DIKLAT GURU PENGEMBANG MATEMATIKA SMK
JENJANG DASAR TAHUN 2009

Bahasa Inggris dalam Pembelajaran Matematika

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DEPARTEMEN PENDIDIKAN NASIONAL
DIREKTORAT JENDERAL PENINGKATAN MUTU PENDIDIK DAN TENAGA KEPENDIDIKAN
PUSAT PENGEMBANGAN DAN PEMBERDAYAAN PENDIDIK
DAN TENAGA KEPENDIDIKAN MATEMATIKA
2009

KATA PENGANTAR

Puji syukur kami panjatkan ke hadirat Tuhan Yang Maha Esa, karena atas karunia-Nya, bahan ajar ini dapat diselesaikan dengan baik. Bahan ajar ini digunakan pada Diklat Guru Pengembang Matematika SMK Jenjang Dasar Tahun 2009, pola 120 jam yang diselenggarakan oleh PPPPTK Matematika Yogyakarta.

Bahan ajar ini diharapkan dapat menjadi salah satu rujukan dalam usaha peningkatan mutu pengelolaan pembelajaran matematika di sekolah serta dapat dipelajari secara mandiri oleh peserta diklat di dalam maupun di luar kegiatan diklat.

Diharapkan dengan mempelajari bahan ajar ini, peserta diklat dapat menambah wawasan dan pengetahuan sehingga dapat mengadakan refleksi sejauh mana pemahaman terhadap mata diklat yang sedang/telah diikuti.

Kami mengucapkan terima kasih kepada berbagai pihak yang telah berpartisipasi dalam proses penyusunan bahan ajar ini. Kepada para pemerhati dan pelaku pendidikan, kami berharap bahan ajar ini dapat dimanfaatkan dengan baik guna peningkatan mutu pembelajaran matematika di negeri ini.

Demi perbaikan bahan ajar ini, kami mengharapkan adanya saran untuk penyempurnaan bahan ajar ini di masa yang akan datang.
Saran dapat disampaikan kepada kami di PPPPTK Matematika dengan alamat: Jl. Kaliurang KM. 6, Sambisari, Condongcatur, Depok, Sleman, DIY, Kotak Pos 31 YK-BS Yogyakarta 55281. Telepon (0274) 881717, 885725, Fax. (0274) 885752. email: p4tkmatematika@yahoo.com

Sleman, 11 Mei 2009
Kepala,

Kasman Sulyono
NIP. 130352806

Daftar Isi

KOMPETENSI

Mampu memahami literatur berbahasa Inggris.

SUB KOMPETENSI

- Memiliki kemampuan membaca dan menjelaskan hal-hal yang berkait dengan bilangan dalam bahasa Inggris.

- Memiliki kemampuan membaca dan menjelaskan hal-hal yang berkait dengan geometri dimensi dua dalam bahasa Inggris.

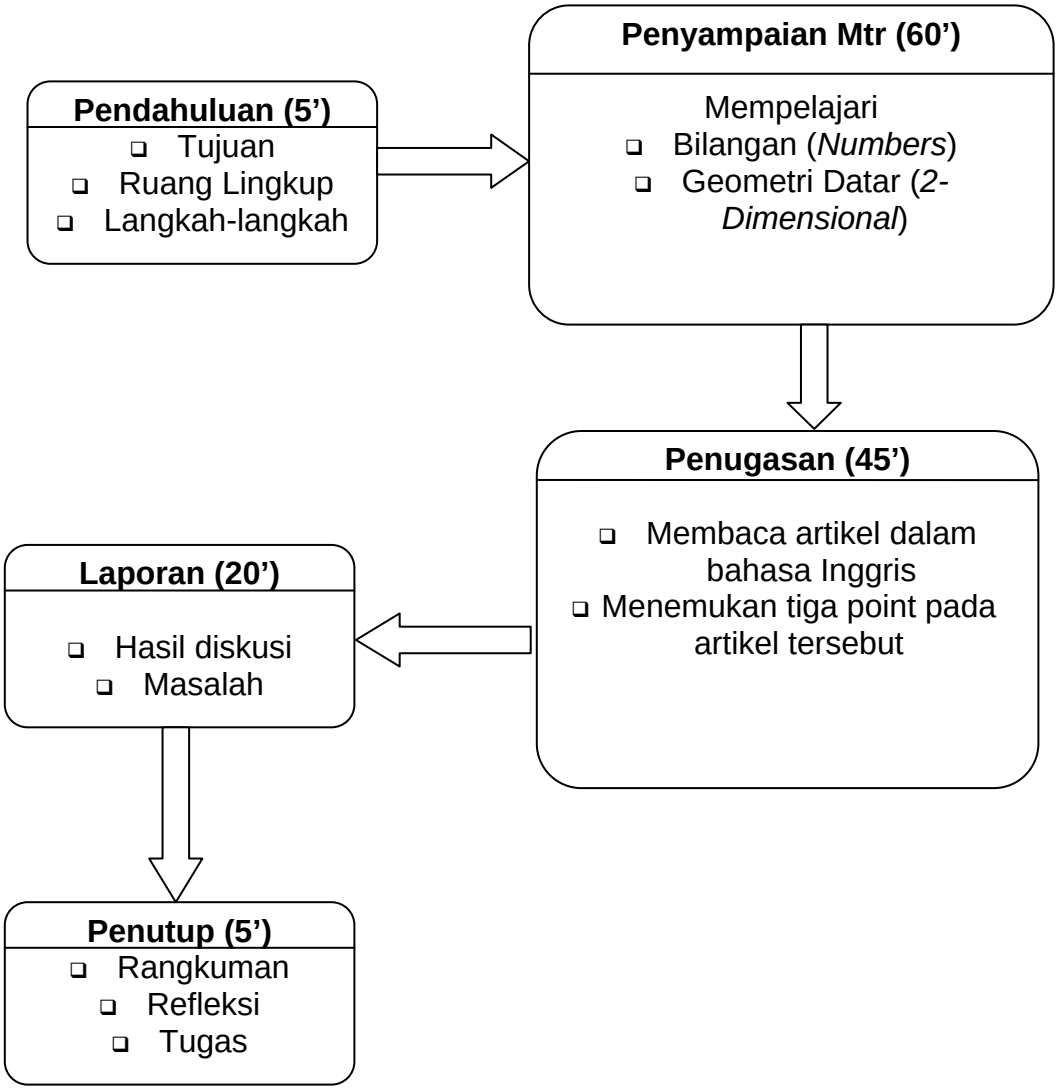
- Memiliki kemampuan membaca artikel dalam bahasa Inggris serta dapat menentukan beberapa point penting pada artikel tersebut.

