Exemplar

Solids and Nets

Objectives	(1) To explore the 2-D representations of simple solids
	(2) To draw the net of a given solid
Dimension	Measures, Shape and Space
Learning Unit	Introduction to Geometry, More about 3-D Figures
Key Stage	3
Materials Required	(1) Computer Software – *Poly*
	(2) Model of a regular tetrahedron and its net
Prerequisite Knowledge	Meaning of various polyhedra, the term "net" and 2-D representation of simple solids

Description of the Activities

Activity 1   2-D representation of a regular tetrahedron

1. Before the lesson, the teacher prepares a model of a regular tetrahedron for demonstration.

2. At the beginning of the lesson, the teacher shows a model of a regular tetrahedron to students.

3. The teacher distributes Worksheet 7.1 to students.

4. Students are asked to draw a 2-D representation of the tetrahedron on Worksheet 7.1.

5. Students compare their figures of 2-D representations with other classmates.

6. The teacher launches the computer program *Poly* and selects **Tetrahedron** from the category **Platonic Solids**. Choose **Three-dimensional shaded polyhedra** in the View Modes of **File | Preference** to view the solid.

7. The teacher uses the program to rotate the tetrahedron and let students visualize the effect of rotation on a 3-D solid.

8. The teacher opens two new windows and selects **Tetrahedron** for both windows but in different view modes. One is **Three-dimensional edges (wireframe)** and the other is **Three-dimensional visible edges**. See Figure 7.1. Students can use different view modes to visualize the same solid.

9. The teacher should point out to students that in the **Three-dimensional visible edges** View Mode, there may be a hidden edge on the screen.

10. Students are asked to complete Table 7.1a of Worksheet 7.1. Students need to draw different 2-D representations of the tetrahedron with the help of the software. The teacher can make remarks on the use of a dotted line to represent an invisible edge in drawing the 2-D representation of a 3-D solid.

11. The teacher discusses with students on the best 2-D representation of the tetrahedron.
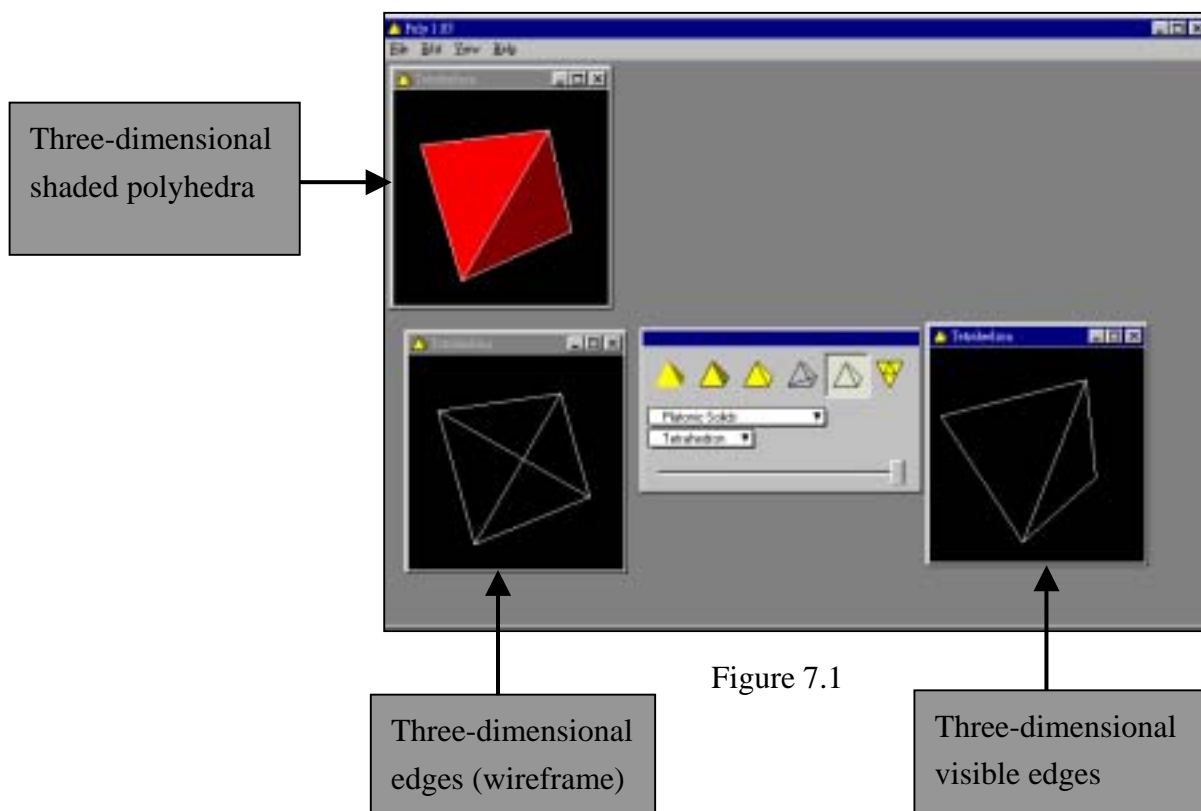

