Ministry of Transport and Communications of Ukraine

ODESSA NATIONAL ACADEMY OF TELECOMMUNICATION
named after A.S. Popov

Department of Informatization and Operation

WORKBOOK
ENGINEERING GRAPHICS
For Bachelors
Specialization in Telecommunications

Approved by Board of Educational Scientific Institute "CTA and L"
Protocol № 16, May 19, 2009

Odessa 2009

UDK 515.2

Tregubova I.A., Kabatsura I.S. : Workbook, Engineering Graphics for Bachelors.- Odessa: ONAT named after A.S. Popov, 2009.- p.

Reviewer: Doctor of Engineering, Professor D.A. Zaitsev;

Editor: Golub N.N.

BASIC RULES OF DRAWINGS DESING ACCORDING TO STANDARDS OF GENERAL SYSTEM OF CONSTRUCTION DOCUMENTATION (GSCD) AND SOME GEOMETRICAL DRAWINGS

P a r t I

1 DESING OF DRAWING SHEETS

1.1 Formats (The State Standard 2.301-68)

Sizes of drawing sheets are selected depending on overall size of the drawing, but is not arbitrary a random choice. Five basic formats of drawings are confirmed by the standard, there are A0, A1, A2, A3, A4 (The State Standard 2.301-68). Sometimes it is necessary to use format A5 (148×210 mm).

The area of format A0 (841×1189) is equal to $1m^2$. Other formats can be received by consequent dividing of format A0 into two equal parts that are parallel to the smaller side of the corresponding format. Format A4 (210×297) may be taken as a unit of measurement for other formats.

Other formats are formed by increasing of short side of basic formats on value that is multiple to its sizes.

The drawing is designed by frame that is drawn by a basic line at the distance of 5 mm from a line of the format edge line. On the left there is a field of 20 mm. The basic caption is situated in the right bottom corner of a drawing field (figure 1.1).

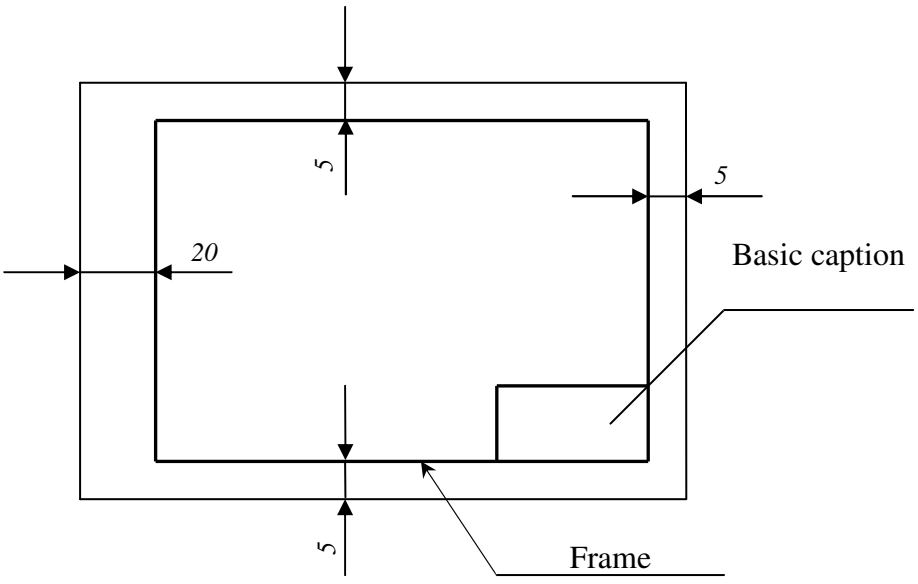


Figure 1.1

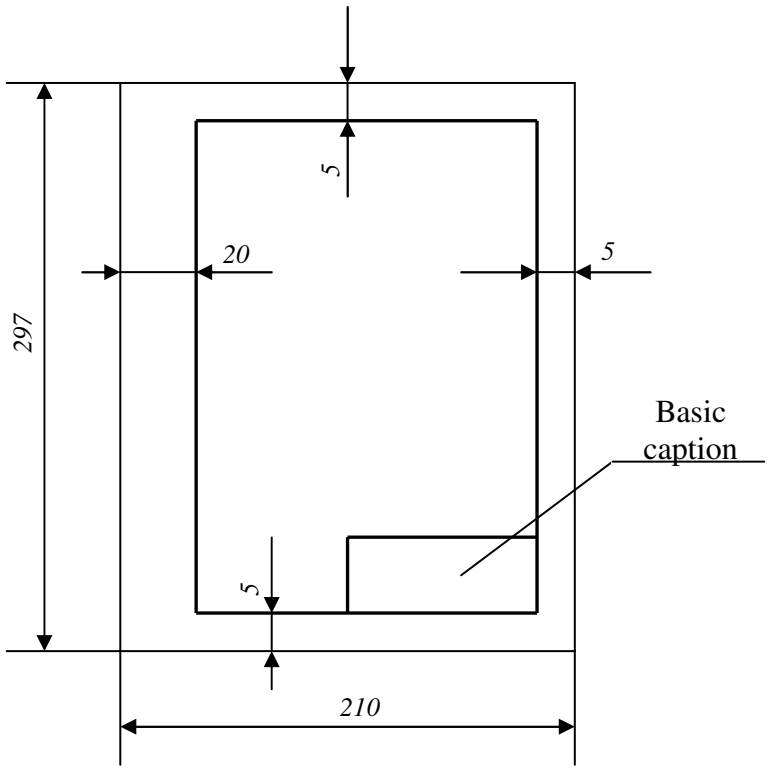


Figure 1.2

Table 1.1 - Sizes of the basic formats

Marking of format	**Sizes of format , mm**
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297

The task: fill in the table sizes of the basic formats using the type №5

A0		***A3***	
A1		***A4***	
A2		***A5***	

1.2 Scales (The State Standard 2.302-68)

A ratio of image linear sizes on a drawing to its real sizes is called scale.

It is better to draw the image in the way that its sizes are equal to object sizes. This scale is called “True size” (1:1).

Depending on the drawing size and object size complexity it is necessary to use “Oversize” or “Downsize” in comparison with the real sizes.

Except the numerical there are linear and angular scales.

The State Standard 2.302-68 has established the following scales:

Downsize	1:2, 1:2,5; 1:4, 1:5, 1:10, 1:15, 1:20, 1:25, 1:40, 1:50, 1:75, 1:100, 1:200, 1:400, 1:500, 1:800, 1:1000
True size	1:1
Oversize	2:1, 2,5:1, 4:1, 5:1, 10:1, 20:1, 40:1, 50:1, 100:1

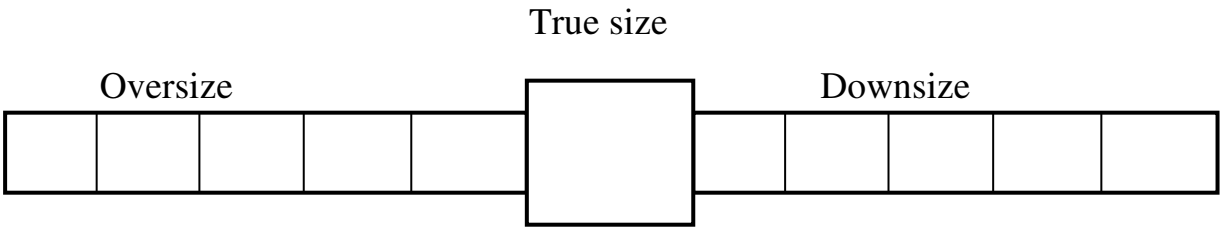
While designing large objects it is possible to use the following scales: 1:2000; 1:5000; 1:10000; 1:20000; 1:25000; 1:50000.

In some cases it is possible to use “Oversize” (100n), where n - an int.

The scale is pointed out without letter “M” in the basic caption with the State Standard 2.316-68 "Drawing rules of drawing captions of technical requirements and tables", which concerns to the image, for example:

$$\frac{A-A}{M1:2};\quad \frac{Buд\ A}{M5:1}\quad \frac{1}{M10:1}.$$

The task: fill in the table different types of scales using the type №5



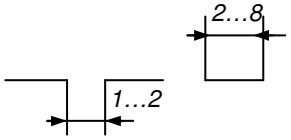
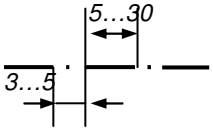
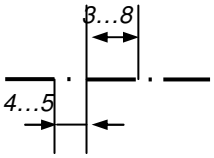
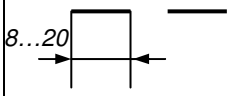
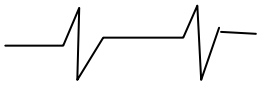
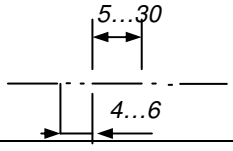
1.3 Drawing lines (The State Standard 2.303-68)

Thickness of all types of a line depends on the thickness of the basic line S used in the drawing. Visible contour lines can be taken within limits from 0,5 up to 1,4 mm. It depends on size and complexity of the drawing. Chosen thickness of other lines should be the same for all images on the drawing.

The strokes length of stroke-lines should be chosen depending on size of the image. Strokes and intervals between strokes in a line should be of approximately identical to the length.

If circle diameter or other geometrical figures sizes in an image are less than 12 mm, the strokes-dashed lines should be replaced with continuous thin lines.

The task: write down purpose of lines by standard type

Name	*Image*	*Thickness of lines*	*Main purpose*
1. Continuous thick basic line		*S*	
2. Continuous thin line		*from S/2 to S/3*	
3. Continuous wavy line		*from S/2 to S/3*	
4. Stroke line		*from S/2 to S/3*	
5. Stroke-dotted line		*from S/2 to S/3*	
6. Stroke-dotted thicken line		*from S/2 to 2/3S*	
7. Open-ended line		*from S to 3/2S*	
8. Continuous thin broken line		*from S/2 to S/3*	
9. Stroke-dotted with two points, thin		*from S/2 to S/3*	

1.4 Drawing types (The State Standard 2.304-81)

All captions on drawings should be implemented by a type according to the State Standard 2.304-81.

The type size h - is a value which is defined by capital letters height in millimeters. The height of capital letters is measured perpendicularly to the basis of the line

The following sizes are accepted: 1,8; 2,5; 3,5; 5; 7; 10; 14; 20; 28; 40.

The State Standard 2.304-81 accepts four kinds of type:

Type A without angle (d=h/14);

Type A with angle 75^{o} (d=h/14);

Type B without angle (d=h/10);

Type B with angle 75^{o} (d=h/10).

The type defines type parameters: distance between letters, minimum line step, minimum distance between words and lines, thickness of type.

Parameters of types are shown in table 4.1.

Height of small letters for the type of type A is 10/14 out of size h.

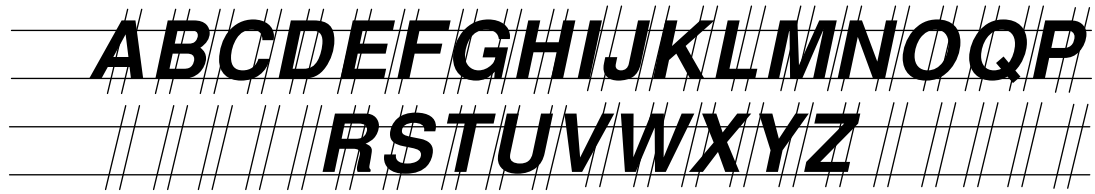
Distance between letters in a word for type of type A is defined by relation (2/14) h, the minimum distance between words is (6/14) h, and the minimum step of lines is (22/14) h.

It is not recommended to use type 1,8. It would be supposed only for type B.

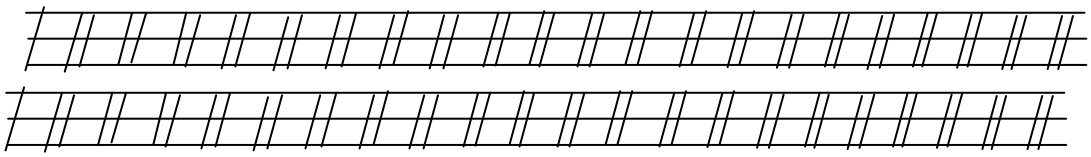
Besides, the standard specifies the form of capital and small letters of Russian, Ukrainian Latin and Greek alphabet, Arabian and Roman figures, various signs and rule for writing fractions, indicators, indexes and deviations.

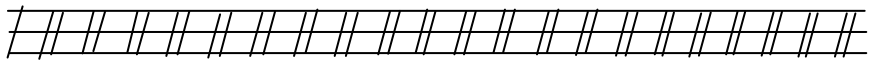
Table 1.2 - Type parametres

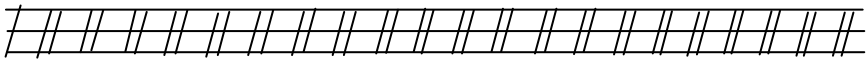
Type parametres		Desig-nation	Type size **in mm.**									
Type size		*h*	1,8	2,5	3,5	5	7	10	14	20	28	40
Height of capital letters and numerals		*h*	1,8	2,5	3,5	5	7	10	14	20	28	40
Height of small letters		*c*	1,3	1,8	2,5	3,5	5	7	10	14	20	28
Thickness of lines of a type	**A**	*d*	-	0,18	0,25	0,35	0,5	0,7	1,0	1,4	2,0	2,8
	B		0,18	0,25	0,35	0,5	0,7	1,0	1,4	2,0	2,8	4,0
Width of letters	**A**	*g*	-	1,1	1,5	2,1	3	4,2	6	8,4	12	16,8
	B		1,1	1,5	2,1	3	4,2	6	8,4	12	16,8	24
Distance between letters	**A**	*a*	-	0,35	0,5	0,7	1,0	1,4	2,0	2,8	4,0	5,7
	B		0,35	0,5	0,7	1,0	1,4	2,0	2,8	4,0	5,7	8
Minimum step of lines	**A**	*b*	-	4,0	5,5	8,0	11,0	16,0	22,0	31,0	44	61,6
	B		3,1	4,3	6,0	8,5	12,0	17,0	24,0	34,0	47,6	68
Minimum distance between words	**A**	*e*	-	1,1	1,5	2,1	3	4,2	6	8,4	12	16,8
	B		1,1	1,5	2,1	3	4,2	6	8,4	12	16,8	24

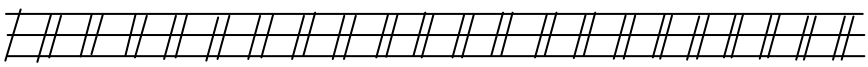


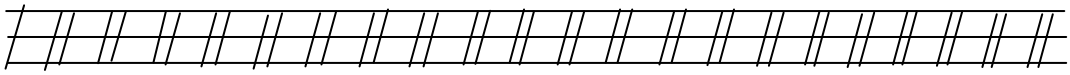
The task: write the above-given example using type size 7











1.5 Basic caption (The State Standard 2.104-68)

Current standard establishes forms, sizes, order of filling the basic captions and additional columns to them in design documents specified by the standards of the General System of Construction Documentation.

Content, location and sizes of columns of the basic captions, additional columns to them and sizes of frames on drawings and schemes should correspond to the form 1, and in text documents to forms 2, 2a.

It is allowed to use form 2 for the following pages of drawings and schemes.

The basic caption and frame are made with continuous basic and continuous thin lines according to the State Standard 2.303-68.

The basic caption is located in the right bottom corner of design documents.

On sheets of format A4 of the State Standard 2.301-68 the basic captions are along the short side of the sheet.

In columns of the basic caption and additional columns (numbers of columns on the form are given in brackets) the following is specified:

In column 1 - the product name (according to the State Standard 3.109-73), and the document name if the code is given to this document ;

In column 2 - document designation;

In column 3 - definition of material of a detail (the column is filled only on drawings of details);

In column 4 - the letter given to the document;

In column 5 - weight of product according to the State Standard 2.109-73;

In column 6 - scale (according to the State Standard 2.302-68 and the State Standard 2.109-73);

In column 7 - sheet serial number;

In column 8 - total number of sheets;

In column 9 - name or index of the enterprise which issued the document;

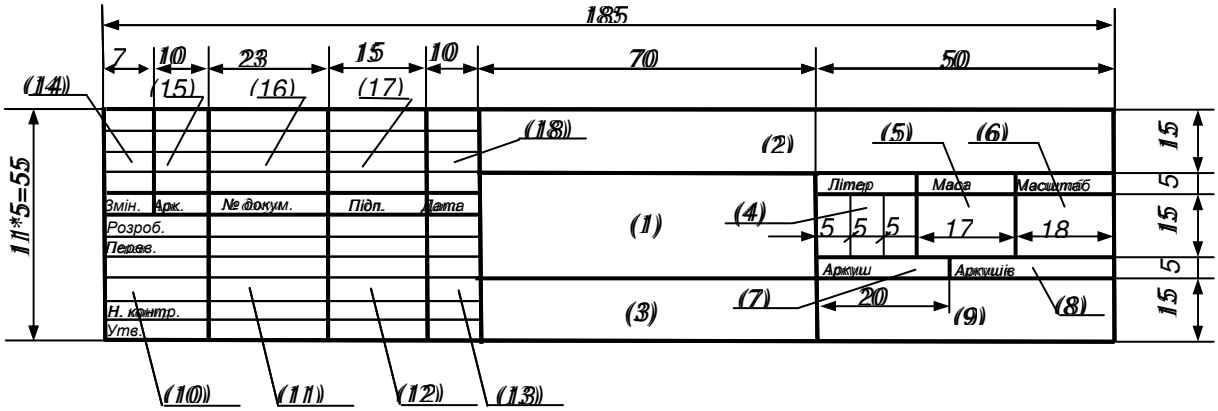
In column 10 - character of work, performed by a person signing the document (Chief of department, Chief of laboratory);

In column 11 - last names of persons who has signed the document;

In a column 12 - signatures of persons whose names are indicated;

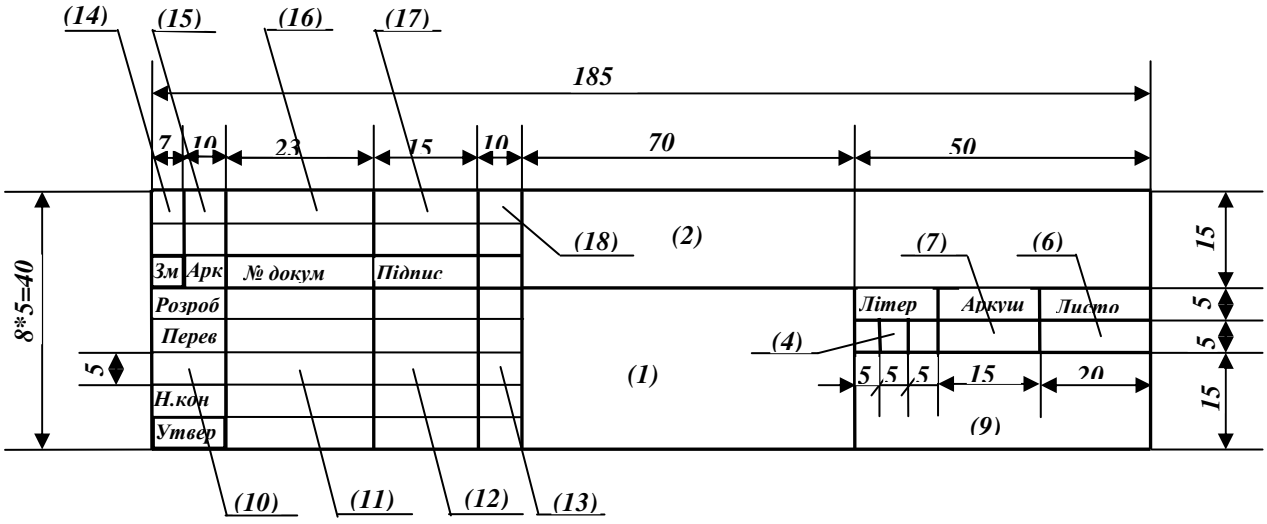
Form 1

Basic caption for drawings and schemes



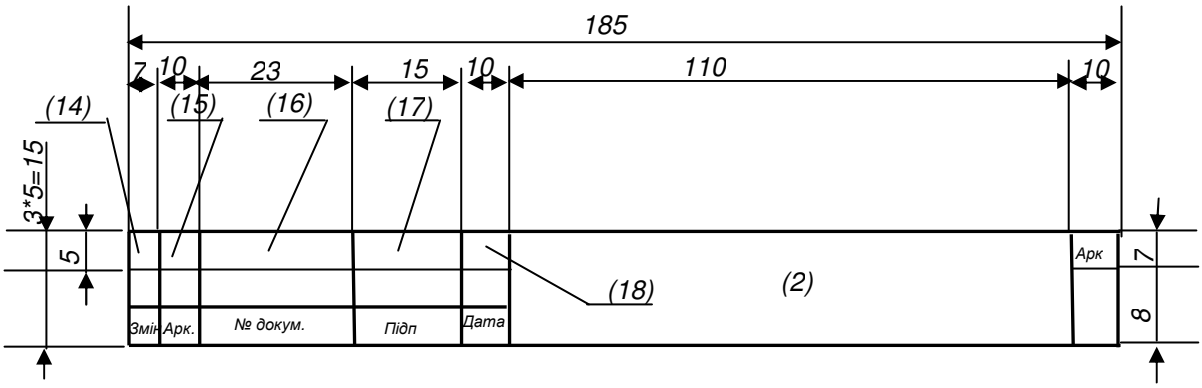
Form 2

Basic caption for text documents (first and title pages)



Form 2a

Basic caption for drawings (schemes) and text design documents (next pages)



Signatures of persons who have developed the document and persons who are responsible for the normative control.

in a column 13 - date of signing of the document;

in a column 14-18 - tables of changes filled in accordance with the requirements of the State Standard 2.503-74;

1.6 Graphic image of materials (The State Standard 2.306-68)

Different shadings are used for conventional graphic images of materials in cross-sections and sections (The State Standard 2.306-68).

