EXERCISES, PROBLEMS AND PRACTICES OF METRIC GEOMETRY

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Barcelona, september 2019

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INTRODUCTION

Legend

In this document the following colour code has been used to differentiate the data (what is known), the operations (Procedures that must be executed to obtain the result) and the solutions (what is sought):

Black or White — DATA
Blue — OPERATIONS
Red — SOLUTIONS

SDW	ACCESS TO SOLIDWORKS SOLUTION FILE
STEP	ACCESS TO SOLUTION FILE IN STEP FORMAT
VIDEO	ACCESS TO THE VIDEO RECORDING OF THE PROCEDURE
	ACCESS TO eDrawing

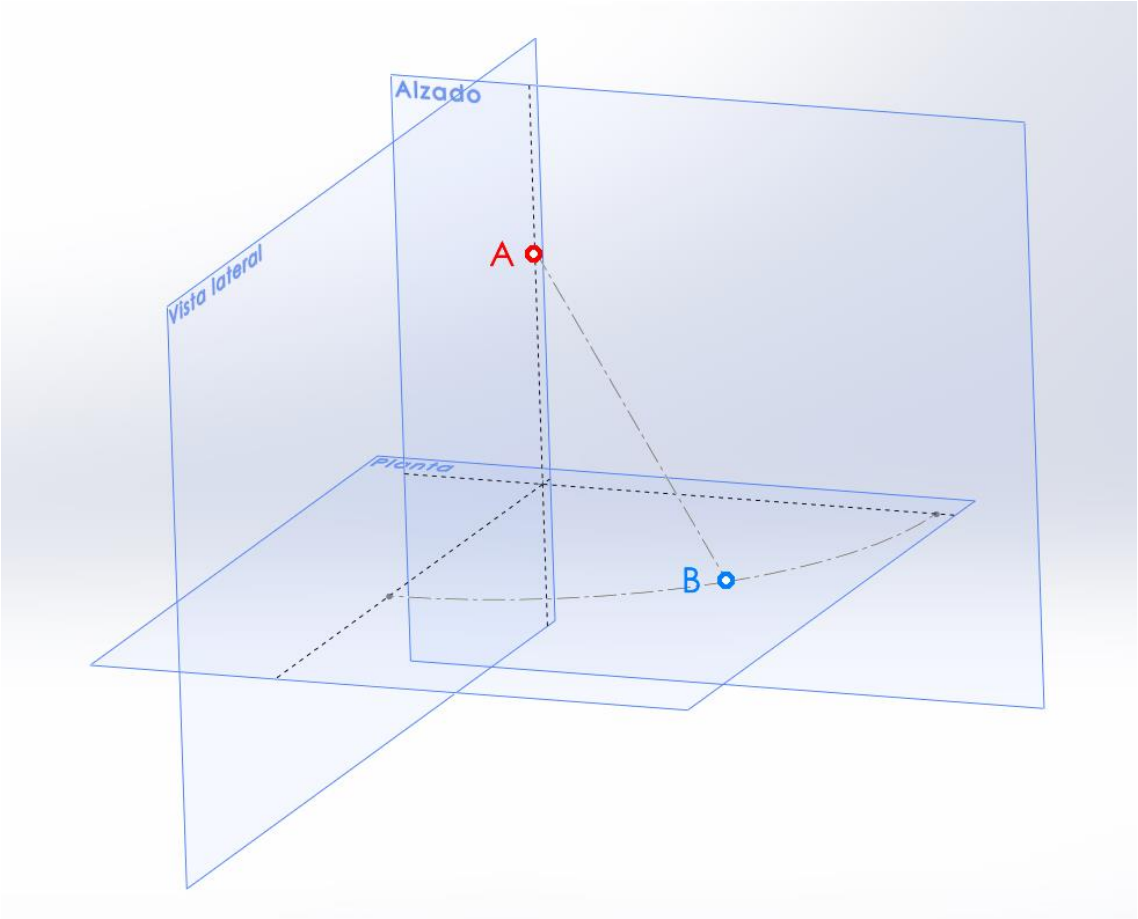
Instruction for reading the graph:

BLACK COLOR = Fixed elements (they do not move or transform).
RED COLOR = Variable elements (those that modify their position in the space after the data is entered based on the fixed elements).
BLUE COLOR = Elements that contain the construction data.

EXERCISES

METRIC OF THE POINT, LINE AND PLANE

E 1



GRAPHIC LEGEND

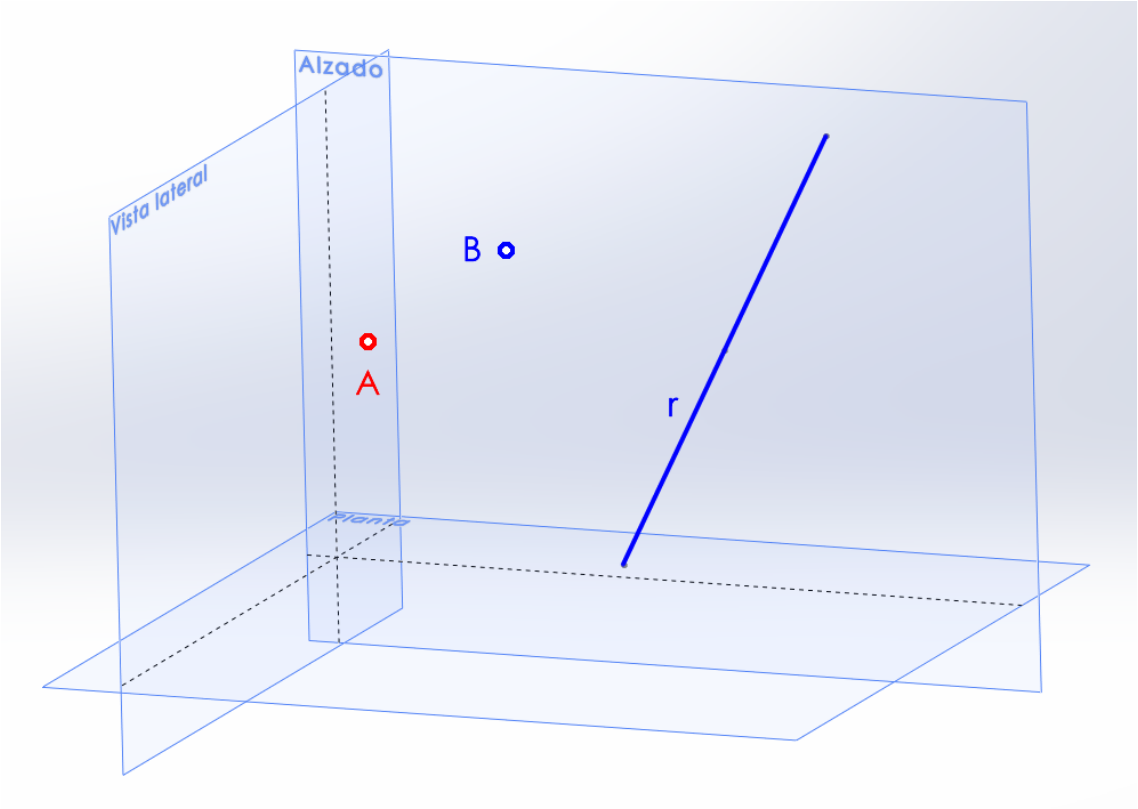
ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

Given the point **A** located **40** units above the **Top PLane** and being coincident with the **Rigth Plane** and the **Front Plane**, calculate the radius of the circle of all points **B** that are at a distance of **80** from **A** and are located on the **Top Plane**.

ANSWER: .....

E 2_1



GRAPHIC LEGEND

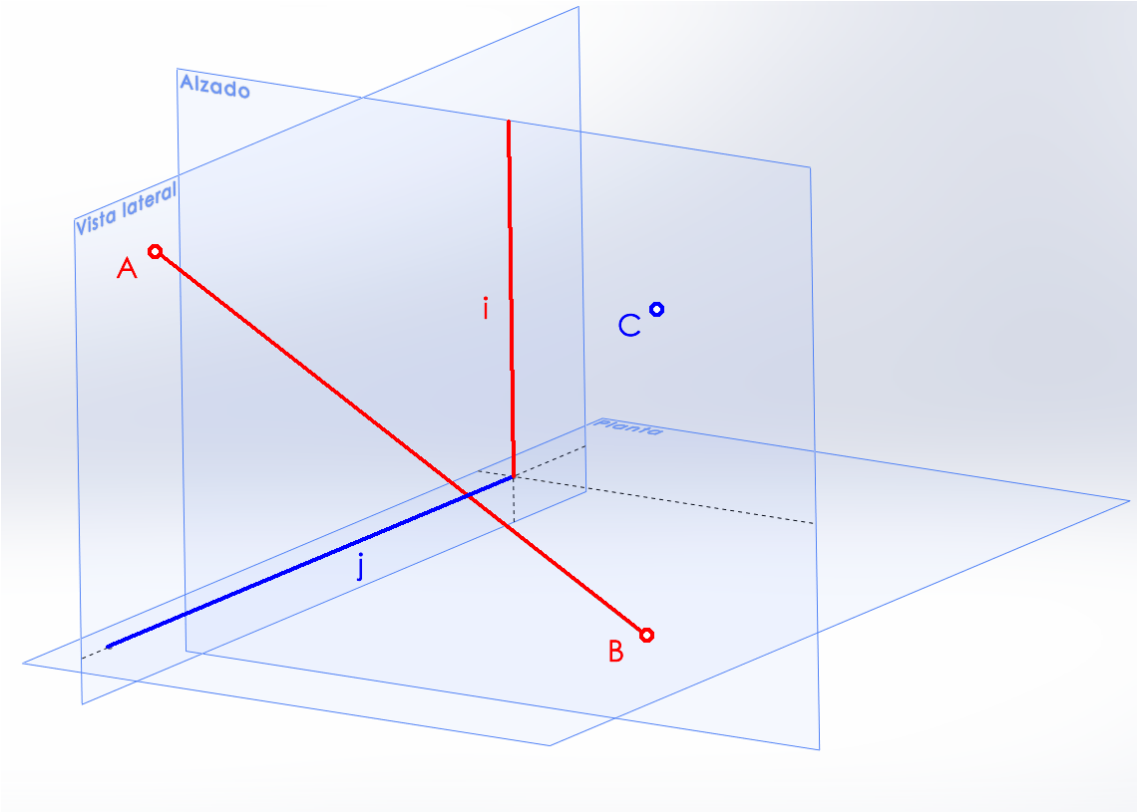
ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

Given the point **A**, calculate the distance from point **B**, which is the orthogonal projection of **A** on the **Front Plane**, to a line **r** contained in **Front Plane** and in a distance of **45** from **A**.

ANSWER: .....

E 2_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

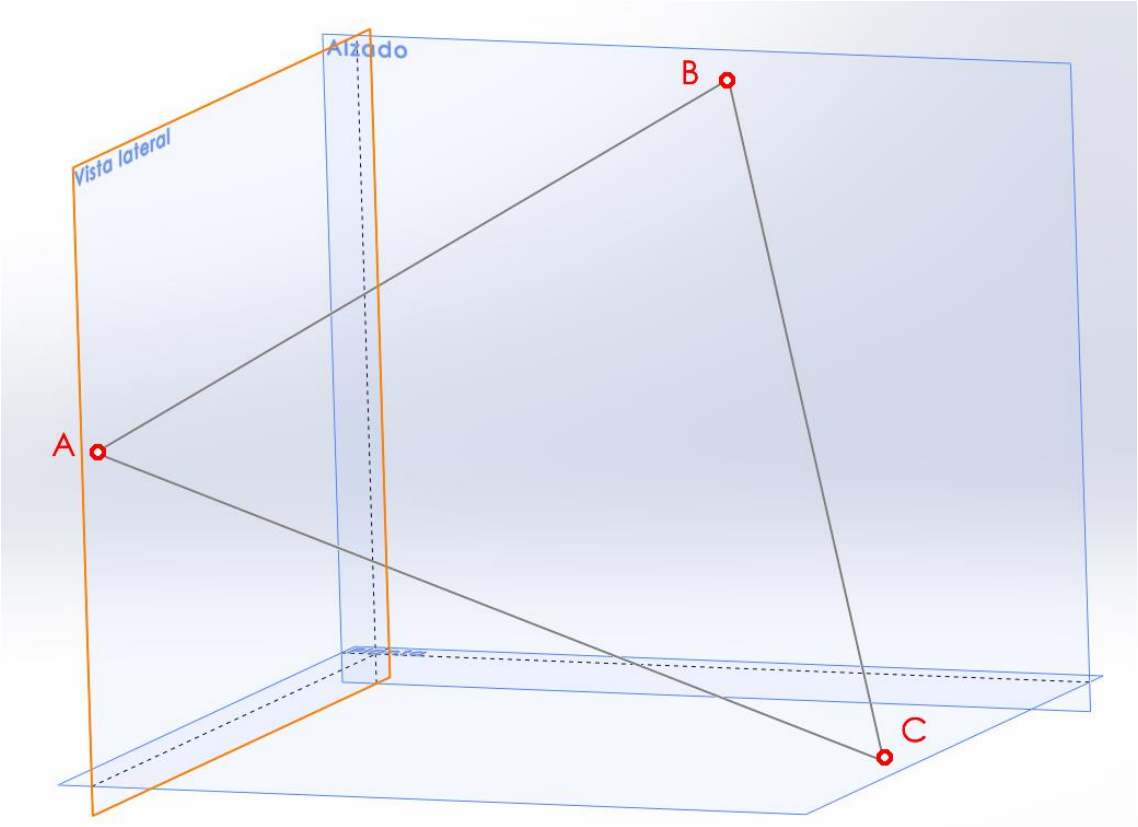
SDW

Given the line **AB**, obtain the position of point **C** on the **Front Plane** at a distance of **60** from line **AB** and at a distance of **20** from line **i**, intersection between the **Front Plane** and the **Rigth Plane**.

Located point **C**, calculate the distance from point **C** to the line **j**, intersection between the **Top Plane** and the **Rigth Plane**.

ANSWER: .....

E 3_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

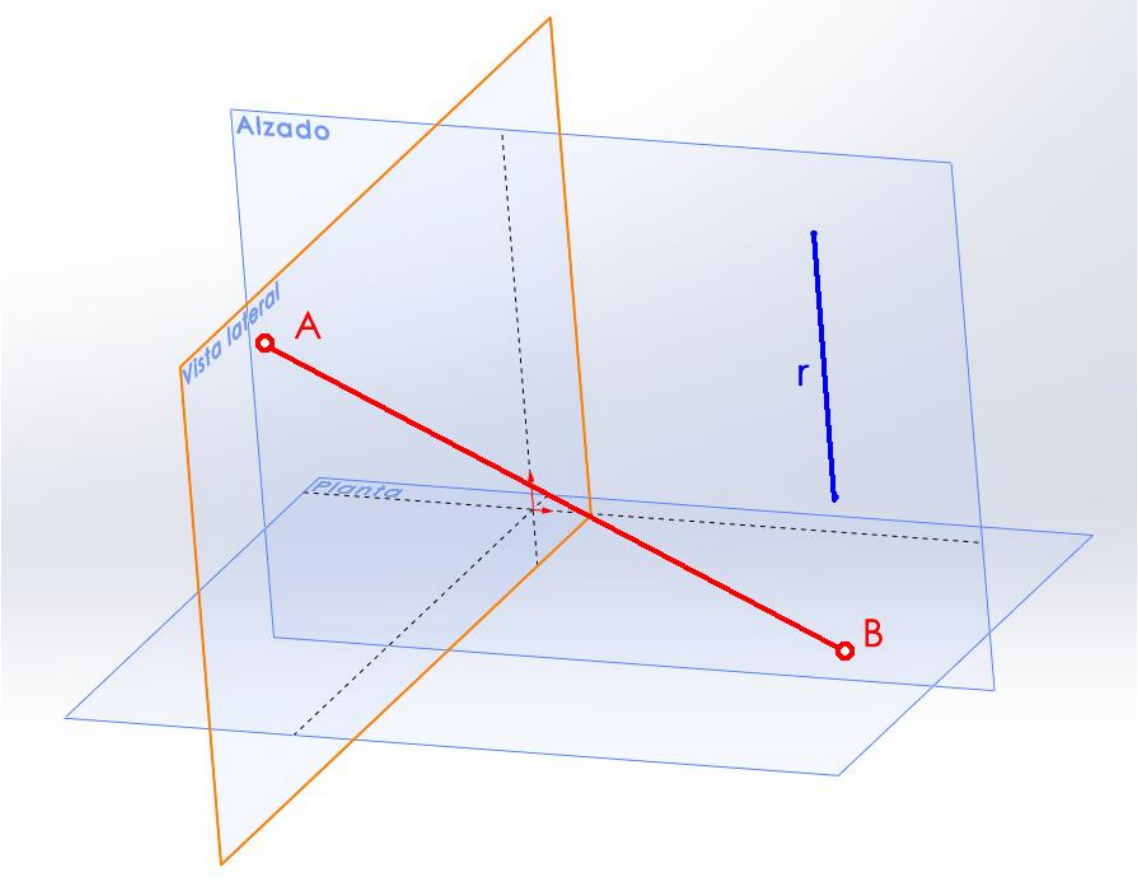
SDW

Given the plane **ABC**, we ask to place a plane **a**parallel to **ABC** at a distance of **16** from the origin of coordinates.

Obtain the distance from **A** to plane **a**.

ANSWER: .....

E 4_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

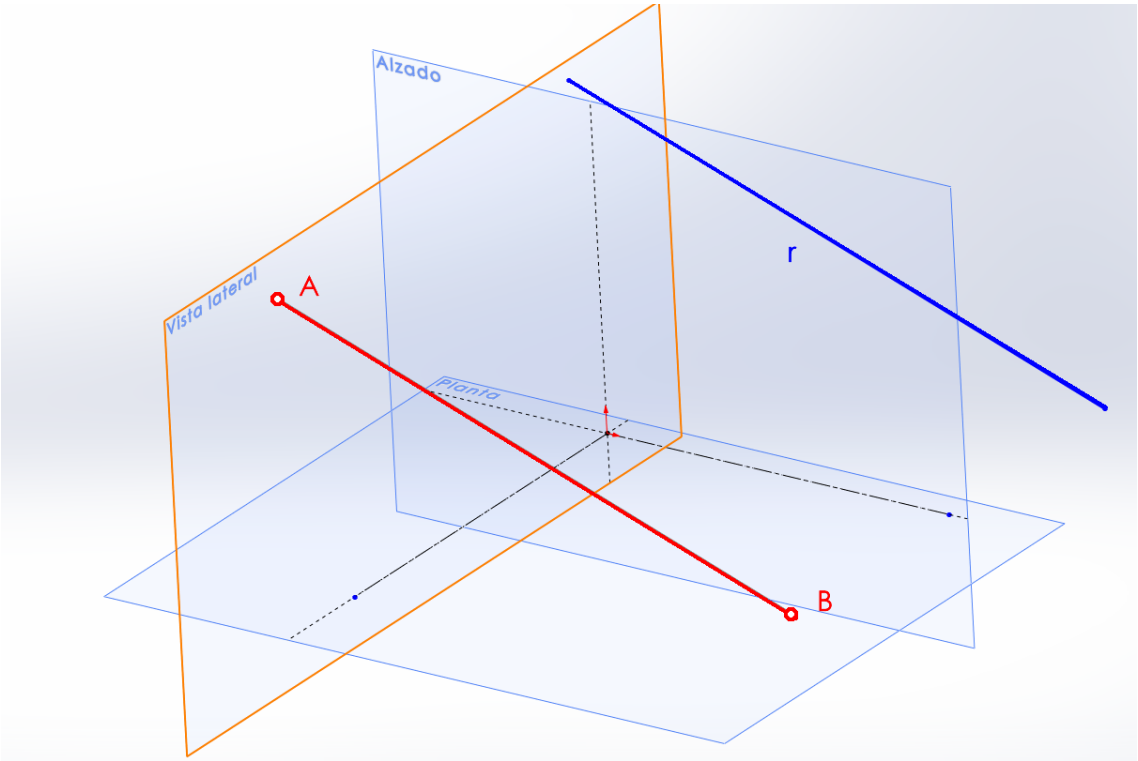
SDW

Given the line **AB**, define a line **r** contained on the **Front Plane**, being parallel to the **Right Plane**, and located at a distance of **45** from line **AB**.

Calculate the distance from the line **r** to the **OZ** axis (intersection of the **Rigth Plane** and the **Front Plane**).

ANSWER: .....

E 4_2



GRAPHIC LEGEND
ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

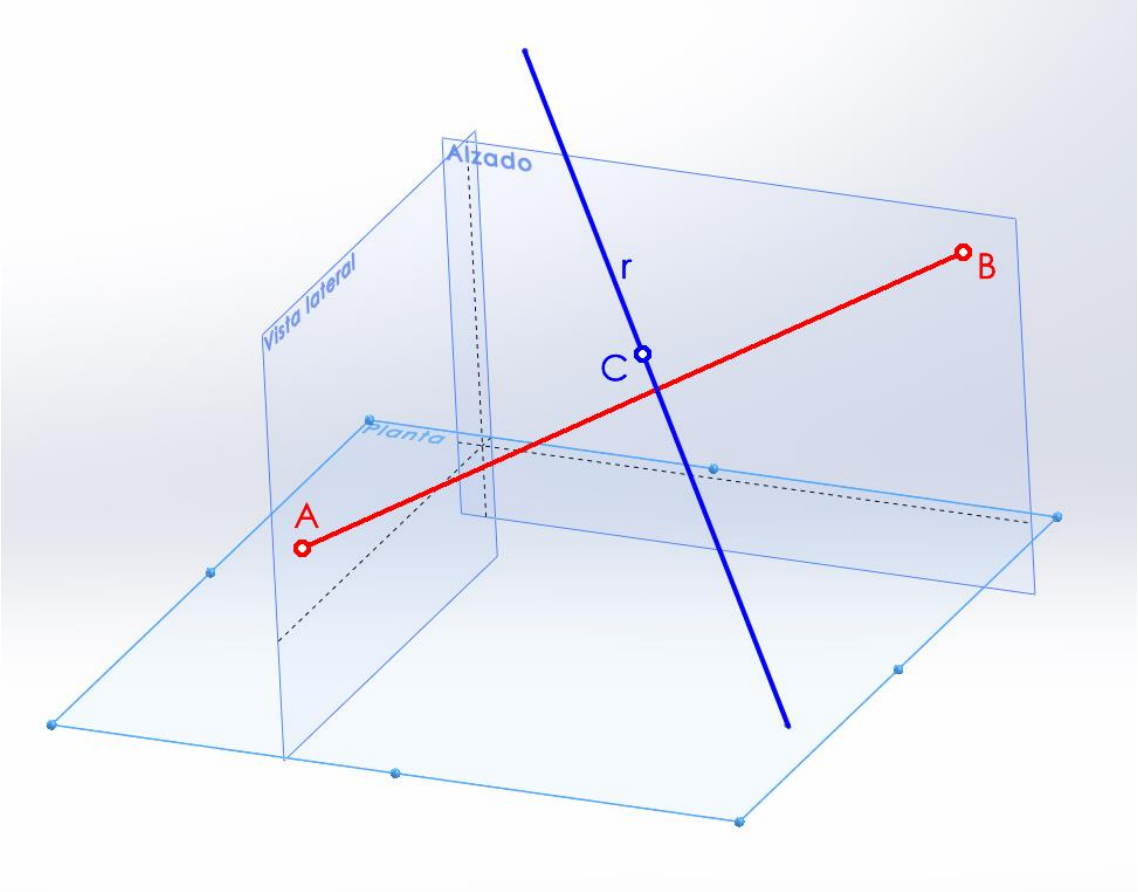
Given the line **AB**, define the **r** line parallel to **AB** with the following conditions:

1. distance from **r** to **AB** = **55**
2. distance from **r** to the **OX** axis (intersection between **Front Plane** and **Top Plane**) = 20

Calculate the distance from line **r** to the axis **OY** (intersection of the **Rigth Plane** and the **Top Plane**).

ANSWER: .....

E 4_3



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

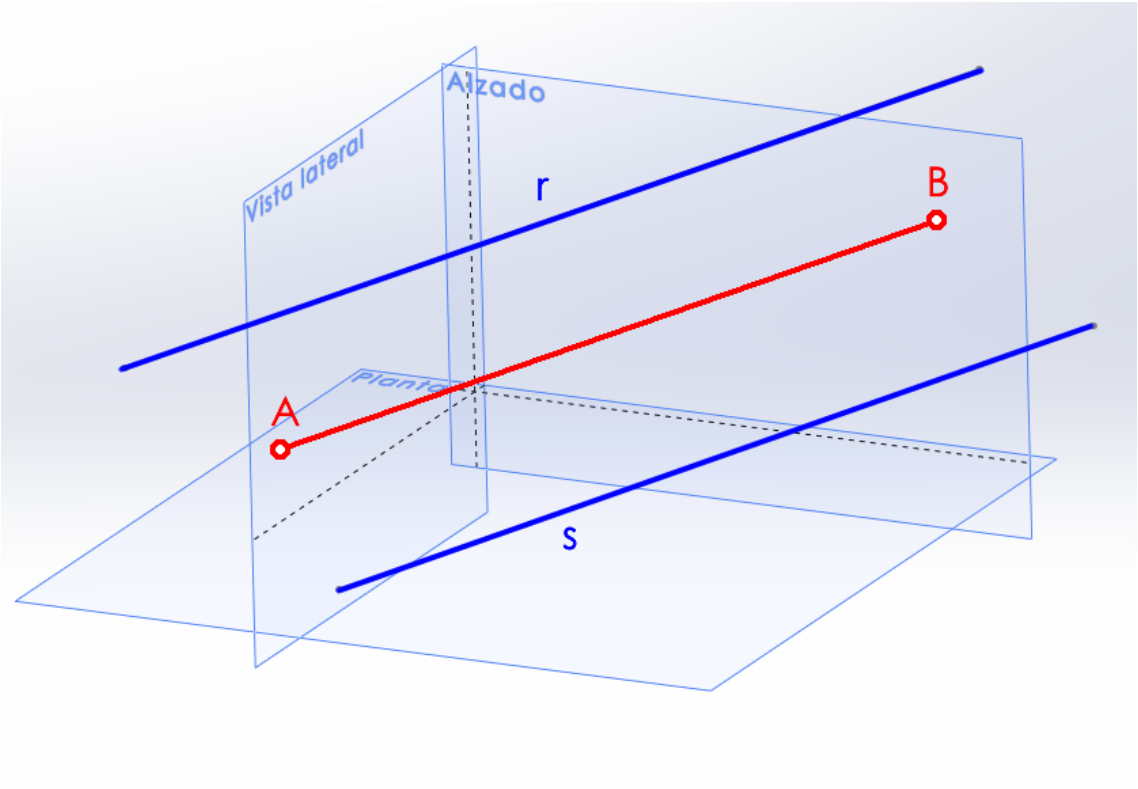
SDW

Given the line **AB**, define a line **r** located on the **Front Plane**, at a distance of **40** from **AB** and which passes through a point **C**, which is the nearest point of **r** to **AB** and is located at a height of **15**.