Three-dimensional shaded polyhedra

Three-dimensional edges (wireframe)

Three-dimensional visible edges

Figure 7.1

Activity 2   2-D representations and the nets of simple solids

1. The teacher prepares a model of regular tetrahedron and its net before the lesson.

2. The teacher shows the regular tetrahedron to students and explains the term "net" by showing the net of the regular tetrahedron.

3. The teacher uses the computer program *Poly* to show a regular tetrahedron and its net to students. Students can visualize the formation of a tetrahedron from its net and vice-versa. See Figure 7.2.
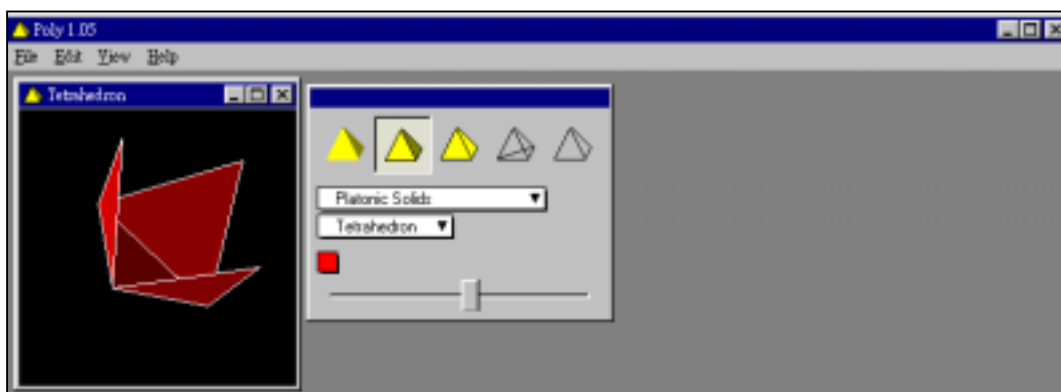
Figure 7.2

4. The teacher distributes Worksheet 7.2 to students.

5. Students are asked to draw the 2-D representation of each solid in Table 7.2a of Worksheet 7.2 by using the program *Poly*.

6. Students then draw the net of the corresponding solid in Table 7.2a without using the computer.

7. Students are divided into groups. As different nets for the same solid can be drawn, students need to compare and discuss their nets with other group members to choose the correct answers.

8. Students can use the software to find out a net of the given solid. They can compare the net generated with their work in step 6.