Sloping parallel lines in shadings are drown as continuous thin lines with line width S/2 . S/3 at an angle of 45^0 to the horizontal line.

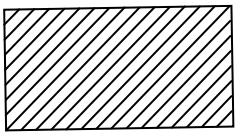
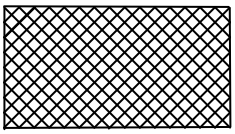
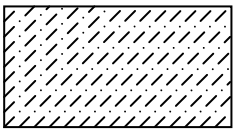
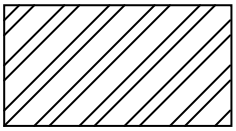
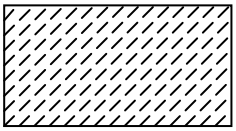
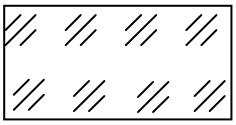
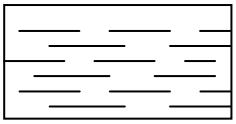
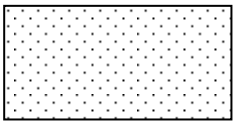
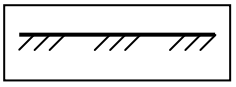
In case of coincidence of draw shading lines direction with direction of contour lines or axial lines it is recommended to draw a line of shading at an angle of 30^0 or 60^0.

All cross-sections and sections of one detail have the same shading. Distance between the lines of shading is chosen out from 1 up to 10 mm.

In case of related crossings of two details it is necessary to draw shading lines with the following directions: one detail shading has right direction, the other – left direction. In case of “crossruled” shading distances between shading lines of the related details are different.

Cross-sections, which width on the drawing is less than 2 mm, are made in black color.

Graphic designations of materials in cross-sections
(The State Standard 2.306-68)

№ P/p	Material	Image	Task
1	Metals		
2	Non-metal product		
3	Concrete		
5	Ceramics		
6	Natural stone		
7	Glass		
8	Liquids		
9	Plaster, asbestos cement.		
10	Ground natural		

2 ELECTRIC SCHEMES

One of methods of giving information about any product or process is electric scheme. It is a document on which component parts of product and connection between them are shown as conventional graphic images.

Schemes considerably simplify image of the product and facilitate the study of it in case, when knowledge of details construction included in the product is not necessary.

Depending on elements and connections between them there are the following kinds of schemes: electric – E; hydraulic - G; pneumatic – P; kinematic - K; optical - L, and also combined – C.

Depending on the basic purpose of scheme there are: structural – 1; functional – 2; of principle – 3; montage (editing) – 4; of connecting – 5, general – 6; location– 7; other – 8; combined – 0.

Structural scheme – determines the basic function parts of the product, their purpose and interconnection.

Function scheme – explains processes which are in separate circles or in product as a whole.

Principle (complete) scheme – determines complete composition of elements and connections between them in product and, as a rule, provides the detailed picture of product working principles.

Montage scheme – shows connection of component parts of product by send-offs, cables or pipelines.

Scheme of connecting – shows the external connection of the product.

General scheme – determines component parts of complex and connection of them between themselves on the place of exploitation.

Scheme of location – determines the relative location of product parts.

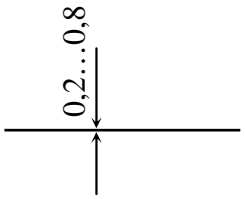
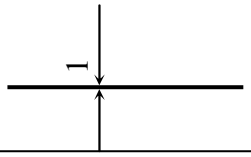
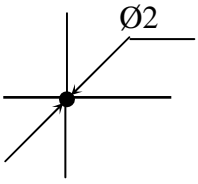
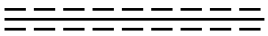
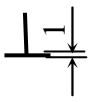
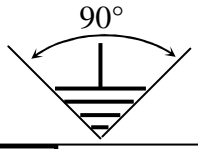
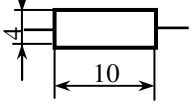
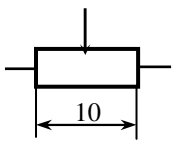
The name of scheme is determined by its aspect and type. For example, «electric principle scheme». The code of scheme consists of letter, which specifies its aspect, and number which marks its type, for example, “electric principle scheme - E3”.

2.1 General rules of schemes implementation

1. Scheme is performed without following of the scale, but in a compact way, with comfort of their reading.

2. Connection lines are drawn as lines with thickness from (0,2 to 1,0 mm) depending on sizes of the scheme. It is recommended to apply the thickness of lines within the limits of 0,3...0,4 mm.

The task – electric schemes
UGP in structural and functional schemes

State Standard	Image and name	Draw the designation
2.751-73	COMMUNICATIONS LINES	
	 **telecommunication line, cable, bas bar**	
	 **line of multipoint communication**	
	 **telecommunication line with subbranch**	
	 **shielded cabel**	
	 **envelop**	
	 **ground**	
2.728-74	**R** **RESISTORS**	
	 **direct**	
	 **alternative**	

3. Number of fractures and crossings of lines must be the least. Distance between nearby parallel lines must be not less than 3 mm.

4. Graphic designations of schemes elements must be performed by lines of the same thickness as connective lines. If there are the thickened lines in conventional graphic designations, their thickness is two times more than the connective lines.

5. It is allowed to increase or decrease graphic designations of elements according to the sizes, indicated standards. The coefficient of increasing or decreasing must be constant for all elements of this scheme.

6. Different technical information may be presented on the scheme.

7. Schemes are performed on sheets by standard format (The State Standard 2.301-68), designed by a frame and a basic caption of 185×55 size.

8. The general rules of schemes performing are ratified by the State Standard 2.701-84 and by the State Standard 2.702-75.

2.2 Rules of structural schemes performing

1. Function parts are presented on a scheme by rectangles or by conventional graphic designations.

2. The graphic construction of a scheme must give the most evident picture of sequence of contacting of functional parts in a product.

3. The name of each function part must be marked on a scheme, if a rectangle is used for its designation . The name or conventional designation is written down into a rectangle.

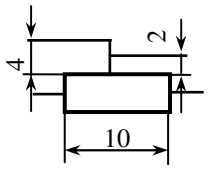
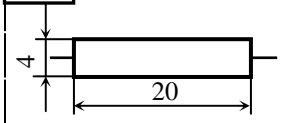
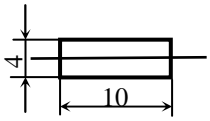
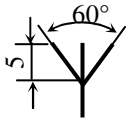
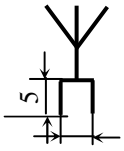
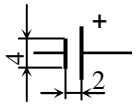
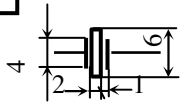
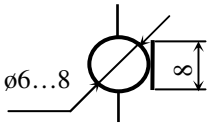
4. If there are many functional parts it's possible to put numbers instead of names in the right side of an image or above it, in the direction from left to right. In this case on a scheme field a table of designations is given.

5. Explanatory captions, diagrams or tables which determine the sequence of processes in time, and also parameters in particular points are recommended to locate on a scheme.

2.3 Rules of function schemes performing

1. Function parts of a product are represented on a function scheme – elements, devices and functional groups and connection between them.

2. Functional parts are presented in a form of conventional graphic designations. Separate functional parts are supposed to be presented in a form of rectangles.

State Standard	Designation and name	To draw designation
	 **configurable**	
	R	
2.728-74	 **functional potentiometer**	
	F	
2.727-68	 **safety fuse**	
	A **ANTENNAS**	
2.735-68	 **asymmetrical**	
	 **symmetrical**	
2.742-68	**CONVERTING ELEMENTS**	
	 **galvanic elements**	
	G	
2.736-68	 **piezoelectric element**	
	B **telephone**	
2.741-68	 **microphone transmitter**	

3. Next information must be pointed out on a scheme:

- Designation of each functional group on principle scheme and its name;
- if a functional group is represented in a conventional graphic designation, its name is not specified;
- position designations and their names which are given on every device principle schemes are represented in a form of rectangle;
- position designation which is given for every device on a principle scheme is represented as a conditional graphic designation;
- position designation which is given for every element on a principle schemes

It is recommended to write down a name into rectangles.

4. Explanatory captions, diagrams, tables which determine the sequence of processes in time, parameters, in particular points are given on the scheme.

2.4 Rules of implementation of principle schemes

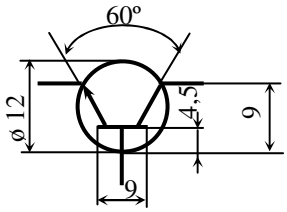
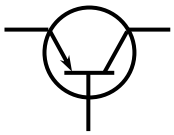
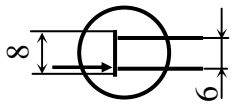
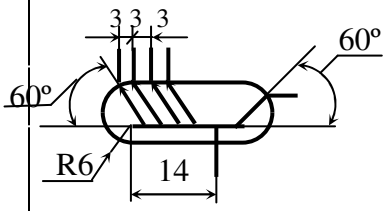
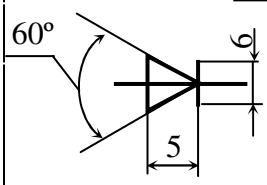
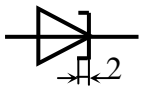
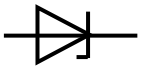
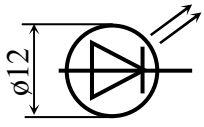
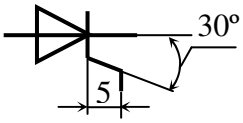
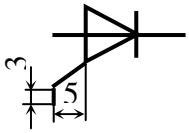
1. Elements and electric connections between them are represented on a principle scheme.

2. Scheme elements are represented in a form of conventional graphic designations. Their form is given in the State Standard 2.721-74 and 2.791-74. It is necessary to pay attention on the image of transistors (State Standard 2.730-73), diodes and resistors because of many mistakes in such images.

3. Schemes are drown for a device that is in the position of “switch off”.

4. Every element must have position designation on a scheme. This designation consists of element letter position designation and element index number, given after letter designation. Index numbers are given for elements in accordance with sequence location on a scheme, numbering from the top down and from left to right. Numbering is began with a figure of one and is between limits of elements group that have same letter designation.

5. Position letter designation is near graphic designation from the right side above them.

1	2	3
2.730-73	**VT** **TRANSISTRORS**	
	 **N-P-N**	
	 **P-N-P**	
	 **fieldistor with n-type channel**	
	 **multiemitter**	
	VD **DIODS**	
	 **diod**	
	 **negative-resistance diode**	
	 **stabilivolt**	
	 **Light Emitting Diode**	
	 **Reverse – blocking trioge thyristor with control on cathode**	
	 **on anode**	

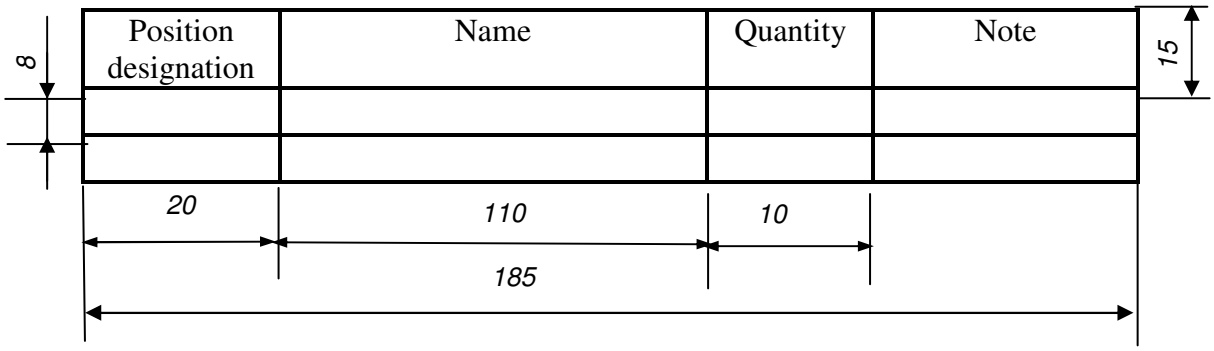
6. The list of elements is placed on the first page of a scheme or it is performed in a form of independent document on the format A4.

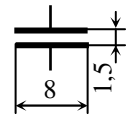
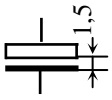
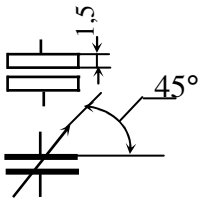
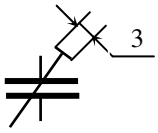
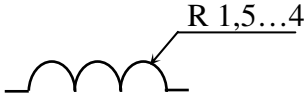
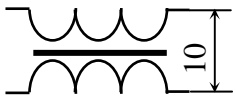
The list of elements is placed above a basic caption.

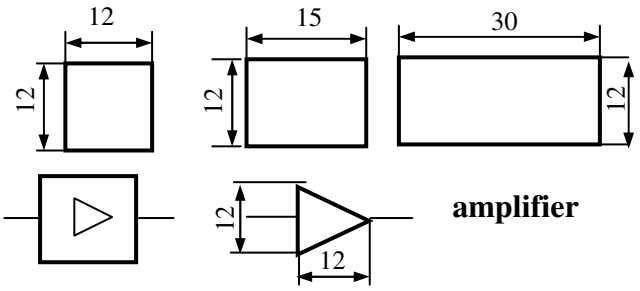
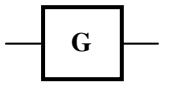
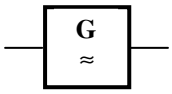
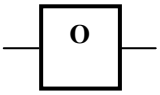
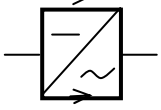
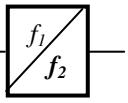
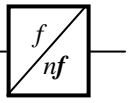
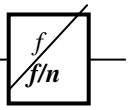
7. Elements in a list are written in groups of letter position designations in alphabetical order.

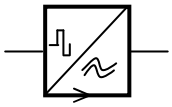
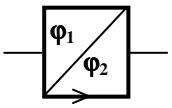
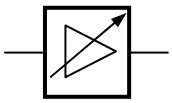
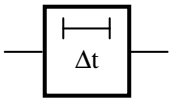
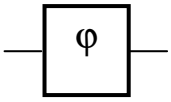
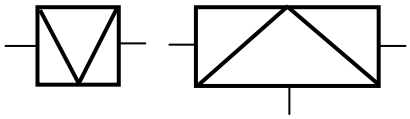
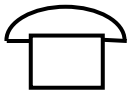
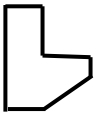
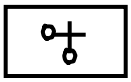
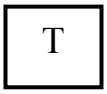
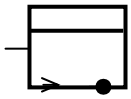
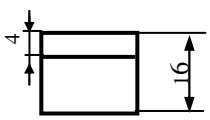
8. Characteristics of input and output circles and parameters which are to be measured on control contacts are recommended to specify on schemes.

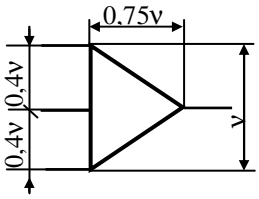
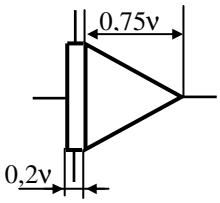
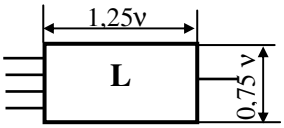
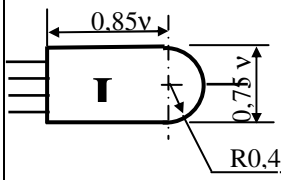
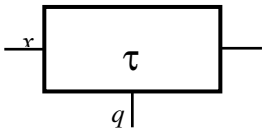
Table of scheme elements list (The State Standard 2.701-84)



1	2	3
	C **CAPACITORS**  **direct capacitance** **electrolytic polar**  **electrolytic polarized**  **electrolytic non-polarized** **variable capacitance**  **configurable**	
	L **INDUCTORS**  **inductance coil** **inductance choke with ferromagnetic**  **single-phase transformer with ferromagnetic iron** **inductance coil with self-wiping contact**	

State Standard	Designation and name	Draw designation
1	2	3
2.737-68	**DEVICES** **DEVICE, FUNKTIONAL GROUP**  **amplifier**  **electronic oscillator**  **audio frequency oscillator** **crystal-controlled oscillator** **TRANSDUCERS**  **oscillator** **rectifier unit**  **current modulator**  **conversion detector**  **multipier**  **frequency demultiplier**	

1	2	3
2.737-68	 **telegraf modulator**  **phase converter**  **variable-gain amplifier** **band-pass filter**  **delay line**  **phase converter**  **modulator, demodulator, discriminator**	
2.739-68	 **telephone**  **manual telephone switch board**  **automatic-telephone system**	
2.740-68	 **telegraph** 	
2.752-71	 **telecontrol device**	

1	2	3
23335-78	**LINEAR UNIT**	
	 **amplifier**	
	 **integrating amplifier**	
23335-78	**NONELINEAR UNIT**	
	 **Maine designation,** L, τ - operation identifier	
	 **nonelinear unit without own input amplifier**	
	 **variable time-lag unit** *x*, *q* – input changing; *q* – control changing	

3 SCHEMES OF ALGORITHMS AND PROGRAMS

Scheme is the most evident method of program description or algorithm of task solving. In this case algorithm or program is represented by sequence of blocks (symbols) and relations between them.