PETA BAHAN AJAR

Mata diklat untuk jenjang dasar ini membutuhkan pengetahuan prasyarat berupa pengetahuan bahasa Inggris dasar. Pada diklat jenjang dasar ini kepada para peserta hanya diberikan pengetahuan yang berkait dengan bilangan dan istilah pada geometri dimensi dua (geometri datar).

Pada diklat tahap lanjut dan menengah, kepada para peserta diharapkan sudah lebih mampu memahami buku maupun literaratur berbahasa Inggris.

SKENARIO PEMBELAJARAN



Unit I
Introduction

A. Rationale

English is very important, not only for students of SMK (Secondary Vocational School); but also for mathematics teacher of secondary vocational school. The reason is, there are a lot of mathematics or mathematics education books, periodicals, jurnals, video cassette recorders, or films, are written ot talked in english such as:

- *The Art of Algebra* by Abrahamson, D; Gray, M.C. (1971). Adelaide: Rigby Limited.
- 40 *Investigational Work*, by Bastow, B.; Hughes, J.; Kissane, B.; & Randall, R.; (1984). Perth: Mawa.
- *Dictionary of Mathematics* by Borowski, E.J.; Borwein, J.M. (1989). London: Collins
- *7th International Congress on Mathematical Education (ICME-7)*. Topic Group 10: Constructivist Interpretations of Teaching and Learning Mathematics. Perth: Curtin University of Technology.
- *An Introduction to Matrices,Vectors, and Linear Programming (2nd Ed)* by Campbell, H.G. (1977). New Jersey: Prentice-Hall, Inc.
- *Dynamics of Teaching Secondary School Mathematics* by Cooney, T.J.; Davis, E.J.; Henderson, K.B. (1975). Boston: Houghton Mifflin Company.
- *Introduction to Logic* by Copi, I.M. (1978). New York: Macmillan.
- *What is Mathematics* by Courant, R.; Courant, H. (1981) Oxford University Press: Oxford.
- *Mathematical Literacy for Living from OECD-PISA Perspective* by De Lange, J. (2005). Paris: OECD-PISA.

In addition, some of Secondary Vocational School has been or will be declared to be Schools Based International (*Sekolah Berwawasan Internasional* = *SB*I). In those schools, english is used or will be used during the teaching and learning process. In anticipating the situation, mathematics teacher should be provicient in english, written or orally. In other to fulfill the needs, during the inservice training, one of the topic is 'Bahasa Inggris dalam Pembelajaran Matematika' or 'English in Teaching Mathematics.' This materials will be used during the session.

B. Objectives

The general aim of the session is to help mathematics teacher to understand english literature especially in mathematics and mathematics education literature. After the session, the participant will be able to:

- Read and explain the materials concerning numbers.
- Read and explain the materials concerning 2-Dimensional Geometry
- Read and explain the articles written in english.

C. The Used of Materials

The materials are written in such a way that can be learned by participants by themselves. Ideally, the materials can be learned before the session. During the session participants can ask to the tutor (*Widyaiswara*) about those materials, especially the spoken problems.

Unit 2
Numbers

A. 17 (seventeen) is an example of a number. It is a **whole number** or **integer**. A number consists of one or more **digit**. 13, 5, and 35 are **odd** numbers; while 2, 4, and 18 are **even** numbers.

- When we **add** one quantity to another we use the symbol '**+**' (**plus**). The name of this operation is **addition**. The result of this operation is called the **sum.**
- When we **subtract** one quantity to another we use the symbol '**–**' (**minus**). The name of this operation is **subtraction**. The result of this operation is called the **difference.**
- When we **multiply** one quantity to another we use the symbol '**×**' (**multiplied by** or **times**). The result of this operation is called the **product.**
- When we **divide** one quantity to another we use the symbol ':' (**divided by**). The name of this operation is **division**. The result of this operation is called the **quotient.**
- The result of these operation are indicated by the symbol = (**equals**)**.**

Practice 1.A

1. Read out the following
   a. 6
   b. 34
   c. 578
   d. 9.573
   e. 812.934
   f. 1.234.567
   g. 9 + 7 = 16
   h. 78 – 24 = 54
   i. 14 × 27 = 378
   j. 36 : 9 = 4

2. Fill in the blank spaces in the following sentences by using single words.
   a. The ---- of three and four is seven.
   b. The operation which uses the symbol "×" is called ---- .
   c. Twelve ---- six equals two.
   d. The result of a subtraction problem is called the ---- .
   e. An integer is also known as a ---- .
   f. Any number consists of combination of ---- .
   g. Seventeen subtracted ---- twenty equals ---- .
   h. Seven multiplied ---- five equals ---- .
   i. When we ---- two quantities, for example eight plus twelve, the answer (twenty) is called the ---- .
   j. The product is the result when one quantity is ---- another

B. $\frac{4}{5}$ (four fifths or four over five) is an example of a **fraction**. In this fraction, 4 is the **numerator** and 5 is the **denominator**. $\frac{16}{5}$ is an **improper fraction**. $4\frac{4}{5}$ is a **mixed number**.

To add or to subtract vulgar fraction, we must express them in terms of the **lowest common denominator**. For example (e.g.) in this subtraction $\frac{2}{3}-\frac{1}{5}$, the lowest common denominator is 15.

To multiply or divide vulgar fraction e.g. $2\frac{2}{3}\times 2\frac{2}{5}\times 1\frac{3}{4}$, we must first change the mixed number to improper fraction $\frac{8}{3}\times\frac{12}{5}\times\frac{7}{4}$ and then **cancel** where it is possible. Then multiply the numerators and the denominators and express the result as a mixed number.