Calculate the distance between the line **r** and the line of intersection between the **Top Plane** and the **Rigth Plane**.

ANSWER: .....

E 4_4



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

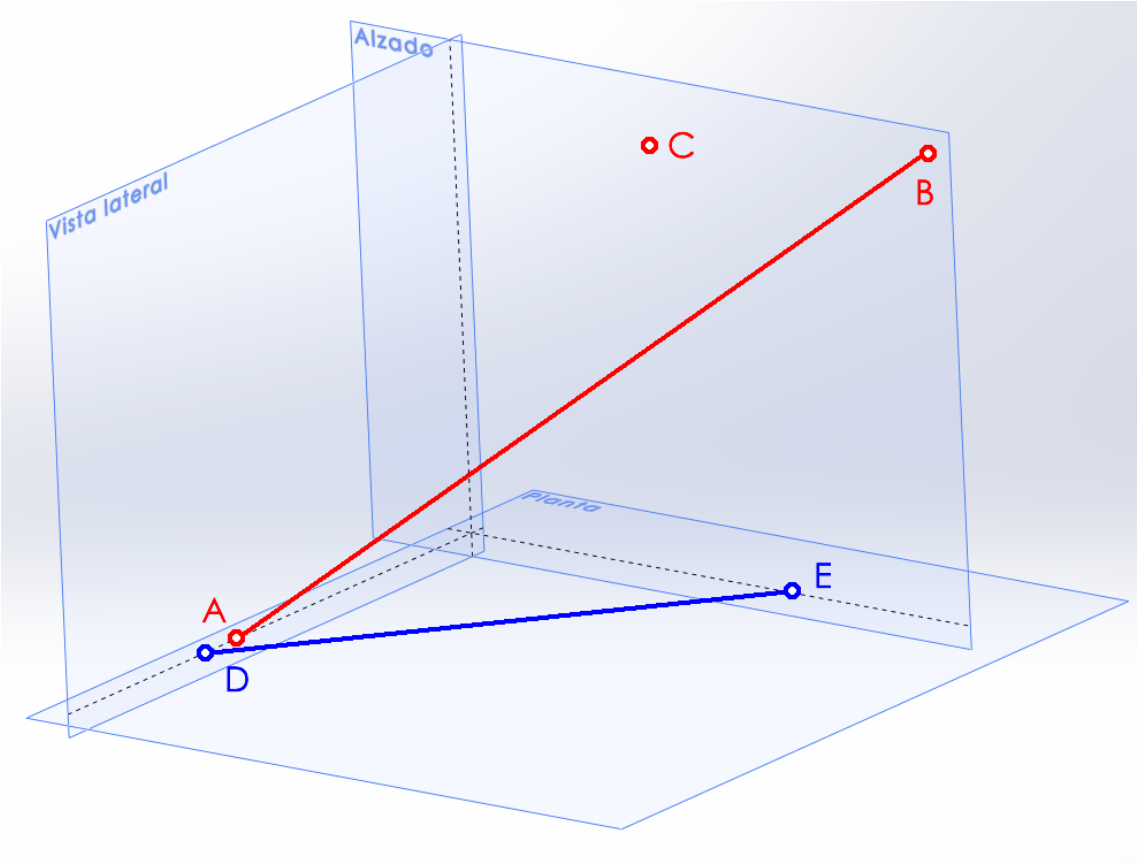
SDW

Given the line **AB**, define the lines **r** and **s**, parallel to **AB**, located on the **Front Plane** at a distance of **80** from **AB**.

Calculate the distance between the lines **r** and **s**.

ANSWER: .....

E 5_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

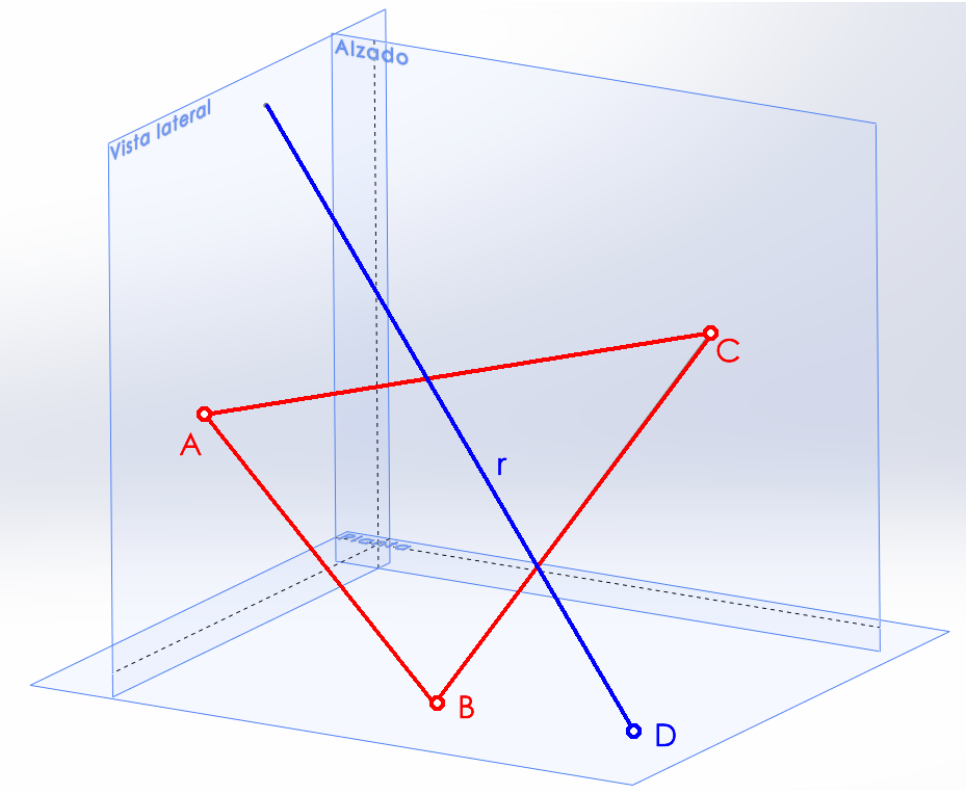
SDW

Given the line **AB** and the point **C**, define a plane **a** coincident with point **C** and at a distance of **15** the the line **AB**.

The line **DE** belongs to the **Top Plane** and is **30** units far from the **origin of coordinates**. Calculate the distance from **DE** to plane **a**.

ANSWER: .....

E 5_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

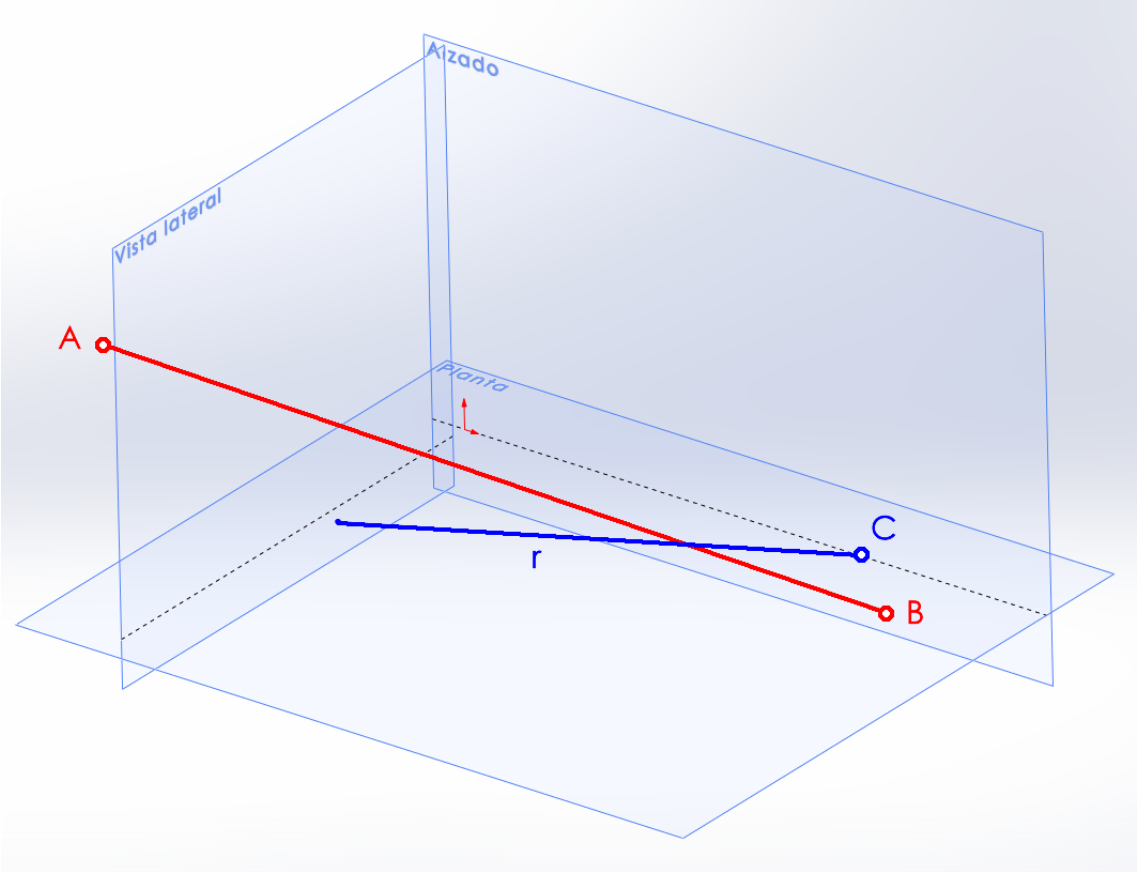
SDW

Given the plane **ABC** plane, define a line **r** located at a distance of **30** above the plane **ABC** and fulfilling that all its points are equidistant from the **Front Plane** and the **Right Plane**.

Calculate the distance between Point **D**, intersection of line **r** and **Top Plane**, and the **Front Plane**.

ANSWER: .....

E 6_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

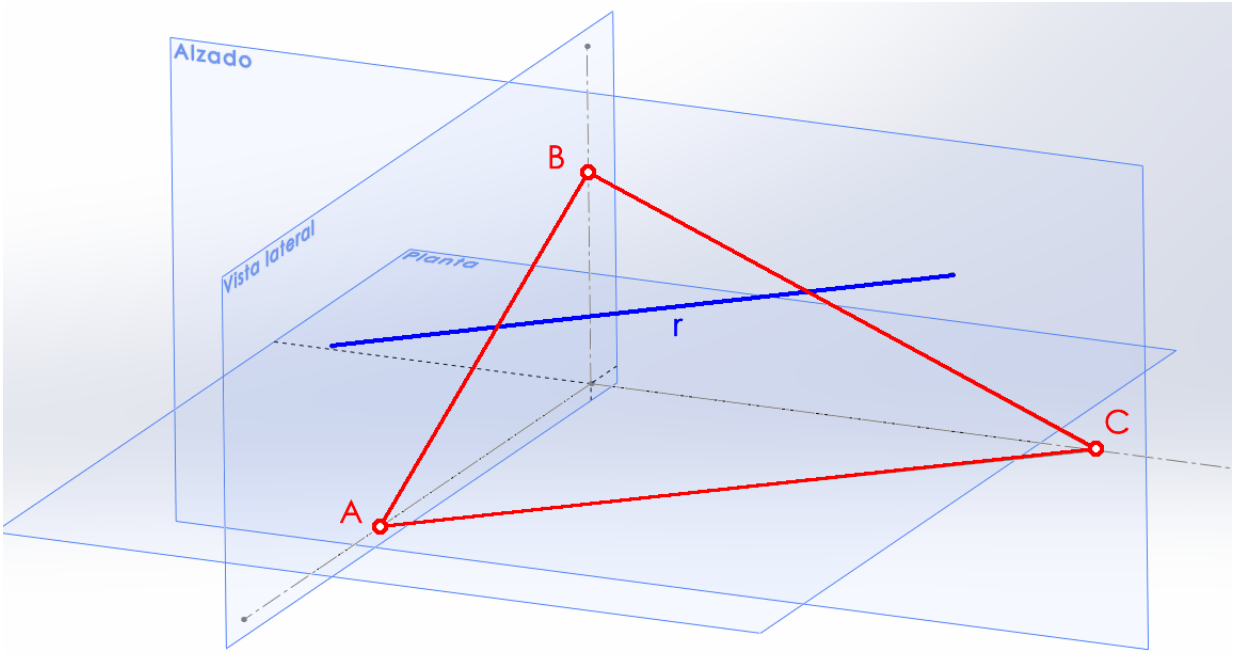
Given the line **AB**, define a line **r** intersecting at point **C** the **Front Plane** and the **Top Plane**. Point **C** is at a distance of **60** from the **origin of coordinates**. The line **r** forms an angle of **45º** with the line **AB** and of **90º** with the line of intersection between the **Front Plane** and the **Top Plane**.

Calculate the angle between the line **r** and the line of intersection between the **Top Plane** and the **Right Plane**.

Choose the smallest possible angle.

ANSWER: .....

E 7_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

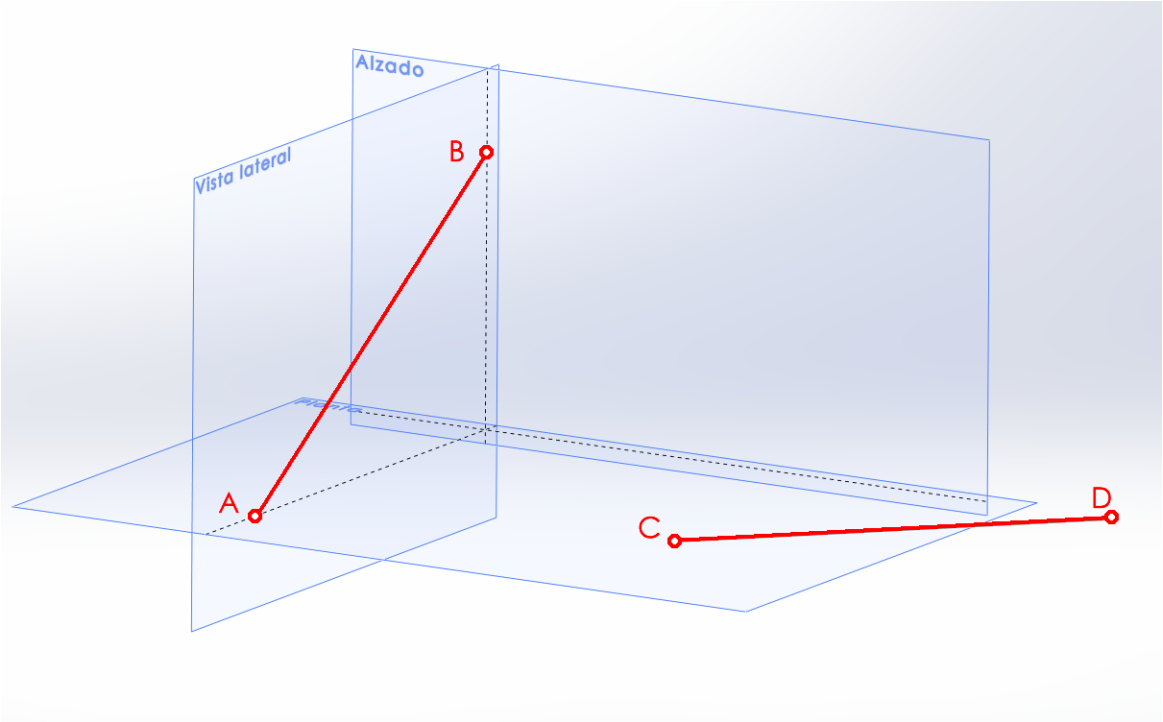
SDW

Given the plane **ABC**, define a line **r** contained on the **Rigth Plane**. Line **r** forms an angle of **30º** with the plane **ABC**.

Calculate the angle between the line **r** and the **Top Plane**.

ANSWER: .....

E 7_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

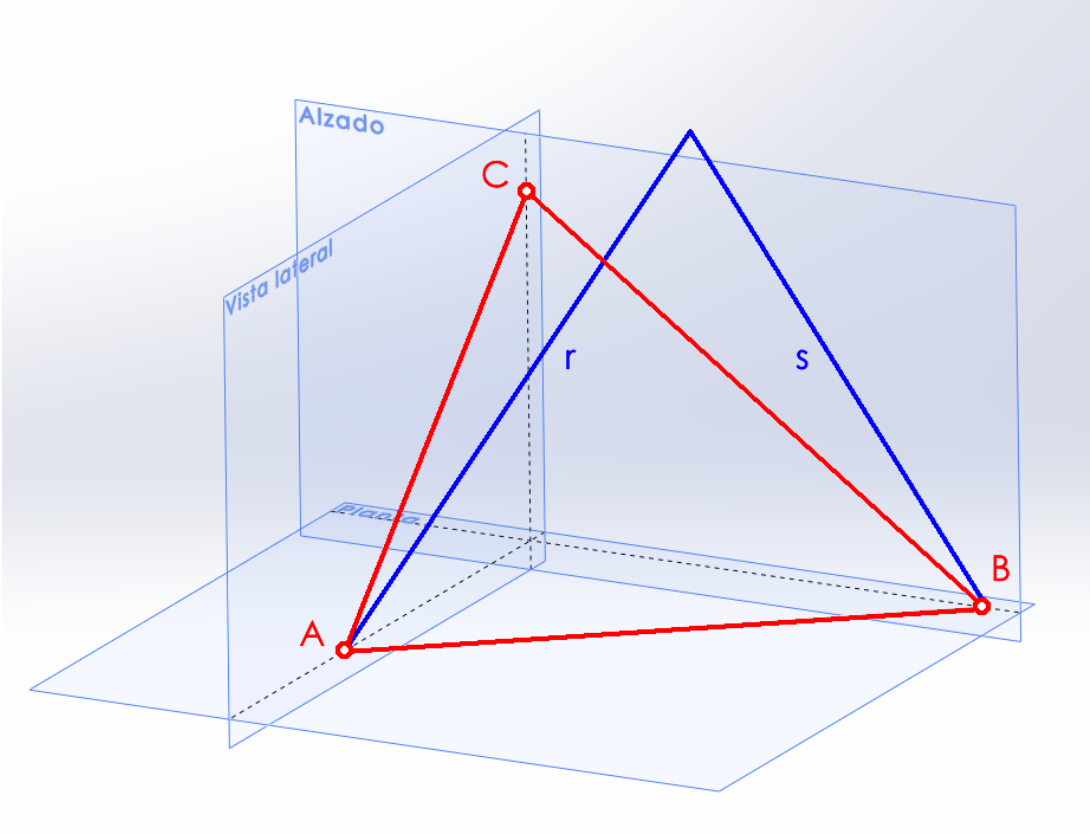
SDW

Given the lines **AB** and **CD**, define a plane **a** that forms an angle of **30º** with **AB** and that contains the line **CD**.

Calculate the angle between the plane **a** and the intersection line between the **Front Plane** and the **Top Plane**.

ANSWER: .....

E 8_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

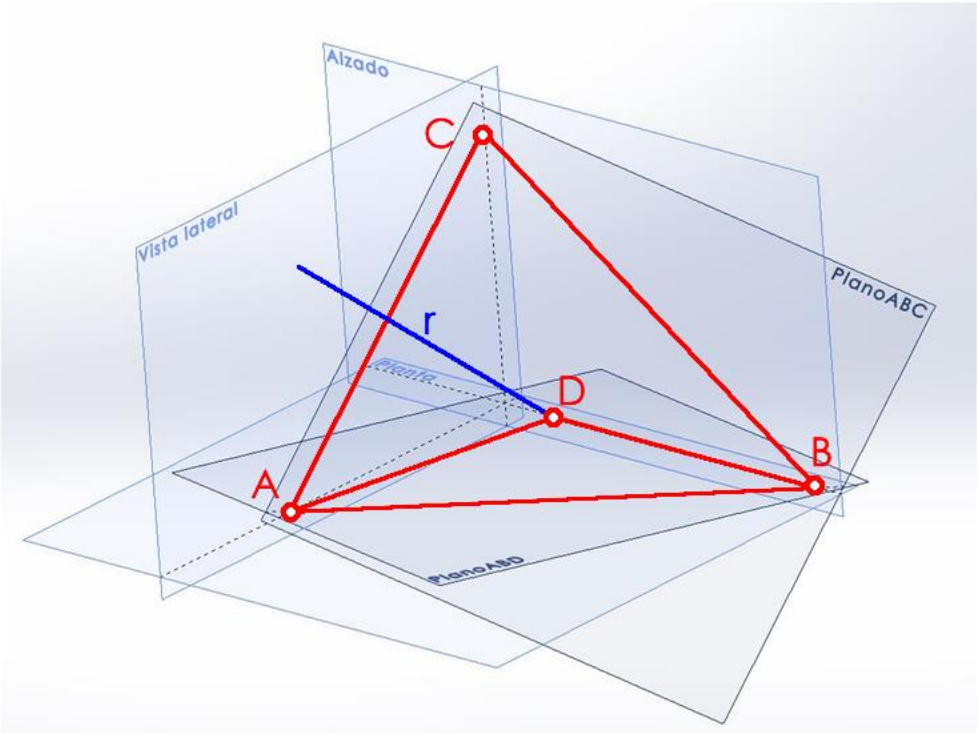
SDW

Given the plane **ABC**, define the lines **r** and **s** that form an angle of **60º** with the **Top Plane** and **45º** with the plane **ABC**. The line **r** passes through point **A** and the line **s** through point **B**.

Calculate the smallest angle between the lines **r** and **s**.

ANSWER: .....

E 9_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

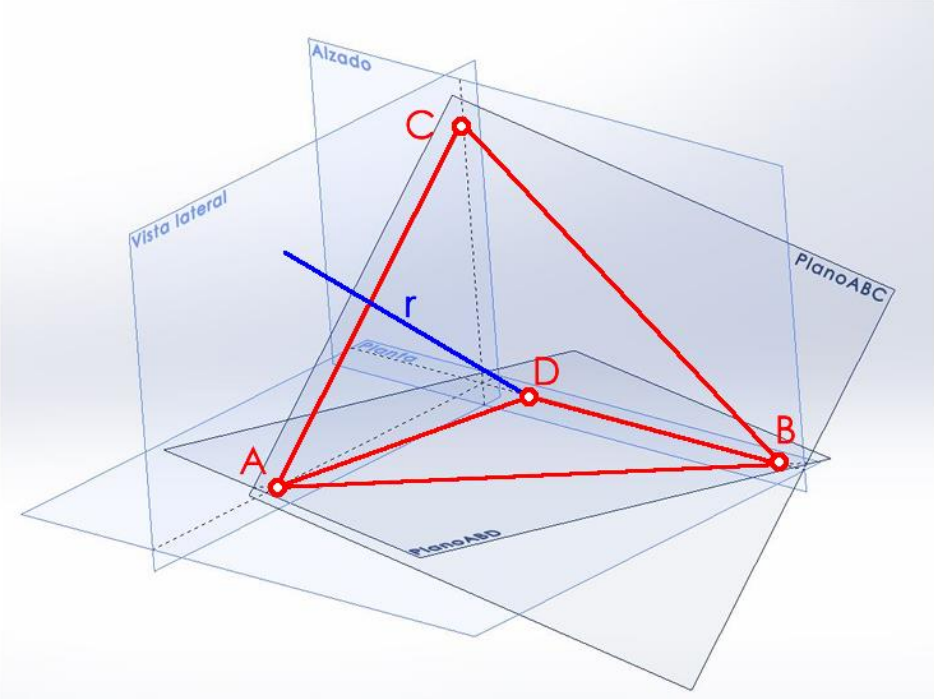
SDW

Given the planes **ABC** and **ABD**, define a line **r** that forms an angle of **50º** with **ABC** and of **30º** with the **ABD** and that ends at point **D**.

Taking into account the possible solutions of **r**, calculate the minimum distance between **r** and **C**.

ANSWER: .....