The basic operations of data processing are explained by blocs. There is information inside blocks which characterizes its functions. Scheme blocks have numeration. Configuration and block sizes, order of scheme construction are determined by the State Standards 19.003-80 and 19.002-80.

Standard establishes name, form, blocks sizes and their functions.

Basic rules of algorithm and programs scheme performing

1. Schemes must be performed in formats according to the State Standards 2.301-68.

2. Stream lines must be parallel to lines of scheme frame.

3. Directions of stream lines from top down and from left to right are accepted as basic. If stream lines haven't fractures, direction is not necessary to be marked.

In other cases direction of stream lines should be defined by an arrow.

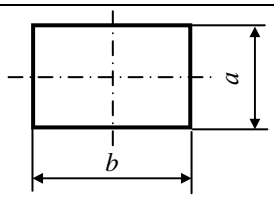
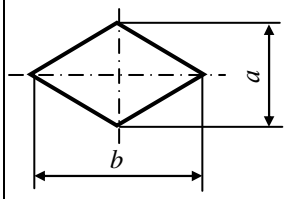
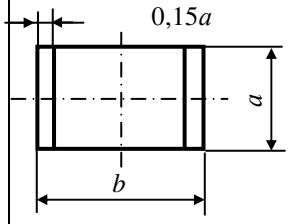
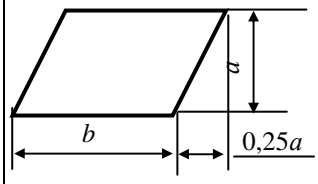
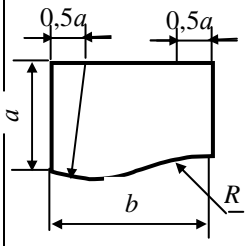
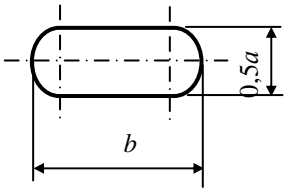
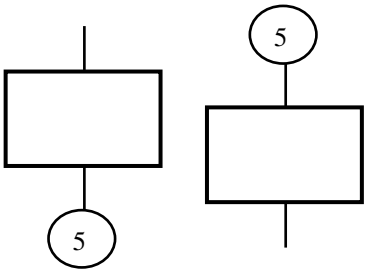
4. Distance between parallel stream lines must be min 3 mm, between other scheme symbols – min 5 mm.

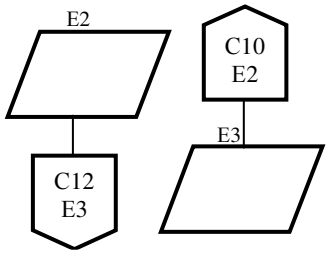
5. Captions inside block must be in a form to be read from left to right and from top to down.

6. Block index number is written from the left part of symbol in the fracture of its case.

7. If explanation does not fit inside the symbol, in this case the comments are used. Comments are situated in free place of algorithm scheme and it is connected with explaining symbol.

The task is the schemes of algorithms. Conventional Graphic designation

State Standard	Designation and name	Draw designation
19.003-80	 **process or calculation**	
	 **logical block**	
	 **predetermened process, program**	
	 **data input-output**	
	 **data input-output**	
	 **start-stop**	
	CONNECTORS	
	 **connector on one page**	

		**off - pages connector**	

Correlation of symbol geometrical sizes is specified in the State Standard 19.003-80. A size α must be chosen out from a numbers 10, 15, 20 mm. It is allowed to increase a size α on a number, that is multiple to 5. The size of b is equal to $1{,}5\alpha$. In case of hand performing of algorithms and programs it is possible to set b equals to 2.

4 ELEMENTS OF DIGITAL TECHNIQUE

Basic rules of construction conventional graphic designations (CGD) of microcircuits

Element of microcircuit CDG has a form of rectangle. Element CGD consists of three fields: basic and two additional.

Additional fields are situated from the left and right from the basic field. Sometimes additional fields are divided into zones which are separated by a horizontal line.

There is a designation of element function in the first line of a CDG basic field. Information about functional setting of outputs is placed in additional fields (figure 4.1).

Each element has output lines and input lines.

Distance between the horizontal side of UGP, limit of zone and output line must be not less and multiple to size C/2.

Height of CGD must be multiple to the constant size of C/2.

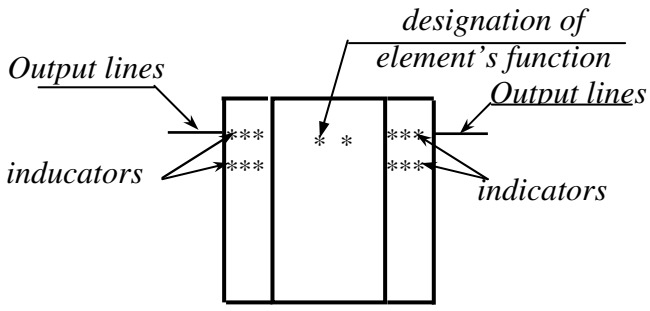


Figure 4.1

In case of division of an output line groups by interval which size mustn't be less than 2C and multiple to the size C. Depending on scheme performing method C mustn't be less than: 5 mm – using hand method or the interval between lines – using automated method.

Width of the additional field must not be less than: 5mm – while performing by hand: or width of one character of printing device – while performing by automated method.

Captions inside CGD are written in the basic font according to the State Standard 2.304-81.

Captions are given in capital letters.

Sometimes other orientation of CGD is used.

Definitions of function or group of functions performed by element are given in capital letters of the Latin alphabet, Arabic numerals and special signs. Some designations of functions are represented in a table. 4.1.

Table 4.1 **Designation of elements functions**

Name of function	Designation
Setting in position *of n*	**Sп**
Setting in position «logical 1»	**S**
Settling in position «logical 0»	**R**
Error	**ER**
Address	**And**
Addressing on co-ordinates X or Y	**X or In**
Blocking	**DE**
Selection	**SE**
Open output	**◊ or ¤**
Output with position of high impedance	**◊ or Z**
Carrying	**CR**
Overflow	**OF**
Repeating	**RP**
Priority	**PR**
Continuation	**SN**
Start	**ST**
Enable	**E**
Expansion	**EX**
Mode	**MO**
Output of `power` from `voltage` source	**U**
Output of `power` from current source	**I**
Collector	**к**
Emitter	**E**
Base	**In**
Output for connecting of `capacitance`	**C**
Output for connecting of inductance	**L**

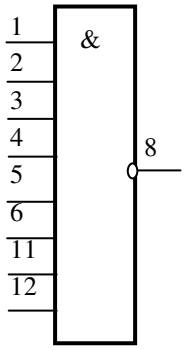
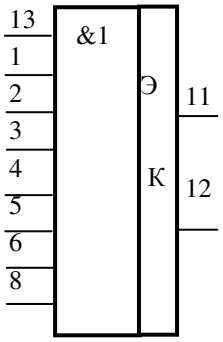
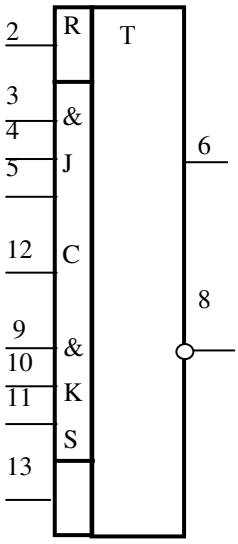
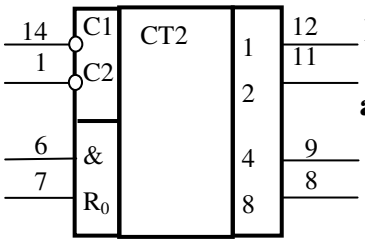
Main designations of outputs are presented in the table 4.2.

Table 4.2 - Main designations of outputs

Name of basic function	Designation	Name of derivative function	Designation
1. Calculator processing	**CP**	Calculator processing section	**CPS**
		Computing device (central processing unit)	**CPU**
2. Processor	**P**	Processor section	**PS**
3. Memory	**M**	Pprogrammable read-only memory	**RPROM**
		Rrandom access memory	**RAM**
		Random access memory with sequential access	**SAM**
		Memory	**STM**
		Device memorizing associative memory	**CAM**
		Pprogrammed logic matrix	**PLM**
		Read-only memory	**ROM**
		Programmable read-only memory	**PROM**
4. Control	**CO**	—	
5. Carrying	**CR**	—	
6. Interrupting	**INR**	—	
7. Transmission	**Tx**	—	
8. Receiving	**Rx**		
9. Input-output	**IO**	Scalable Input/ Output Initiative Parallel Input/ Output Initiative	**IOS** **IOP**
10.Register	**RG**	Left to right or top – down shift register Right to left or down - top sift register Register with a reverse shift	**RG** **RG** **RG**
11. Meter	**CT**	N base counter 2 counter 10 counter	**Stn** **St2** **St10**
12. Decoder	**DC**		
13. Coder	**CD**		
14. Multiplexor	**MUKH**		
15. Demultiplexor	**DMX**		
16. Multiplexor	**MS**		

17. Generator	**G**	Series generator with rectangular impulses Generator with continuous sequence of impulses Generator of single impulse Generator of linearly variable signals Generator of sinus signal	**Gn** **GN** **G1 or** **Gj** **GSIN**
18. Triger	**T**	Two – phase Triger	**TT**
19. Former	**F**		
20. Amplifier	**▷ or >**	Constant gain amplifier	**▷▷or >>**

The task - Elements of digital technique

State Standard	Designation and name	Draw designation
2.743-82	 **Basic field**  **Basic field with left additional field**  **Basic field with right additional field**  **Basic field with left and right additional fields**	

5 SOME INFORMSTION FOR TEXT DOCUMENTATION

According to the State Standard 3008-95 the basic rules for diploma work are developed in Odessa National Academy of Telecommunication . Student work must be written by official state language.

Test part with illustrations is performed on one side of sheet of A4 with fields not less than: left – 25 mm, top and down – 20 мм, right – 10 мм. Text is written (manuscript) by inks or typed using computer technologies – in Word editor using Times New Roman type, the size – 14, distance between lines – 1,2. Tables are designed using the size type 12.

Distance between title (section or subsection) and next or previous text mustn't be less than, line of text.

Space before paragraph must be the same through all the text.

Formulas and equations are directly after a text, in the middle of a line. Formula number is in round brackets from the right side of line, for example:

(2.2) - it is the second formula of the second section.

Digital material as a rule is designed in a form of table.

Tables are numbered and are given names, for example:

Table 5.1 - Type parametres

Type parametres	Desig-nation	Type size **in mm.**									
Type size	*h*	1,8	2,5	3,5	5	7	10	14	20	28	40
Height of capital letters and figures	*h*	1,8	2,5	3,5	5	7	10	14	20	28	40
Height of small letters	*c*	1,3	1,8	2,5	3,5	5	7	10	14	20	28

Number and name are located above a table.

Figures must be placed without rotation of a format. If it is impossible, figure is located with rotation of format in a clockwise direction.

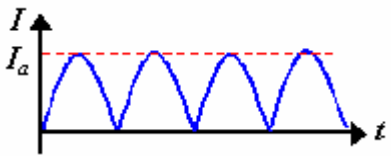


Figure 5.1 - Graphic of function

Figures have numbers and name. Reduction "Fig." isn't possible.

Format A1 is used for all graphical information and are designed by a frame and a basic caption according to the State Standards 2.301-68 and 2.104-68.

DESCRIPTIVE GEOMETRY.

TASKS

Part II

Task for practical work or student self – directed work are presented in this chapter. Before the lesson student must learn proper sections of course from text book.

Knowledge of theoretical is checked at the beginning of the lesson.

Graphic constructions are performed maximally exactly with help drawings instruments. Letters and numbers are drawing using drawing type.

All **sizes are represented in millimeters!**

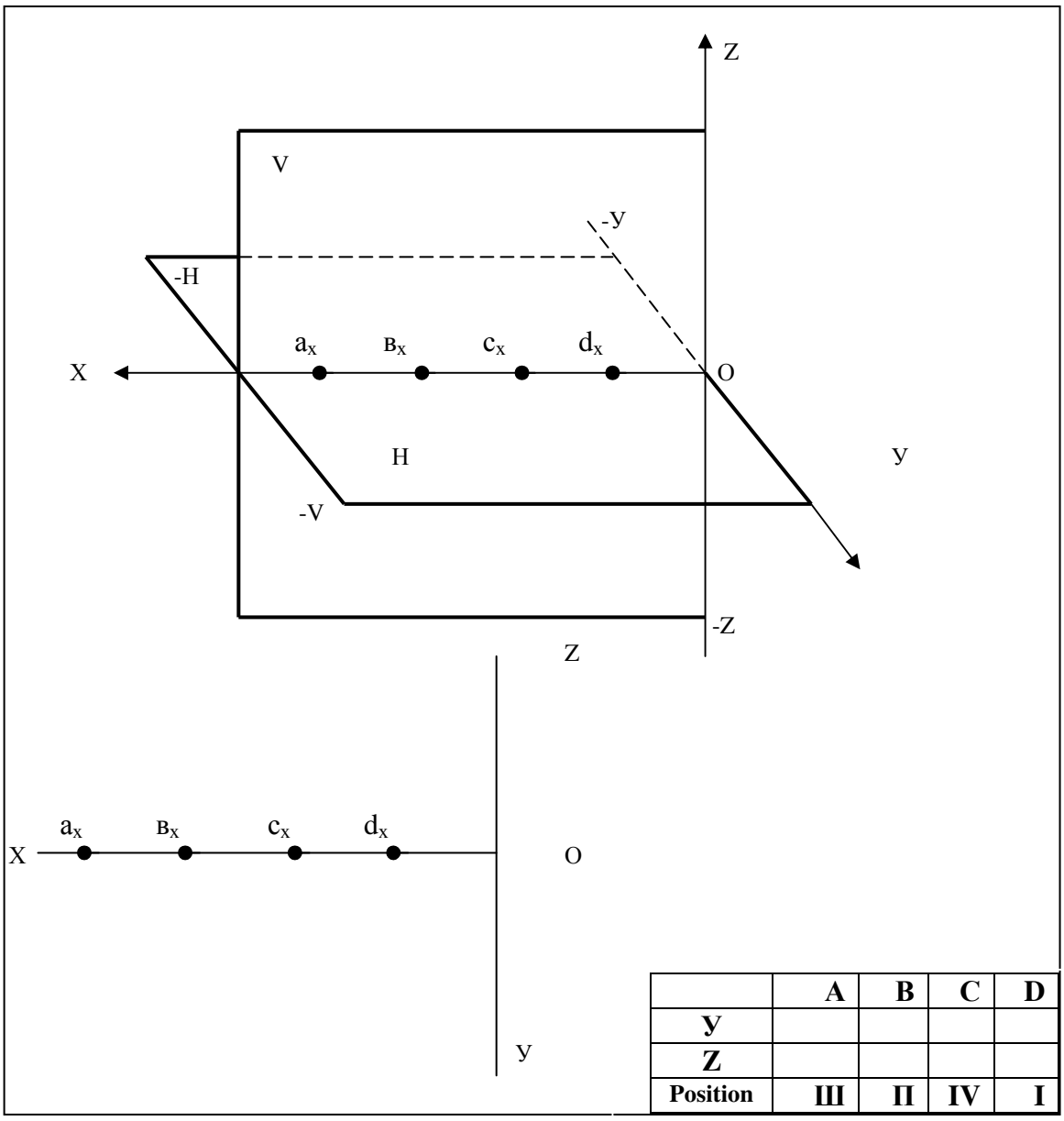
Basic designations and symbols are represented in table 2.1.