To write a decimal fraction we use a **decimal point**. For example, if we **convert** $2\frac{1}{4}$ into a decimal fraction, the result is 2,25 (two point two five). if we convert $\frac{2}{3}$ into a decimal fraction, the result is $0,\overline{6}$ (nought point six **recurring**).
17 : 3 = $5,\overline{6}$ or 5,67 **correct to two decimal places**, while π is equal to 3,142 **correct to four significant figures**.

Practice 1.B

1. Read out the following
   a. $\frac{1}{2}$
   b. $\frac{1}{3}$
   c. $\frac{1}{4}$
   d. $\frac{2}{13}$
   e. $\frac{1}{5}\times\frac{1}{3}$
   f. $\frac{1}{3}\times\frac{3}{5}$
   g. $\frac{7}{4}\div\frac{2}{3}$
   h. $3\frac{1}{4}+2\frac{7}{10}=5\frac{19}{20}$
   i. $\frac{2}{3}-\frac{1}{5}=\frac{7}{15}$
   j. $\frac{1}{6}-\frac{1}{8}=\frac{1}{24}$
   k. 81,355
   l. 3,6 + 7,2 = 10,8
   m. 10 : 6 = 1,6
   n. 655 : 3 = 218,3
   o. 6,5 × 42,6 = 276,9
   p. 781,9 + 63,5 = 845,4

2. Using single words, fill in the blank spaces in the following sentences:
   a. In the vulgar fraction seven ninths, ---- is the denominator and ---- is the ---- .
   b. To ---- a vulgar fraction to a decimal fraction, we simply ---- the numerator by the denominator.
   c. The ---- ---- ---- of two third and a half is six.
   d. An integer plus a fraction makes a ---- ---- .
   e. An improper fraction exists when the ---- is greater than the ---- .
   f. To multiply a decimal fraction by ten, we simply move the ---- ---- one place to the right.
   g. 57,074 correct to ---- ---- ---- is 57,1.

h. To add or subtract vulgar fraction, we must ---- them in ---- ---- their lowest common denominator.
i. To devide a decimal fraction by ---- we simply move the decimal point one ---- to the ---- .
j. $\frac{5}{2} \times \frac{2}{9}$ becomes $\frac{5}{9}$ if we ---- the two's.

C. If in a given classroom, there are fourteen boys and seven girls, we say that the **ratio** of girls to boys is 1 : 2 (one to two).

When we build a model ship, we make it to **scale**. For example, if a model is built to scale of 1 : 30 (one to thirty), this mean that 10 centimeters on the model **represent** 300 centimeters on the ship itself. The scale of a map shows the ratio of the distance on the map to the distance on the area covered by the map. On a map this ratio is called the **representatives fraction**.

3 : 6 (three to six) and 5 : 10 (five to ten) are two equal ratios, in other words 3,6 and 5,10 are **in proportion**, **in direct proportion**, or **directly proportional**. If it takes 5 men one hour to do a job, and 10 men half an hour to do the same job, we can say that the number of men and the time are in **inverse proportion**, or that these quantities are **inversely proportional**.

36% (thirty-six **percent**) is really a fraction with a numerator of thirty-six and a denominator of one hundred. The farction $\frac{8}{40}$ **expressed as a percentage** is 20%. If a number is **decreased** by 10%, the ratio of the new number to the old number is 90 : 100. If a number is **increased** by 10%, the ratio of the new number to the old number is 110 : 100. If we borrow a sum of money at a **rate of interest** of 10%, we must pay back the money in the same proportion. If a student scores 81% in one exam and 87% in the next, his **average** (or **mean**) **percentage** is 84%.

Practice 1.C

1. Answer these question.
   a. Which fraction with a denominator of sxteen is in proportion to one over four?
   b. If a plan is drawn to a scale of 1 : 50 (one to fifty), what is the actual measurement which is shown on the plan as four centimetres?
   c. Divide one hundred and forty sheep into two groups in the ratio of 3 : 4.
   d. The scale of a map is five centimetres to one kilometre. What is the representative fraction of the map?
   e. On the same map, what length will represent nine kilometres?
   f. Divide thirty-six pounds into three parts in the ratio 6 : 5 : 1.
   g. Five families have a total of 100 sheep. How many sheep will six families have if the numbers are in proportion?
   h. A concrete mix of cement, sand and gravel is made in the ratio of 2 : 5 : 8. What is the weight of each part in thirty tonnes of concrete?
   i. In a class of student the ratio of successes to falures in an examination was 9 : 2. If eighteen students passed the examination, how many failed?
   j. If ten litres of oil weigh eight kilograms, and a litre of water weighs one kilogram, what is the ratio of the relative density of oil and water?

2. Answer these question.
   a. What is four and a half percent of eight hundred people?
   b. What is thirty percent of fifty?
   c. Express fifty-six as a percentage of seventy.
   d. What percentage is four fifths?
   e. What fraction is seventy-five percent?
   f. What decimal fraction is sixty-three point nine percent?
   g. What is the ratio of men to women if sixty percent are men?
   h. How much interest has a bank been paid if it receives a total of six fifths of the sum borrowed?
   i. In a class of twenty-five students, twenty come to school by bus and five by car. What is the ratio of those who come by car to those who come by bus, and what percentage of the class does each group represent?
   j. The numerator of a fraction is 6. This numerator is equal to thirty-three point three recurring percent of the denominator. What is the fraction?

3. Fill in the blank spaces in the following sentences:
   a. To convert a ---- to a fraction, divide ---- 100.
   b. If three metres of material cost 225 units of money and eight metres cost six hundred units of money, the lengths and prices are ---- ---- .
   c. If the plan of building is drawn to a ---- of 1 : 65, one centimetre on the plan ---- sixty-five centimetres on the building.
   d. In a certain country, rainy days and dry days are in the ---- 1 : 7.
   e. If we wish to ---- a vulgar ---- as a ---- , we must ---- by one hundred.