E 9_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

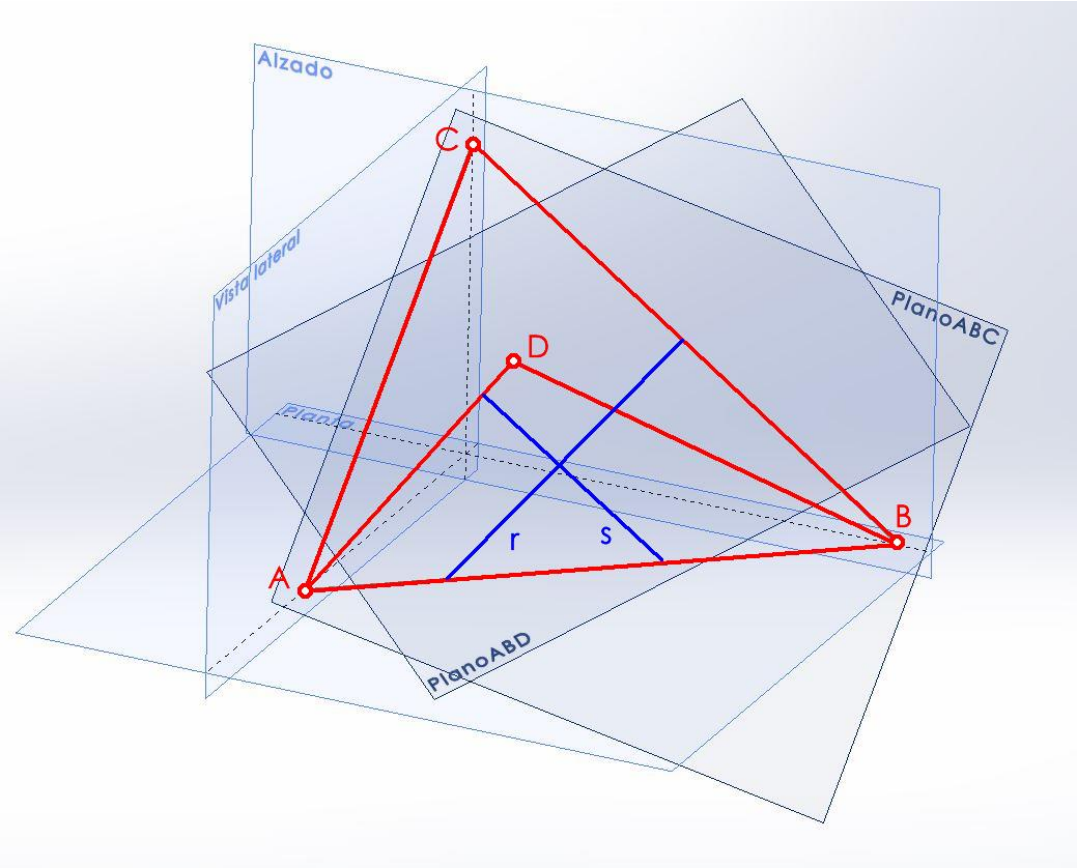
SDW

Given the planes **ABC** and **ABD**, define a line **r** that forms an angle of **50º** with **ABC** and of **30º** with **ABD** and that ends at point **D**.

Taking into account the possible solutions of **r**, calculate the minimum angle between **r** and **AC**.

ANSWER: .....

E 10_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

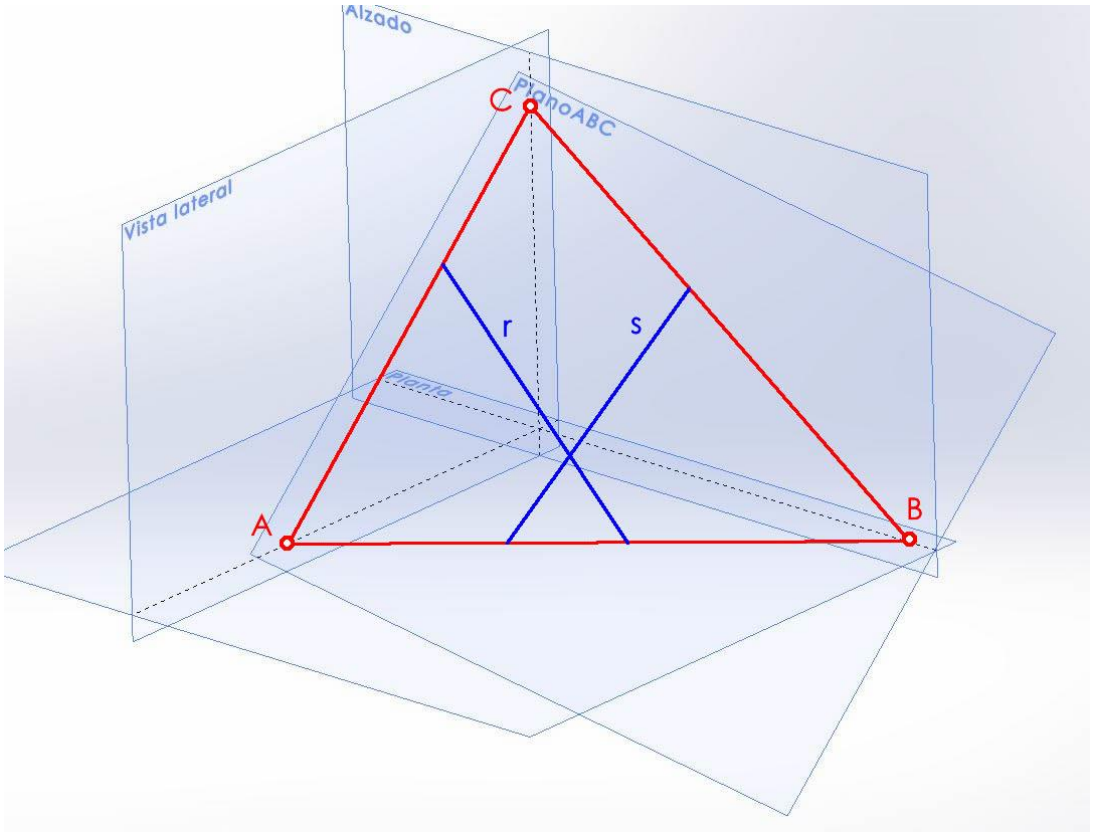
SDW

Given the planes **ABC** and **ABD**, define the lines **r** and **s** on the planes **ABC** and **ABD**, respectively. The lines **r** and **s** have a slope of **30%.**

Calculate the smallest angle between the lines **r** and **s**.

ANSWER: .....

E10_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

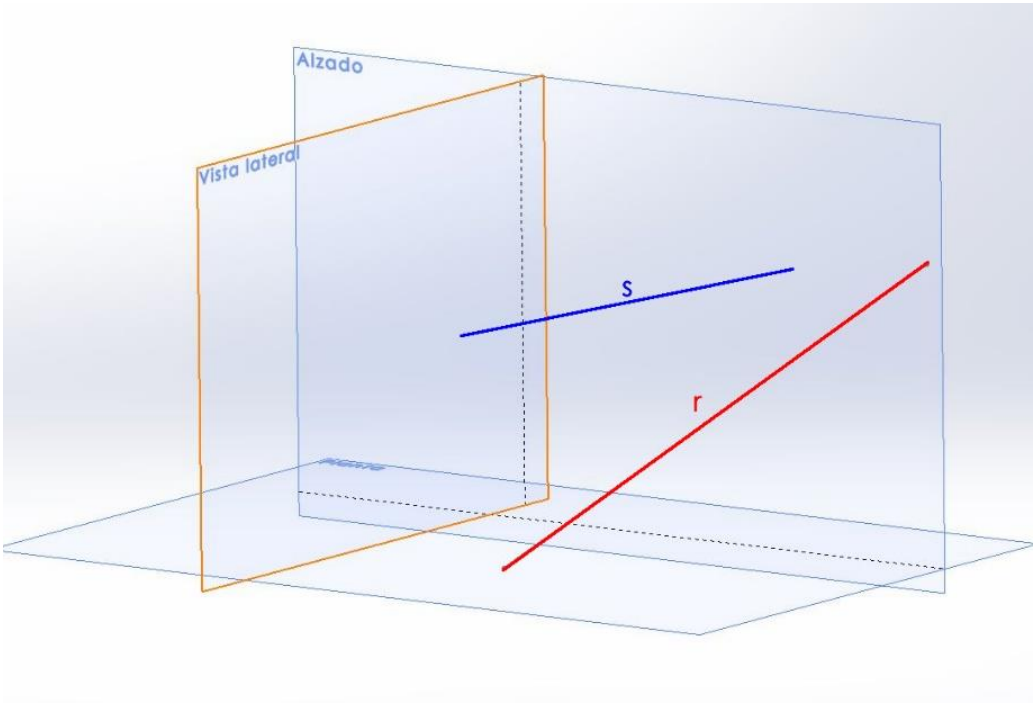
SDW

The lines **r** and **s** belong to the given plane **ABC** and have a slope of **100%.**

Calculate the smallest angle between the lines **r** and **s**.

ANSWER: .....

E 11_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

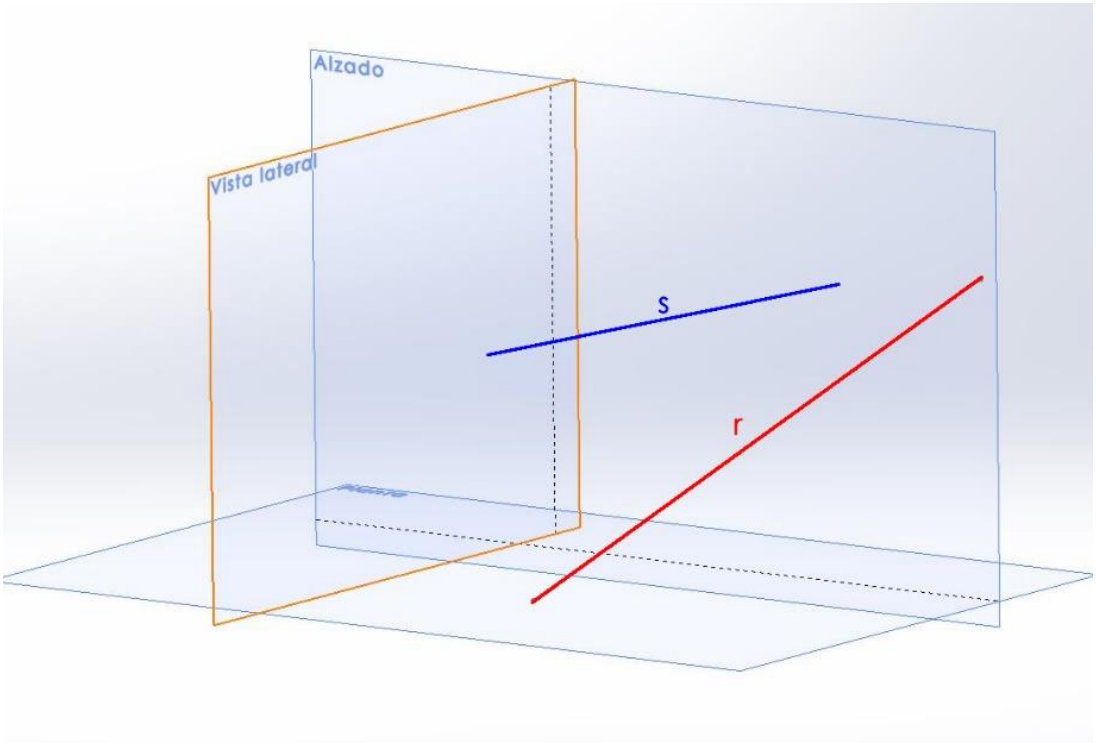
SDW

Given the line **r**, define the line **s** that forms an angle of **50º** with **r** and has the minimum possible slope.

The biggest angle between the possible solutions of the line **s** is:

ANSWER: .....

E 11_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

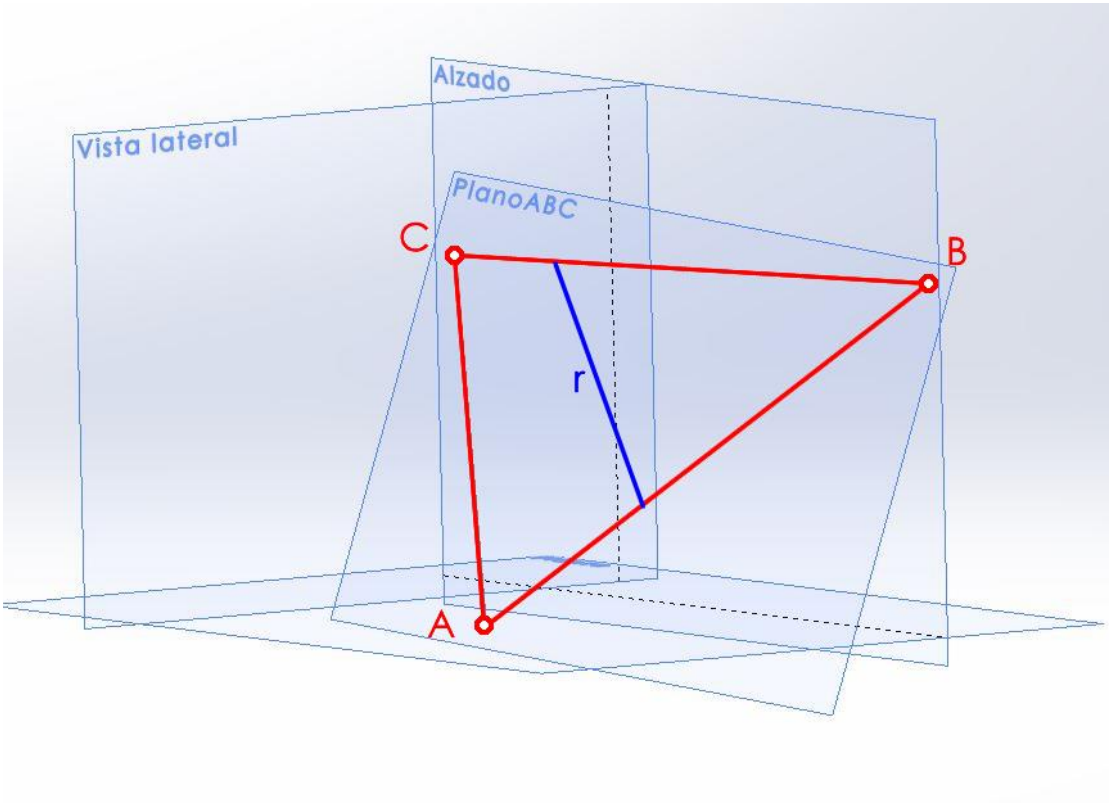
SDW

Given the line **r**, define the line **s** that forms an angle of **30º** with **r** and has the maximum possible slope.

The slope of the line **s** is:

ANSWER: .....

E 11_3



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

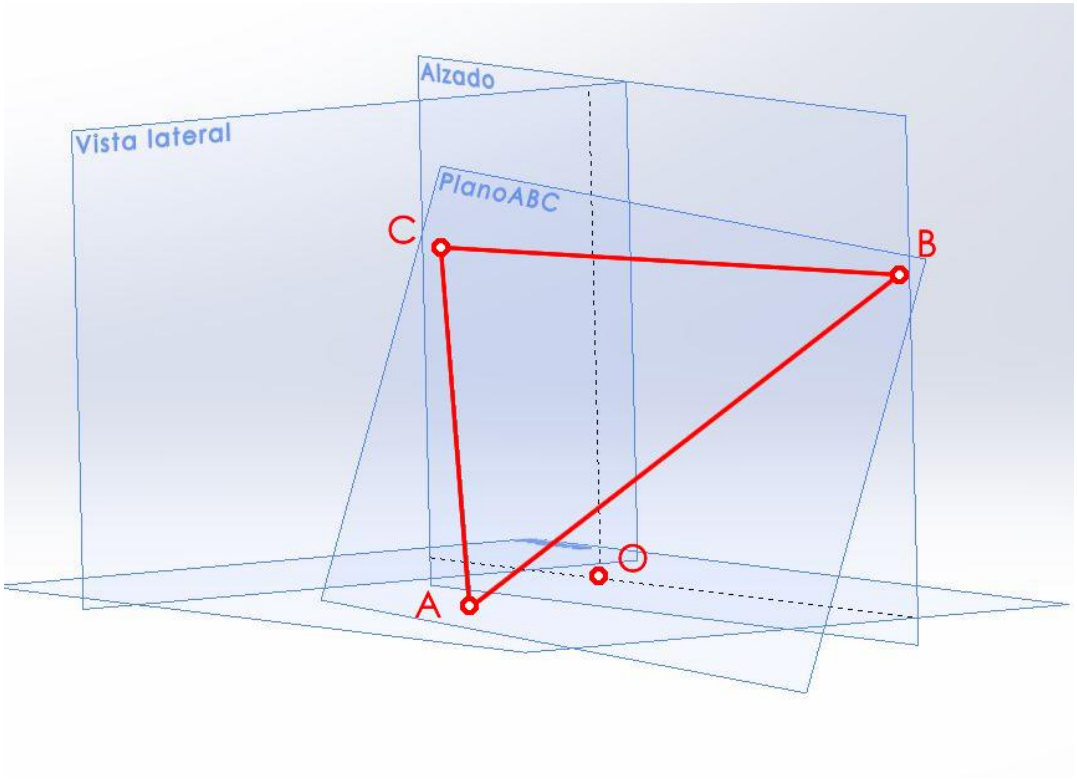
SDW

Given the plane **ABC,** define the line **r** of **ABC** that has the maximum possible slope.

The slope of line **r** is:

ANSWER: .....

E 12_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

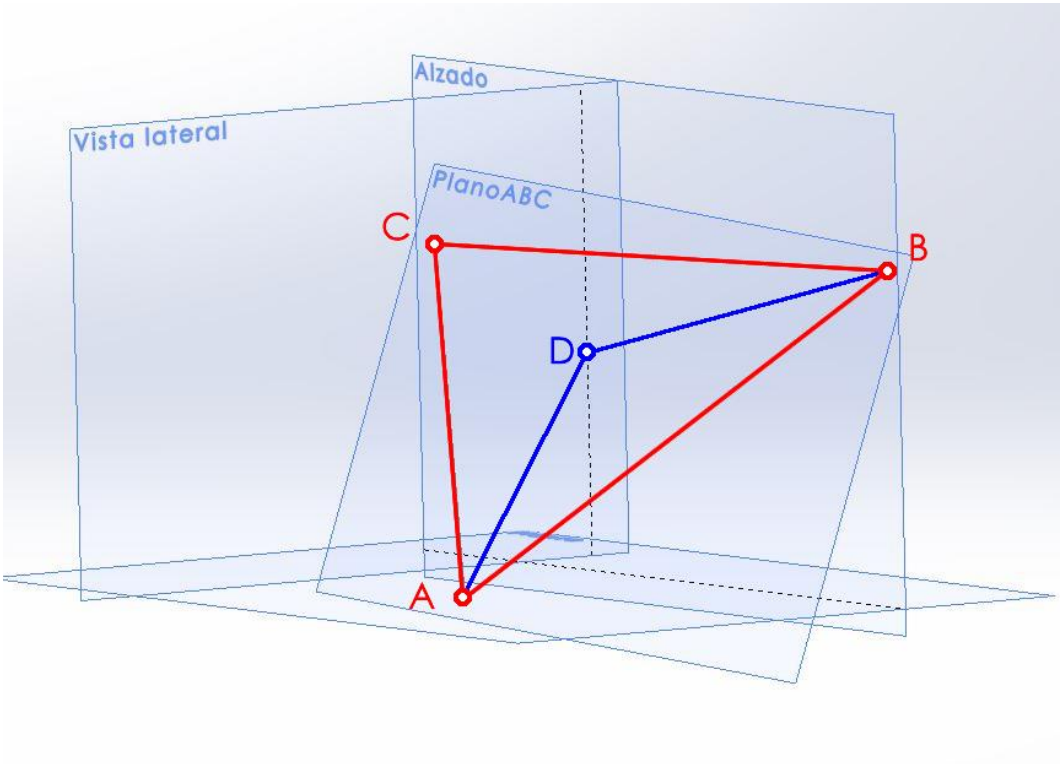
SDW

Given the plane **ABC,** define a parallel plane to **ABC** at a distance of **40**.

Of the possible solutions, calculate the minimum distance between the point **O** (intersection between **Front Plane**, **Top Plane** and **Rigth Plane**) and the plane parallel to **ABC**.

ANSWER: .....

E 13_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

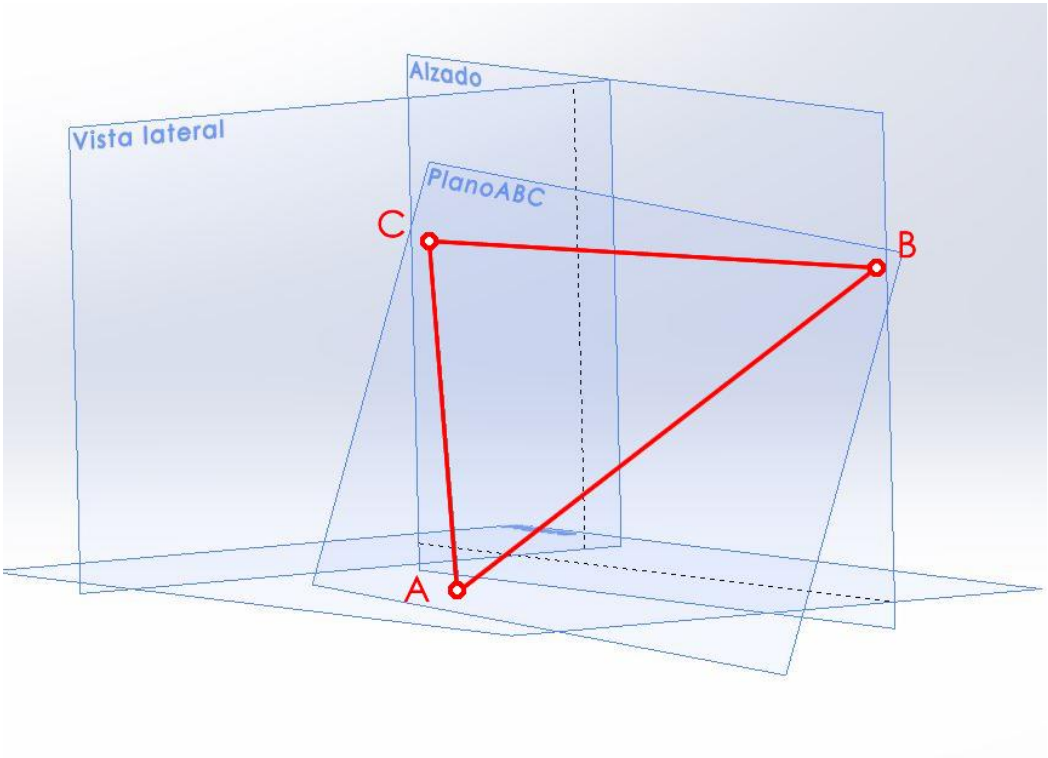
Given the plane **ABC,** define a plane **ABD** that forms an angle of **45º** with **ABC** similar to that of the construction above.

Calculate the smallest angle between the plane ABD and the Front Plane.

(From the possible planes **ABD** choose the one that forms the biggest angle with the **Front Plane**)

ANSWER: .....

E 13_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

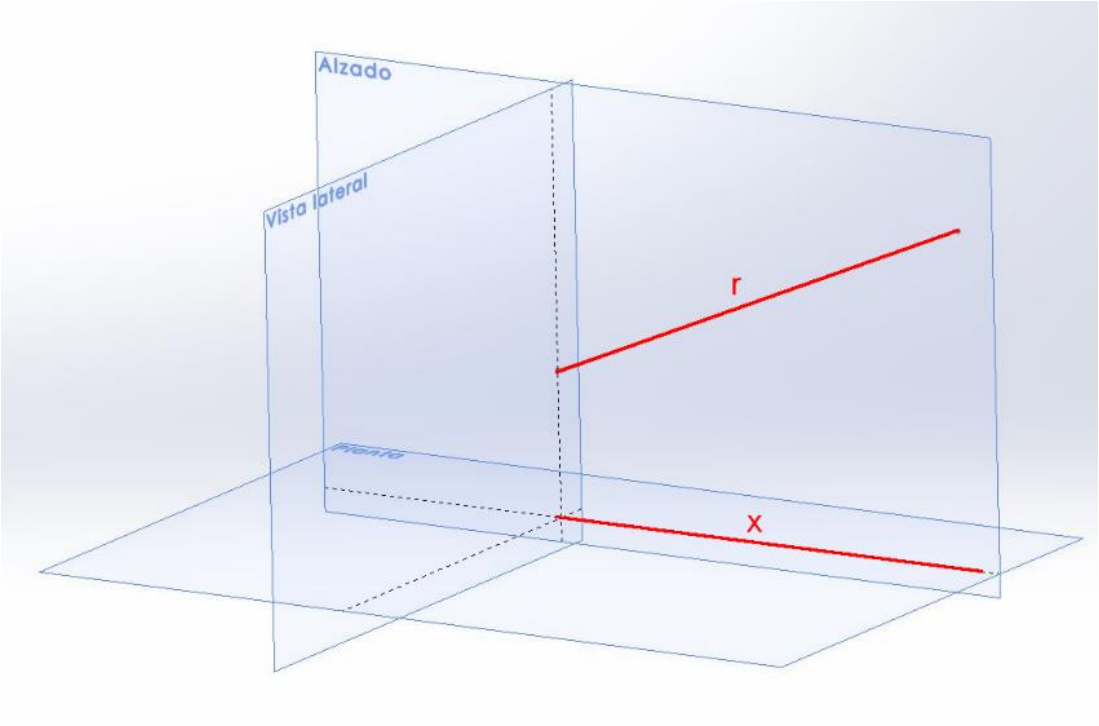
SDW

Given the plane **ABC**, define a plane **ABD** that forms an angle of **45º** with **ABC**.