Основні позначення і символи

H; V; P;	plane of projection: horizontal, frontal, profile
A; У; C; D…	point of space
a; a'; a"…	projection of point: horizontal, frontal, profile
α; β;…	surface
AB	line
[AB]	segment
$\lvert\Phi_1, \Phi_2\rvert$	distance between geometrical elements
Φ_1, Φ_2	angle between geometrical elements
∥	parallel to
⊥	perpendicular to
≡	equal
∩	intersection
∈	belong to
∧	conjunion of «and»
⇒	logical order
⇔	equivalency

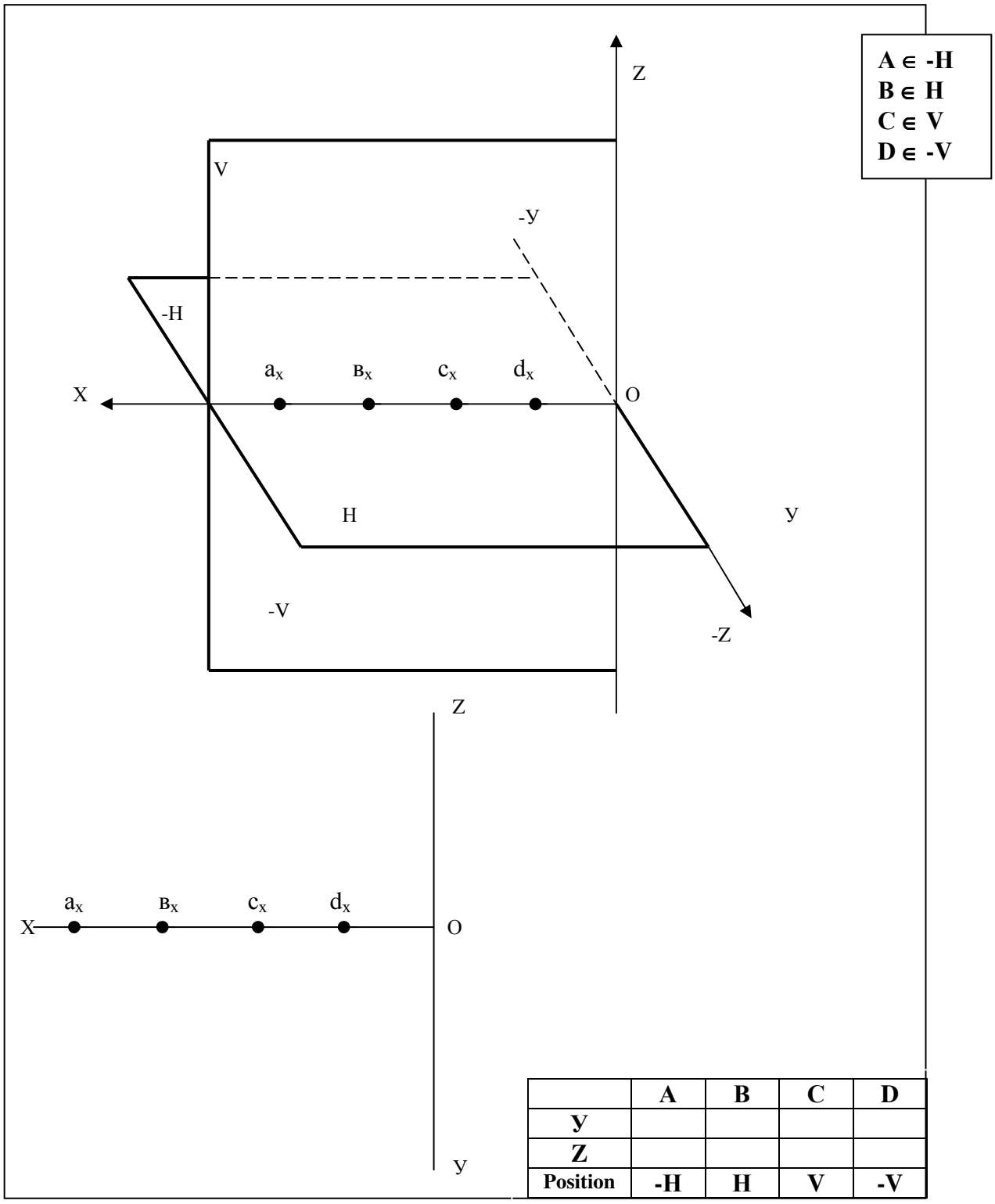
1. POINT

Task № 1. Draw the position of points and their projections in space in four quadrants



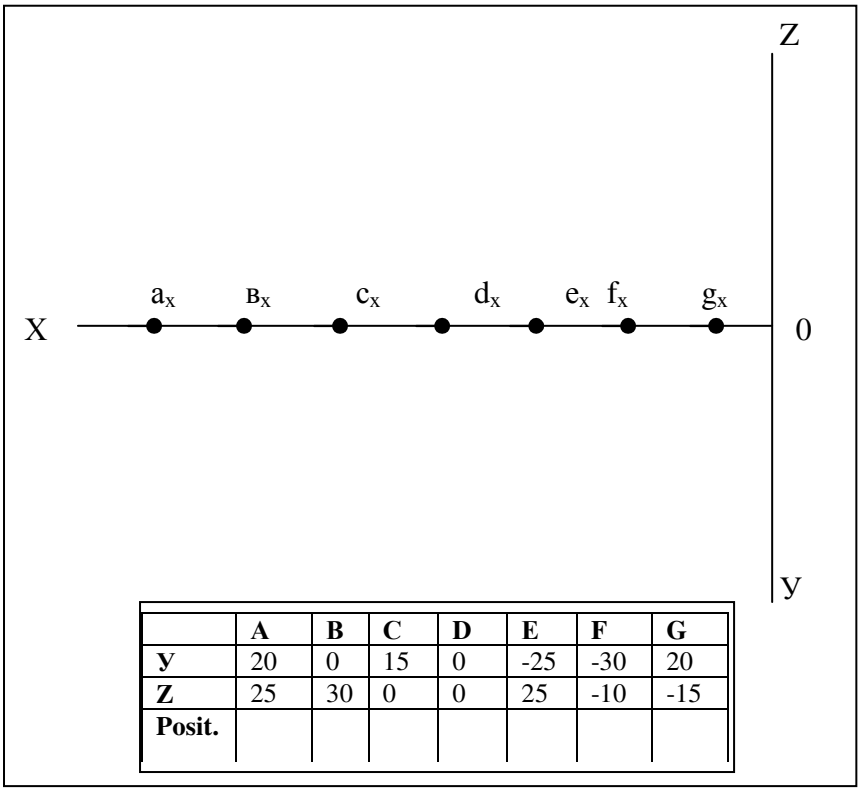
	A	B	C	D
y				
Z				
Position	**III**	**II**	**IV**	**I**

Task № 2. Draw the position of points and their projections lying on -H, H, V, -V planes.



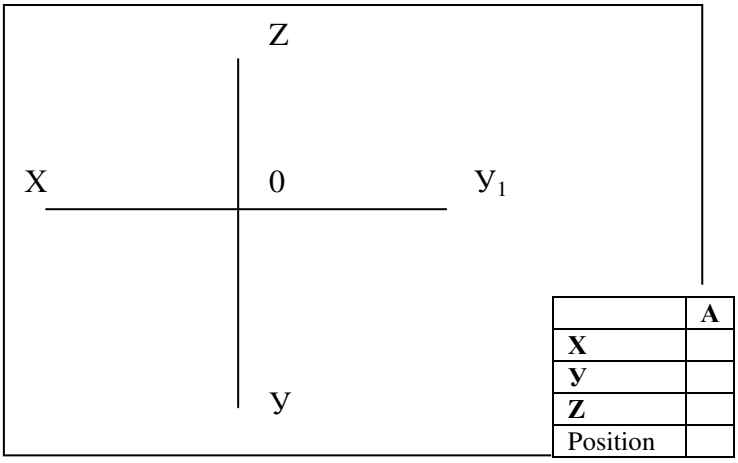
	A	B	C	D
y				
Z				
Position	**-H**	**H**	**V**	**-V**

Task № 3. Determine two projections of point according to their co-ordinates. Write down position of these points in space in a table.

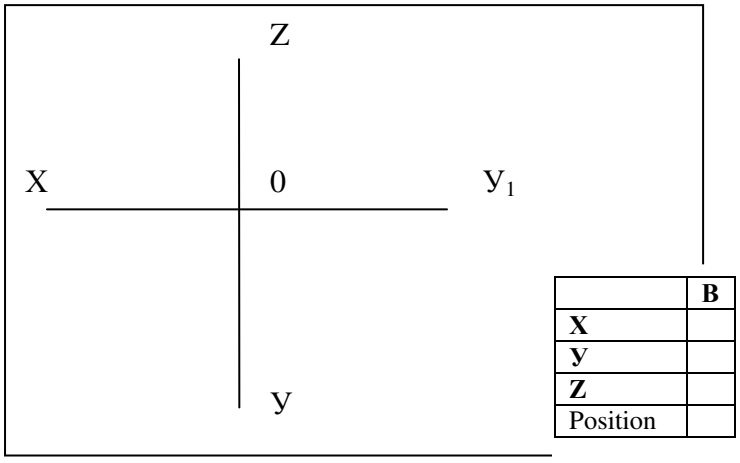


	A	B	C	D	E	F	G
y	20	0	15	0	-25	-30	20
Z	25	30	0	0	25	-10	-15
Posit.							

Task № 4-5. Determine three projections of point according to their co-ordinates



	A
X	
y	
Z	
Position	

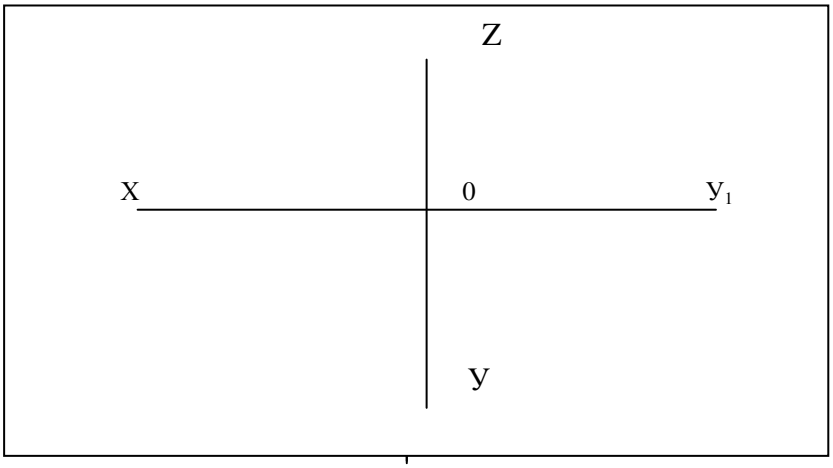


	B
X	
y	
Z	
Position	

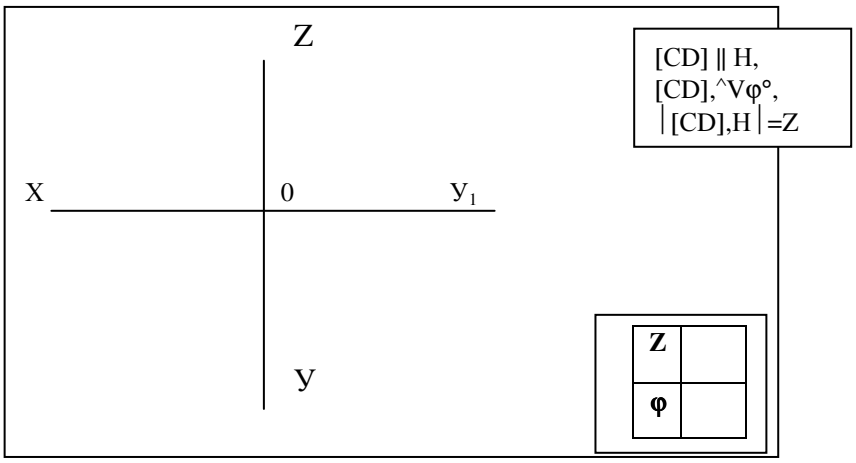
№ Var.	Task №4			Task.№5		
	X	**y**	**Z**	**X**	**y**	**Z**
1	15	5	10	10	10	0
2	15	5	15	10	15	0
3	15	5	20	10	20	0
4	15	5	25	10	25	0
5	15	15	10	10	30	0
6	15	15	20	15	10	0
7	15	15	25	15	15	0
8	10	5	10	15	29	0
9	10	5	15	15	25	0
10	10	5	20	15	30	0
11	10	5	25	20	10	0
12	20	5	10	20	15	0
13	20	5	15	20	20	0
14	20	10	10	20	25	0
15	20	15	10	20	30	0
16	20	25	10	25	10	0
17	20	15	20	25	15	0
18	20	15	25	25	20	0
19	25	5	10	25	25	0
20	25	10	15	25	30	0
21	25	10	20	5	10	0
22	25	10	25	5	15	0
23	25	15	10	5	20	0
24	25	15	15	5	25	0
25	25	15	20	10	5	0
26	25	15	25	15	5	0
27	25	20	10	20	5	0
28	25	20	15	25	5	0

2. LINE

Task № 6. Draw three projections of oblique lineAB

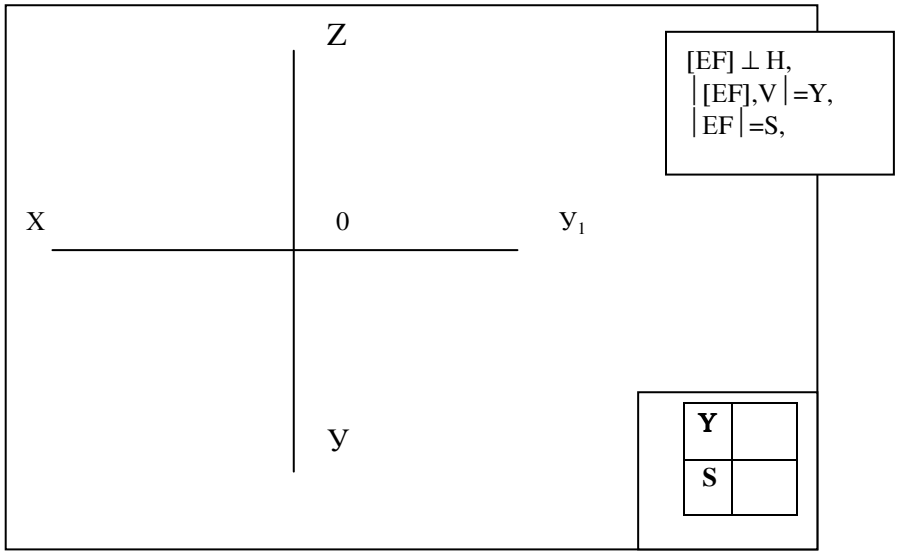


Task № 7. Draw three projections of horizontal line CD which is situated on the distance Z from H – plane on the angle φ to V.



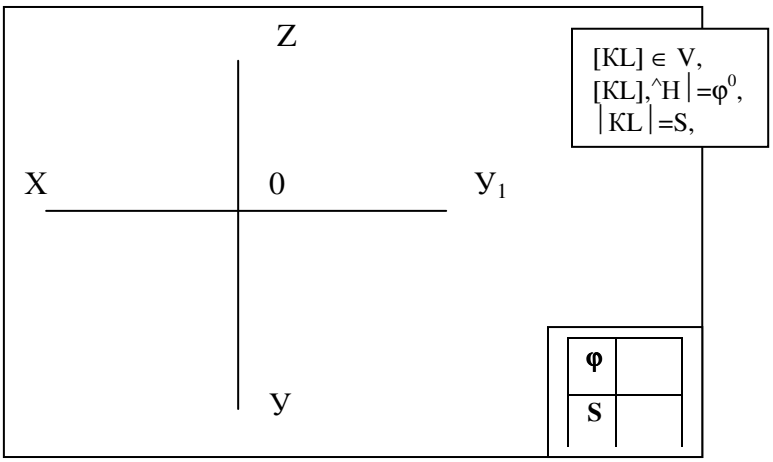
Variant	Z	φ^0
1; 15	5	30
2; 16	5	45
3; 17	5	60
4; 18	10	30
5; 19	10	45
6; 20	10	60
7; 21	15	30
8; 22	15	45
9; 23	15	60
10; 24	20	30
11; 25	20	45
12; 26	20	60
13; 27	25	30
14; 28	25	45

Task № 8. Draw three projections of line EF perpendicular to H - plane, which is located on the distance Y from V. True length of EF is equal S.



Variant	Y	S
1; 15	25	15
2; 16	5	15
3; 17	5	20
4; 18	5	25
5; 19	25	20
6; 20	10	15
7; 21	10	20
8; 22	10	25
9; 23	25	25
10; 24	15	15
11; 25	15	20
12; 26	15	25
13; 27	20	15
14; 28	20	20

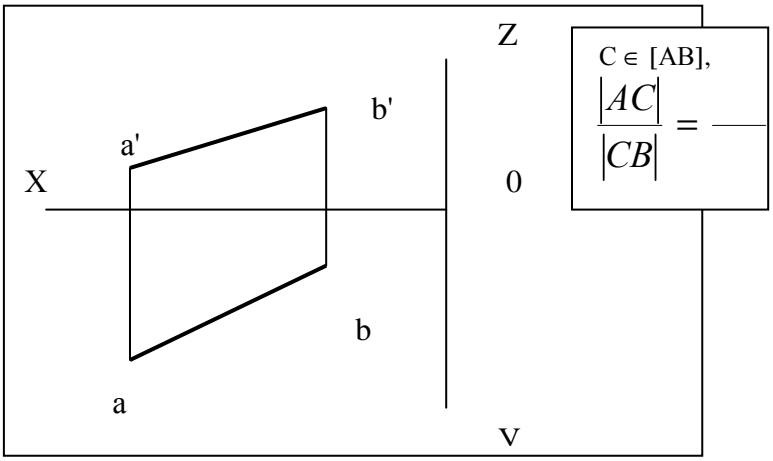
Task № 9. Draw three projections of line KL which lies on a V – plane at the angle φ to H - plane. True length of KL is equal S.



Variant	φ^0	S
1; 15	30	15
2; 16	30	20
3; 17	30	25
4; 18	45	15
5; 19	45	20
6; 20	45	25
7; 21	45	30
8; 22	60	15
9; 23	60	20
10; 24	60	25
11; 25	60	30
12; 26	75	15
13; 27	75	20
14; 28	75	25

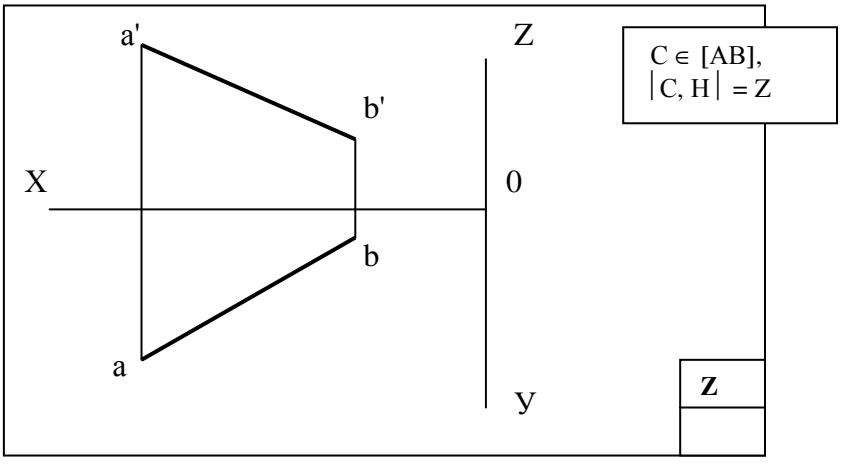
3. POINT ON LINE

Task № 10. Take the point C on the AB that separates line in the given ratio



Variant	Ratio
1; 15	1 : 2
2; 16	1 : 3
3; 17	1 : 4
4; 18	1 : 5
5; 19	2 : 1
6; 20	2 : 3
7; 21	2 : 5
8; 22	3 : 1
9; 23	3 : 2
10; 24	3 : 4
11; 25	4 : 1
12; 26	4 : 3
13; 27	5 : 1
14; 28	5 : 2

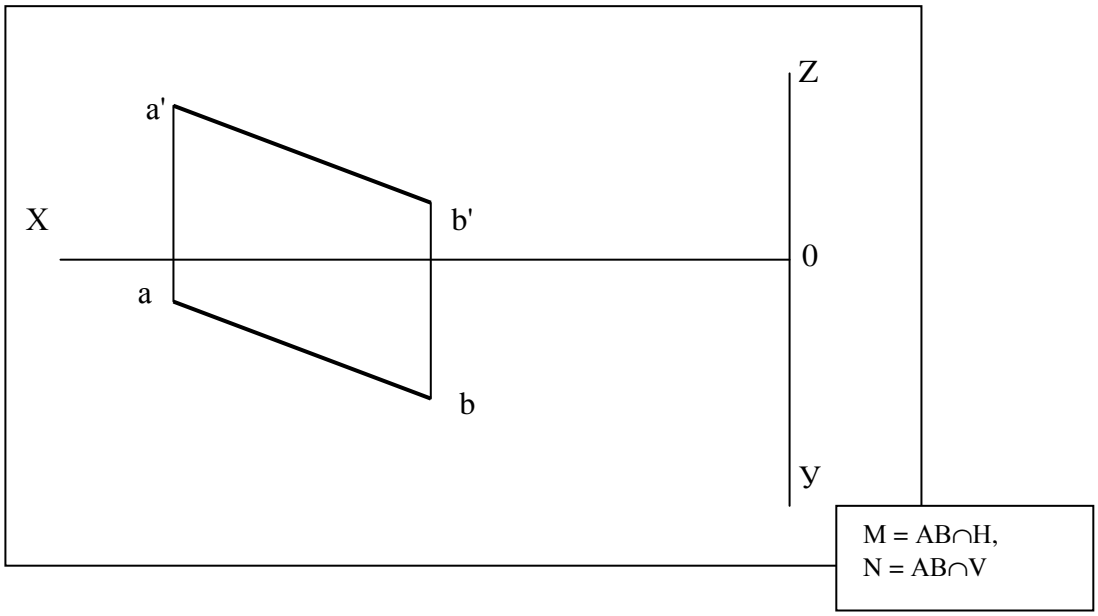
Task № 11. On the line AB take the point C, which is located on distance Z from H -plane.