9. A representative from each group is asked to present their answers to the whole class.

10. The teacher gives comments.

Worksheet 7.1:   2-D Representation of a Regular Tetrahedron

1.   Draw a 2-D representation of the tetrahedron on the space provided. Compare
     your figure with your classmates.

2-D representation of the regular tetrahedron

2.   With the help of the program *Poly*, draw as many 2-D representations of the
     tetrahedron as you can in Table 7.1a. Remember to use a dotted line to represent
     a hidden edge in the drawing.

2-D representation of the regular tetrahedron	

Table 7.1a

Worksheet 7.2   2-D Representations and the Nets of Simple Solids

1.   Launch the program *Poly*.

2.   Use the program to draw the solids listed in Table 7.2a. Drag the solid on the screen to rotate it. Draw the 2-D representation of each solid in Table 7.2a under the column of 2-D representation.

3.   Note that you can find the specified solid from the following table of category in *Poly*.

Solid	Category
Tetrahedron	Platonic Solids
Cube	Platonic Solids
Triangular Prism	Prism and Anti-Prisms
Pentagonal Prism	Prism and Anti-Prisms
Square Pyramid [J1]	Johnson Solids
Elongated Square Pyramid [J8]	Johnson Solids

4.   Without using the computer, draw the net of the corresponding solid in Table 7.2a under the column "Net".

5.   Compare and discuss your answers with your classmates.

6.   Use the program *Poly* to find a net of a solid. Compare your nets with those drawn by the computer.

Solid	2-D representation	Net
Tetrahedron		
Cube		
Triangular Prism		
Pentagonal Prism		
Square Pyramid		
Elongated Square Pyramid		

Table 7.2a

Notes for Teachers
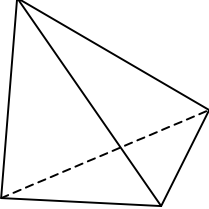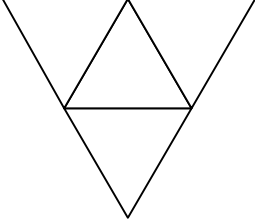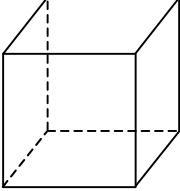
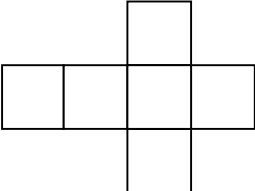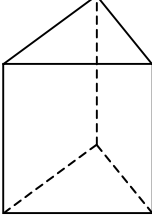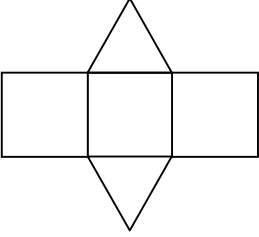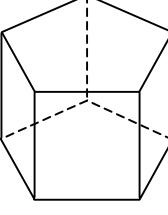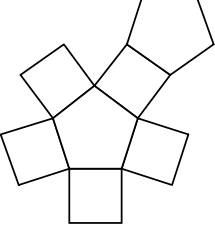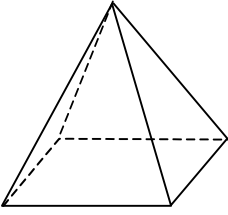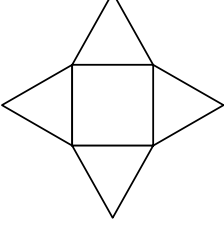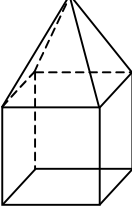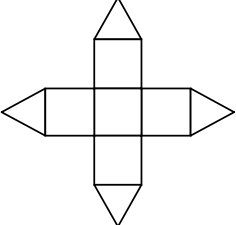1. In the exemplar, all the faces of the solids are regular polygons.