Taking into account all possible solutions, the minimum angle between **ABD** and the **Top Plane** is:

ANSWER: .....

E 14_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

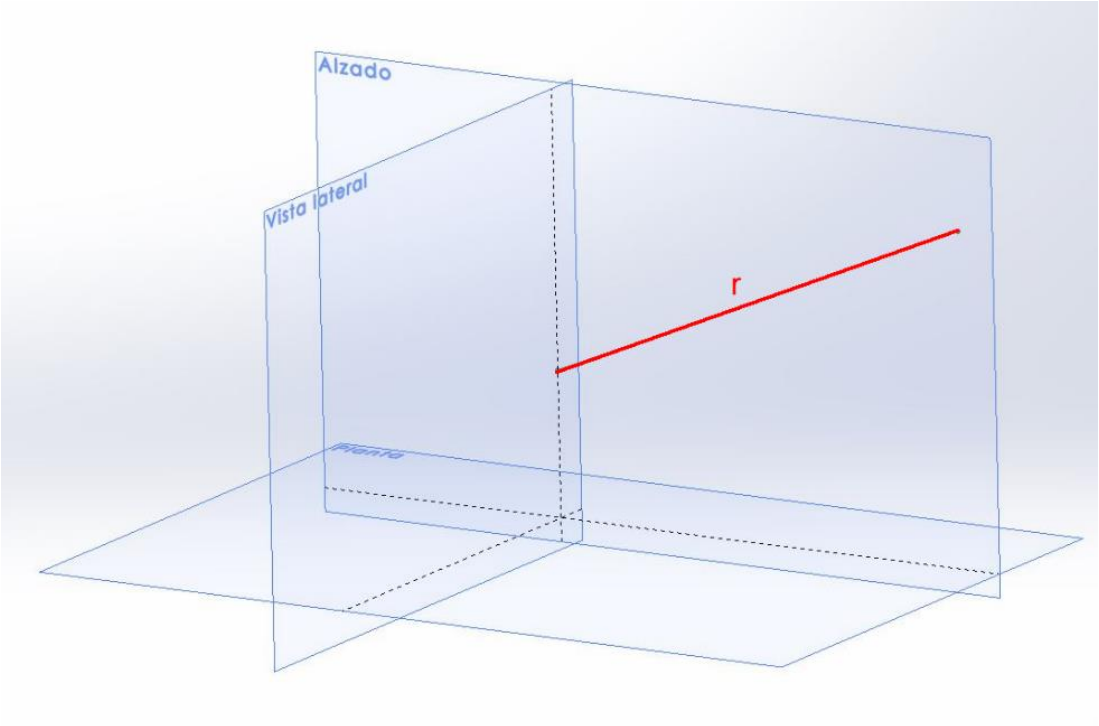
SDW

Given the line **r**, define a plane **ABC** of **80%** of slope and that contains **r**.

The smallest angle between the **x** axis of the coorditante system and the **ABC** plane is:

ANSWER: .....

E 15_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

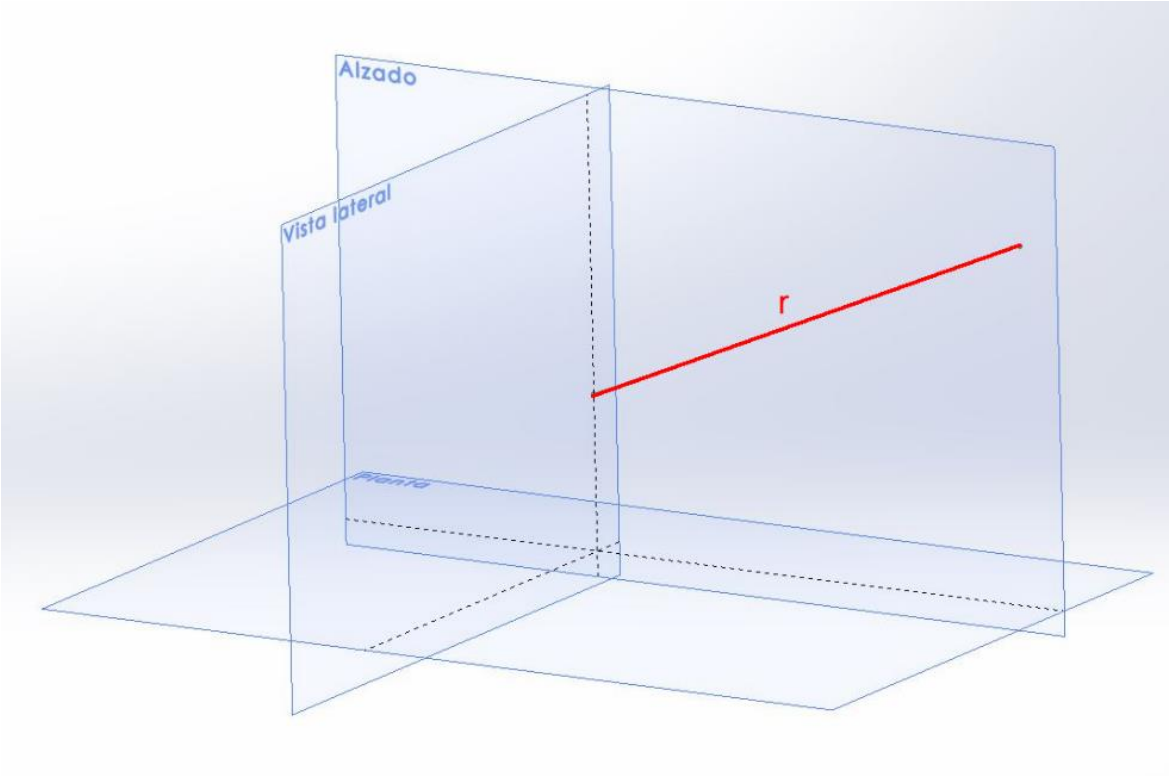
Given the line **r,** define a plane **ABC** that forms an angle of **50º** with **r**.

From all the solutions choose the one with the **maximum possible slope**.

The slope of the plane **ABC** is:

ANSWER: .....

E 15_2



GRAPHIC LEGEND
ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

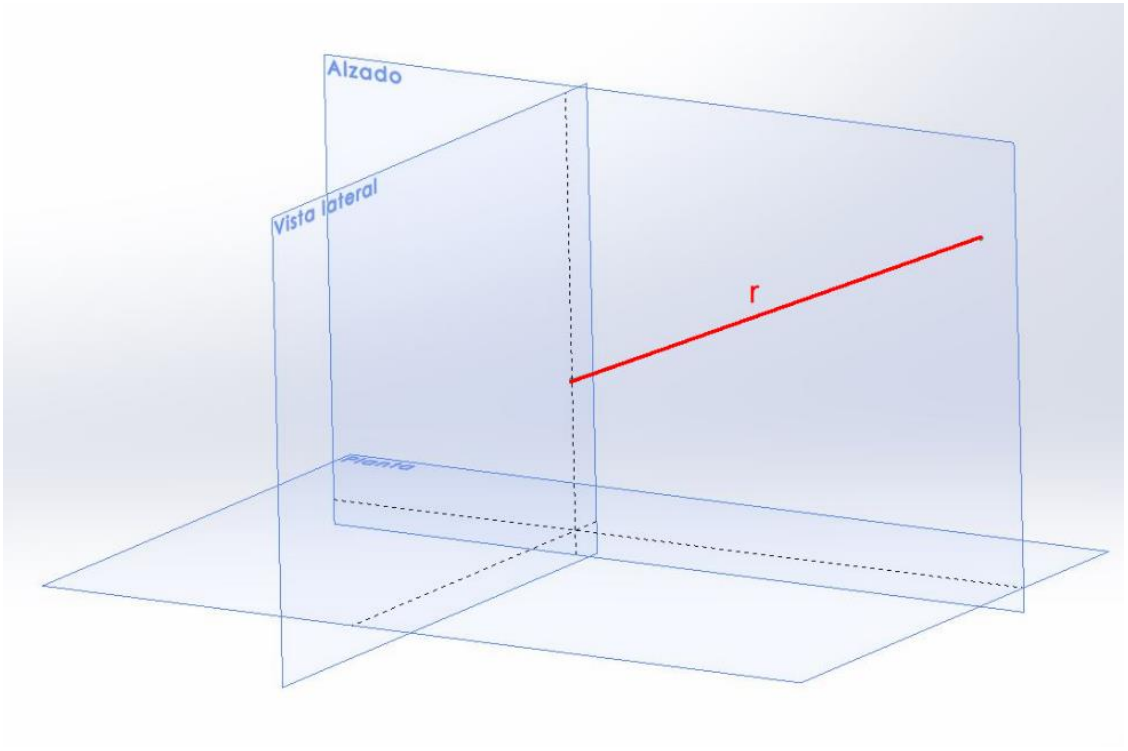
Given the line **r**, define a plane **ABC** that forms an angle of **50º** with **r**.

From all the solutions choose the one with the **minimum possible slope**.

The slope of plante **ABC** is:

ANSWER: .....

E 15_3



GRAPHIC LEGEND
ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

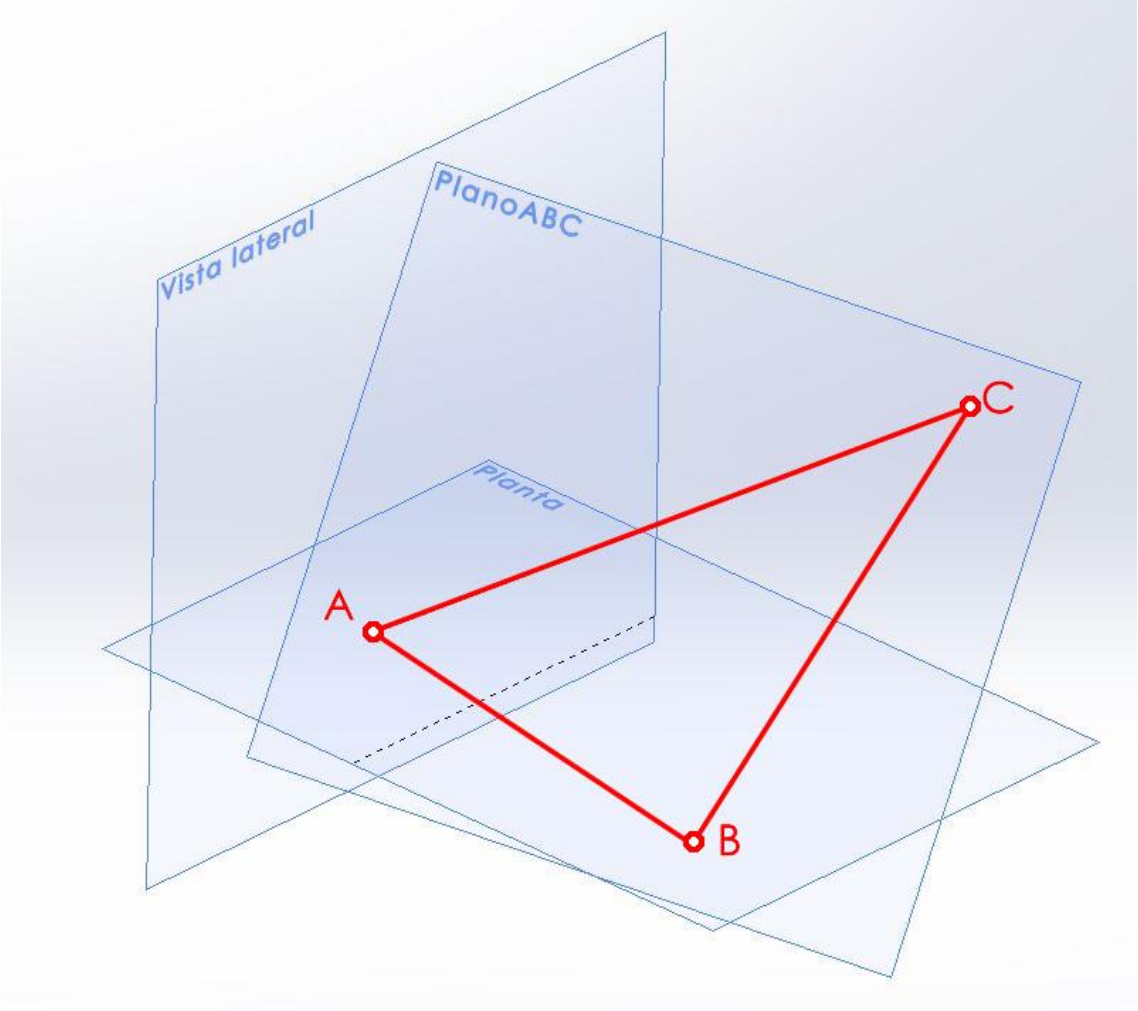
SDW

Given the line **r**, define a plane **ABC** that contains **r** and has theminimum possible slope.

The slope of the plane **ABC** is:

ANSWER: .....

E 16_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

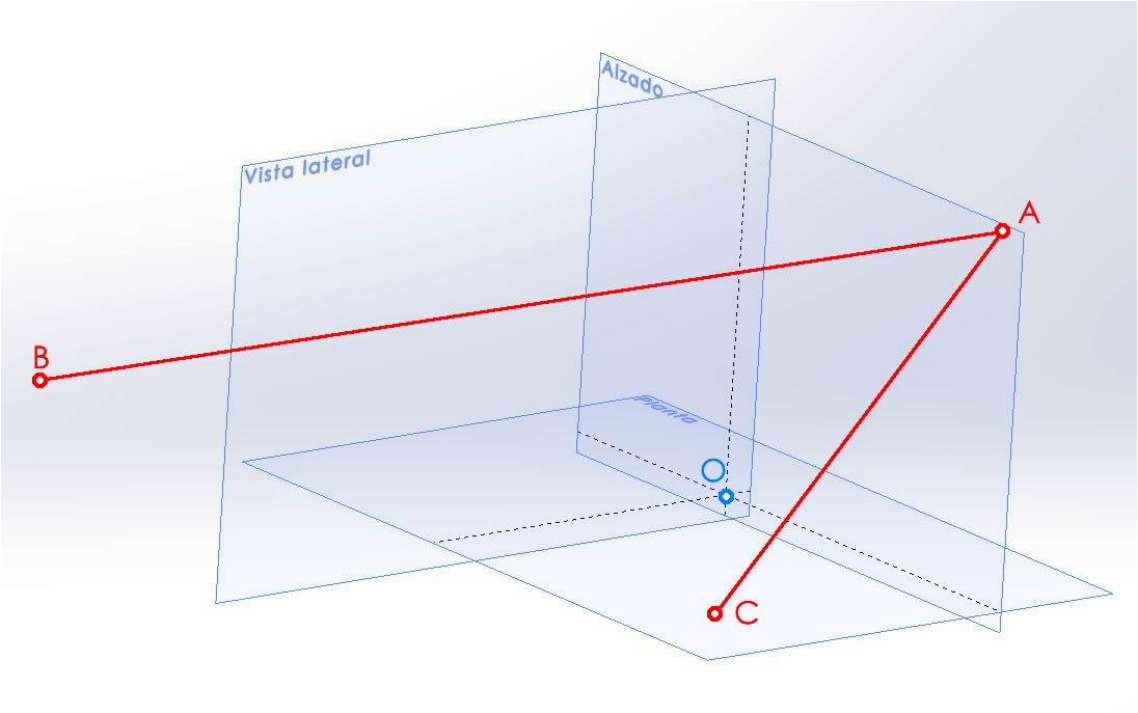
Given the plane **ABC**, define a plane **a** that forms an angle of **50º** with **ABC** and **30º** with the **Top Plane**.

From all the solutions choose the one forming the **minimum possible angle** with the **Rigth Plane**.

The angle between the plane **a** and the **Rigth Plane** is:

ANSWER: .....

E 17_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

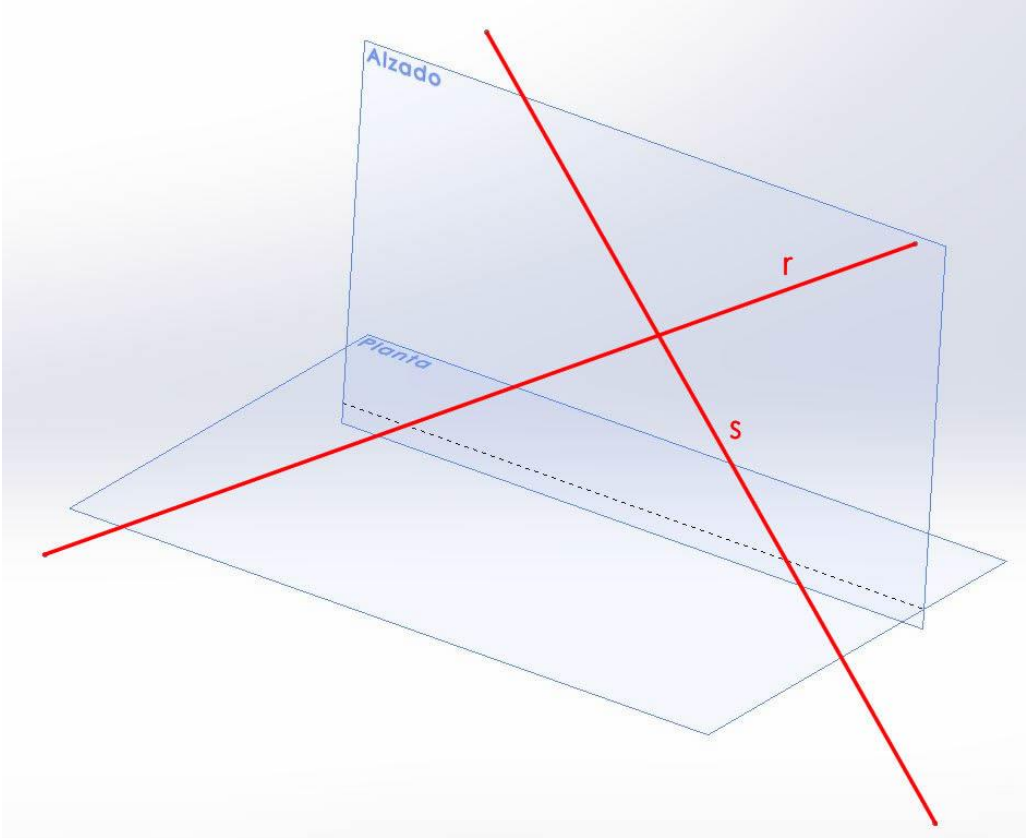
Given the lines **AB** and **AC** define a plane **a** which forms equal angles with **B** and **AC**.

From the possible planes **a** choose the closest to point **O**, intersection between the three reference planes.

The smallest angle between plane **a** and the **Front Plane** is:

ANSWER: .....

E 18_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

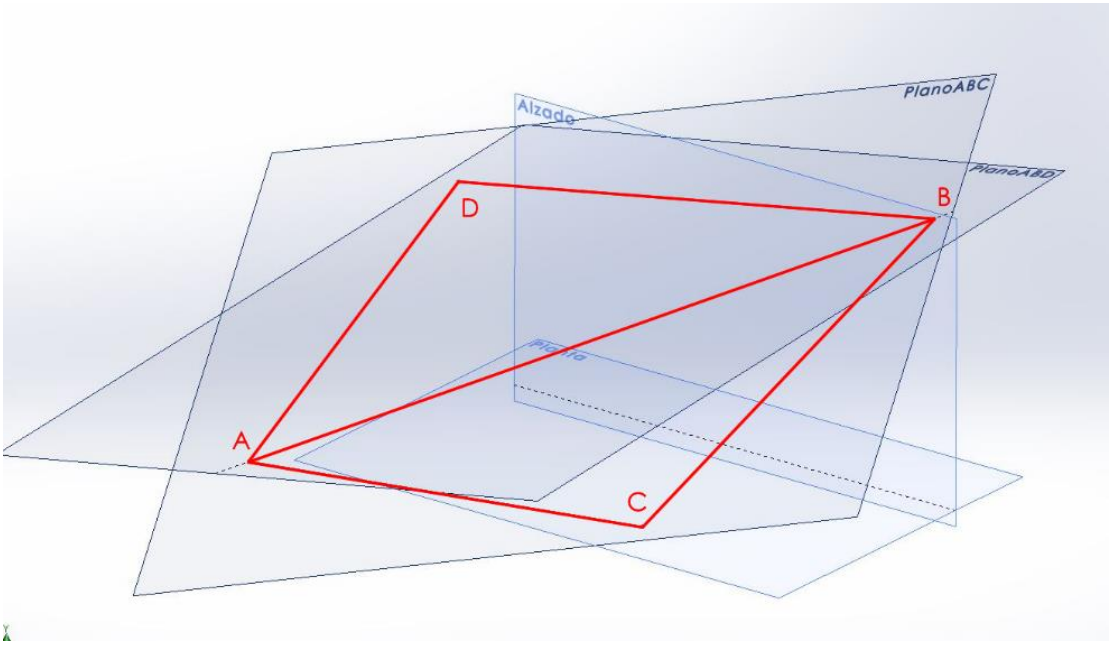
Given the lines **r** and **s** define a plane **a** that forms equal angles with **r** and **s**.

From the possible planes **a** choose the one forming the **maximum possible angle** with the **Front Plane**.

The smallest angle between plane **a** and the **Front Plane** is:

ANSWER: .....

E 19_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

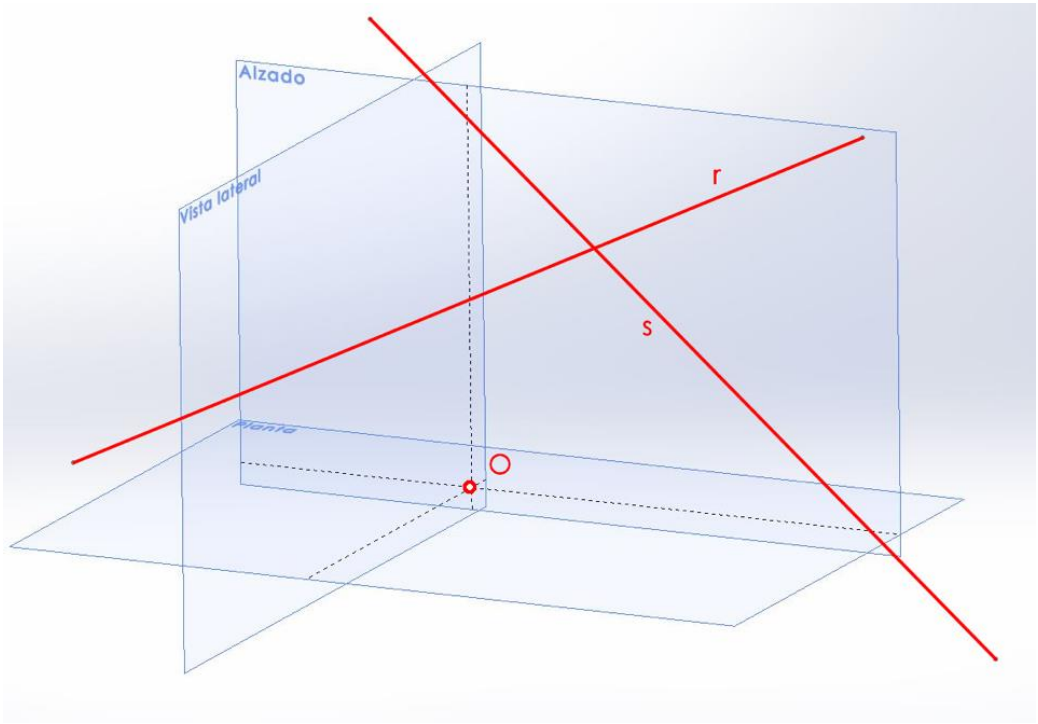
Given the planes **ABC** and **ABD**, define a plane **a** that forms equal angles with **ABC** and **ABD**.

From the possible planes **a** choose the one which forms the smallest angle with the **Top Plane**.

The smallest angle between plane **a** and the **Front Plane** is:

ANSWER: .....

E20_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

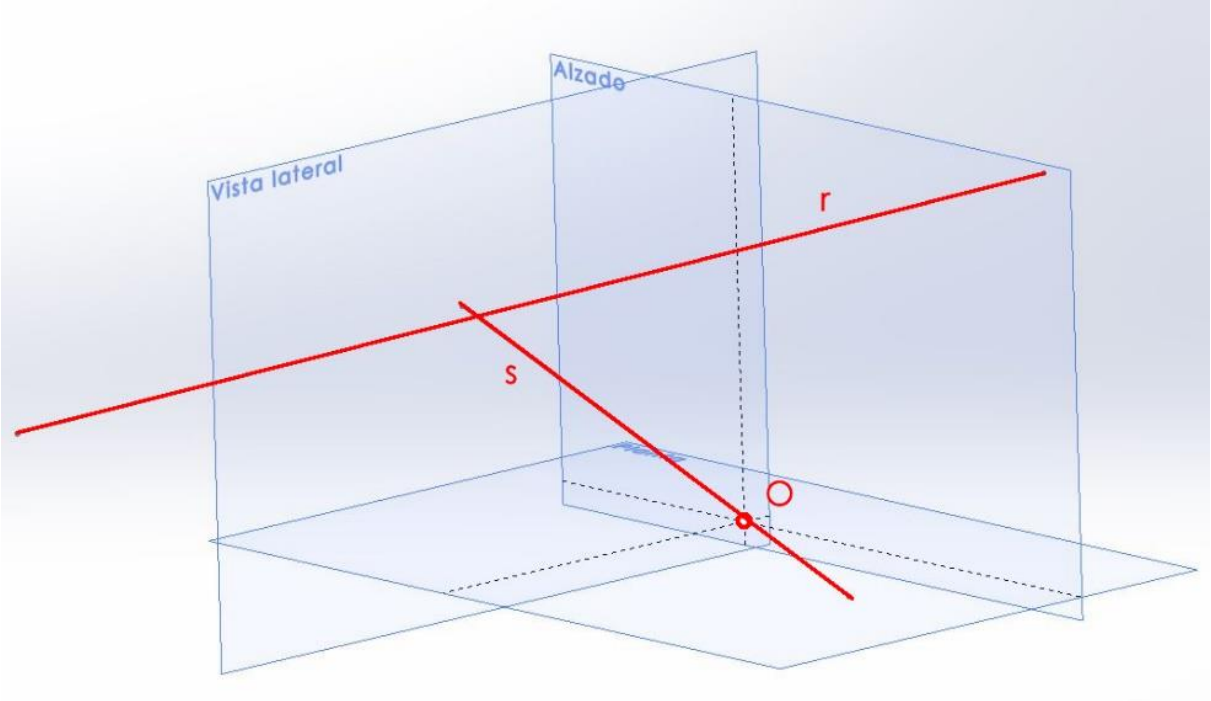
SDW

Given the lines **r** and **s** define a plane **α** which equidist from **r** and **s**.