Variant	Z
1; 15	10
2; 16	12
3; 17	15
4; 18	18
5; 19	17
6; 20	16
7; 21	15
8; 22	14
9; 23	10
10; 24	11
11; 25	14
12; 26	16
13; 27	19
14; 28	13

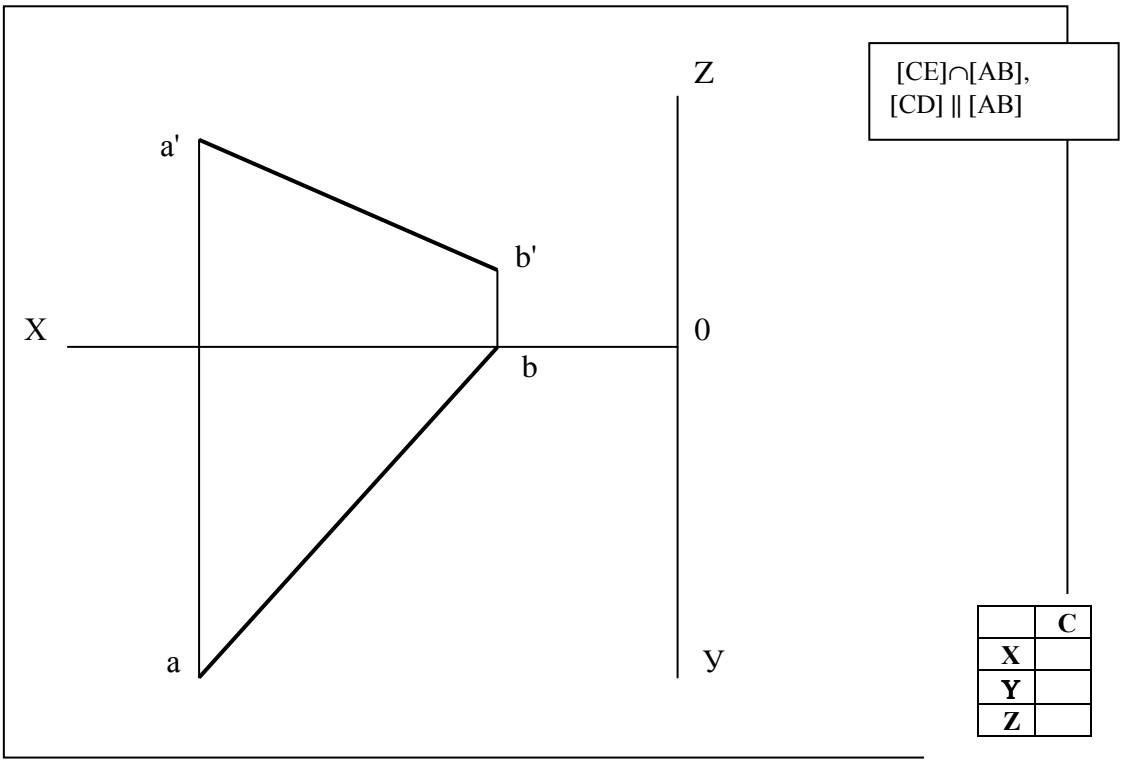
4. TRACES OF LINE

Task № 12. Find the traces of the line AB and define what quadrants of space it is passes through.

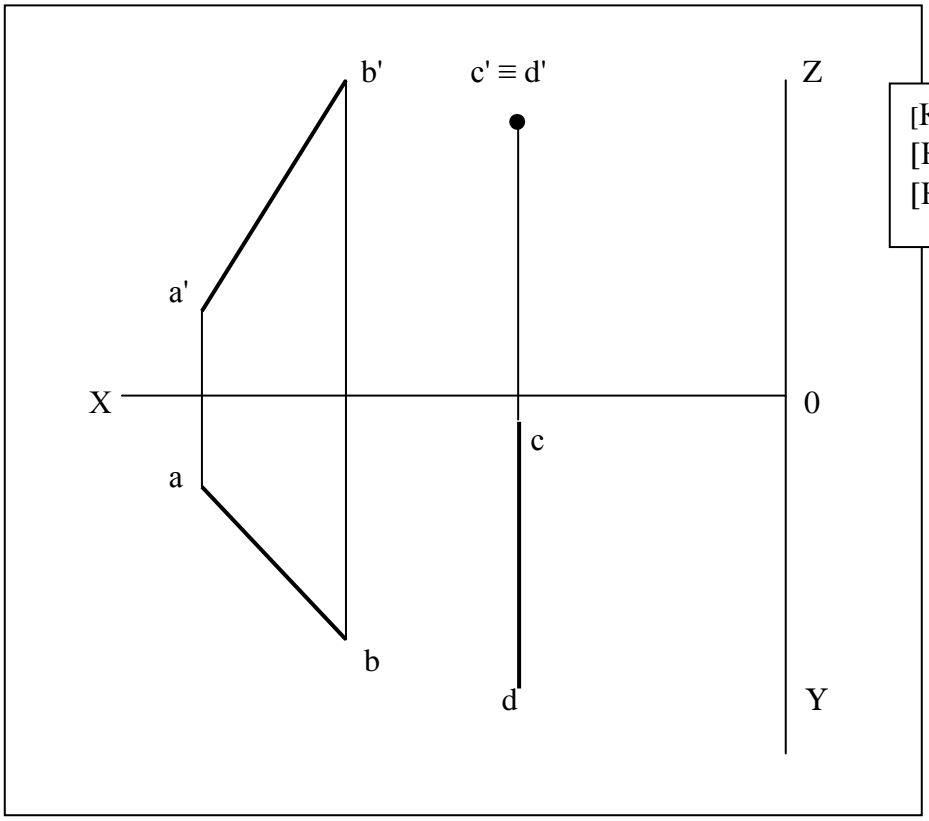


5 TWO LINES: CROSS AND PARALLEL LINES

Task № 13. Draw the line CE through the point C, that intersecting the line AB and the line CD parallel to AB

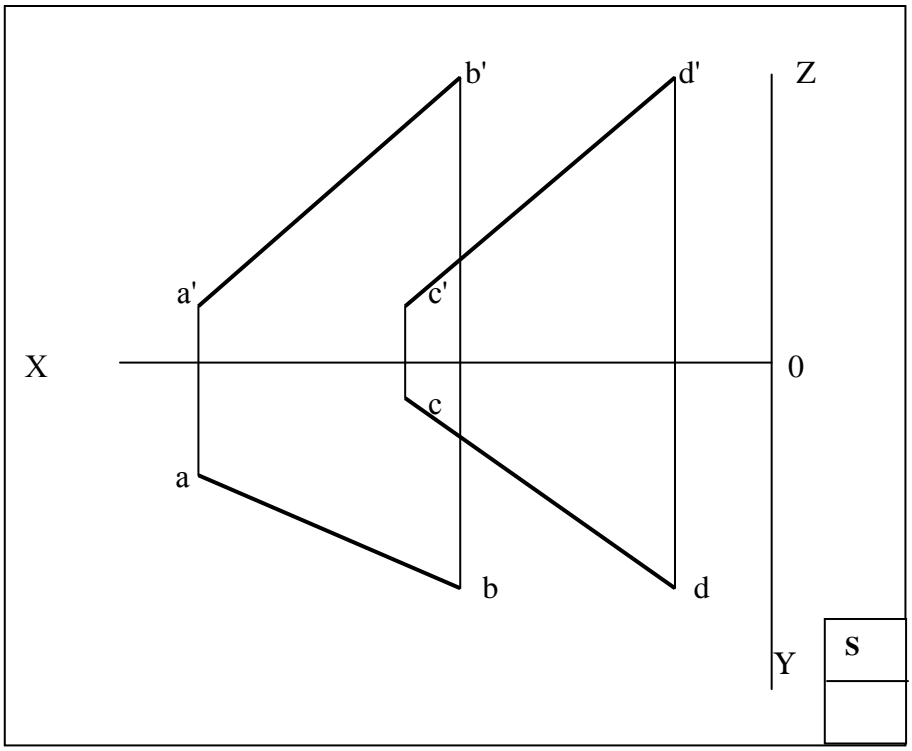


Task № 14. Draw the line KL, parallel to V - plane and that intersects the lines AB and CD



[KL] ‖ V,
[KL]∩[AB],
[KL]∩[CD]

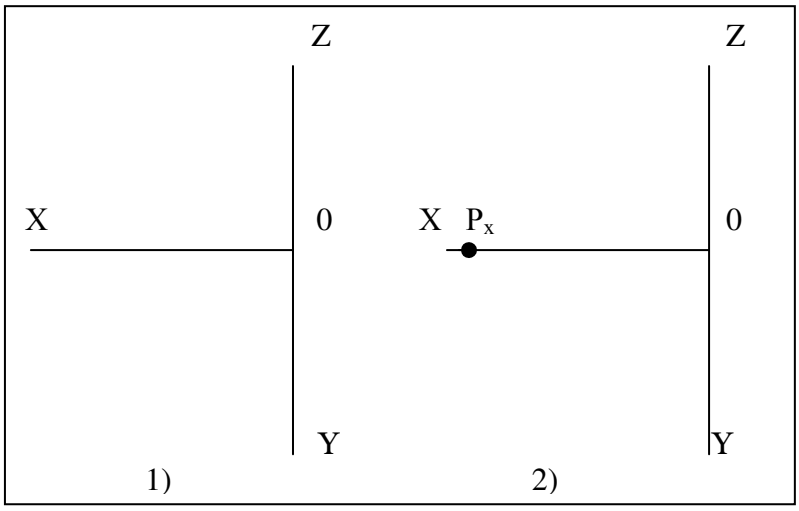
Task № 15. Draw the horizontal line EF, which is located on the distance S from the H - plane, that crosses the lines of AB and CD.



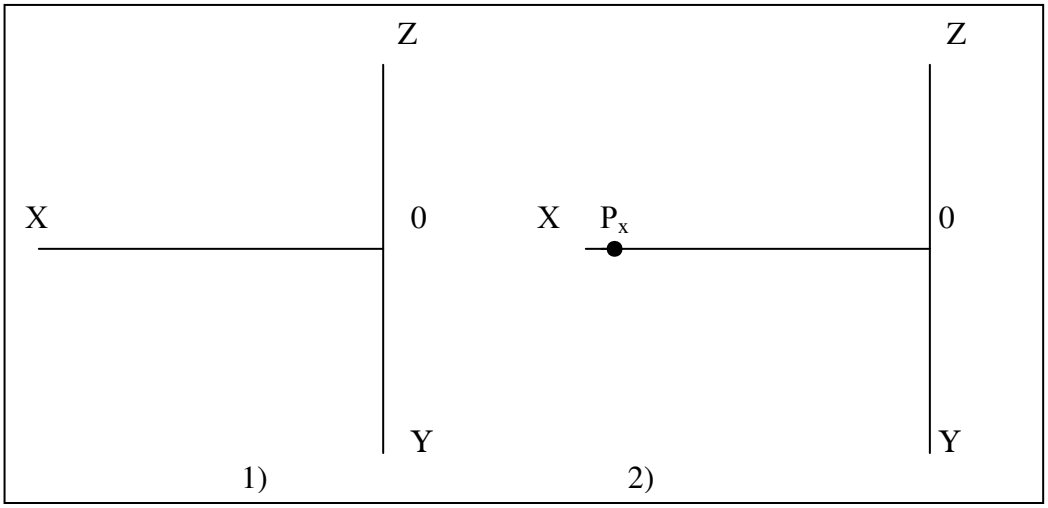
Variant	S
1 … 7	10
8 … 14	15
15 … 21	20
22 … 28	25

6. METHODS OF PLANE DEFINING

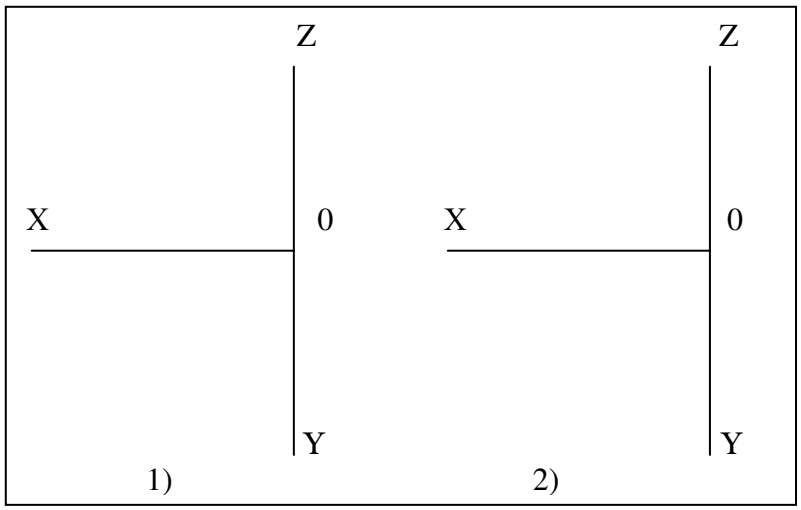
Task 16. Draw the oblique plane represented on a drawing given by:1) triangle; 2) traces of a plane



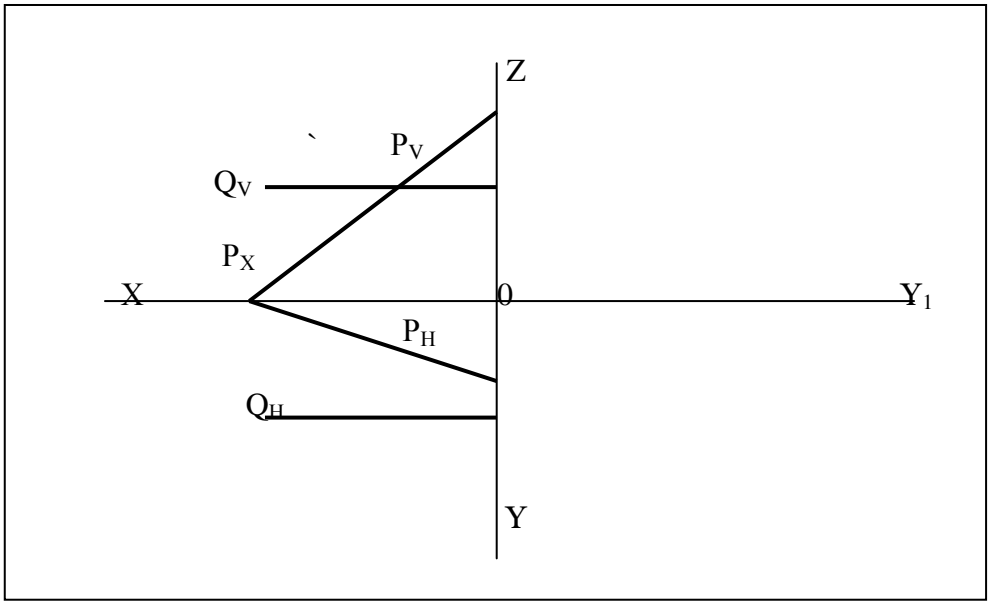
Task № 17. Draw a plane perpendicular on H- plane, set by:
1) triangle; 2) traces of a plane.



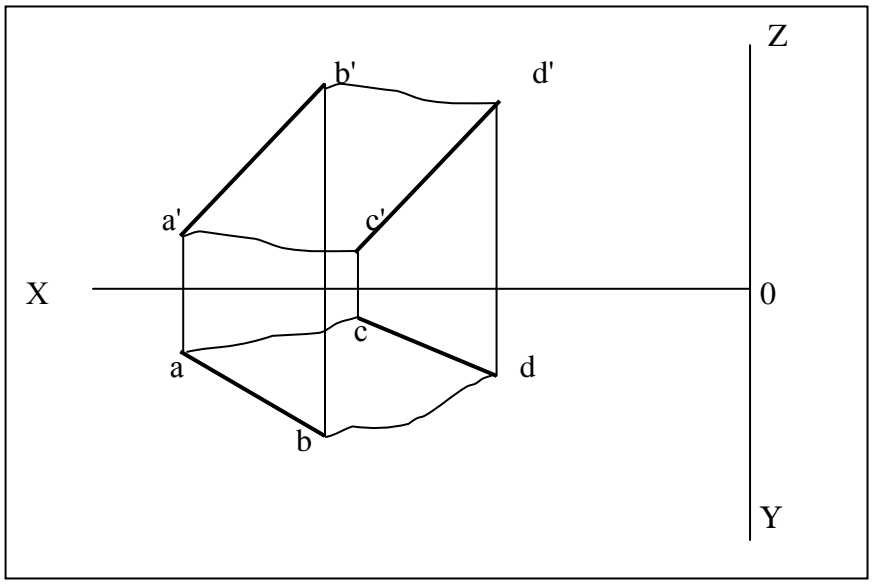
Task № 18. Draw horizontal plane, set by: 1) two parallel lines AB and CD; 2) traces.

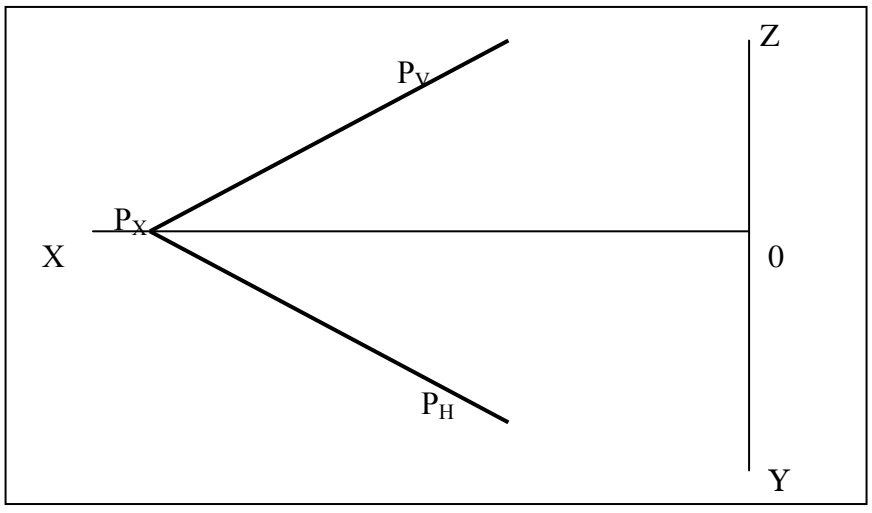


Task № 19. Define profile traces of the planes P and Q and draw it.