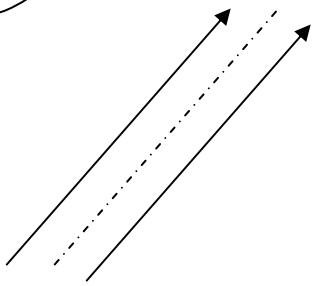
Unit 3
2-Dimensional Figures

A. This line is **horizontal**.

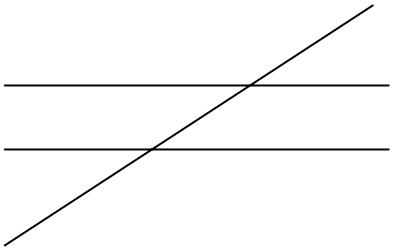
This line is **vertical**.

This line is **oblique**.

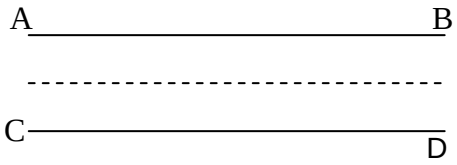
These lines are **curved**.



These two lines are **parallel**. They are **equidistant** at all points.



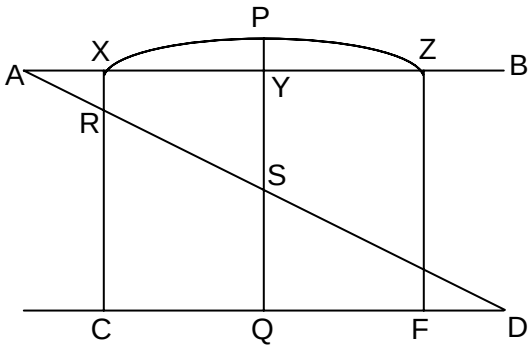
A straight line drawn across a set of two or more parallel lines is called **transversal**.



The broken line marks the **locus** of a point equidistant from AB to CD. The locus of a point is the the path traced by that point when it moves in accordances with a given law.

Practice 2.A

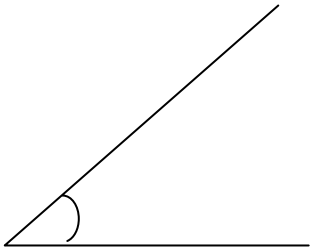
1. Look at the figure and say which lines are:
   a. vertical
   b. transversal
   c. parallel
   d. oblique
   e. horizontal
   f. curved

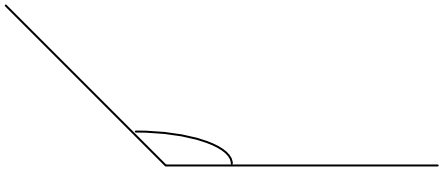


2. Using the word you have learned, describe the following mathematical symbols.

a. the plus symbol
b. the minus symbol
c. the multiplication symbol
d. the equals symbol
e. the pi symbol

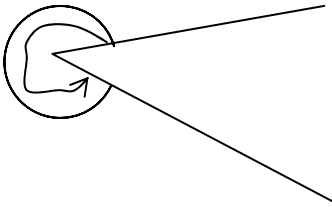
B. These two lines **meet at an angle**. This angle is less than 90° (ninety degrees). It is an **acute** angle.





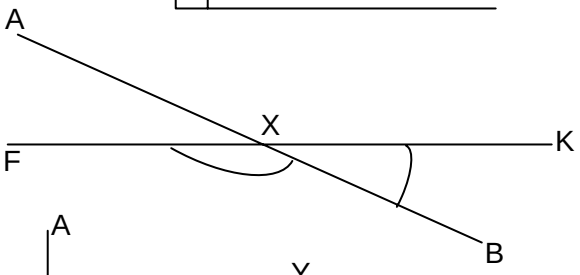
This is an **obtuse** angle.

This is a **reflex** angle.

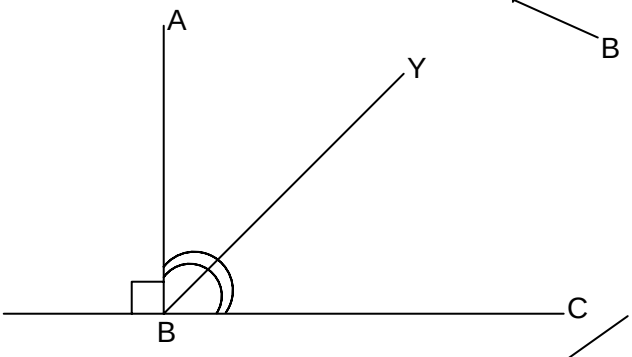


These two lines meet at an angle of 90°. They form a **right angle**. The two lines are **perpendicular** to each other.

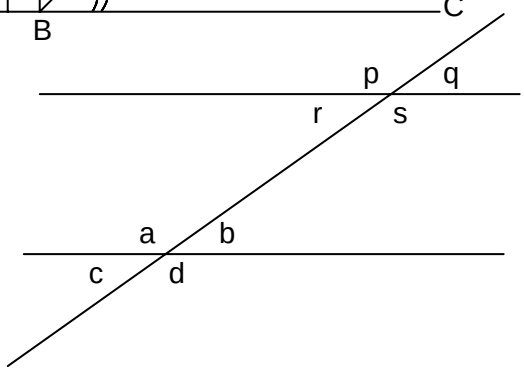
Lines FK and AB **intersect** at point X. The angles FXB and BXK are next to each other, or **adjacent**. The sum of these angles is 180°. They are **supplementary** angles.



Angles ABY and YBC are equal. Line BY **bisect** angle ABC. BY is the **bisector** of angle ABC. The sum of angle ABY and YBC is 90°. They are **complimentary** angles.