The distance from the line , intersection between plane **α** and the **Top Plane**, to the origin of coordinates **O** is:

ANSWER: .....

E 21_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

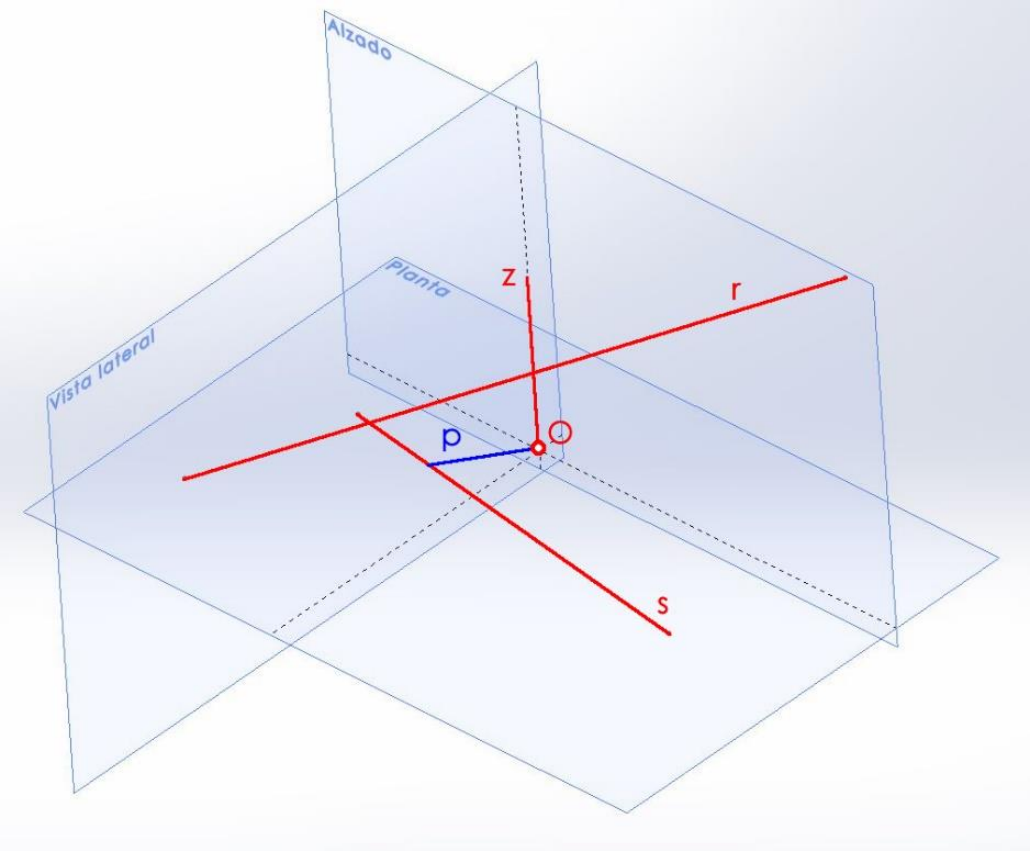
SDW

Given the lines **r** and **s** define a line parallel to **s**, limited between the **Rigth Plane** and the **Top PLane** with a length **5 times smaller** than that of **r** and at a distance from **r** equal the length of **s**.

The distance from the obtained line parallel to **s** to the coordinates origin **O** is (choose the line parallel to **s** that is the closest to **O**):

ANSWER: .....

E 22_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

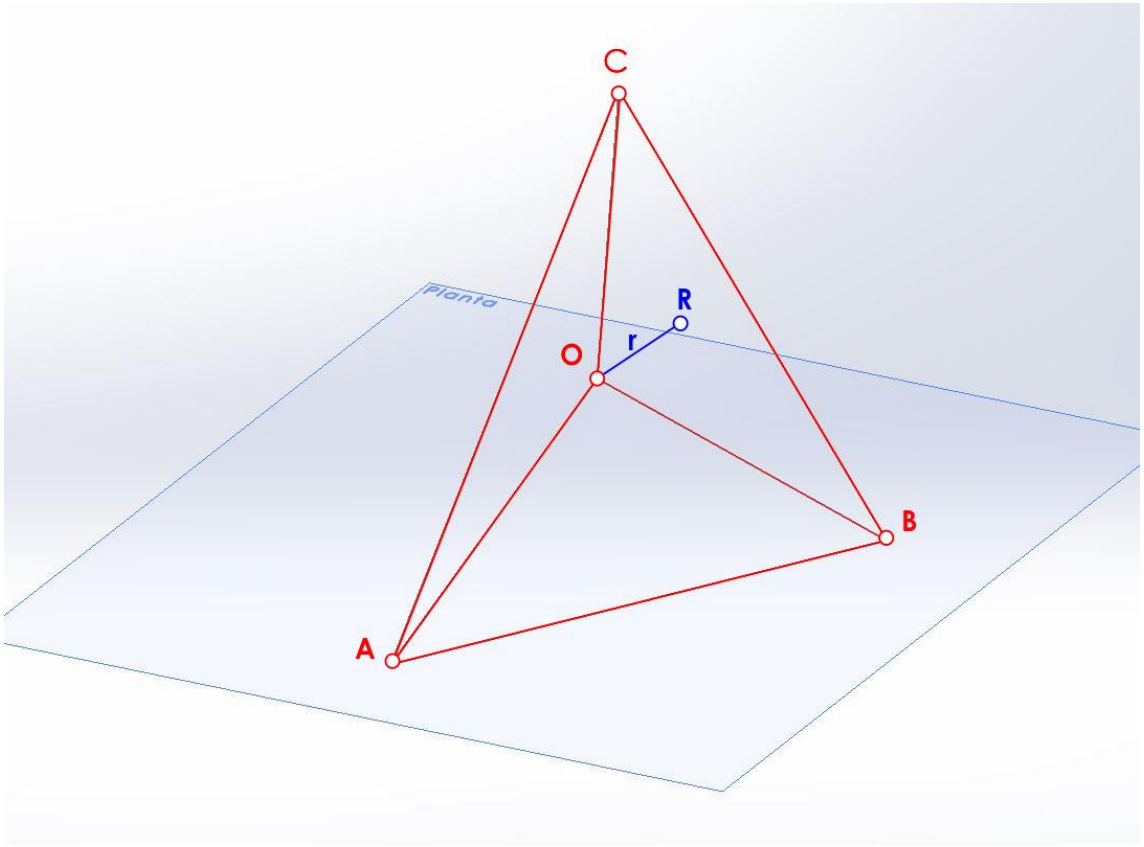
SDW

Given the lines **r** i **s** define a segment **p**, limited by **O,** origin of coordinates, and by the line **s**. The smallest angles between **r** i **s** i **p** obey to the next proportion: angle **rs**/angle **sp** = **3/4**.

The smallest angle between **p** (from the possible segments **p** choose the closest to the **Rigth Plane**) and the line **z** (intersection of the **Rigth Plane** and the **Front Plane**) is:

ANSWER: .....

E 23_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

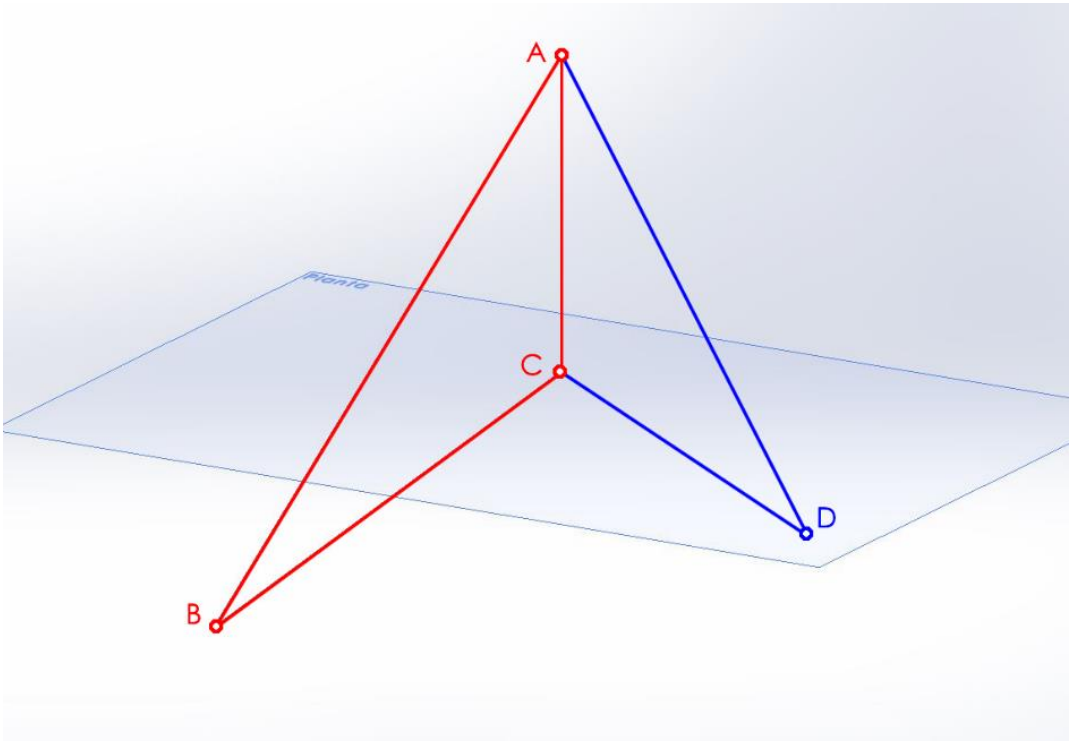
SDW

Given the pyramid **ABCO**, define the segment **r** (between **O** and a point **R** of the face **ABC**) that form equal angles with all the faces of the pyramid.

The smallest angle resulting between **r** and **ABC** face is:

ANSWER: .....

E24_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

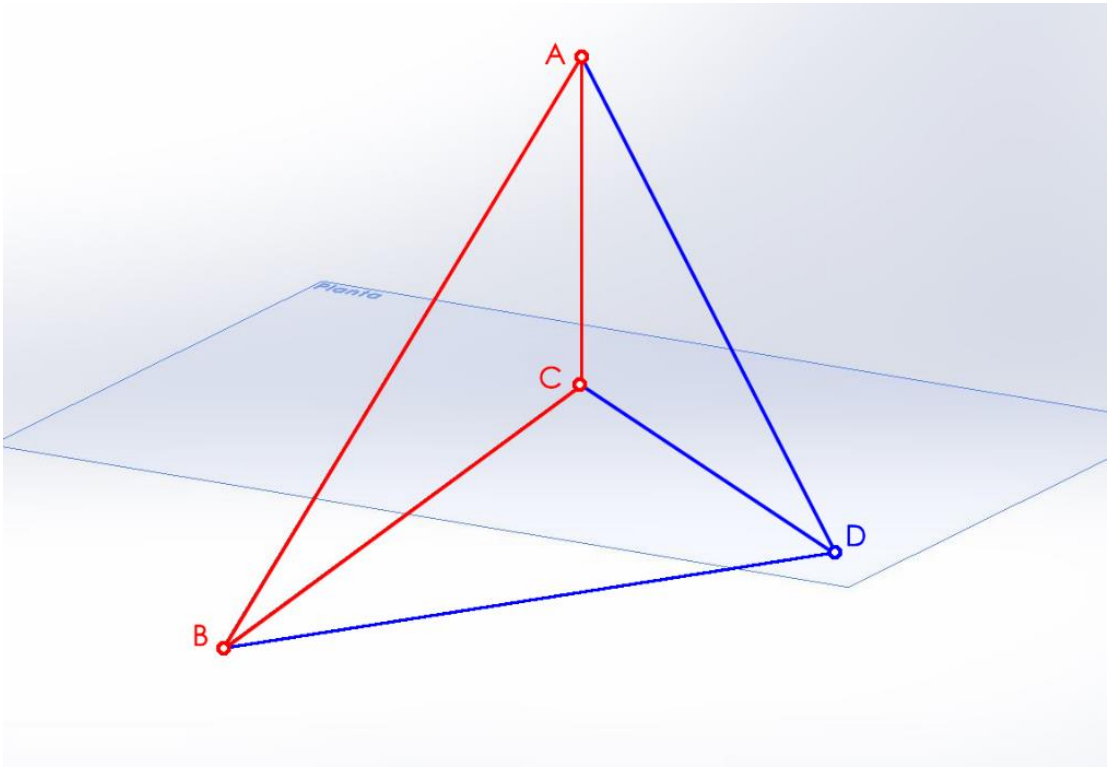
SDW

Given the triangle **ABC**, define a point **D** on the **Top Plane** such that the angle **ABC** is half the angle defined between the planes **ABC** and **ACD**.

If the smallest angle **BAD** measures **45º**, the angle **CDA** mesures:

ANSWER: .....

E 25_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

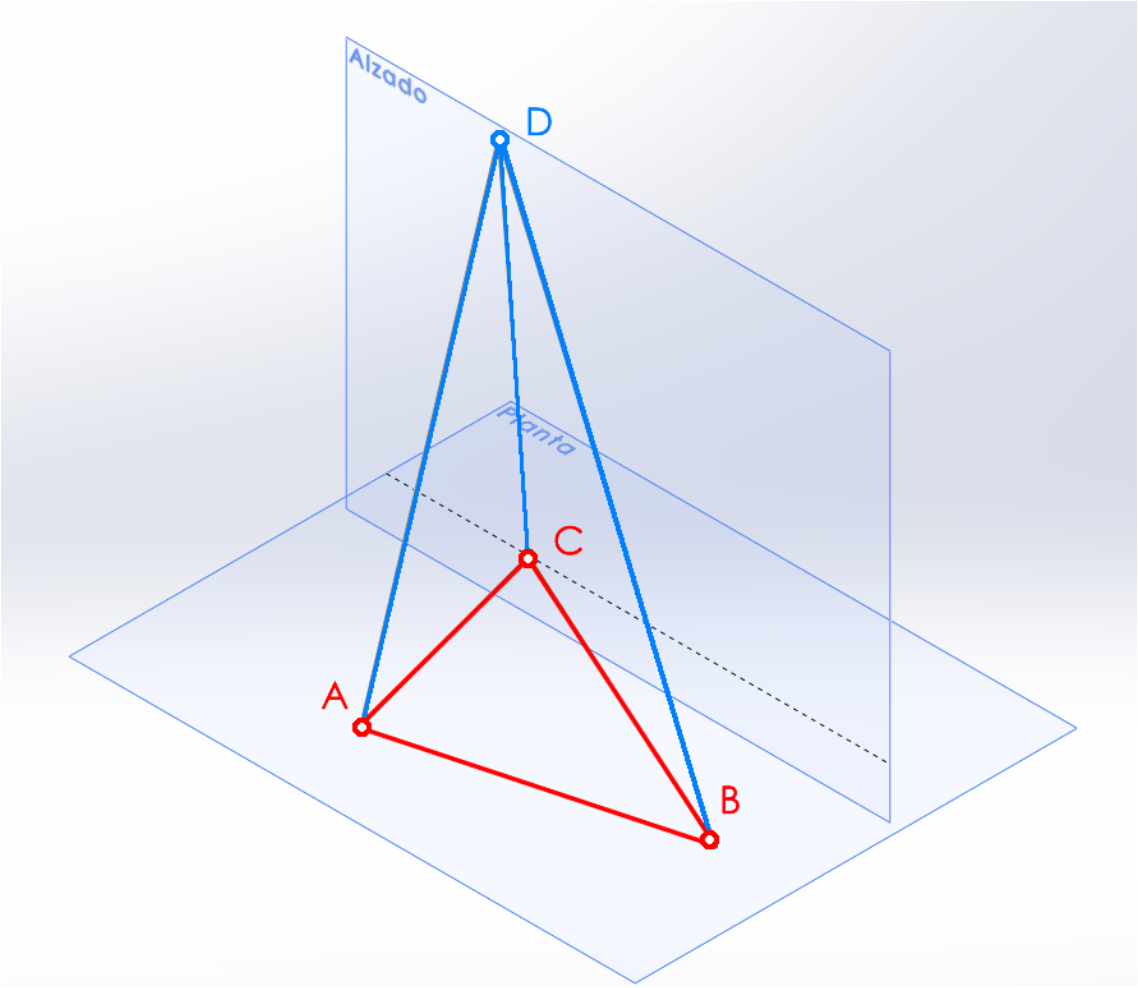
SDW

Given the triangle **ABC** define a point **D** on the **Top Plane** such that the angles between the planes **ABD**-**CBD**, **ABC**-**ACD** and **ABD**-**ACD** maintain the ratio of **1-2-3**, respectively.

The smallest angle between the planes **ABD**-**CBD**is:

ANSWER: .....

E 26_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

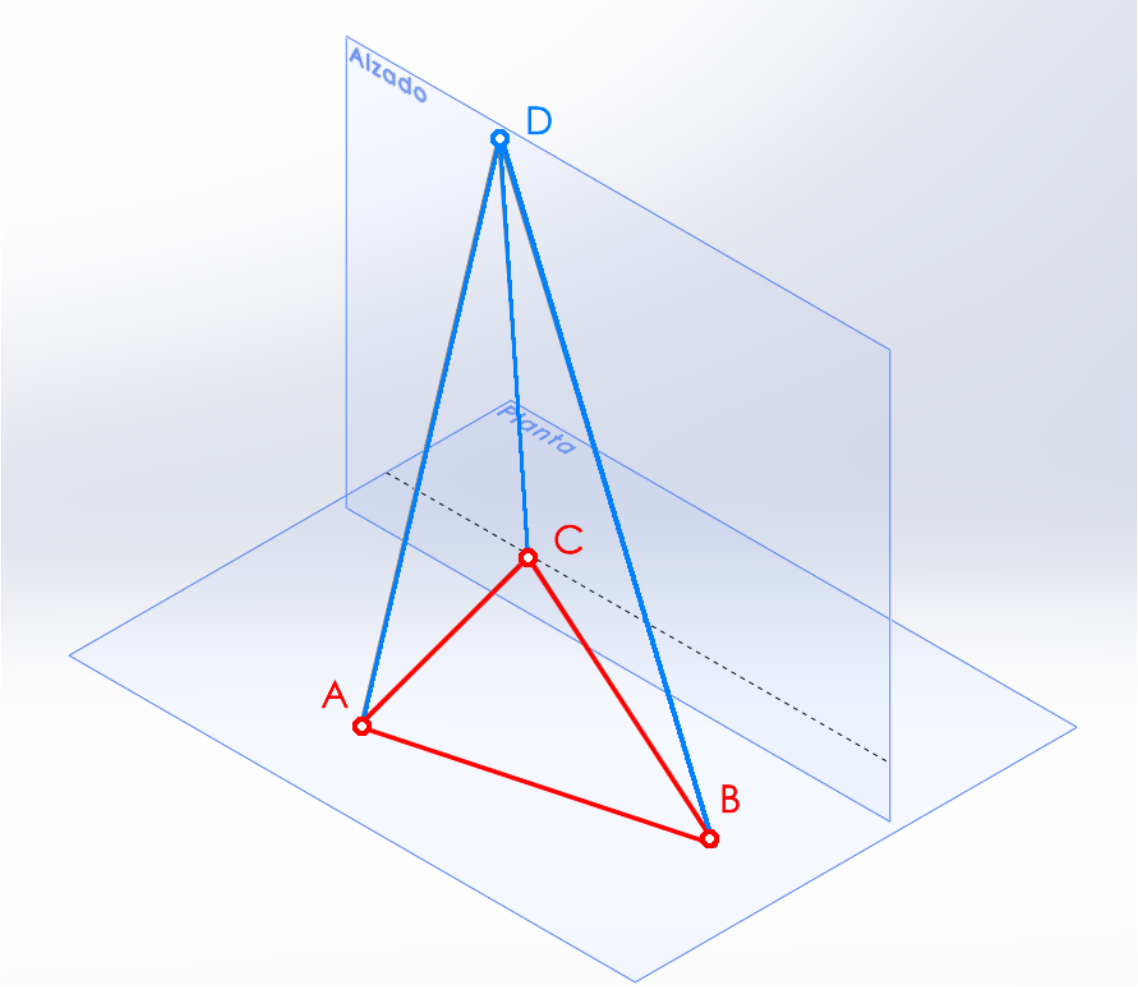
SDW

Given the triangle **ABC**, define a point **D** such that the slopes of the planes **BCD**, **ABD** and **ACD** maintain the proportion of **1-2-3,** respectively.

If the distance from **D** to the plane **ABC** is **100**, the slope of **BCD** is:

ANSWER: .....

E 26_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

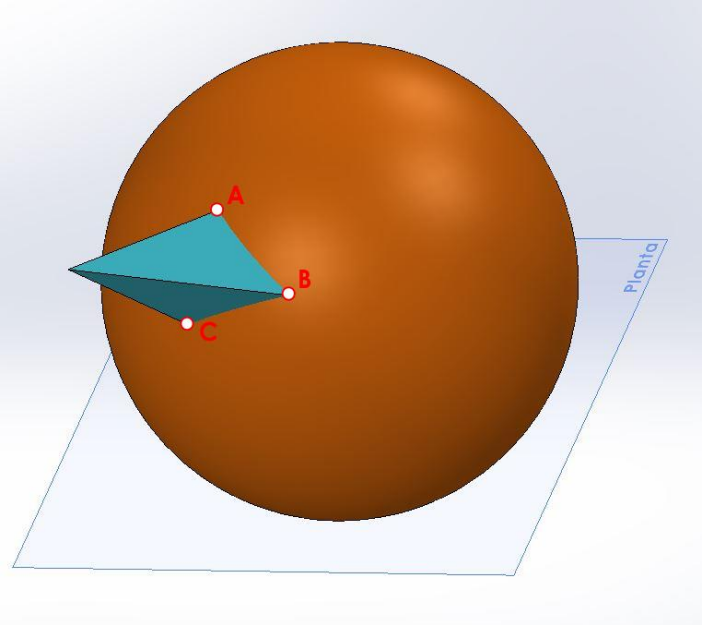
Given the triangle **ABC**, define a point **D** such that the slope of the lines **CD**, **BD** and **AD** maintain the ratio of **1-2-3,** respectively.

If the distance from **D** to the plane **ABC** is **200**, the slope of **CD** is:

ANSWER: .....

POLYHEDRA AND SOLIDS OF REVOLUTION

PYRAMID 3_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

To the given sphere of radius 100 a pyramid with an equilateral triangular base ABC (the distance AB, AC, CB is 50) is added.

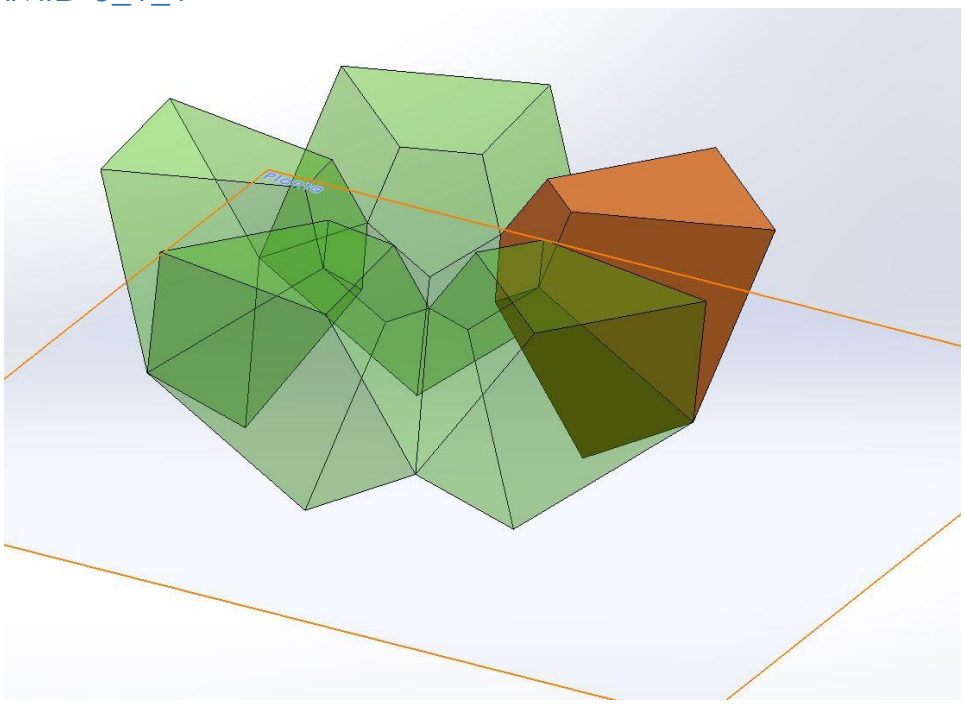
The planes tangent to the sphere surface at **A**,**B** and **C** have proportional slopes, fulfilling the proportion **1**,**2** and **3,** respectively.