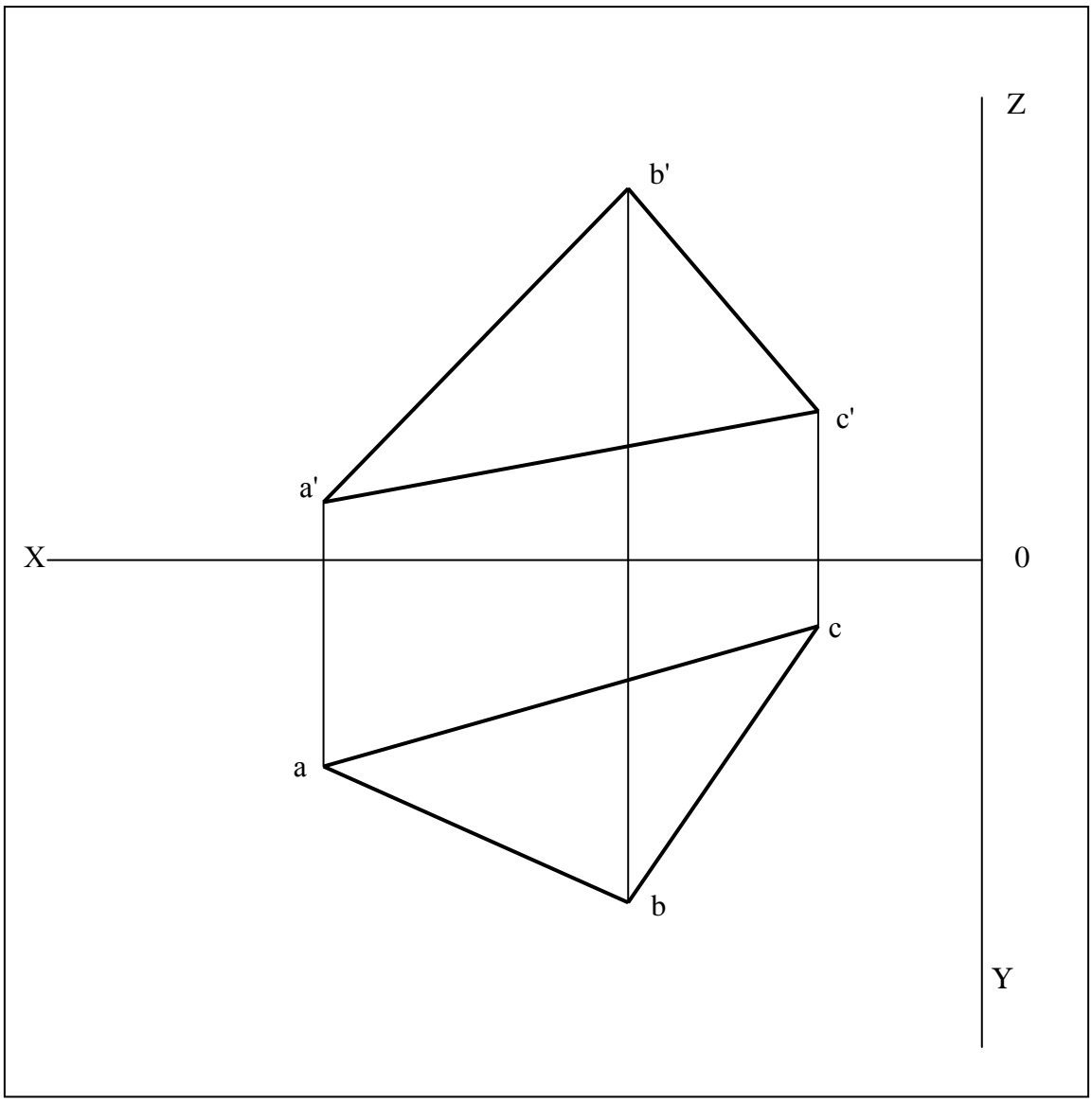
Task № 20-21. Draw projections of a line lying in the given plane.



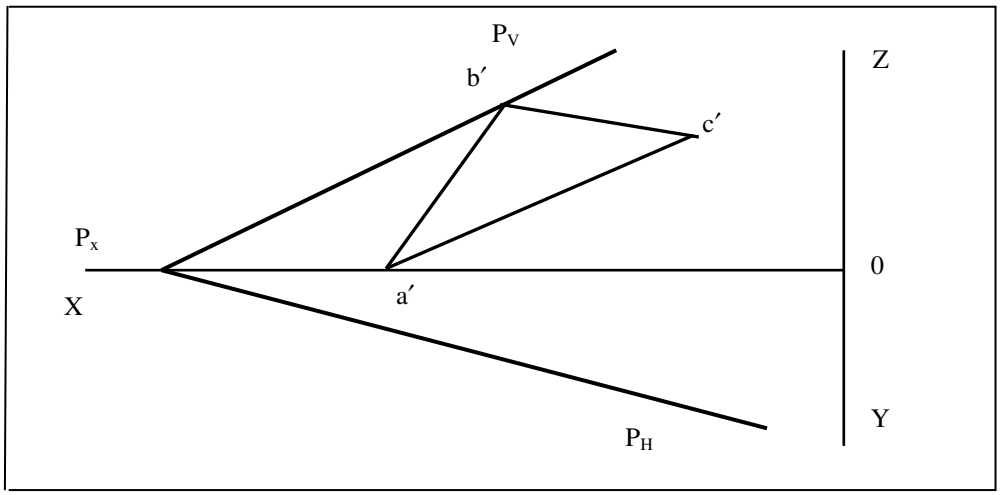


7. BELONGING OF GEOMETRICAL ELEMENTS

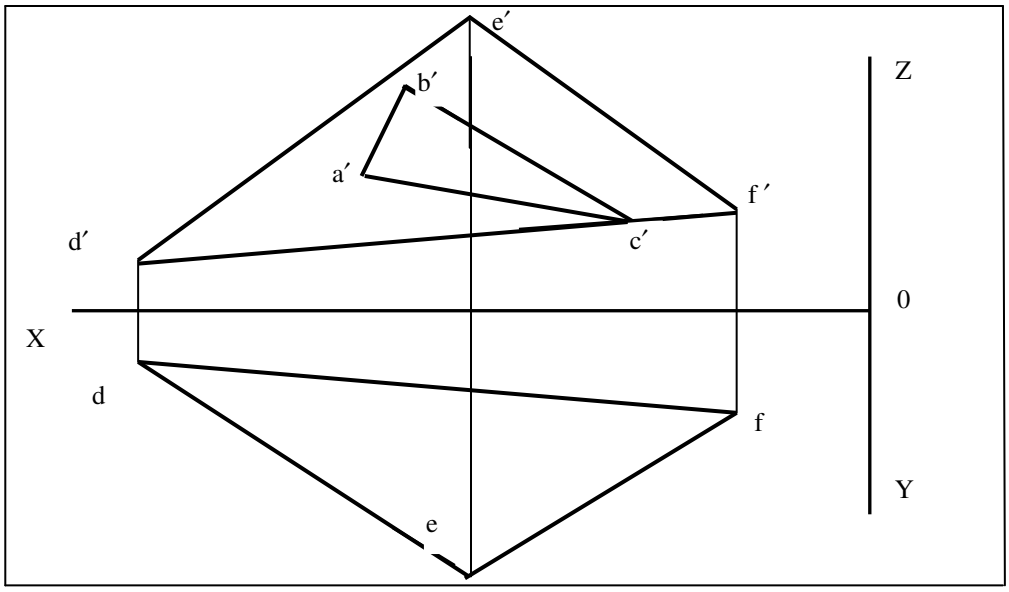
Task № 22. Build the horizontal line and the frontal line in the triangle ABC.



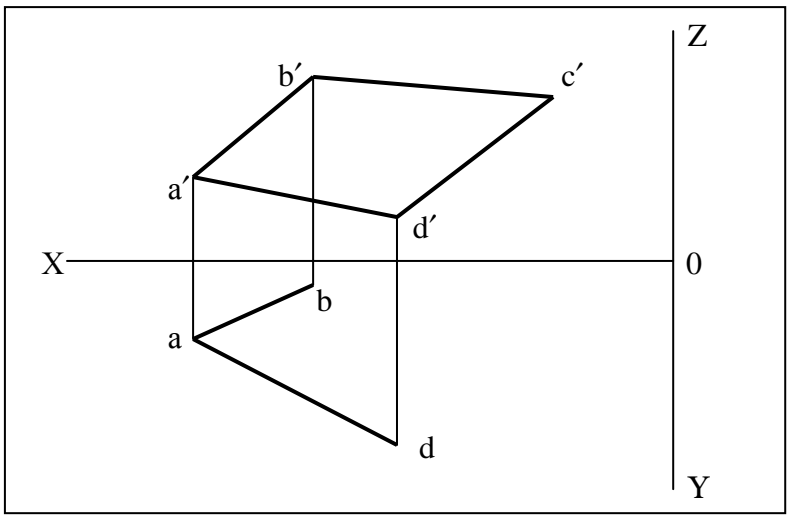
Task № 23. Define horizontal projection of the triangle ABC lying in V - plane



Task № 24. Define horizontal projection of the triangle ABC lying in Δ DEF

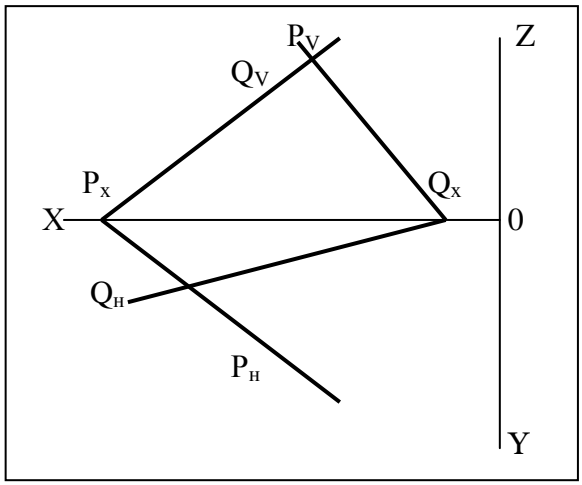


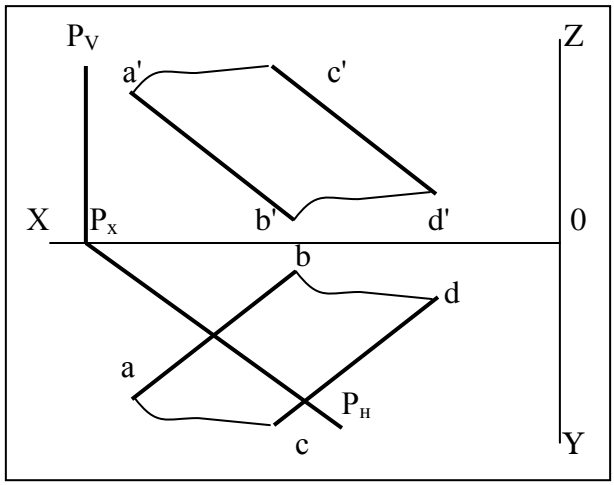
Task № 25. Define horizontal projection of the point C of quadrangle ABCD.



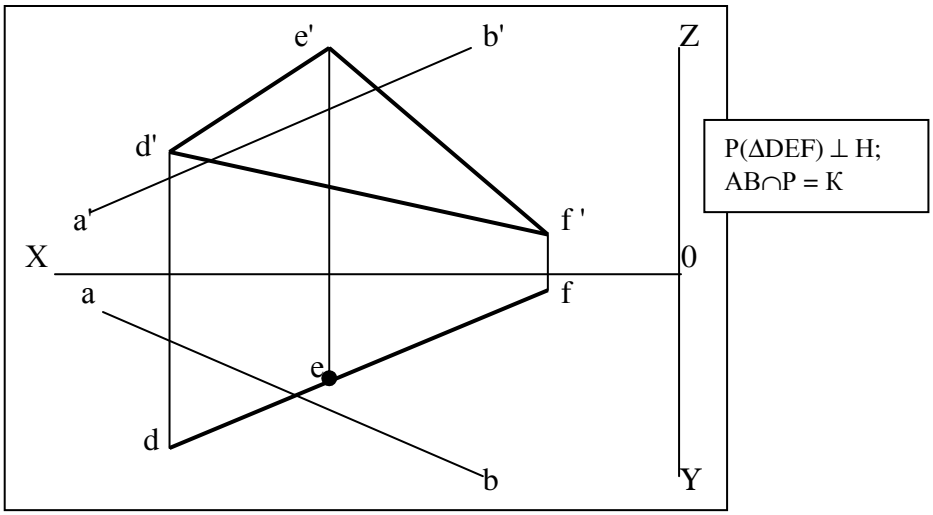
8 INTERSECTIONS OF PLANES

Task № 26-27. Find the intersecting of two planes



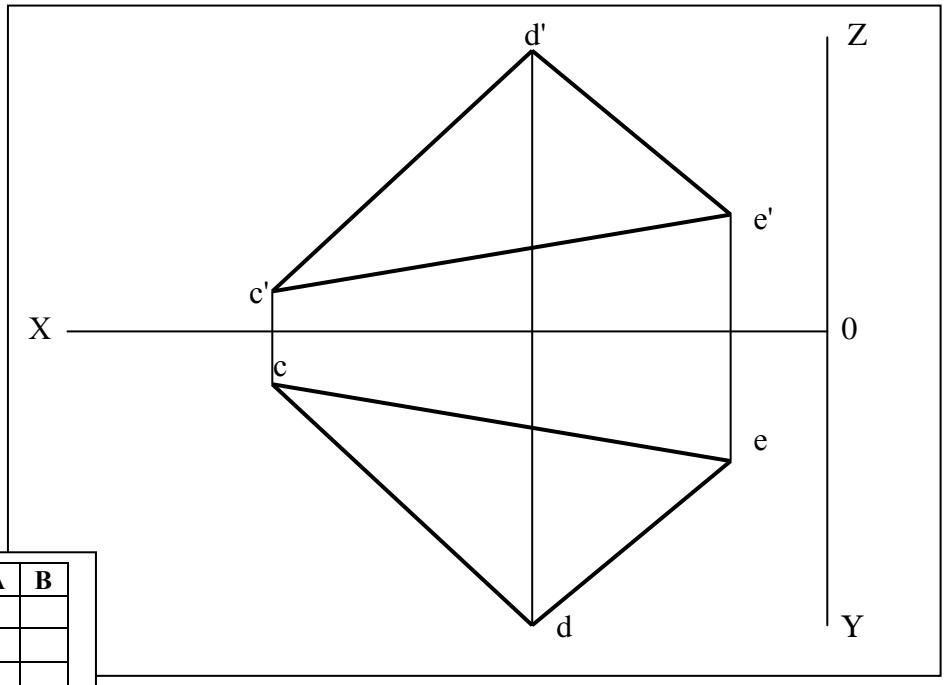


Task № 28. Find the point of intersecting of line of AB with the plane and define visibility



9. POSITION TASKS

Task № 29. Find the point of intersection of the line AB with the plane and define visibility.

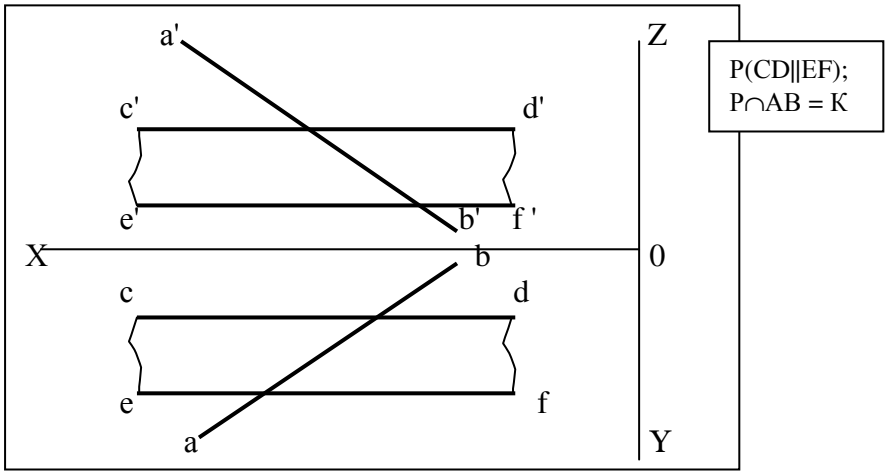


	A	B
X		
Y		
Z		

Variant	A			B		
	X	Y	Z	X	Y	Z
1…6	60	0	25	25	30	5
7…12	65	25	15	10	5	20
13…19	60	30	15	10	5	25
20…24	55	25	0	20	0	30
25… 28	55	30	0	20	5	30

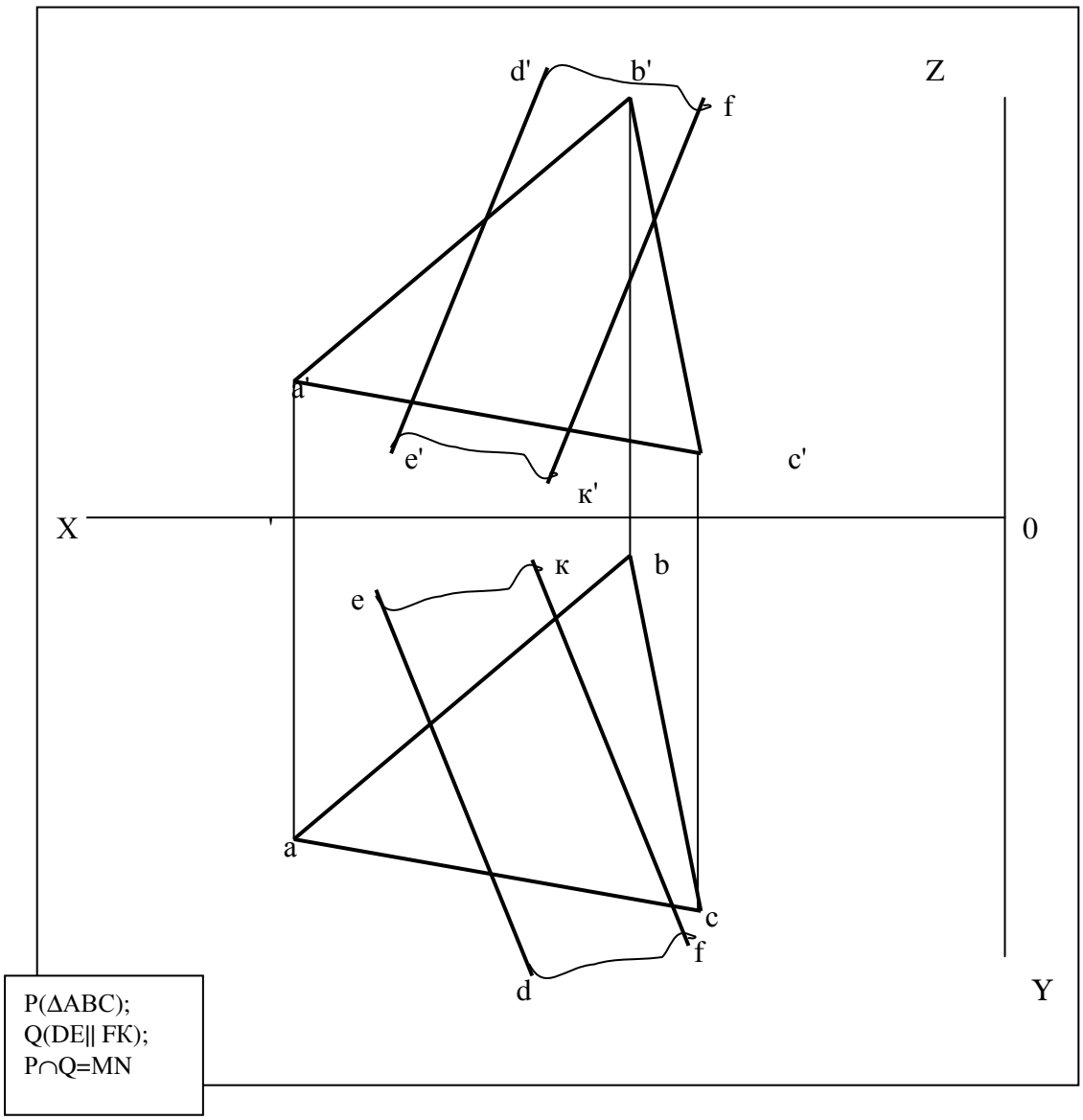
P(ΔCDE),
P∩AB = K;
Plan of solving the task:
1. AB ∈ Q ∧ Q ⊥ H or Q⊥V.
2. Q∩P = MN.
3. MN∩AB = K.