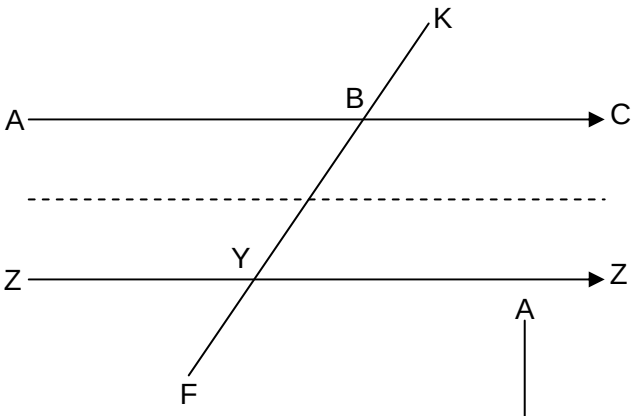
This figure shows a transversal line drawn across two parallel lines. Angles r and q are equal (**opposite** angles). Angles b and q are equal (**corresponding** angles). Angles b and r are equal (**alternate** angles).



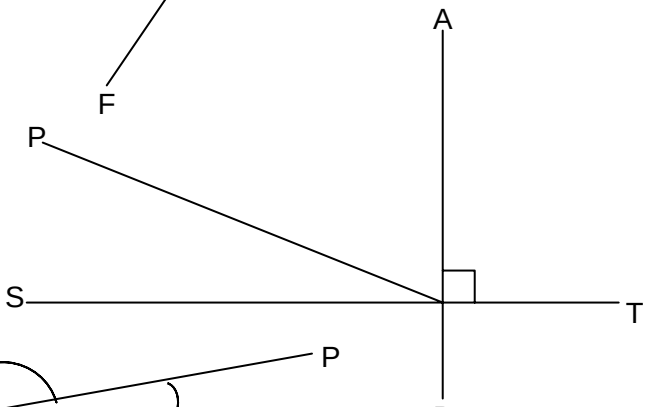
Practice 2.B

1. Describe the lines and angles in the following figures.

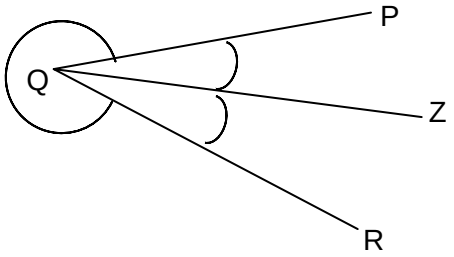
a. .



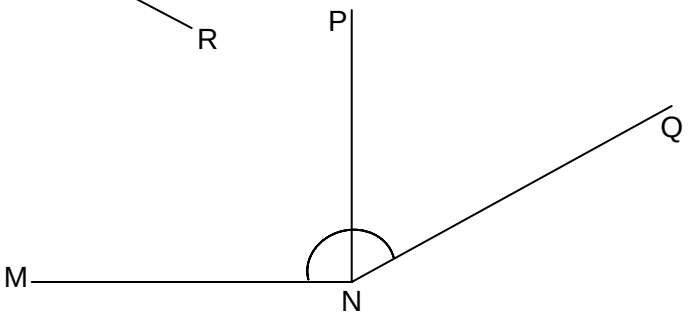
b. .



c. .

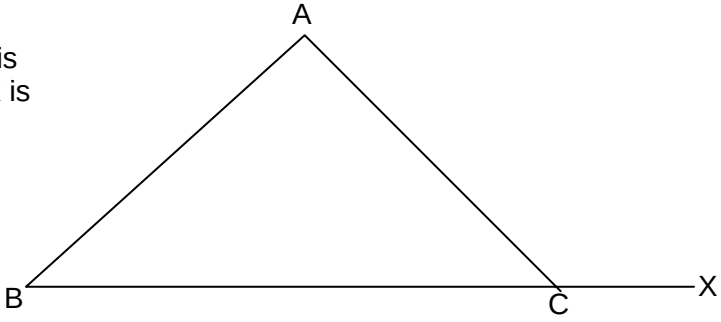


d. .

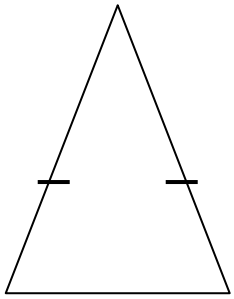


C. A triangle is a three-sided figure. The three sides of a triangle meet at points called **vertices** (singular: **vertex**). The vertex at the top of a triangle may be called the **apex**, and the line at the bottom may be called the **base**.

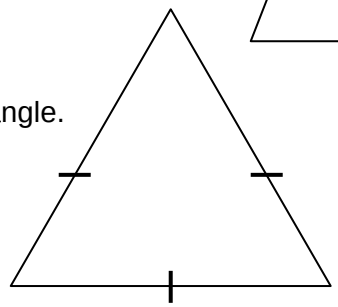
In triangle ABC, line BC is **produced** to point X. ACB is an **interior** angle, and ACX is an **exterior** angle.



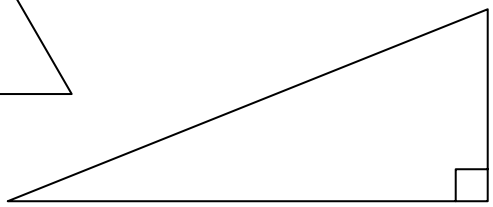
This is an **isosceles** triangle.



This is an **equilateral** triangle.



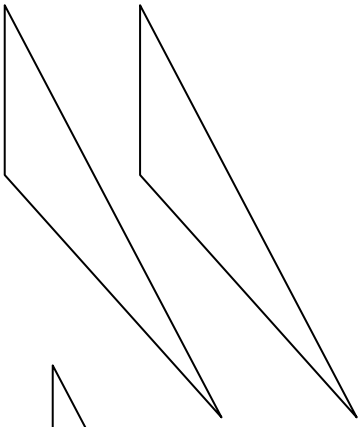
This is a **right angled** triangle. In a right angled triangle the side opposite the right angle is called the **hypotenuse**. The **theorem** of Pythagoras states:
"In a right angled triangle the square on the hypotenuse is equal to the sum of the squares on the other two sides."