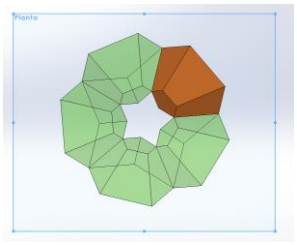
The vertex of the pyramid is located on a plane tangent to the sphere with the minimum possible slope.

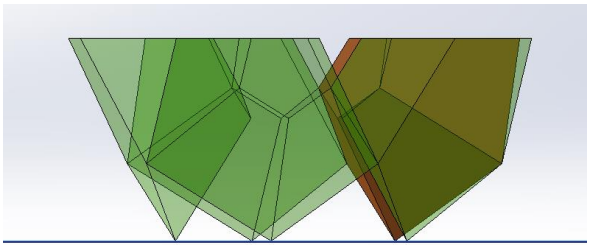
The angle between the face of the pyramid with the smallest slope and the **Top Plane** is:

ANSWER: .....

PYRAMID 5_1_1







GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

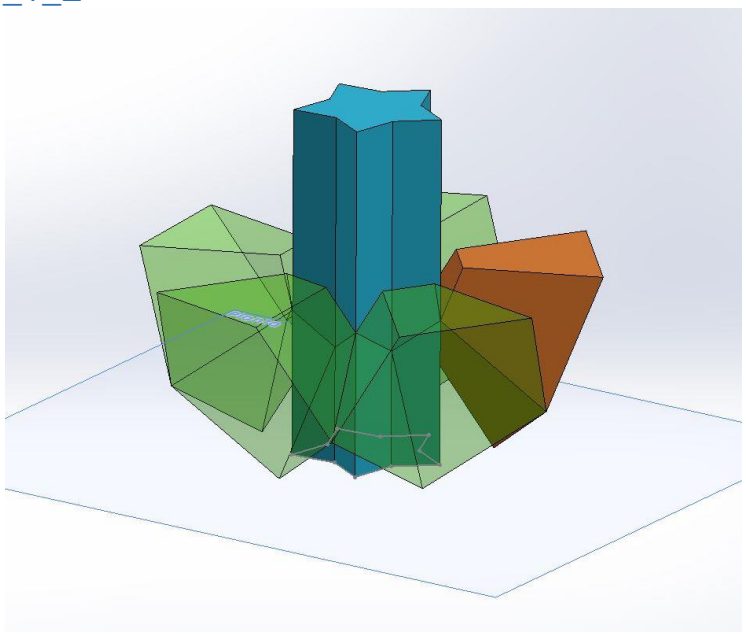
Given an upright truncated pyramid of regular pentagonal bases (in brown), build the above group of five identical truncated pyramids. The group of pyramids must meet the following conditions:

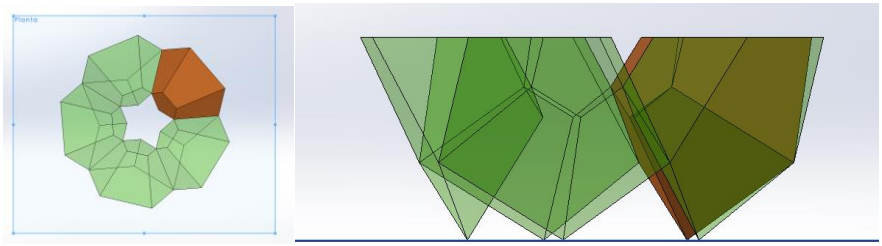
1. The pyramids have a single point of contact with the **Top Plane**.
2. The pyramids contact each other along one of their lateral edges.
3. The five points of contact with the **Top Plane** are the vertex of a pentagon.

The maximum height of the group of pyramids is:

ANSWER: .....

PYRAMID 5_1_2





GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

Given an upright truncated pyramid of regular pentagonal bases (in brown),build the following group of five identical truncated pyramid. The group of pyramids must meet the following conditions:

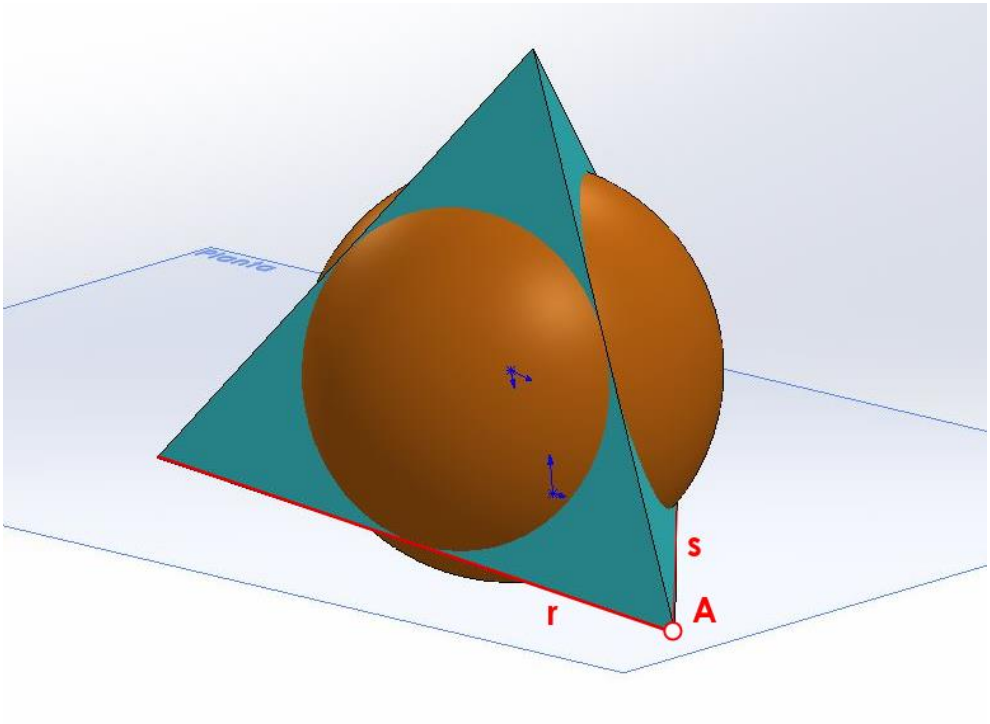
1. The pyramids have a single point of contact with the **Top Plane**.
2. The pyramids contact each other along one of their lateral edges.
3. The five points of contact with the **Top Plane** are the vertex of a pentagon.

Two of the top edges of each of the pyramids are coincident with the base edges of one vertical axis prism (blue color).

The edge of the base of the vertical prism mesures:

ANSWER: .....

TETRAHEDRON 1_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

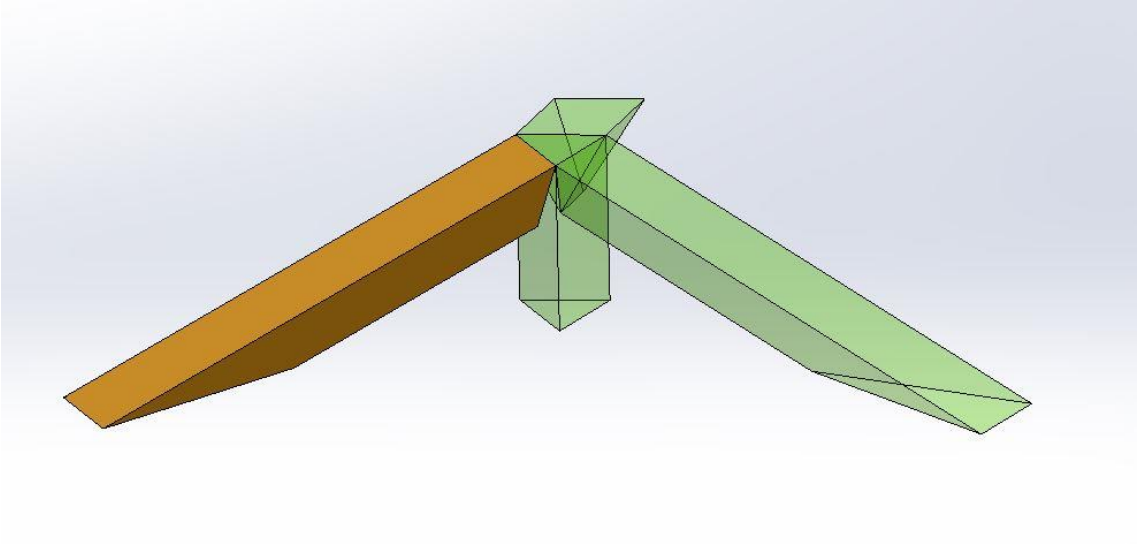
SDW

The given **sphere** of radius **100** is tangent to the **Top Plane** and intersects with a **tetrahedron** in such a way that all the edges of the **tetrahedron** are tangent to the surface of **the sphere**.

If the vertex **A** of the **tetrahedron** is located on the **Top Plane** and the edges **r** and **s** have the same slope, the slope of the plane **rs** is:

ANSWER: .....

PRISM 3_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

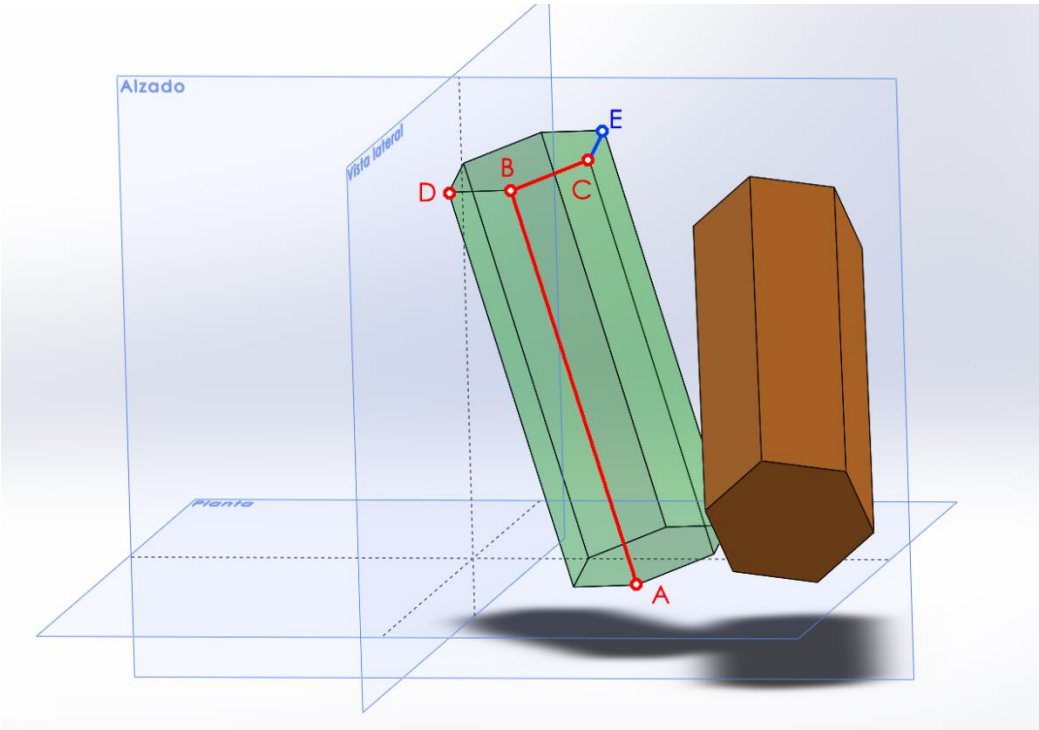
SDW

Given the **prism of an equilateral triangular cross-section** (in brown), it is limited by the **Top Plane** and by another **equal prism with a vertical axis**. Build the construction above knowing that the four prisms intersect resulting in a single **tetrahedron**.

The maximum distance between two points of the tilted prisms is:

ANSWER: .....

PRISM 6_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

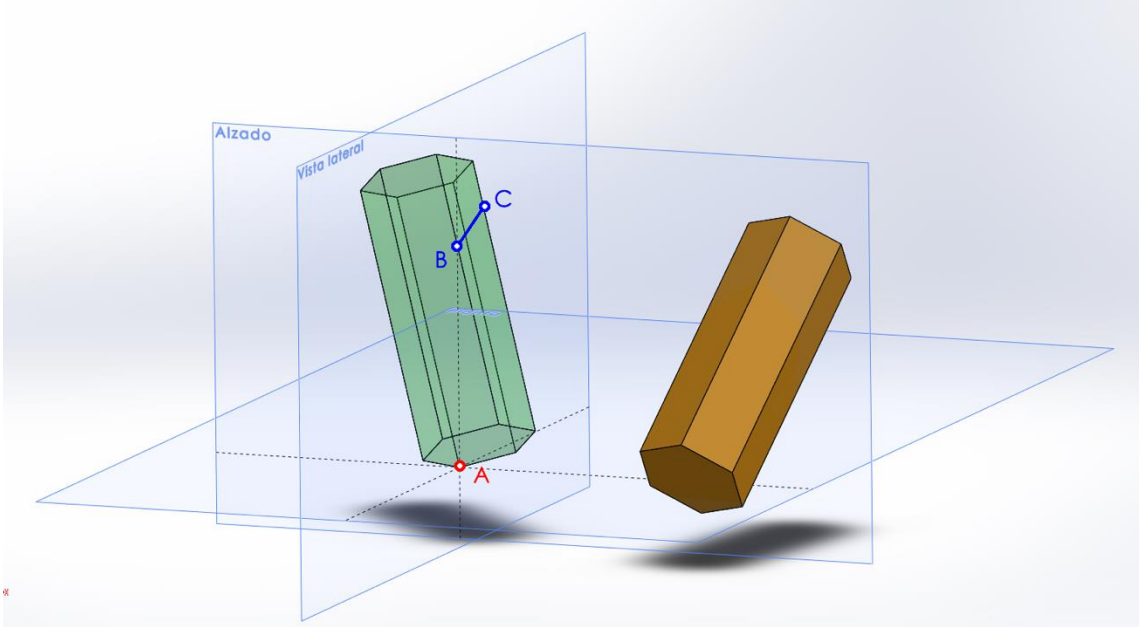
Given the **right prism of hexagon base** (in brown), position it as the green and transparent prism above fulfilling the following conditions:

1. Point **A** is the only point of contact between the prism and the **Top Plane**.
2. Point **B** belongs to the same lateral edge of the prism as the point **A**.
3. The edge **BC** of the base makes the only contact between the prism and the **Front Plane**.
4. The point **D** of the base is the only point of contact of the prism with the **Rigth Plane**.
5. The **lateral edges** of the prism form **60º** with the **Top Plane** and **20º** with the **Rigth Plane**.

Once the prism is positioned, **the smallest angle between the edge CE and the Front Plane is**:

ANSWER: .....

PRISM 6_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

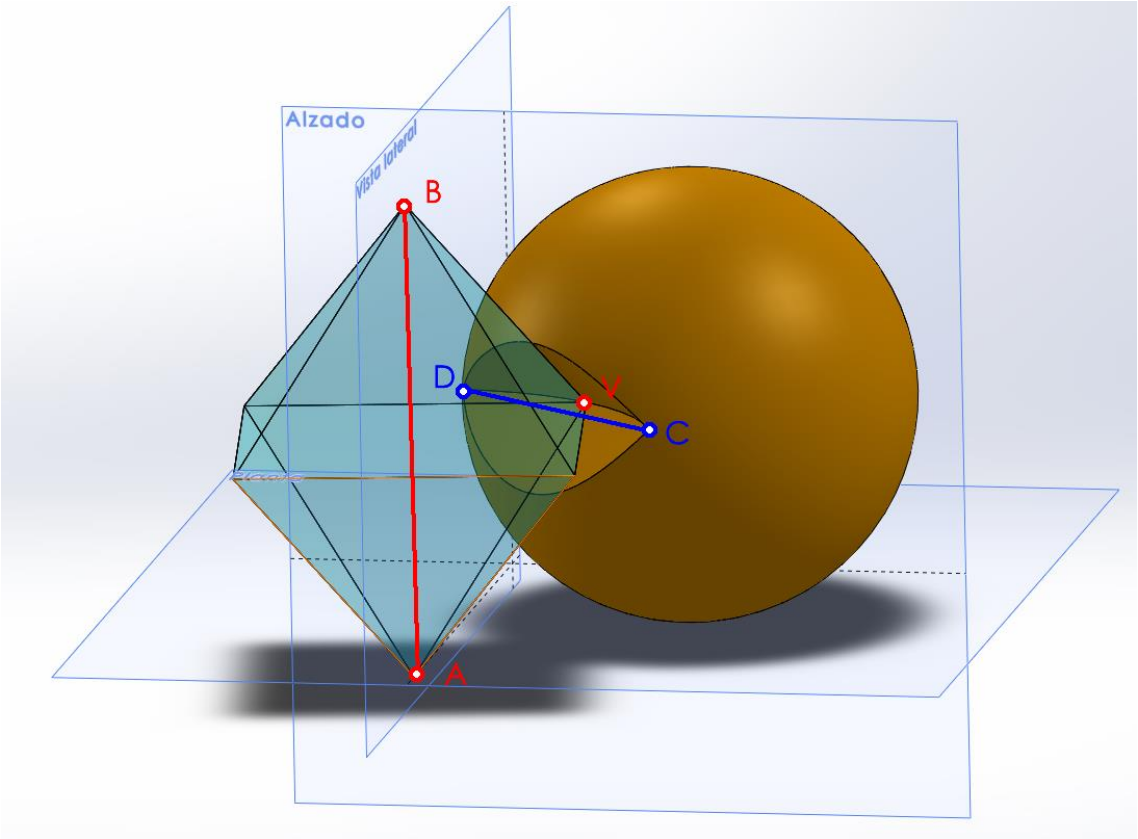
Given the **right prism of hexagon base** (in brown), position it as the green and transparent prism above fulfilling the following conditions:

1. **Four of the lateral fac**es of the prism have a slope of **200%**.
2. **The lateral edges** of the prism form the same angle with the **Front Plane** and the **Rigth Plane**.
3. Point **A** is at the **origin of coordinates** and is the only point of contact of the prism with the **Top Plane**.

Once the prism is positioned, the slope of the segment **BC**, intersection between one face of the prism and the **Rigth Plane**, is:

ANSWER: .....

OCTAHEDRON 1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

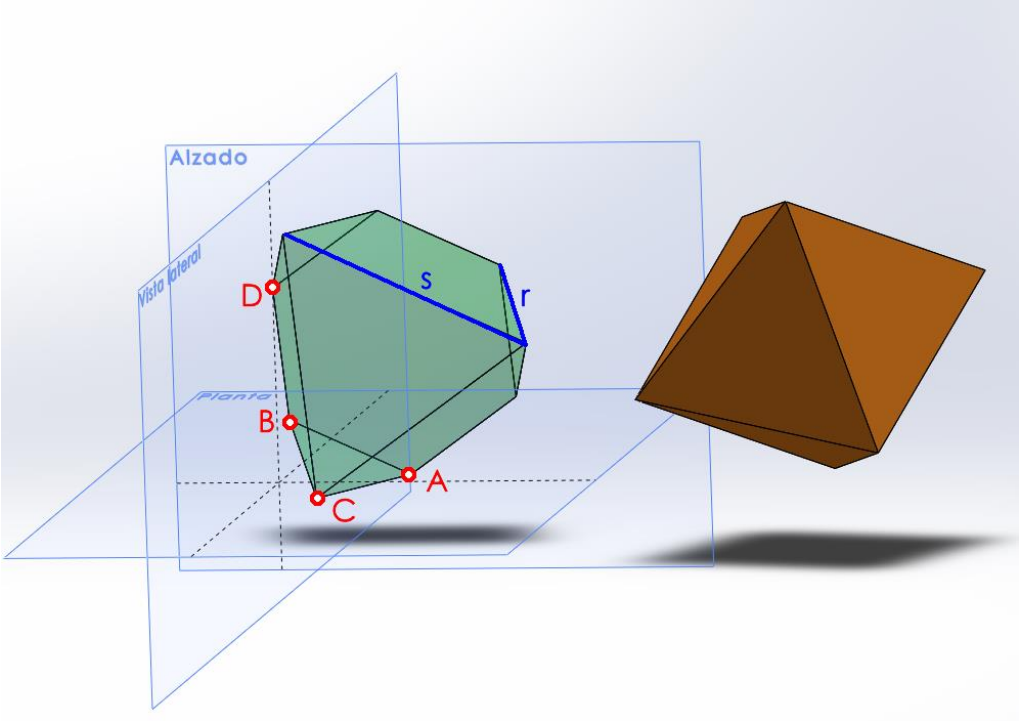
SDW

An **Octahedron** with a side of **90** revolves around its diagonal **AB**, which is a perpendicular line to the **Top Plane** that is contained on the **Rigth Plane** and at a distance of **100** to the center **O** of the Sphere. The point **A** is on the **Top Plane**.

Octahedron's spin causes a cut on the **sphere**. The length of the segment **CD** resultant from the cut by the vertex **V** of **Octahedron**, is:

ANSWER: .....

OCTAHEDRON 2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

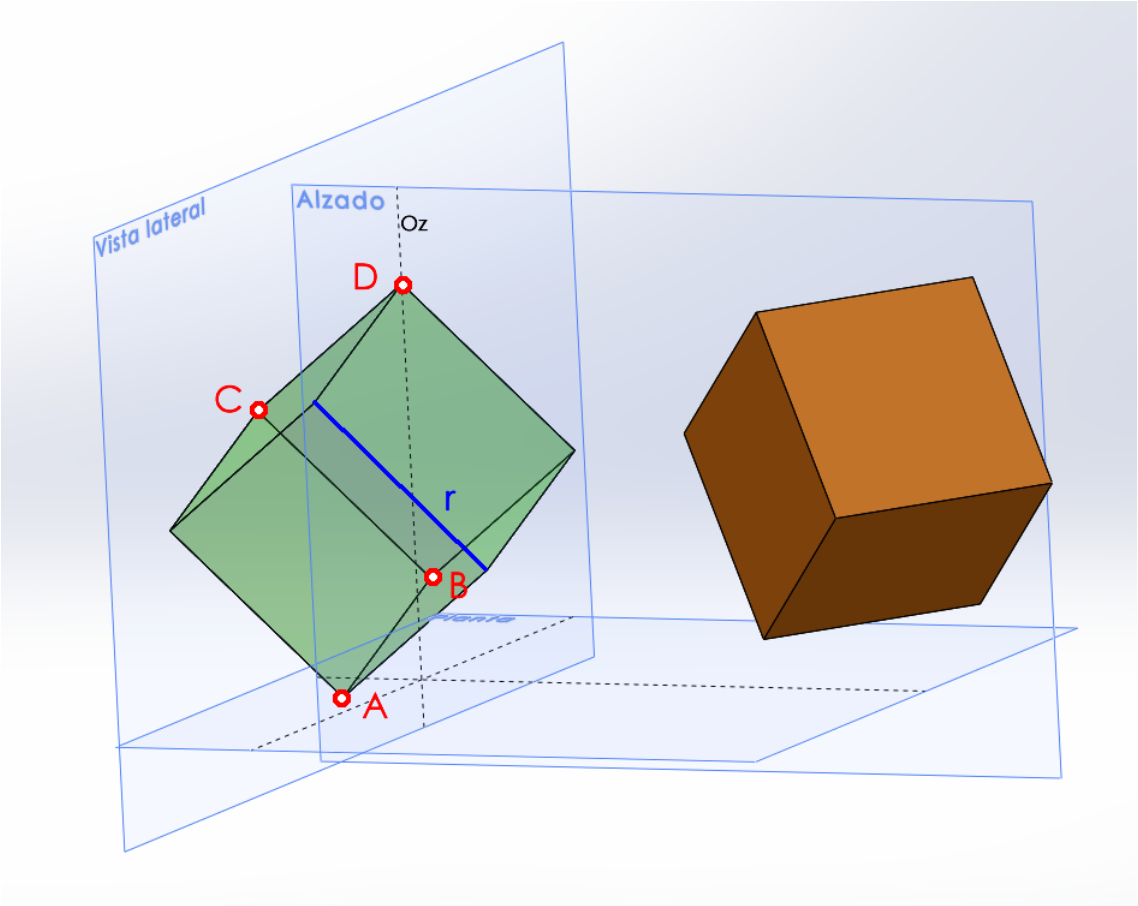
Given an **Octahedron** with a side of **90** (in brown), position it with the fulfilling the following conditions (construction in green):

1. The **Front Plane** cuts the **Octahedron** resulting in a **Regular Hexagon**.
2. The face **ABC** has a slope of **60%**.
3. The point **C** is the only contact of the **sectioned Octahedron** with the **Top Plane**.
4. The point **D** is the only contact of the **sectioned Octahedron** with the **Rigth Plane**.

Once the **Octahedron** has been positioned, the smallest angle between the face **rs** and the **Front Plane** is:

ANSWER: .....