2. Answers to Worksheet 7.1

2-D representation of a regular tetrahedron	
(a)	(b)
(c)	(d)
(e)	
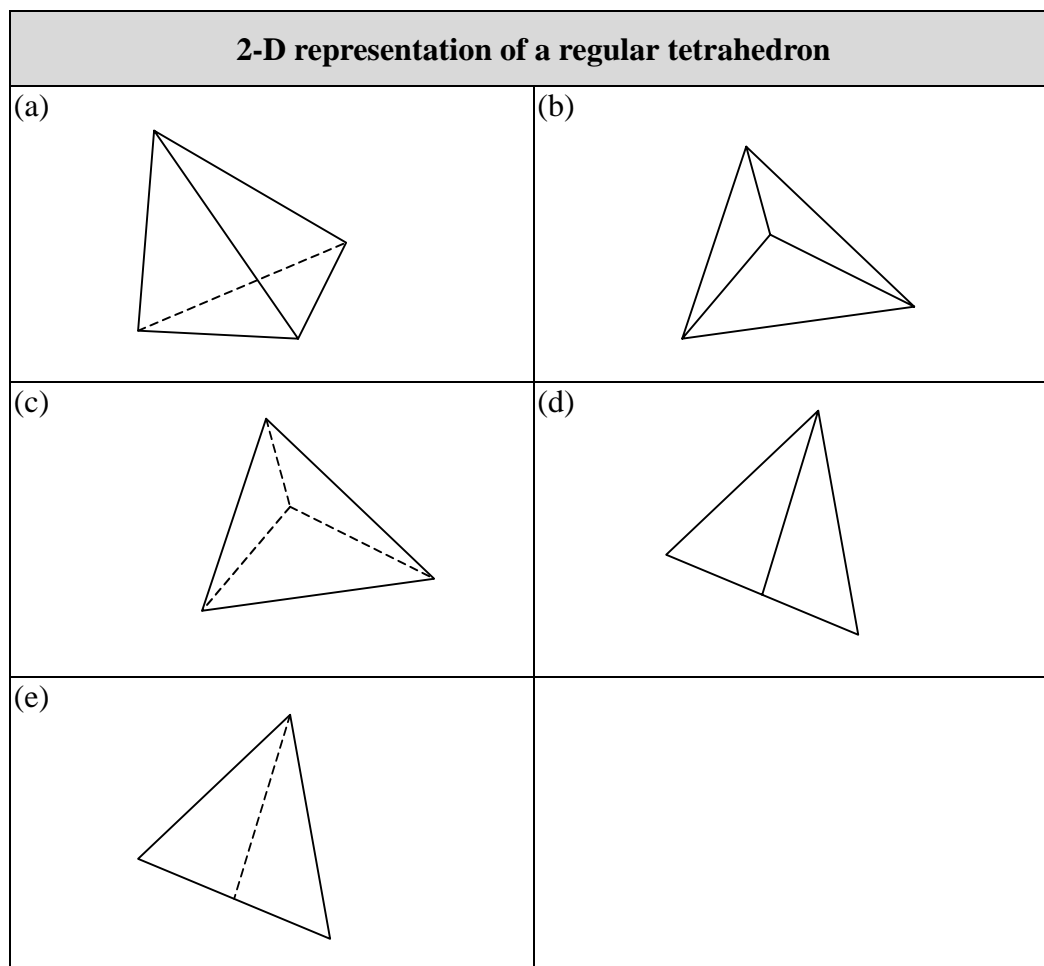
3. The teacher can ask students which of the above representations can "best" illustrate a tetrahedron. An ideal 2-D illustration should consist of visible edges and dotted lines representing the "hidden" edges. Figure (a) and (c) are two examples.

4. A net is a 2-D "unfolded figure" of a 3-D solid. Students should have come across the idea of net in primary school levels. However, it is found that students are quite weak in their spatial visualization especially for more complicated solids. It is expected that through these hands-on experiences, students have opportunities to develop their spatial visualization skills which enables them to imagine mentally how a 3-D solid can be "unfolded" to form a 2-D net.