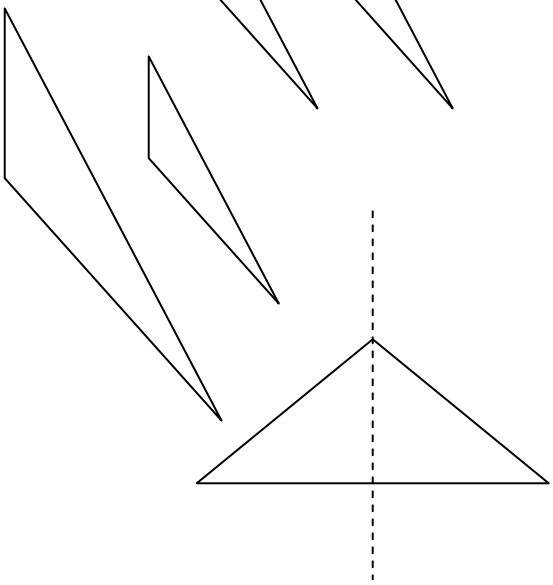
If the following parts of two triangles are equal,

a. two sides and the **included** angle; or
b. a right angle, hypotenuse, and side; or
c. two angles and a **corresponding** side; or
d. all three sides;

then the two triangles are **congruent**.



If two triangles have their corresponding angles equal, they are **similar**.

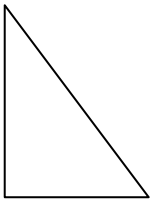


These two triangles are on either side of an **axis of symmetry** (or **centre line**). They are **symmetrical** triangles.

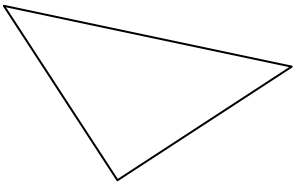
Practice 2.C

1. Describe each triangle, and use your ruler to discover any relationships between the triangles (i.e. symmetry, similarity, or congruence)

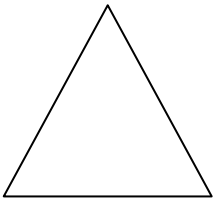
a. .



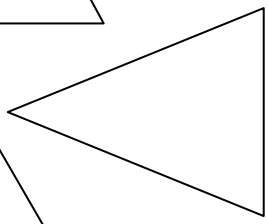
b. .



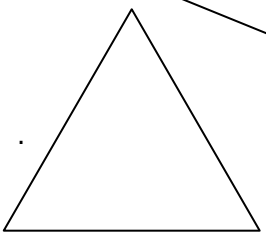
c. .



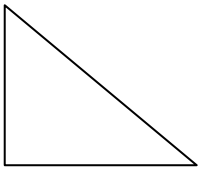
d. .



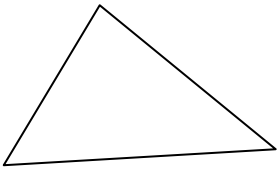
e. .



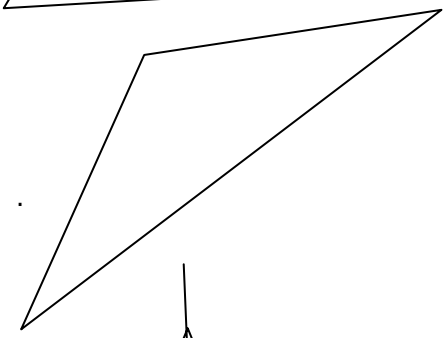
f. .



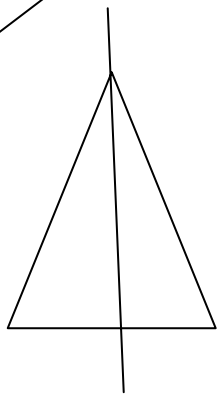
g.



h. .

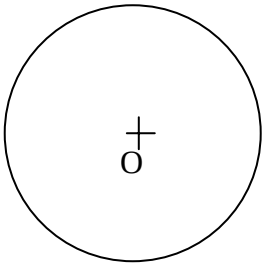


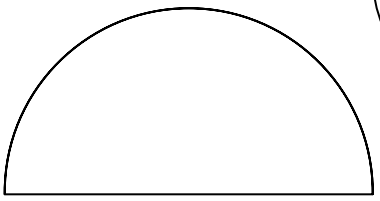
i. .



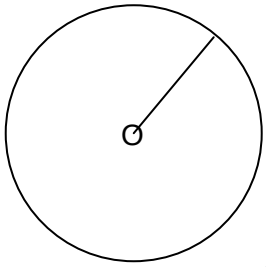
2. Using the word you have learned, fill in the blank spaces in the following sentences.
   a. If each of the angles in a triangle is equal to 60°, the triangle is called ---- .
   b. A line which meets another ---- at 90° is called a ---- line.
   c. If two angles of a triangle are equal to 45°, the triangle is called a ---- triangle.
   d. If we ---- a right angles, we have two ---- angles of 45°.
   e. Each triangle has three points, or ---- .

D. This is a **circle**. The centre of a circle is called its **point of origin**. The distance around a circle is called its **circumference**.



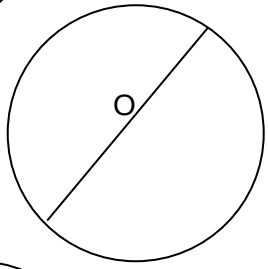


A half circle is called a **semi-circle**.

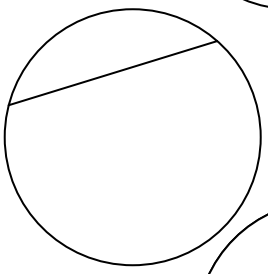


The line drawn from the point of origin to the circumference is called the **radius** (plural: **radii**).

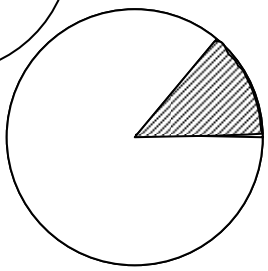
The line drawn from one side of the circle to the other, passing through the point of origin to the circumference, is called the **diameter**.



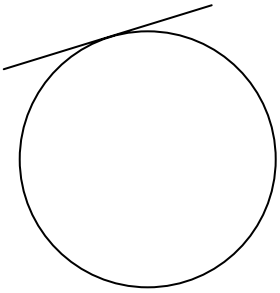
A part of the circumference of a circle is called an **arc**. A straight line joining the ends of an arc is called a **chord**. The part of a circle enclosed by an arc and a chord is called a **segment**.