Task № 30. Find the point of intersecting of line AB with a plane and define visibility.

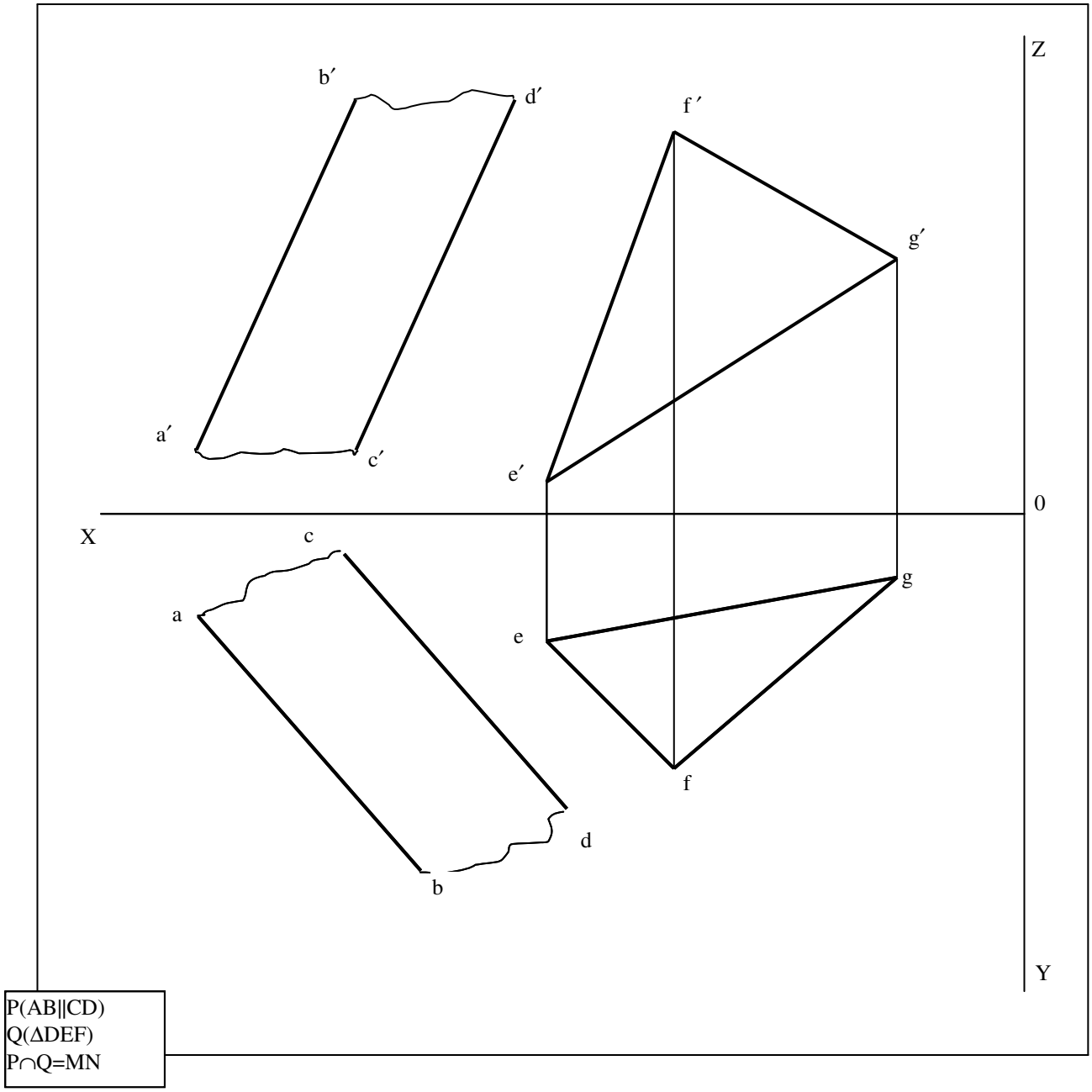


P(CD||EF);
P∩AB = K

Task № 31. **Find the intersection of two planes. Define visibility.**

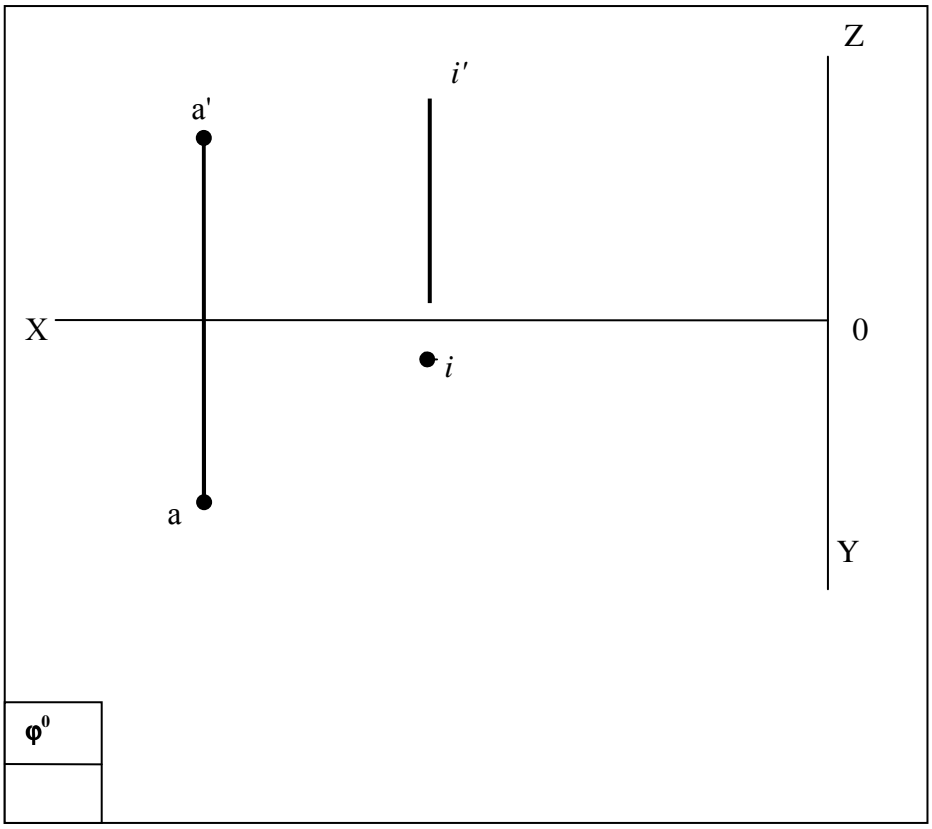


Task №32. Find the intersection of two planes



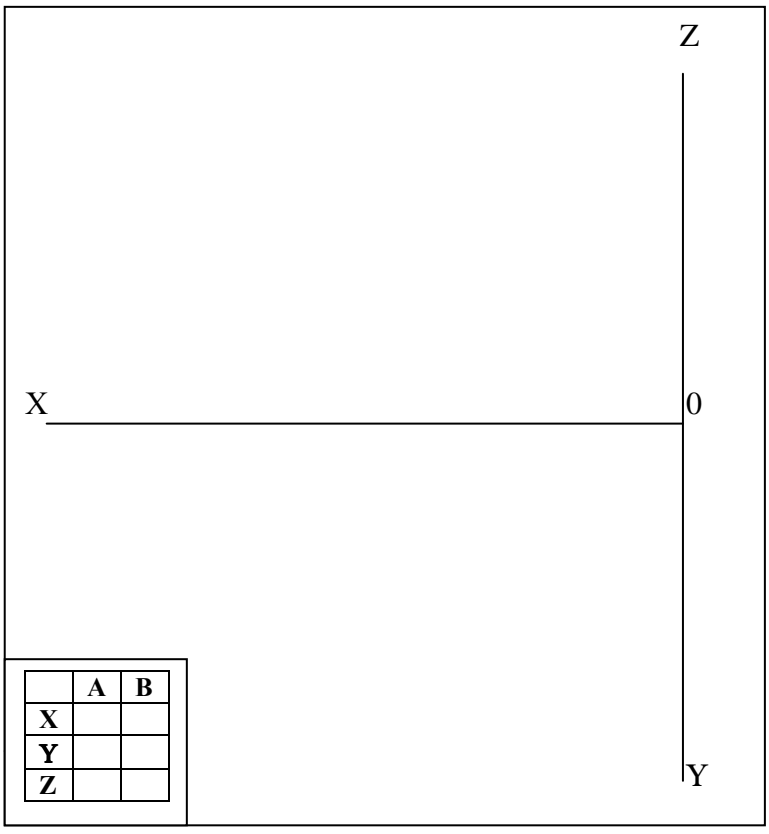
10. GRAPHICAL COMPUTATION. ROTATION

Task № 33. Rotate the point A on the angle φ^0 against a clock –wise direction.



Variant	φ^0
1 … 4	45
5 … 9	60
10 … 15	90
16 … 21	75
22…28	120

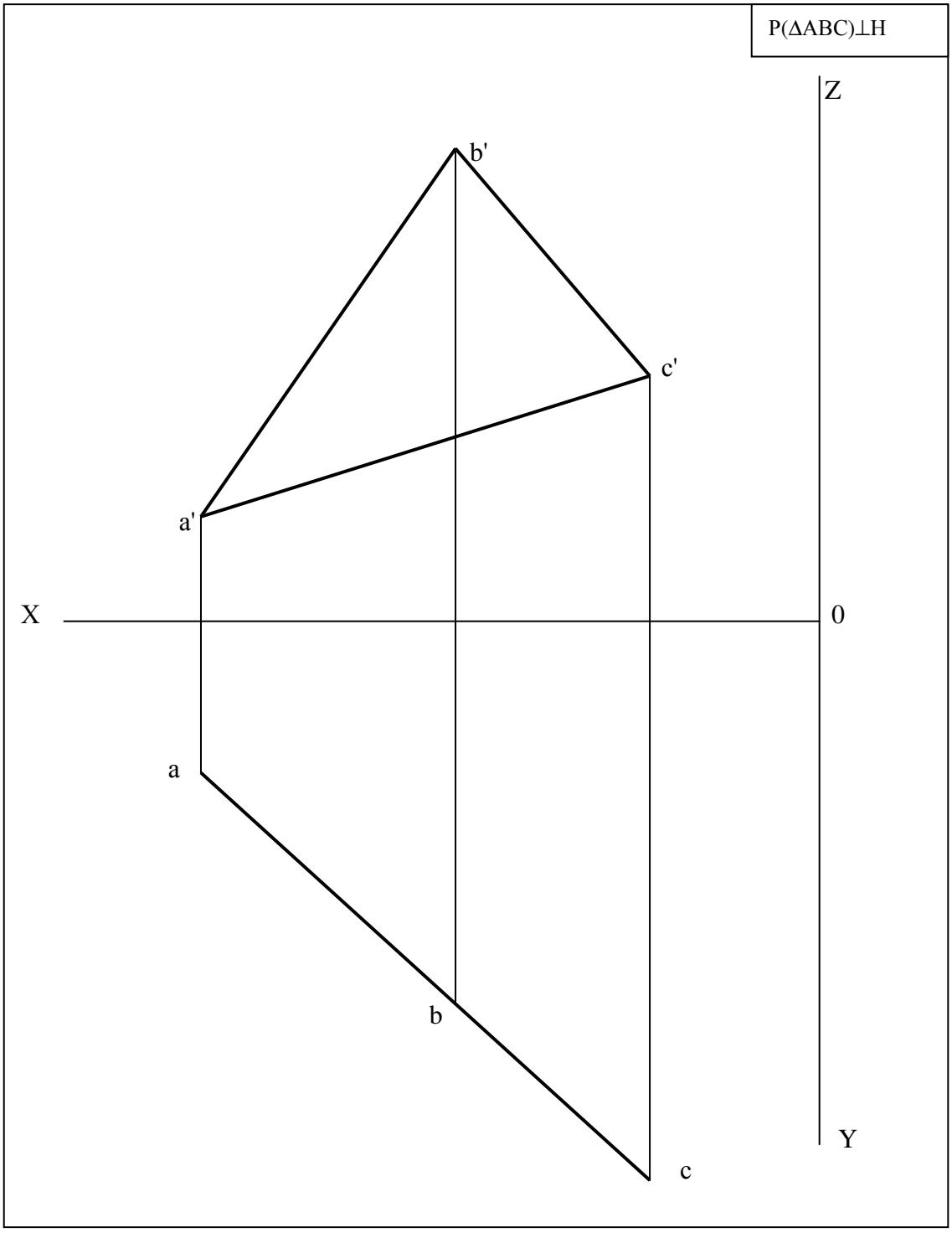
Task № 34. Find the true length of the line AB.



	A	B
X		
Y		
Z		

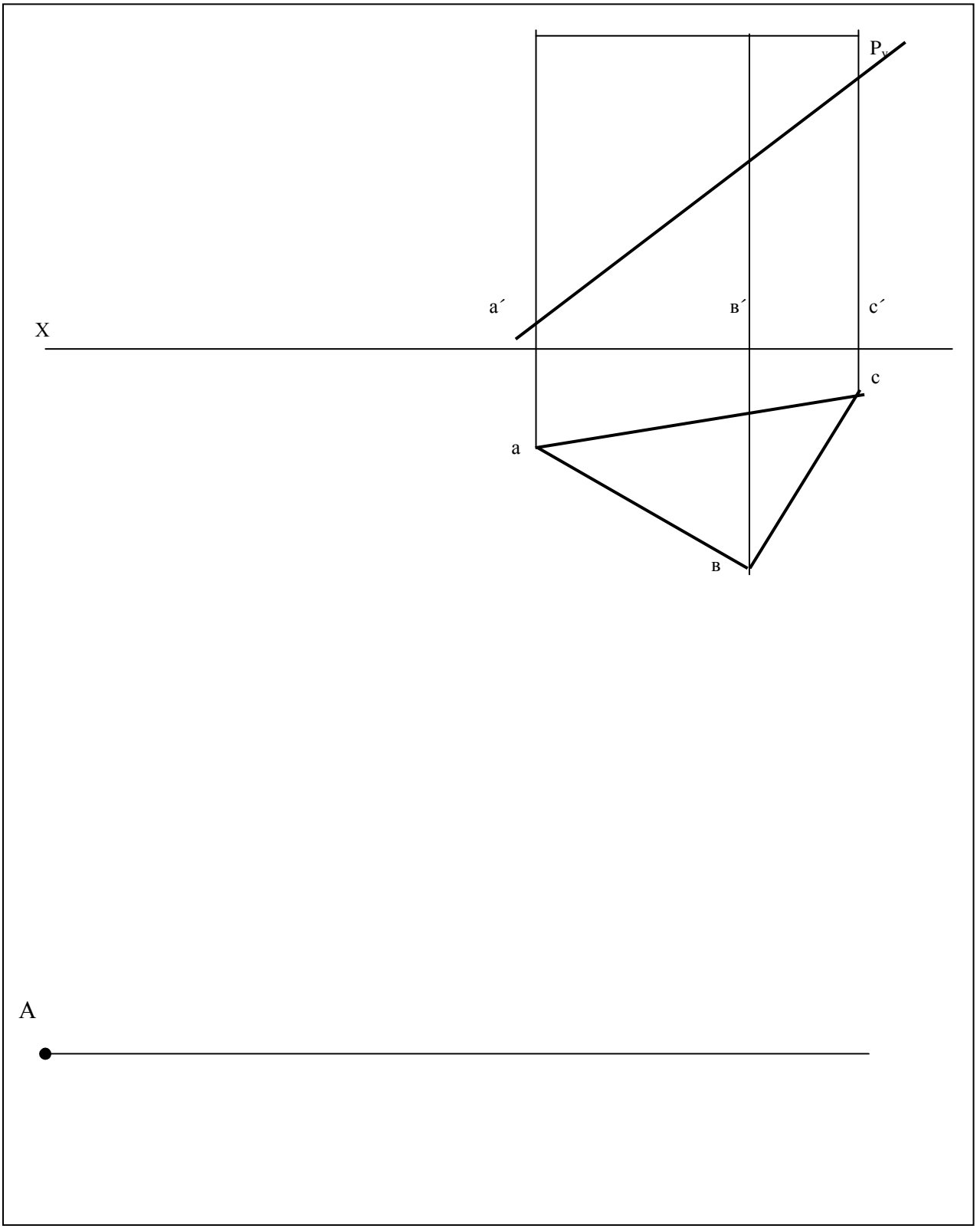
Variant	A			B		
	X	**Y**	**Z**	**X**	**Y**	**Z**
1…5	60	0	25	25	30	5
6…10	65	0	10	20	25	5
11…15	65	25	15	10	5	20
16…20	60	30	15	10	5	25
21…25	55	25	0	20	0	30
26… 28	55	30	0	20	5	30

Task № 35. Find the true size of triangle ABC.