CUBE 1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

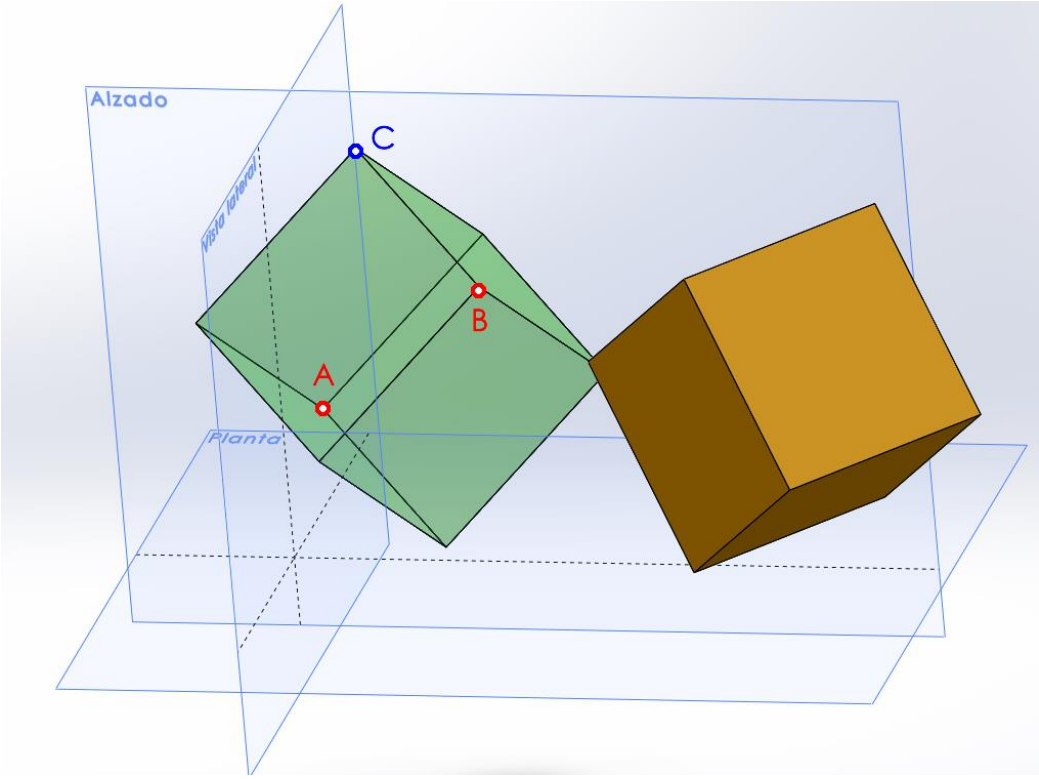
Given a **Cube** with an edge of **100** (in brown) position it (green construction) fulfilling the following conditions:

1. The face **ABC** has half the slope that that of face **BCD**.
2. The edge **AB** is parallel to the **Rigth Plane** and forms an angle of **20º** with the **Top Plane**.
3. The point **D** is located on the intersection line between the **Front Plane** and the **Rigth Plane**.

Once positioned the **Cube**, the distance from the edge **r** to the **Oz** axis is:

ANSWER: .....

CUBE 2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

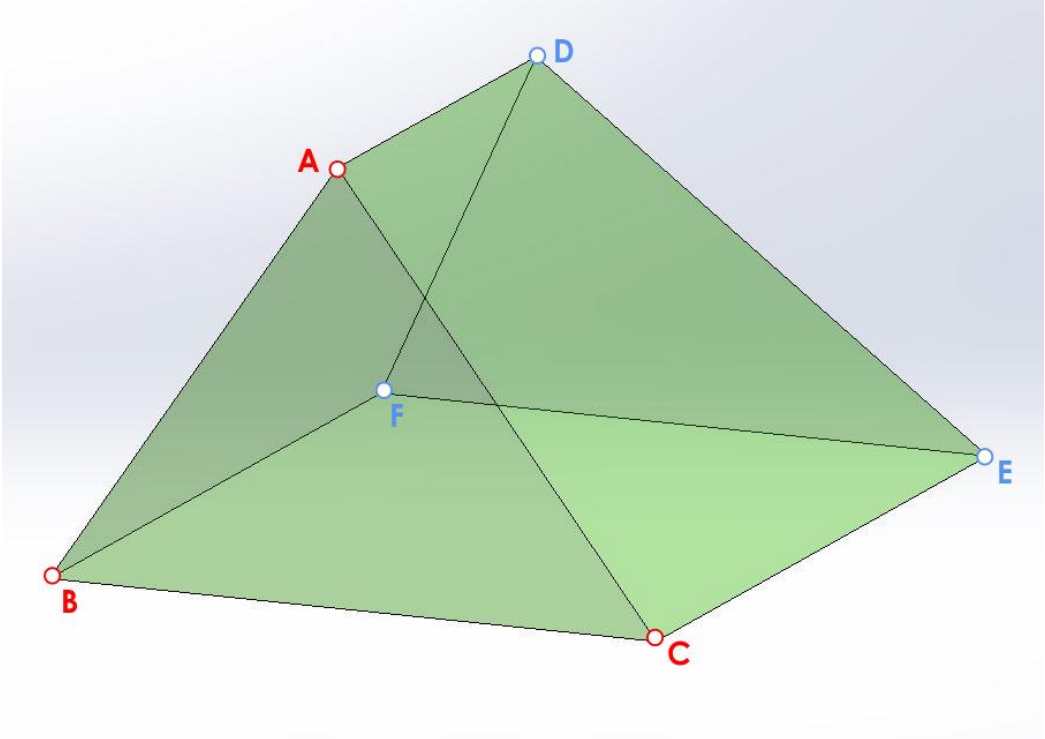
Given a **Cube** with an edge of **100** (in brown) position it (green construction) fulfilling the following conditions:

1. The Diagonal **AB** forms equal angles with the **Front Plane**, the **Top Plane** and the **Rigth Plane**. (**A** is closer to the reference planes than **B**).
2. The edge **BC** forms equal angles with the **Front Plane** and the **Rigth Plane**.
3. The vertex **B** is at a distance of **35** from the **Front Plane** and of **140** from the **Top Plane**.

Once positioned the **Cube**, the distance from the vertex **C** to the **Rigth Plane** is:

ANSWER: .....

TRAPEZOID 1_1

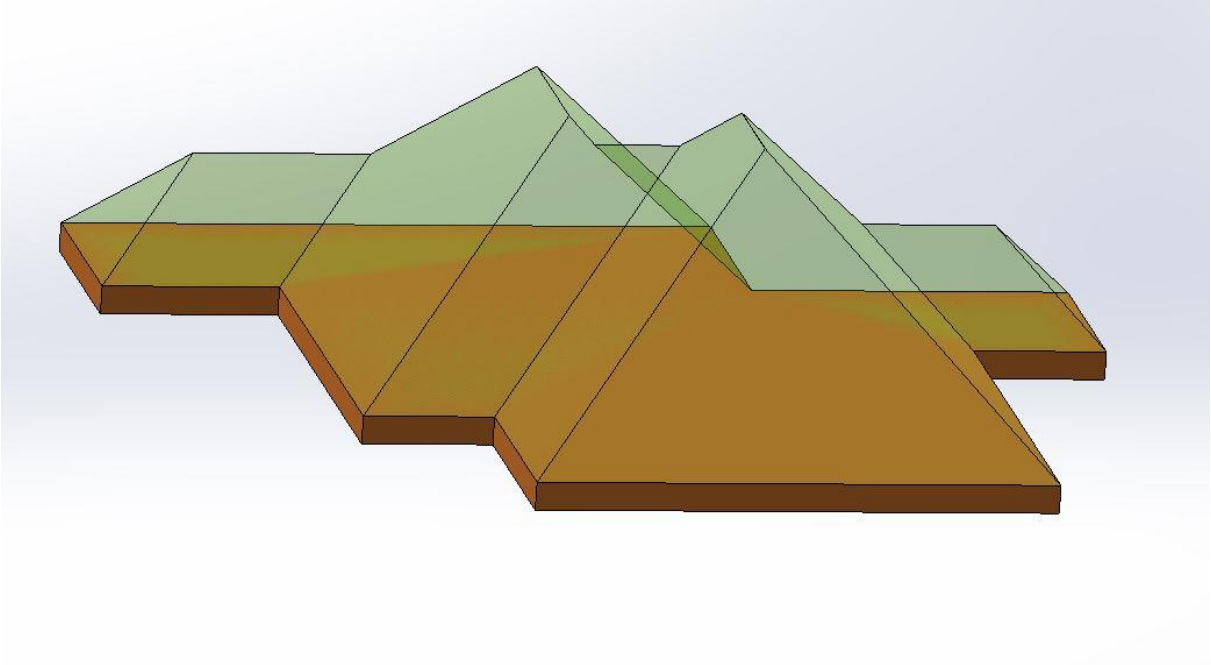


An irregular polyhedron is defined from a square **BCEF** of side **100**.
The lateral faces **ABD**, **DFE** and **CDE** have slopes of **150%, 300%** and **100%,** respectively. Being the square **BCEF** on the **Top Plane.**
All lateral faces form acute angles with the base.

If the edge **AD** measures **60**, the face **ABC** has a slope of:

ANSWER: .....

TRAPEZOID 1_2



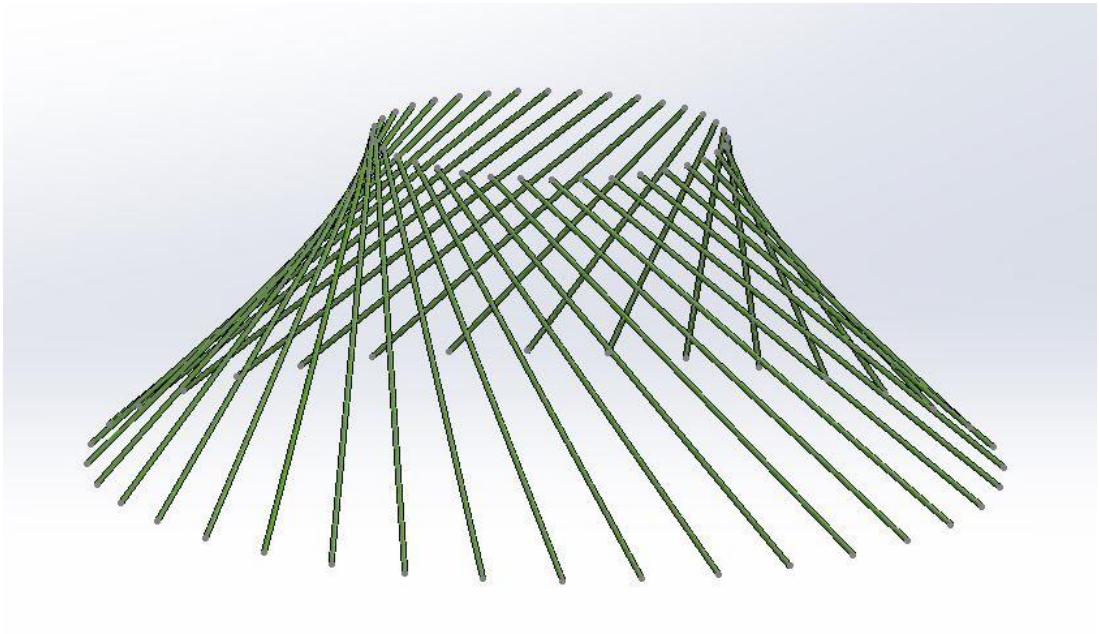
SDW

Given the **brown Prism** above, build on its upper base the trapezoidal structures (in green) knowing that the slopes of all lateral faces are of **100%**

The maximum height of the set (prism plus trapezoidal structures) measured with integers is:

ANSWER: .....

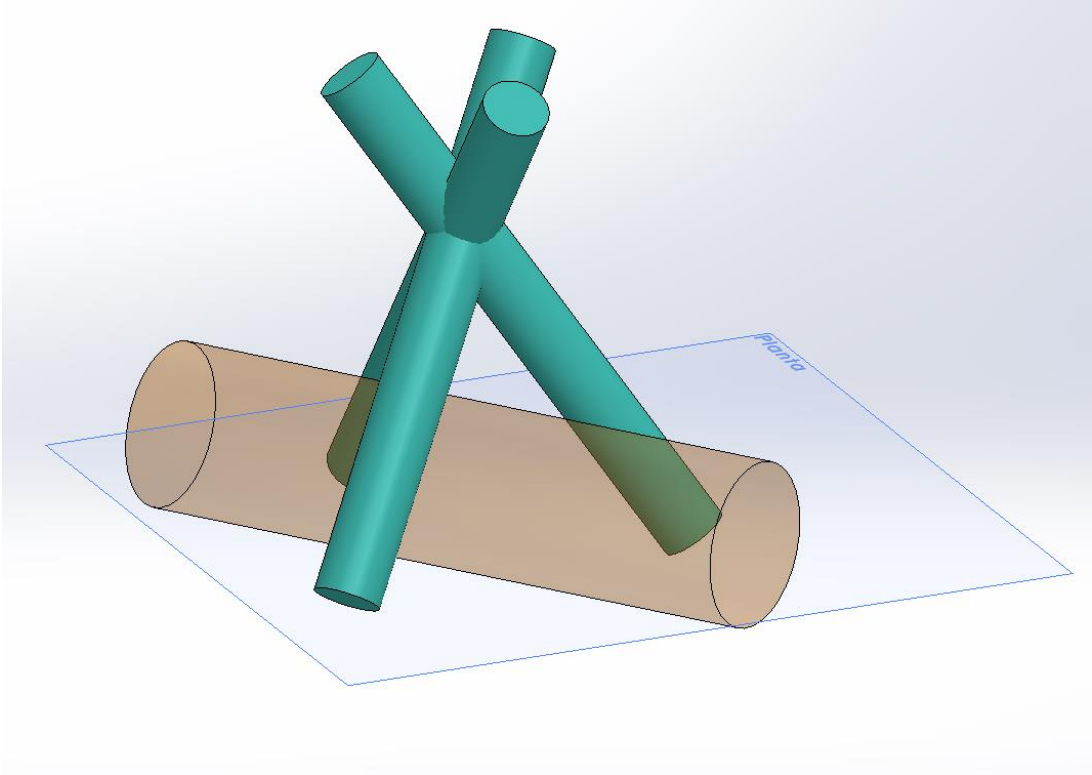
CYLINDER 1_1



With 36 cylinders of diameter **30** and length **3.000** the structure of the image is generated. If the distance between the axis of two opposite cylinders is of **2.000** and the angle between them is **100º**, calculate the minimum distance between the surfaces of two adjacent cylinders.

ANSWER: .....

CYLINDER 2_1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

3 Cylinders (in green) of diameter **100** have theis base tangent to the **Top Plane**. Their axes areintersect at the same point **I,** at a distance of 500 from the **Top Plane.** In the three cases the distance between the point **I** and the base at the bottom is twice that between point **I** and the base at the top.

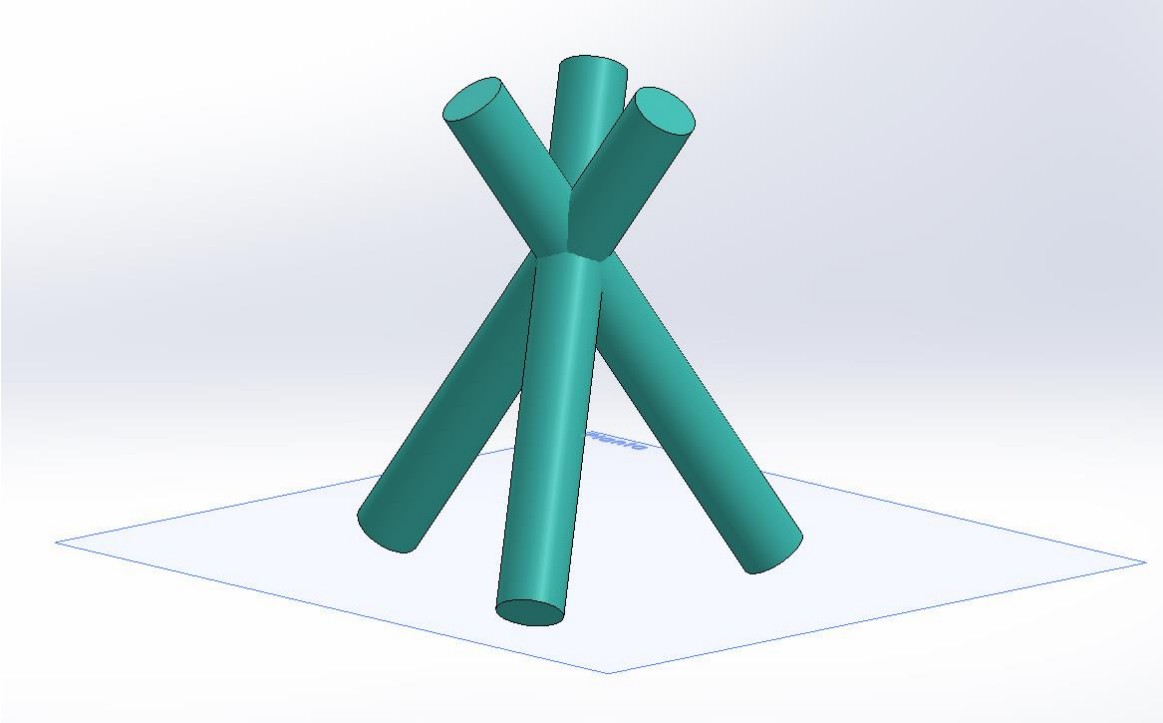
The points of contact of the cylinders with the **Top Plane** define an equilateral triangle of **500** of side.

A **fourth cylinder** (in brown) is tangent to the previous three cylinders and to the **Top Plane**.

Calculate the maximum diameter of the **fourth cylinder**.

ANSWER: .....

CYLINDER 2_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

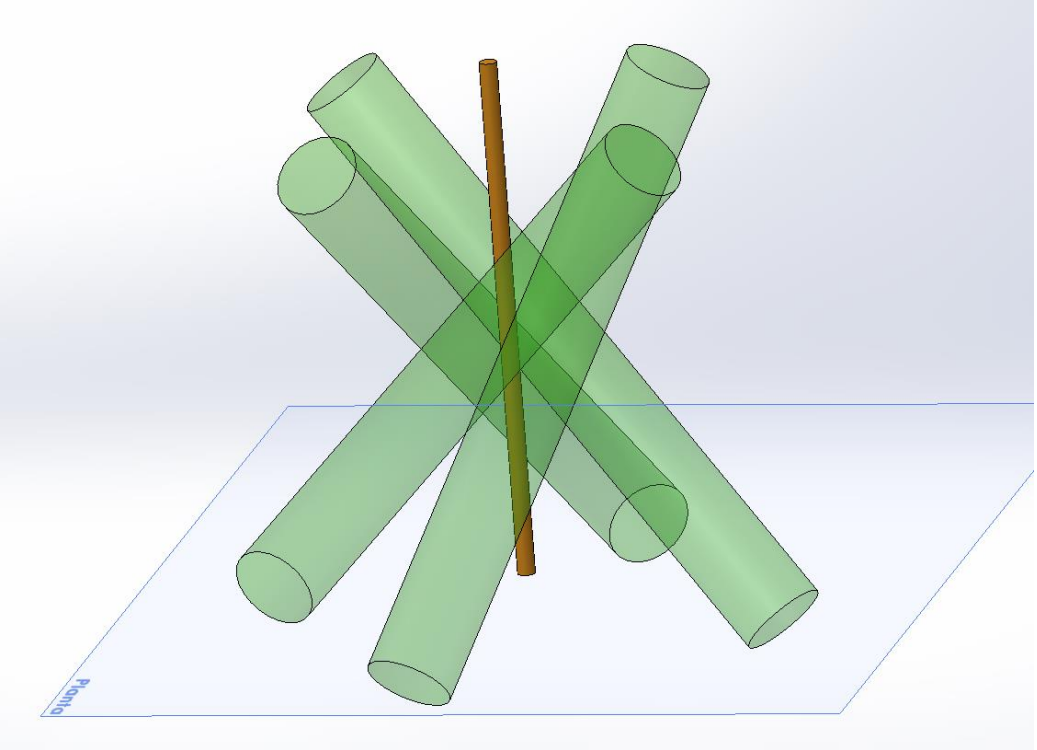
3 Cylinders (in green) of diameter **100** have theis base tangent to the **Top Plane**. Their axes areintersect at the same point **I,** at a distance of 500 from the **Top Plane.** In the three cases the distance between the point **I** and the base at the bottom is twice that between point **I** and the base at the top.

The points of contact of the cylinders with the **Top Plane** define an equilateral triangle of **500** of side.

Calculate the length of the cylinders.

ANSWER: .....

CYLINDER 2_3



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

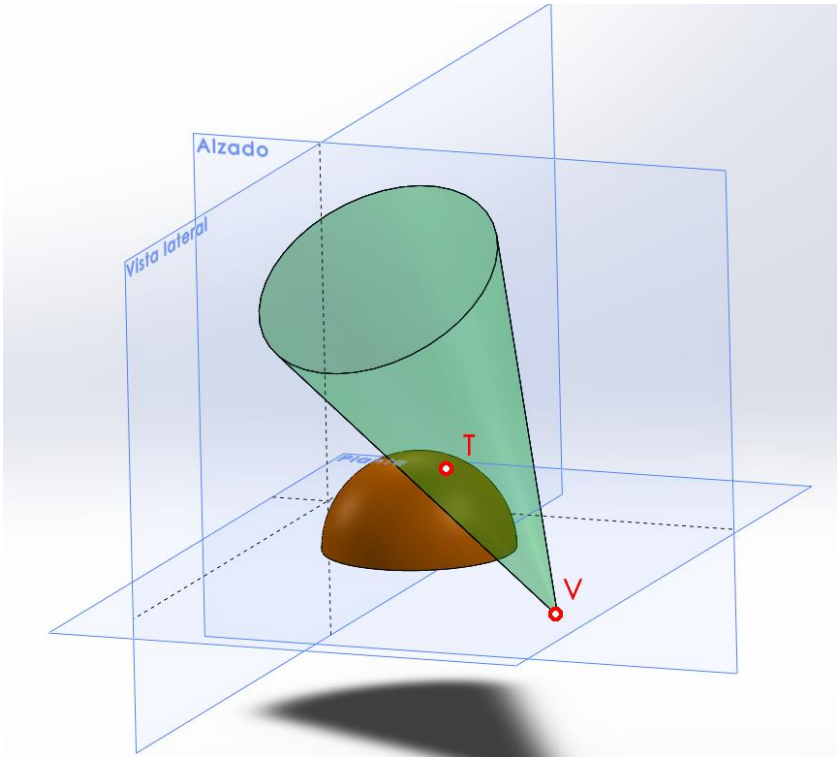
4 cylinders with a diameter of **100** and a longitude of **800** intersect each other. The distance between the axes of the opposite cylinders is **120** and the angle among them is **45º**.

The axes of the cylinders intersect with the **Top Plane** defining the vertex of a square of side **400**.

The diameter of the vertical cylinder (in brown) tangent to the four green cylinders is:

ANSWER: .....

CONE 1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

A **30** units radius **semi-sphere** with its base on the **Top Plane** is given. Its centre equidist **50** from the **Front Plane** and the **Rigth Plane**.

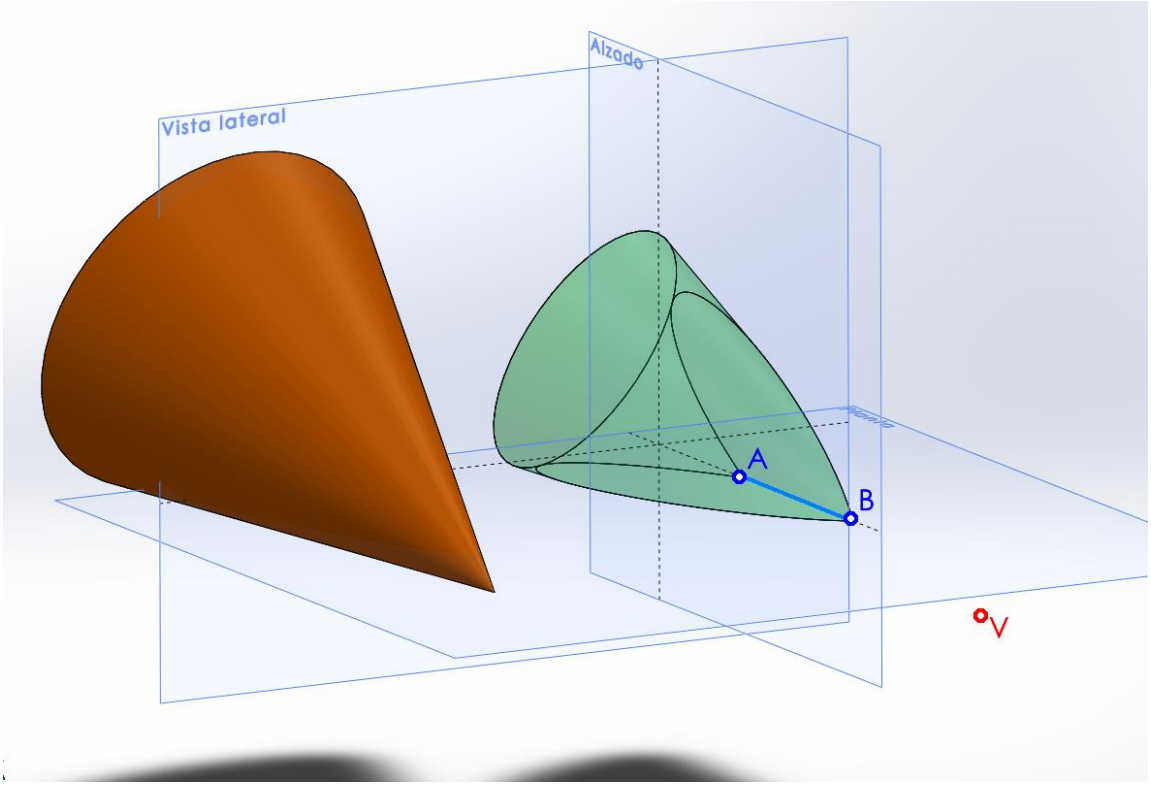
Build a **revolution cone** fulfilling the following conditions:

1. The **generatrix** is **4** times longer than the **radius** of the base of the cone, and the **axis** measures **150**.
2. The base is tangent to the **Rigth Plane** and to the **Front Plane**.
3. The **vertex V** is the only contact point of the cone with the **Top Plane**.
4. The plane defined by **V**, **T** (tangency point between the cone and the sphere) and **the axis** of the cone forms **30º** with the **Front Plane**.