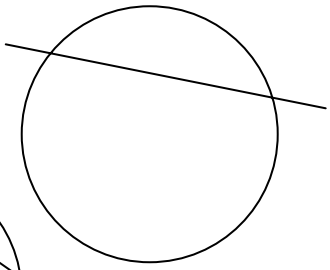
A part of a circle enclosed by two radii and an arc is called a **sector**.



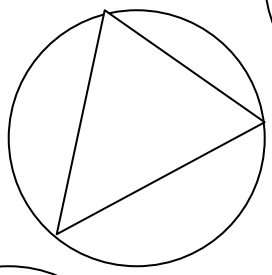
A line meeting the circumference but which (when **produced**) does not intersect it is called a **tangent**.



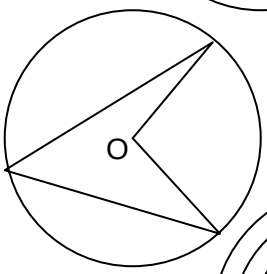
A line which intersects the circumference in two places is called a **secant**.



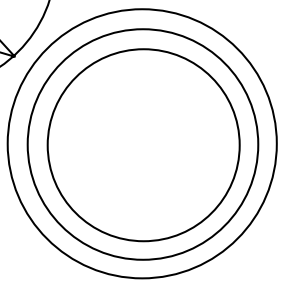
A circle which passes through the vertices of a triangle is called the **circumcircle** of the triangle, and its centre is called its **circumcentre**. The circle is **circumscribed** around the triangle.



The angle **subtended** at the centre by an arc of a circle is equal to twice the angle subtended by that arc at the circumference.



These circles have the same point of origin.



They are **concentric**.

Practice 2.D

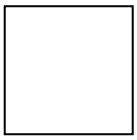
1. Do these task.

    a. A circle has a radius of 3 centimeters. Calculate:
        i. the diameter
        ii. the circumference.
    b. A circumference of a circle is approximately 15,7 cm. Calculate:
        i. the approximate radius
        ii. the approximate diameter.
    c. What is the angle subtended by a semi-circle equal to?
    d. The angle subtended by an arc at the circumference is 35°.
        i. What is the angle subtended by the same arc at the point of origin.
        ii. How can you calculate the answer to (i)?
    e. If two chord of a circle, AB and CD, intersect at O, what is the relationship between AO × OB and CO × OD?

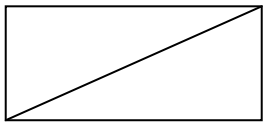
2. Using the word you have learned, fill in the blank spaces in the following sentences.
    a. If we draw the ---- of a circle, the line divides the circle into two equal ---- .
    b. ---- circles are circles which have the same ---- of ---- .
    c. A semi-circles ----- an angle of 90° at the ---- .
    d. A triangle has been ---- if a circle passes through its ---- .
    e. A ----- is the area enclosed by an arc and two ---- , while a ---- is the area enclosed by an arc and a ---- .
    f. If a line passes through a circle and intersects the circumference, it is called a ---- , but a ---- meets the circumference without intersecting it.

E. A line is **1-dimensional**. Triangles and circle are **2-dimensional**. Here are some more 2-dimensional figures.

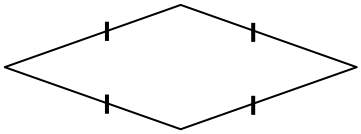
This is a **square**. Objects shaped like a square are **square**.



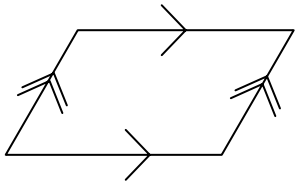
This is a rectangle. Objects shaped like a **rectangle** are **rectangular**. The line drawn from one corner to the opposite corner is called the **diagonal**.



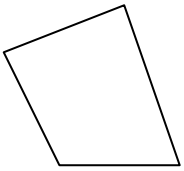
This is a **rhombus**.



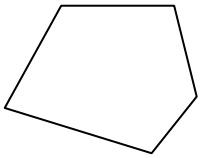
This is a **parallelogram** or **rhomboid**.



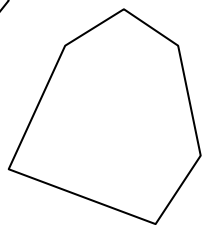
This is a **quadrilateral** or **quadrangle**.



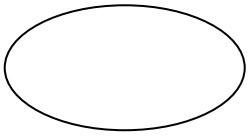
This is a pentagon. Objects shaped like a **pentagon** are **pentagonal**.



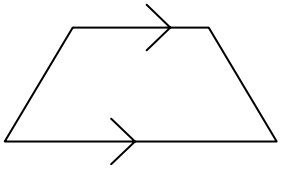
This is a **hexagon**. Objects shaped like a hexagon are **hexagonal**.



This is an **ellipse**. Objects shaped like a ellipse are **elliptical**.



This is an **trapezium**.



Note:

A figure with many, or an unspecified number of, sides is called **polygon**.
A four-sides figure which is circumscribed by a circle called **cyclic quadrilateral**.
The sum of the sides of a two dimensional figure is called the **perimeter**.

Practice 2.E

1. Using the word you have learned, fill in the blank spaces in the following sentences.
   a. A ---- is a ---- with six sides.
   b. A four-sided figure is called a ---- .
   c. A shape with five sides is a ---- .
   d. A four-sided figure with two sides parallel is called a ---- .
   e. A rhomboid has two ---- and two ---- angles.
   f. The ---- of the ---- angles of quadrilateral is equal to 360°.
   g. A ---- may be called an equilateral rectangle.
   h. If two ---- of a parallelogram are vertical, the other two are ---- .
   i. A ---- which has length and width is ---- - ----
   j. A figure with four equal ---- but no right angles is called a ---- .

Unit 4
Reading

This article was written by Fadjar Shadiq in 1987 and published in SAMEN (Science and Mathematics Education Newsletter) as bulletin news of SMEC (Science and Mathematics Education Centre), Curtin University of Technology, Perth, Western Australia.

