies to solve problem (1).



For the doors of the tent:





- For problem (1) and (2), students' answer is still about the length of cloth (e.g. they need to buy 38 meter of cloth). Therefore, problem (3) is aimed to bridge students from length (of cloth) problem to area problem. To solve problem (3), students need to "convert" the length of cloth into the area of cloth, namely: from 38 meter long of cloth into 38 × 1 of cloth (note: the width of the cloth is 1 meter). At the beginning students may solve the problem by calculating the area of each piece of cloth/fabric.
- Problem (4) is aimed to guide students to make the net of a triangular prism. This question is important to help students to formulate the formula of triangular prism's surface area in more formal way since this problem will help students think that a triangular prism compounded by two triangles and three rectangles. Therefore, it is expected that students are able to find that the surface area of a triangular prism is the sum of the area of two triangles and the area of three rectangles.
- Problem (5) is aimed to guide students to conclude what they have done on problem (1) to problem (4).

Task 1:

1. Our scout team wants to make a tent that is made of 100 sacks. Every sack has size 60cm× 40cm. Determine **possible dimension(s)** of our tent that can be made of 100 sacks without leaving any sacks.

   Note: we should split every sack.

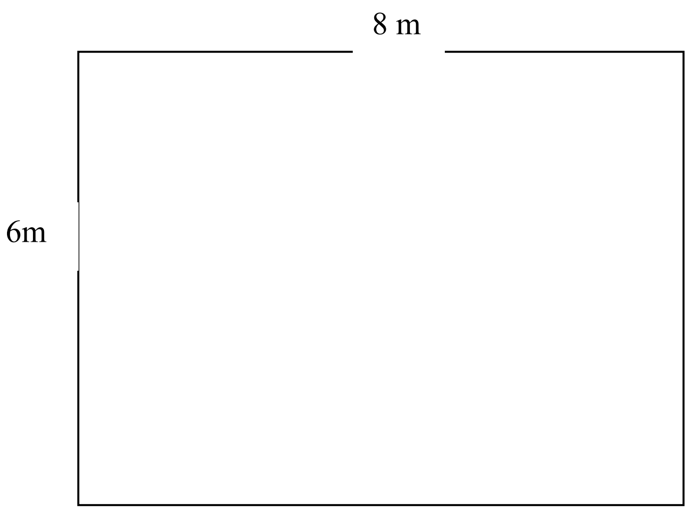
Possible solution:

Suppose every sack is split, so the size of the sack will be 60cm× 80cm.

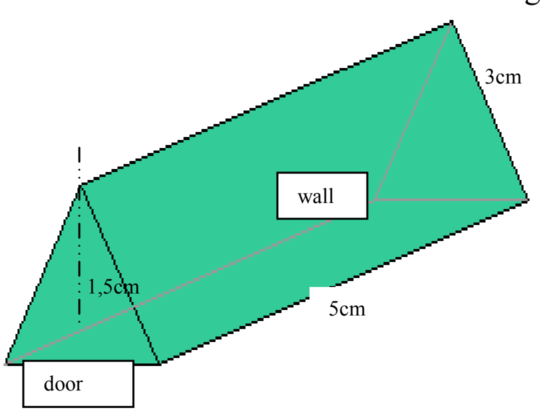
Arrange the sacks so we will get a rectangle with size:

length = 80cm × 10 = 800 cm = 8 m

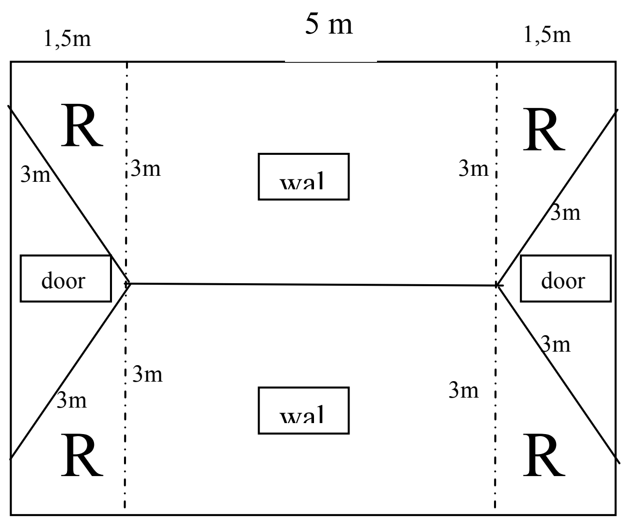
width = 60cm×10 = 600 cm = 6 m



We can make a tent without base in triangular prism with size:

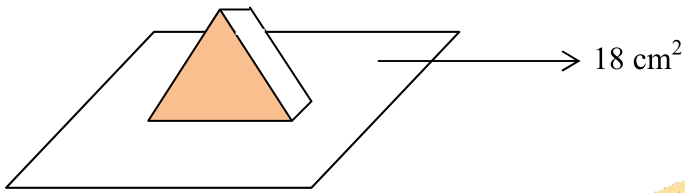


The net of the tent could be:



R : part that remain

2. Eighteen centimeter square of aluminium foil is needed to pack a triangular prism-chocolate bar. Determine the **possible dimensions** of the cartoon package that can contain 10 triangular prism-chocolate bars.

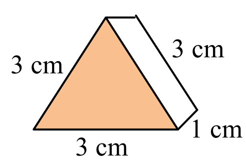


Solution:

The area of aluminium foil is the surface area of a chocolate bar. Therefore:

18 = 2 area of triangles + 2 area of rectangular sides + 1 area of rectangular base

One possible dimension for a chocolate bar is:



Therefore one of the possible dimensions of the cartoon package is

SCORING FOR THE TASK 1

Problem 1:

Step	Score
1. Splitting sack	5
2. Drawing the result of merging 100 sacks	10
3. Predicting possible dimension of tent	15
4. Argument of prediction	20
TOTAL	50

Problem 2:

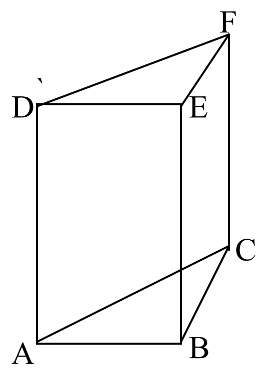
Step	Score
1. Illustrating/drawing	5
2. Formulating dimension of one chocolate	20
3. Predicting dimension of cartoon package	15
4. Final answer	10
TOTAL	50

Homework (individual task):

1. Given a triangular prism which its base is equilateral triangle. If the sides of the triangles are 4 cm and the height of prism is 12 cm, find the area of triangular prism.

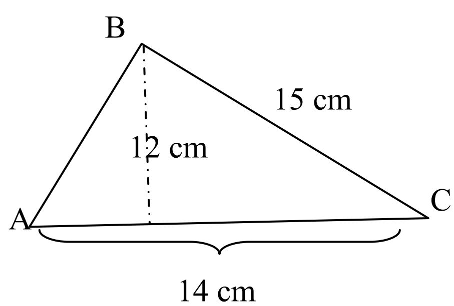
2. The base of a triangular prism is a right triangle. The right sides are 6 cm and 8 cm. If the height of the triangular prism is 15 cm, find the area of triangular prism.

3.



ABC is an isosceles triangle.
AB = BC = 5 cm and AC = 8 cm

4.



The base-side and top-side of a prism made of triangle above.
Find the surface area of the prism, if its height is 20 cm.

Answer:

1. First, the altitude of the equilateral triangle must be calculated by using Pythagorean Theorem. The altitude of the equilateral triangle: $\sqrt{4^2 - 2^2} = 2\sqrt{3}$ cm.

   Area of the triangular prism =

   (2×area of triangle) + (3×area of rectangle)

   $(2\times(\frac{1}{2} \times 4 \times 2\sqrt{3})) + (3\times(12 \times 4)) = 144+8\sqrt{3}\ \text{cm}^2$

2. Area of triangular prism =

   (2×area of triangle) + area of 3 rectangles

   $(2\times\left(\frac{6\times 8}{2}\right)) + (8\times 15) + (6\times 15) + (10\times 15) = 48+120+90+150 = 378\ \text{cm}^2$

3. Area of triangular prism =

   (2×area of triangle) + area of 3 rectangle

   $(2\times(\frac{1}{2}\times 8\times 3)) + (2\times 5\times 10) + (8\times 10) = 24+100+80 = 204\ \text{cm}^2$

4. Area of triangular prism =

   (2×area of triangle) + area of 3 rectangles

   $(2\times(\frac{1}{2}\times 14\times 12)) + (14\times 20) + (15\times 20) + (13\times 20) = 168+280+300+260 = 1008\text{cm}^2$