5.   Answers for point 4 in Worksheet 7.2.

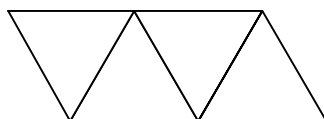| **Solid**		
Tetrahedron		
Cube		
Triangular Prism		
Pentagonal Prism		
Square Pyramid		
Elongated Square Pyramid		

6. The teacher is advised to disable the option **Two-dimensional net** in the **Preferences** (Refer to Point 4 of the Operation Procedure) when students do Worksheet 7.2 so that they can only use their imagination to draw the nets of the specified solids without the help of the computer.

7. The teacher may guide students to answer the following questions in order to help them draw the net.
    (a) What kinds of polygons are the faces of the solid?
    (b) Which faces are joined together?
    (c) Select a face of the solid and draw it. Look at which faces join this face and draw them.
   Continue with the above process until all faces have been drawn.

8. The teacher should bring to the attention of students that there is more than one net representing the same 3-D solid.
    For example, below is another net for the regular tetrahedron.

    Note: Not every net consisting of four equilateral triangles can be folded to form a regular tetrahedron. Here is an example.
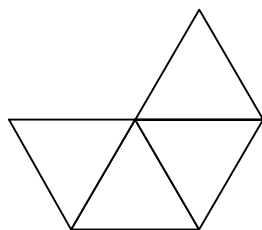

    The teacher should help students identify the above cases.

9. The computer can only show one of the nets for each solid. Students need to compare and discuss with other classmates whether their answers are correct or not.

10. The objective of Activity 2 is to find a net rather than to find <u>all</u> the nets for a given solid. Whether a net can be folded to form the given solid is important.

11. The teacher can use the program *Poly* to produce the net for making the model of a regular tetrahedron before the lesson. Of course, the teacher can guide students to produce the print out of the nets on paper. Let them cut out the nets and fold them into different solids. This activity can supplement Activities 1 and 2 by providing hands-on experiences.

Operation Procedure

1. An evaluation verision of the program *Poly* can be downloaded from the web site http://www.peda.com.

2. *Poly* version 1.07 is used in this exemplar. It contains English and Chinese interfaces.

3. Details of the Dialogue box
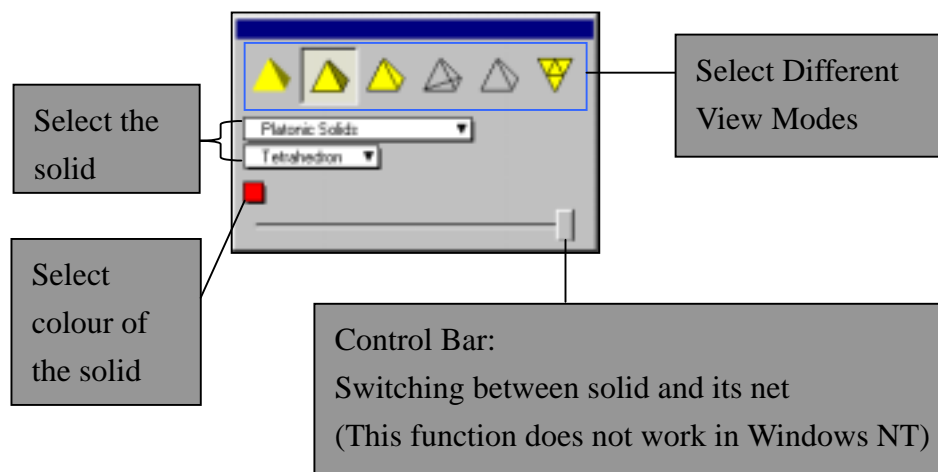
4. Details of different View Modes

   Select **File | Preferences** to choose different View Modes. The following dialogue boxes of **Available View Modes** will appear.

5. Construction of net for model making

   Select the solid you want. Choose the option "Two-dimensional net". Select **View | Printer** to print the net or copy it to the clipboard for further editing.