Please find out three important points from the article.

WHAT RESEARCH SAYS ABOUT MATHEMATICAL PROBLEM SOLVING

The development of the ability to solve problems has long been recognized as one of the major goals of mathematics education. Every individual in our society is faced with making decisions, they must have the ability to think creatively, laterally, divergently, rationally, objectively, and systematically. Teaching mathematical problem-solving means teaching how to: define the problem to be solved, devise a plan, choose appropriate strategies, collect and analyze relevant information, evaluate relevant information, evaluate the results and make decisions.

A problem was defined by Cooney, Davis & Henderson (1975) as: "… a question which presents a challenge that *cannot* be resolved by some *routine* procedure known to students." Two types of problems have been identified (Charles, 1982: le Blanc, Proudfit & Putt, 1980): (1) standard textbook (translation) problems, and (2) process problems. In solving *translation problem*, the emphasis is on translating a real word situation in the problem into mathematical terminology or mathematical sentence in the solution. The Translation problem requires only the application of skills, principles, or concepts known to students, while the *process problem* requires, in addition, the use of strategy or some non-algorithmic approach. Process problems emphasize the process of obtaining the solution rather than solution itself.

Solving problems is one of the most difficult activities in the mathematics curriculum at all grade levels. The *National Assessment of Educational Progress (NAEP)* reported in 1988 that only 29 percent of large national sample of 17-years-old in the USA were able to solve the following problem:

> Lemonade cost 95c for one 56 once bottle. At the school fair, Bob sold cups holding 8 ounces for 20c each. How much money did the school make on each bottle?

In 1980, the National Council of Teachers of Mathematics (NCTM) recommended that problem-solving should be the focus of the school mathematics in the United States. Although problem-solving is one of the major goals of mathematics education many students still have difficulties with this important task. The performance of United States' students increased from NAEP II to NAEP IV. However, in reporting the fourth NAEP results Kouba et al (1988) stated: "Students have trouble with items that do not involve routine, familiar tasks."

WHAT IS NEEDED IN SOLVING PROBLEMS

Shoenfeld (1985), in his book Mathematical Problem Solving, described four requirements for solving mathematical problems:

1. *Resources*. Mathematical knowledge possessed by the individual that can be brought to bear on the problem at hand.
2. *Heuristic*. Strategies and techniques for making progress on unfamiliar or nonstandard problems; rules of thumb for effective problem solving
3. *Control*. Global decisions regarding the selection and implementation of resources and strategies.
4. *Belief Systems*. One's mathematical world view", the set of (not necessarily conscious) determinants of an individual's behavior.

Problem solving activities in school focus mostly on instructional techniques such as problem-solving strategies, Polya's four steps method (understanding, the problem, devising a plan, carrying out, and looking back), and the teaching of computer programming languages such as LOGO or BASIC (Frank, 1988). This means that research on the teaching of problem-solving has been concerned largely with heuristics, rather than with other requirements such as students' beliefs system.

Students' beliefs, views, ideas, and conceptions of mathematics are developed in the classroom over a long period. Inevitably, students' beliefs about mathematics can help or hinder them as good problem solvers. (Garafalo, 1987; Erlwanger, 1975). Research on students' beliefs about mathematics has revealed: mathematics to be regarded as computation (Frank, 1988), rule based (NAEP IV), and mostly memorizing (NAEP IV); formal mathematics has little or nothing to do with real thinking (Schoenfeld, 1985); the primary aim in mathematics is to get the answer (Confrey, 1980; Frank, 1988); and mathematics problems are solved in less than 10 minutes (Schoenfeld, 1985) and in a few steps (Frank, 1988).

As mathematics teachers, one of our tasks is to help students to develop an awareness of their cognitive functioning, so that they are better able to control and regulate their cognitive actions during their problem solving activities. Teaching strategies are required to focus students' attention on their assumptions and beliefs. For example, teacher question such as: "Why did you use this strategy?"; "Are you sure about this pattern?"; "What happens if x is a negative number?", or "Why do you think you usually make this error?" can help students to become more aware of their cognitive functioning as a first step towards evaluating and modifying it.

Recent research has attempted to find ways of better shaping students' beliefs about mathematics. Frank (1988) suggested four strategies for mathematics teachers to help their students develop positive beliefs about mathematical problem-solving activities:

1. *Start problem-solving early*
2. *Be sure your problems are problems, i.e., non-routine*
3. *Focus on solution, not answer*
4. *de-*emphasize computation

IMPLICATION FOR MATHEMATICS EDUCATION IN INDONESIA

The Indonesian Department of Education and Culture (Depdikbud, 1987) formulated the following aims of mathematics teaching for primary and secondary school students:

(a) to enable learners to be able to successfully tackle situations in their changeable lives, through action training based on thinking; logically and rationally, critically and accurately, objectively, creatively, and effectively
(b) to enable learners to apply their knowledge of mathematics correctly in their daily lives and in other subjects

The first aim can be achieved if students learn how to solve process problems which require logical, rational, creative, and systematic thinking, and ingenuity in conception and reflection. The second aim can be attained if students also learn how to solve translation problems which emphasize translating real-world situations into mathematical terminology and solving the problem by using mathematical principles or mathematical concepts.

Since 1982, problem-solving has been discussed during the in-service and On-service training courses for secondary school mathematics teachers. In 1987, the team of Indonesian instructors of mathematics provided a collection of problems appropriate for secondary school students. However, the intended curriculum, which is prescribed in the national syllabuses, must be completed on time. This forces teachers to focus on the products, or learning outcomes rather than on processes such as problem-solving. This is compounded by mathematical instruction which is focused too much on content and not enough on mathematical behavior.

We need to change this situation. Indonesian students must be active learners rather than mere knower of mathematical fact and procedures. Mathematics teachers in Indonesia should committed to their primary mission to help learners to be better problem-solvers. This commitment is based on our mathematics teaching aims. Based on the research findings described above we should be aware that mathematical problem-solving instruction should not focus on only on resources and heuristics, but also on students' belief system.

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