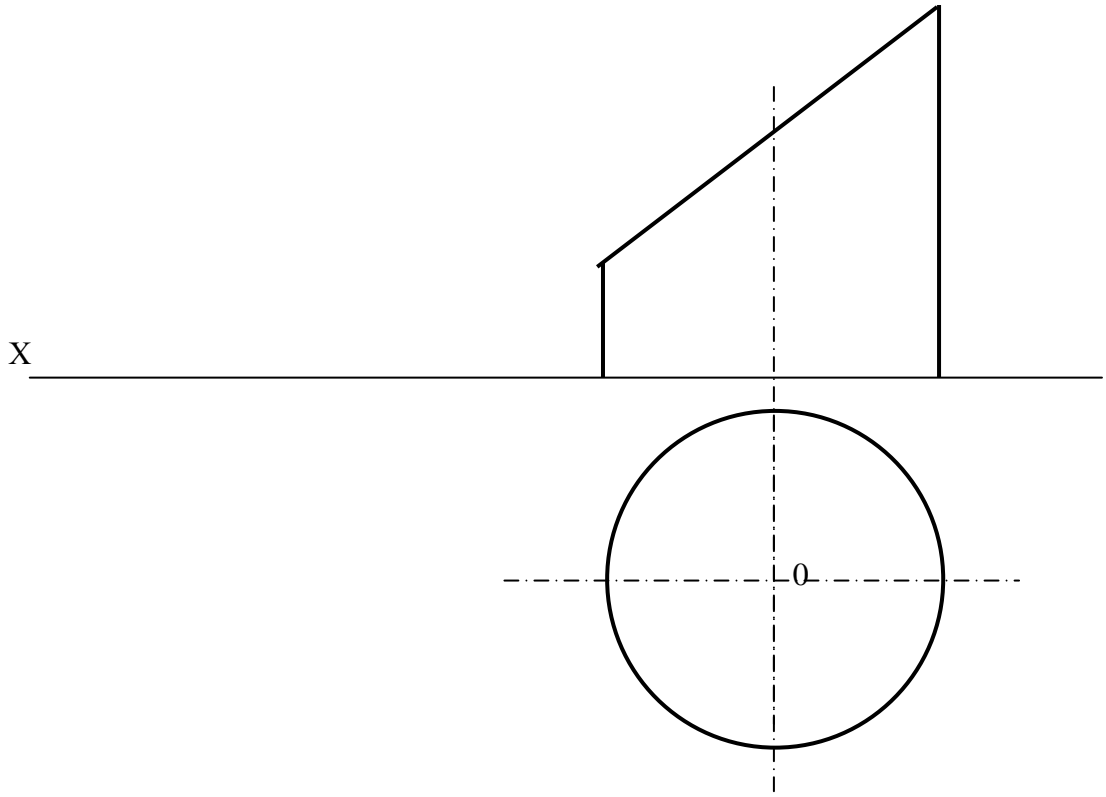


11. POLYHEDRONS. DEVELOPMENTS

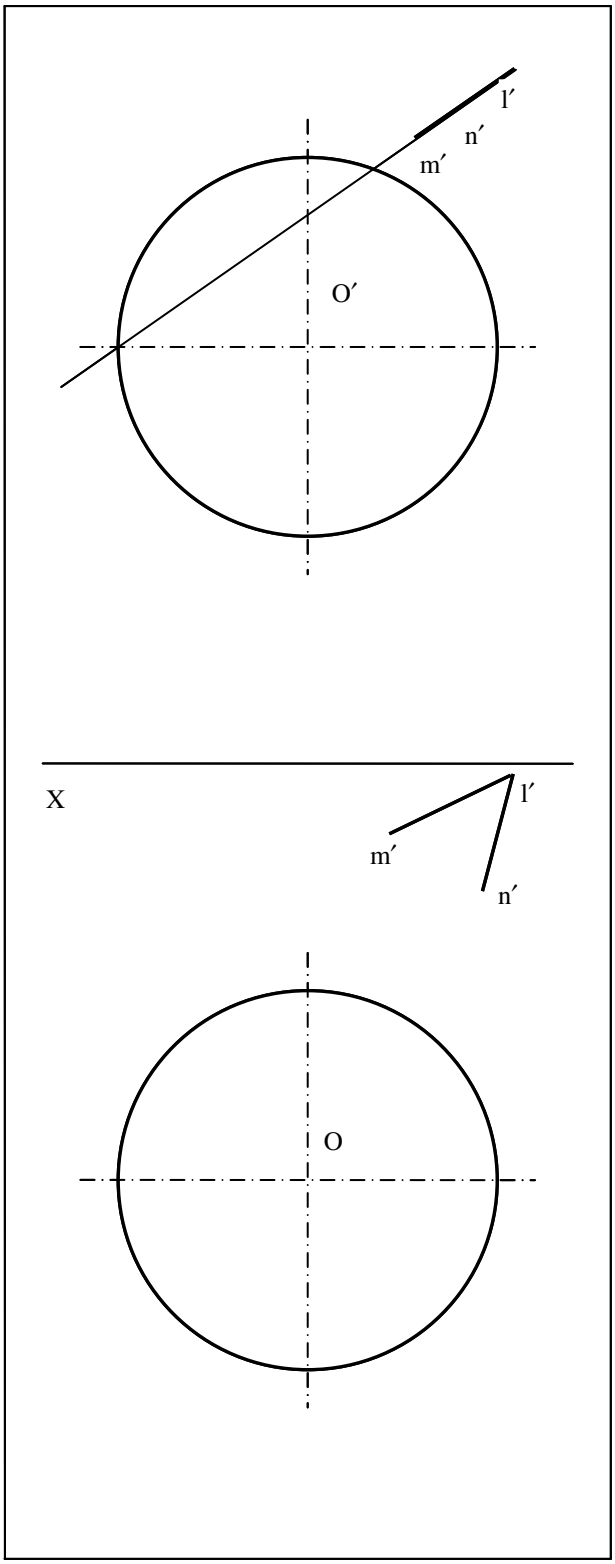
Task № 36. Find intersection of the plane and the polyhedron (prism). Draw the development of the cut part of prism.



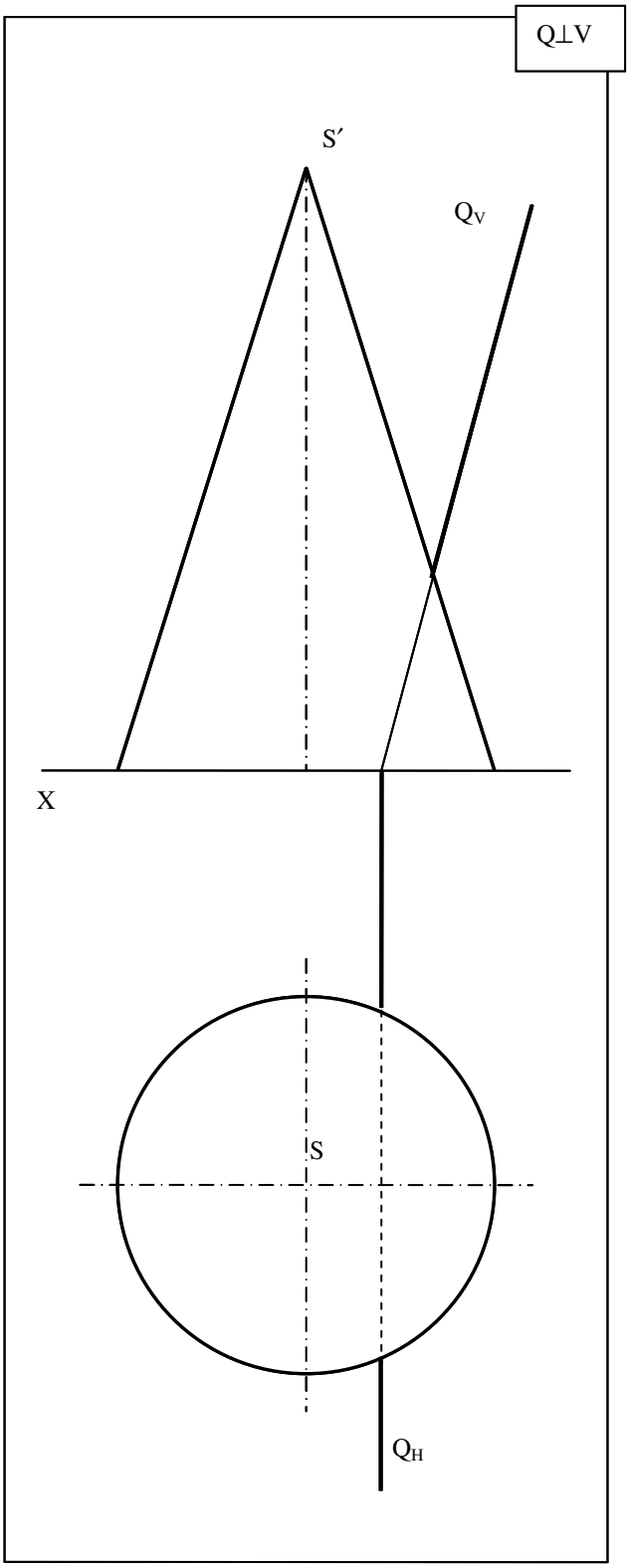
Task № 37. Find intersection of the plane and the cylinder. Draw the development of the cut cylinder.



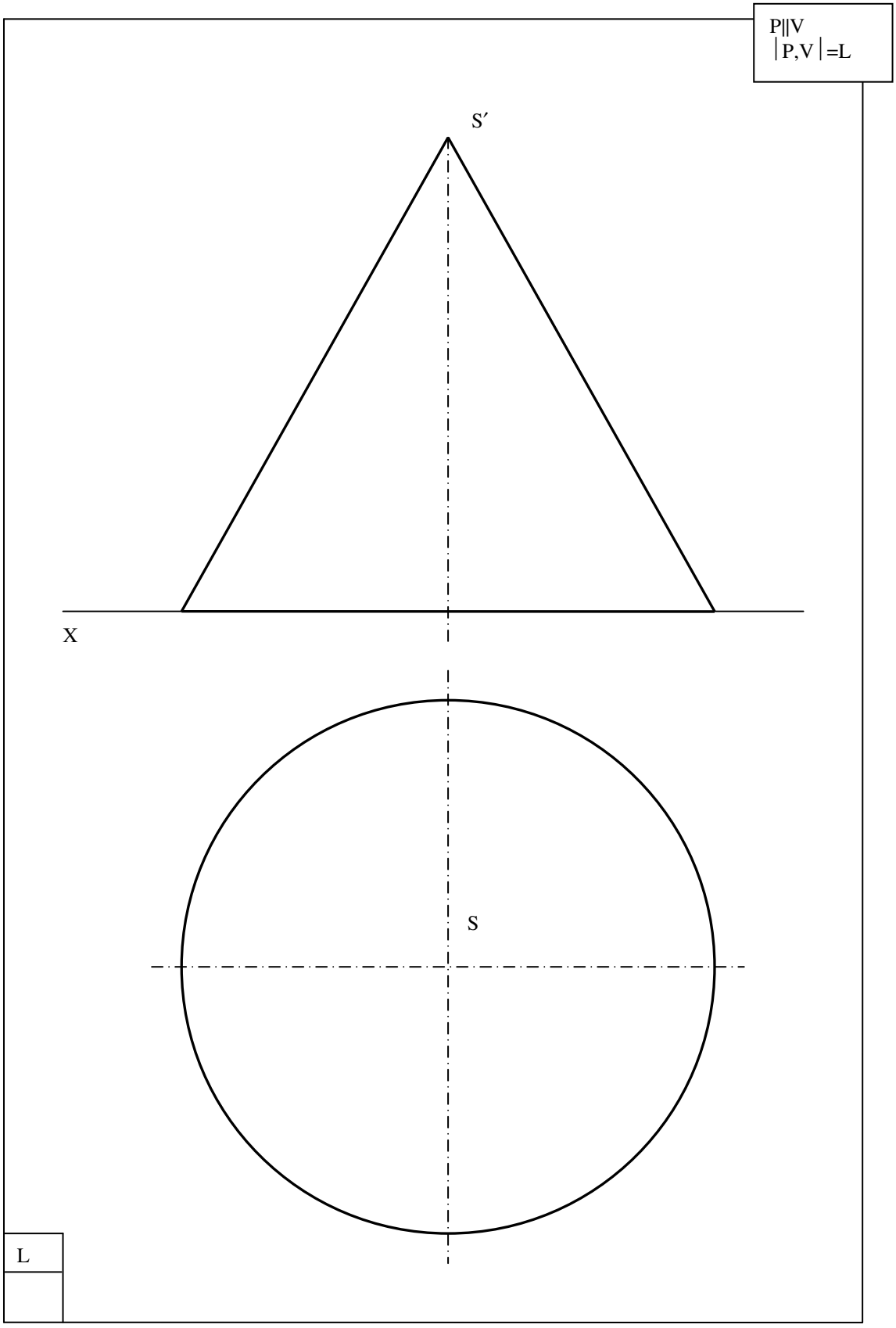
Task № 38 Find intersection of the plane and the sphere



Task № 39 Find intersection of plane and cone

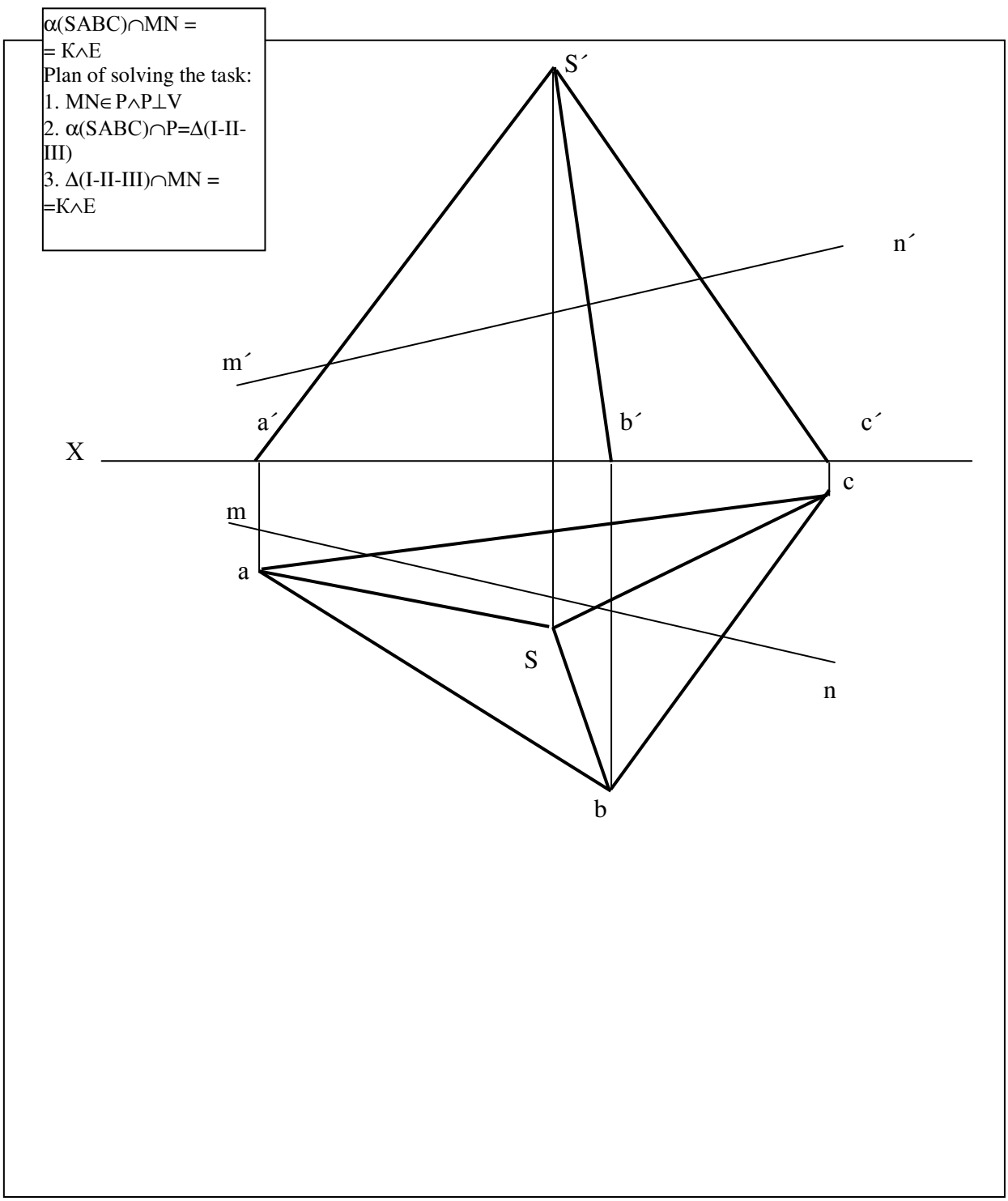


Task№ 40. Find intersection of the frontal plane P and the cone, the plane is located in the distance L from V - plane



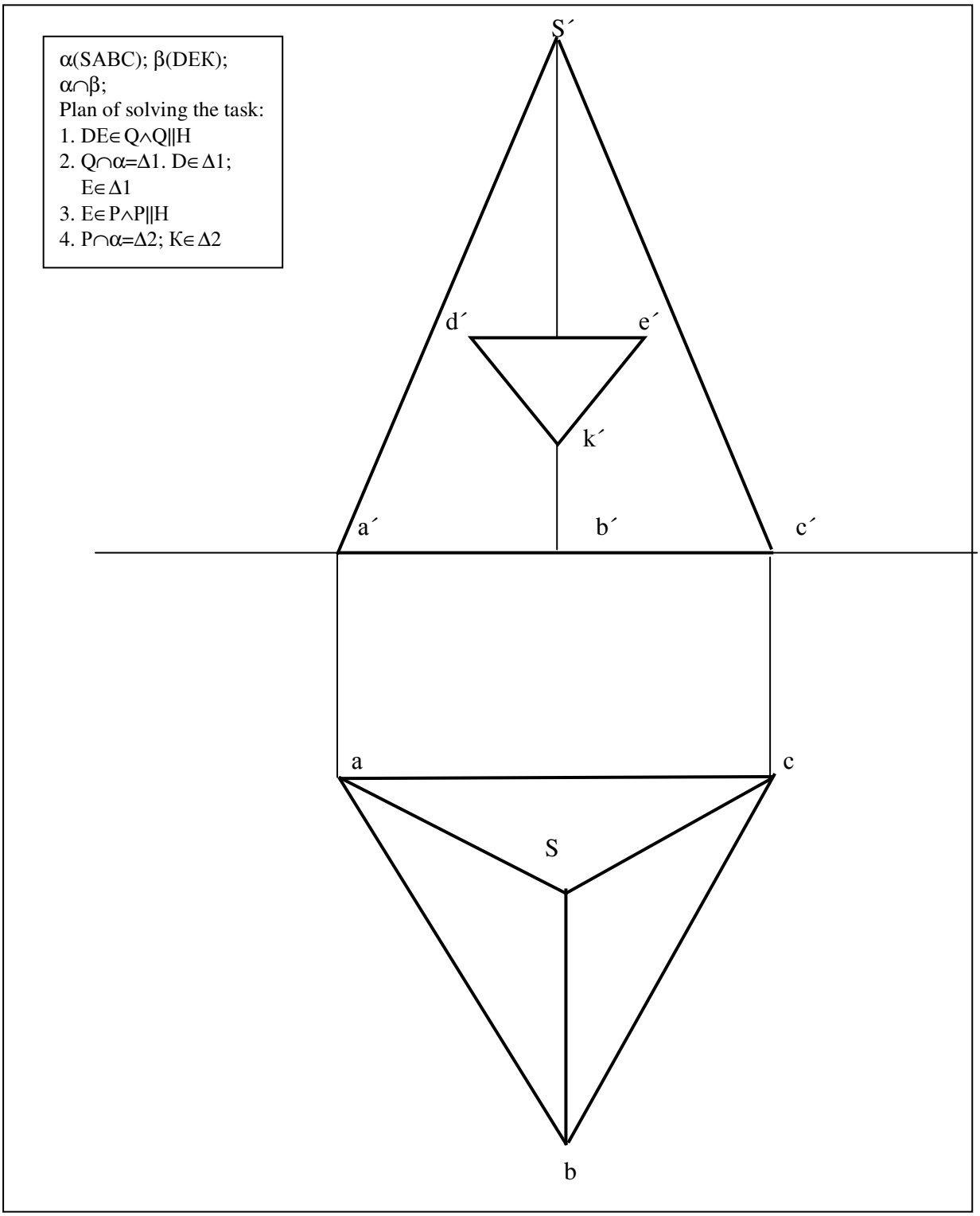
12 INTERSECTION OF LINE WITH SURFACE

Task № 41. Find the points in which the line intersects the pyramid. Define visibility of the line.



13. Intersection of solids

Task № 42. **Find the intersection of a pyramid and prism.**



CONTENTS

1.	Basic rules of drawings design according to standards of general system of construction documentation (GSCD) and some geometrical drawings	3
2.	Descriptive geometry. Tasks	37