If the distance from **V** to the **Front Plane** is **98.62** the height of the point **T** is:

ANSWER: .....

CONE 2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

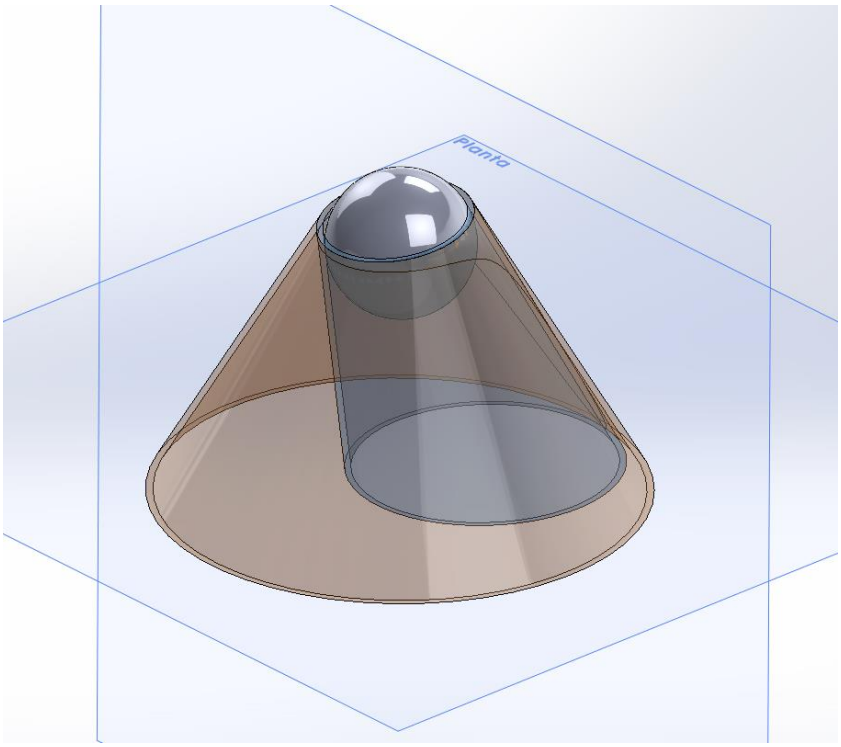
Define and position a **cone of revolution** (in brown) fulfilling the following conditions (green construction):

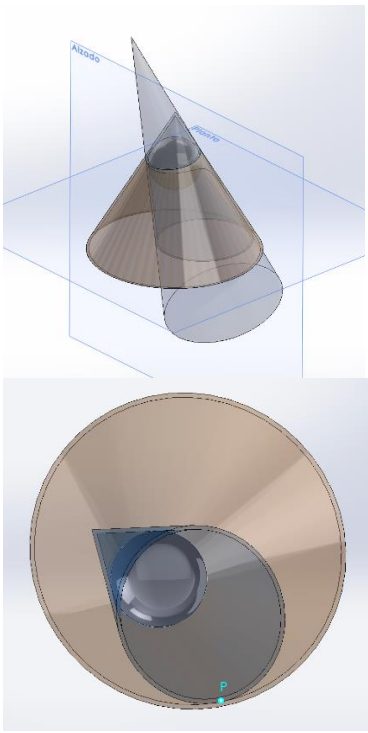
1. The base of the cone is tangent to the **Rigth Plane** and to the **Front Plane**.
2. The vertex **V** is at a distance of **25** from the **Top Plane**.
3. The intersection of the cone with the **Top Plane** and the **Front Plane** generate two symmetrical ellipses.

Calculate the length of the segment **AB**, intersection of the two ellipses.

ANSWER: .....

CONE 2_1





GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW	SDW	SDW
ESFERA	***CON EXTERIOR***	***CON INTERIOR***

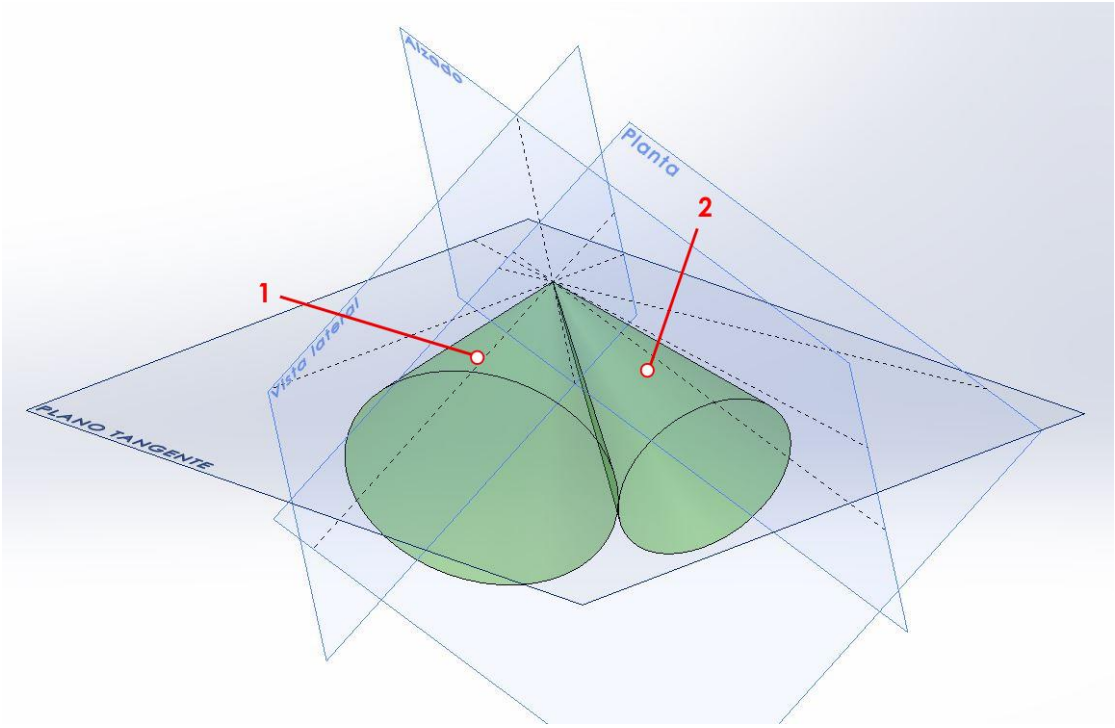
Given two hollow cones and a sphere that fulfill the following conditions:

1. The outer cone has its base on the **Top Plane**.
2. The sphere is tangent to the inner surfaces of the two cones.
3. The inner cone has an elliptical base on the Top **Plane** that is tangent to the horizontal base of the outer cone at point **P**.

The height of the assembly is:

ANSWER: .....

CONE 2_2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE, PLANO TANGENTE= TANGENT PLANE

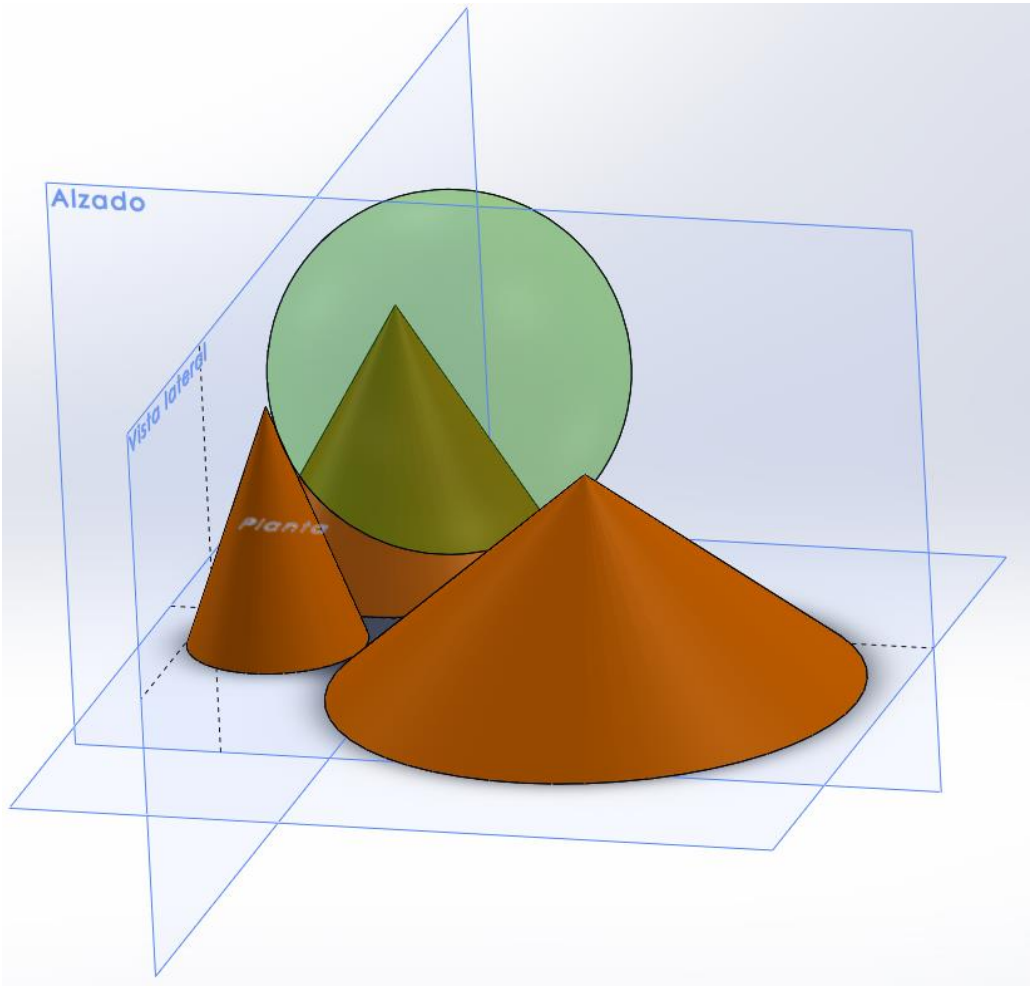
Two cones with the vertex at the origin of coordinates are tangent to each other. The **cone 1** is tangent to the **Top Plane** and the **Rigth Plane** and its axis measures **100**. The **cone 2** is tangent to the **Front Plane** and **Top Plane**.

The two cones share a tangent plane **a** that forms an angle of **50º** with the **Top Plane**.

The length of the **cone 2** axis is:

ANSWER: .....

SPHERE 1



GRAPHIC LEGEND

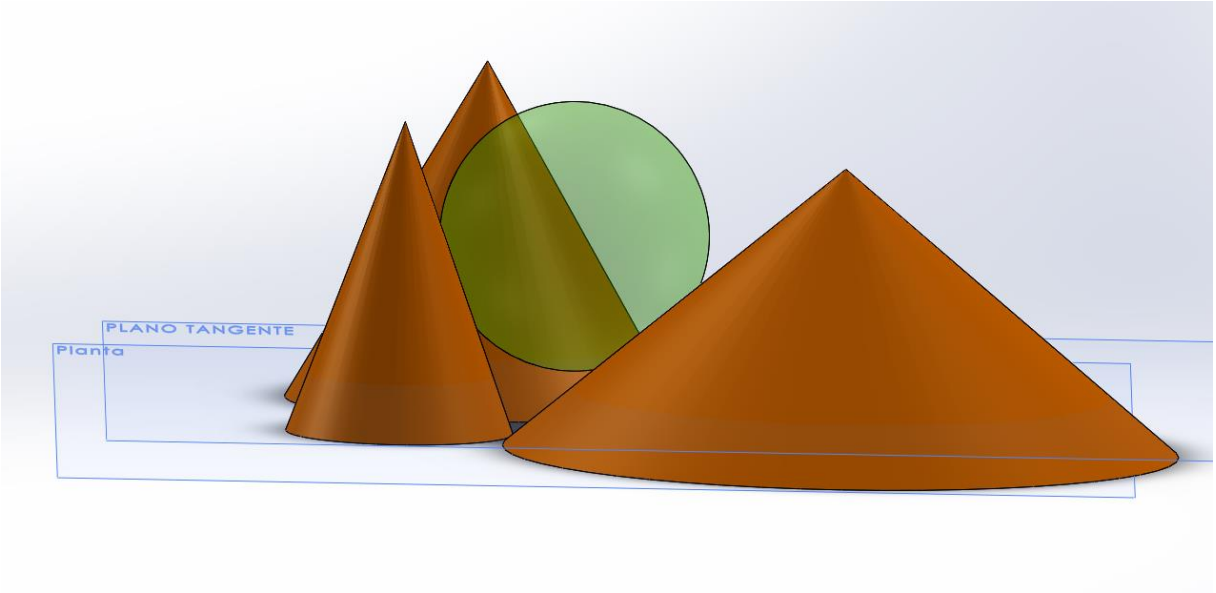
ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

Given **three cones** (in brown) determine the minimum distance from the surface of a **sphere** (in green), of radius **SR 40,** to the **Top Plane.** The sphere is tangent to the three cones as shown above.

ANSWER: .....

SPHERE 2



GRAPHIC LEGEND

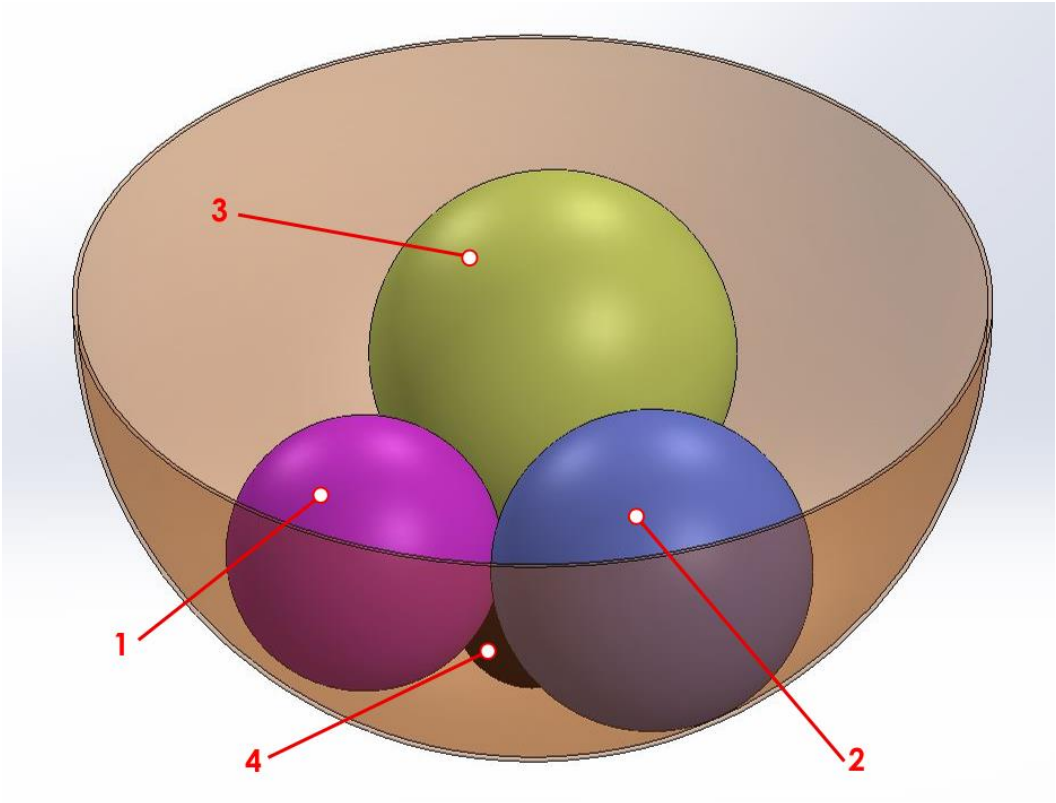
ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE, PLANO TANGENTE= TANGENT PLANE

SDW

Given **three cones** (in brown) calculate the radius **SR** of a **sphere** (in green) that is tangent to the three cones, as shown above, and to a plane located at a distance of **10** above the **Top Plane**.

ANSWER: .....

SPHERE 3



SDW

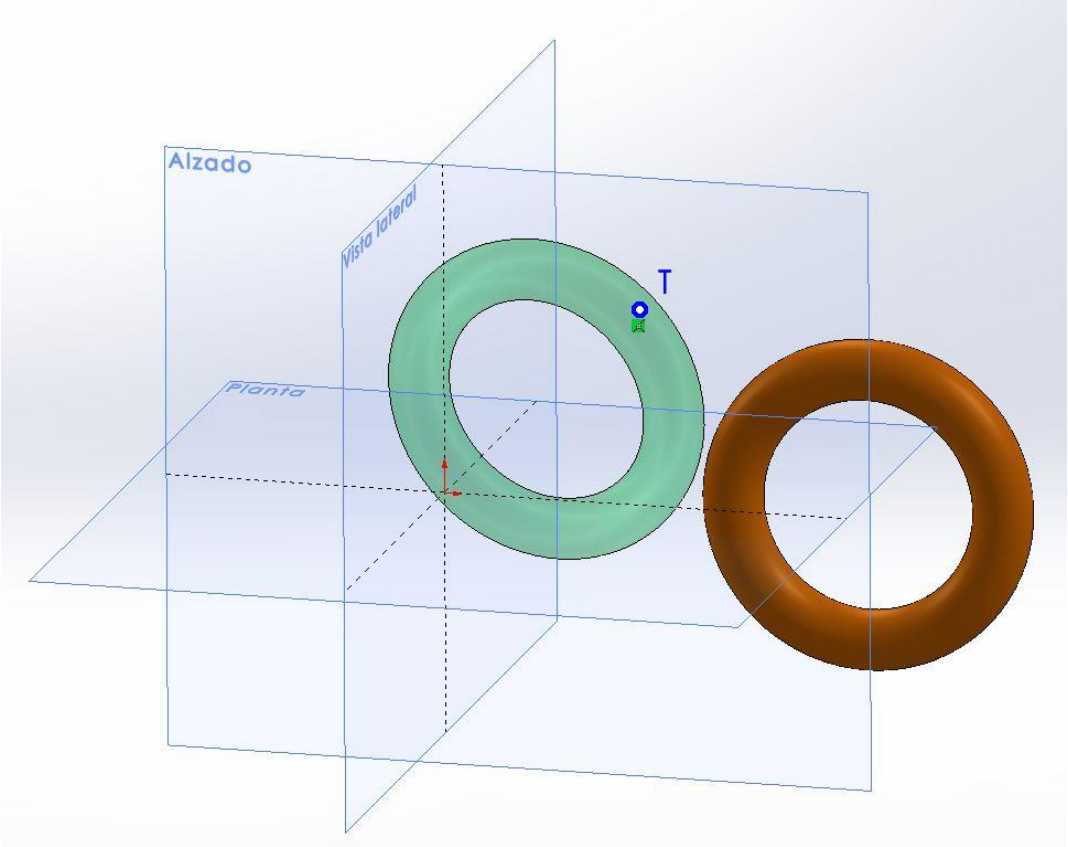
A **semispherical bowl** (in brown) is placed with its upper base horizontal and contains 4 balls. The **ball 4** (in black) is tangent to the inner face of the bowl at its lowest point and is tangent to the balls **1**, **2** and **3**.

The balls **1**, **2** and **3** are tangent between themselves, tangent to the **ball 4** and to the inner face of the bowl.

If the radius of the balls **1**, **2** and **3** are of **150**, **175** and **200**, respectively, the radius of the **ball 4** is:

ANSWER: .....

TORUS 1



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

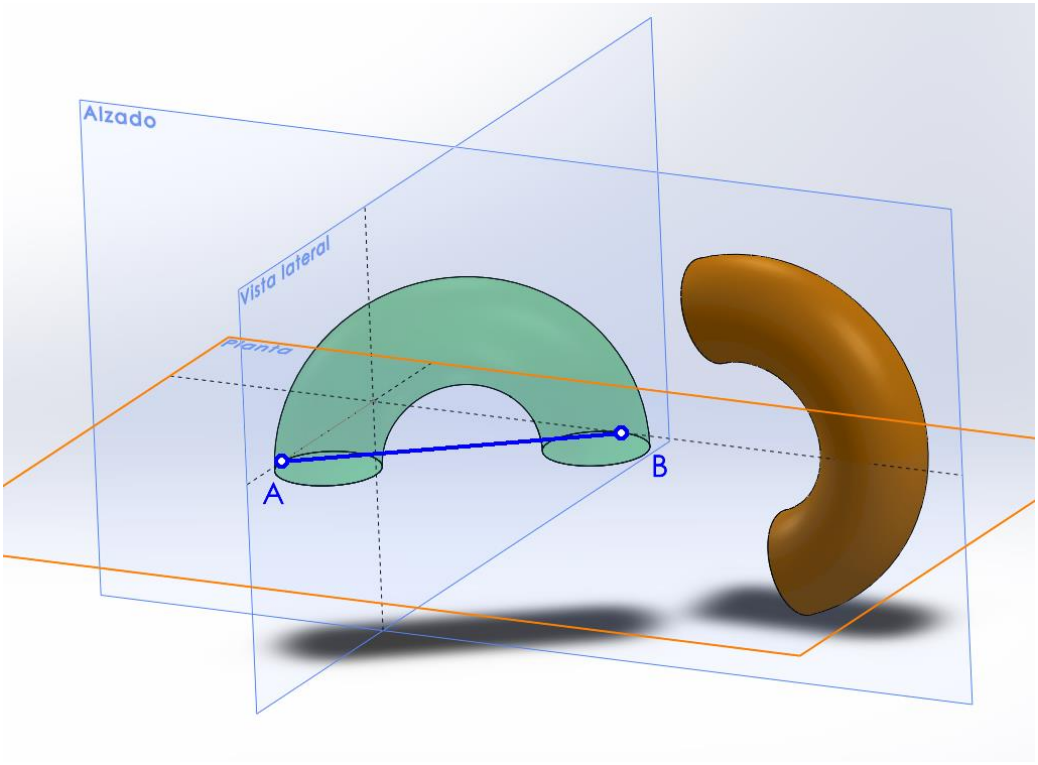
Given a **Torus** (in brown) position it fulfilling the following conditions (in green):

1. The Torus is tangent to the **Front Plane**, **Rigth Plane** and **Top Plane** ias shown above (first quadrant).
2. Its axis of revolution forms equal angles with the **Front Plane**, **Rigth Plane** and **Top Plane**.

Once positioned the Torus, **the height of the point of tangency** T of the Torus with the **Front Plane** is:

ANSWER: .....

TORUS 2



GRAPHIC LEGEND

ALZADO = FRONT PLANE, VISTA LATERAL = RIGTH PLANE, PLANTA = TOP PLANE

SDW

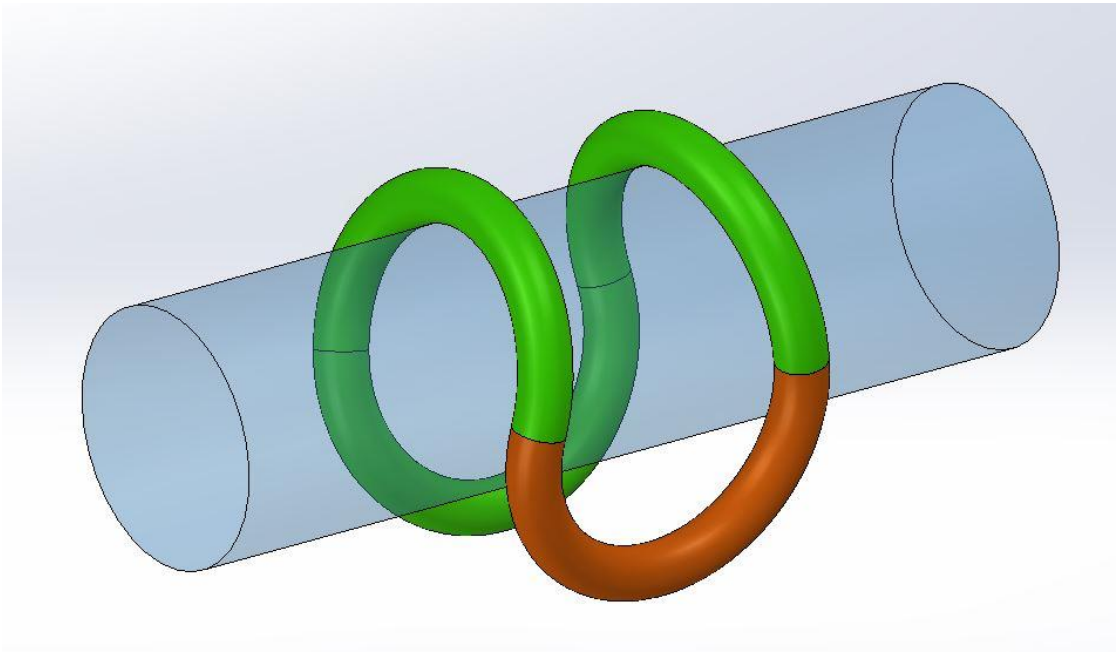
Given a **half Torus** (in brown) position it in accordance with the following conditions (in green):

1. The two end circles of the **half Torus** are contained on the **Top Plane**.
2. One of these circles is tangent to the **Rigth Plane** at point **A** and the other os tangent to the **Front Plane** at point **B**.
3. The length from its axis of revolution to the **OZ axis** (intersection of the **Front Plane** and the **Rigth Plane**) is **25**.

Once positioned the half Torus, the angle between the line **AB** line and the **Rigth Plane** is:

ANSWER: .....

TORUS 3_1



SDW

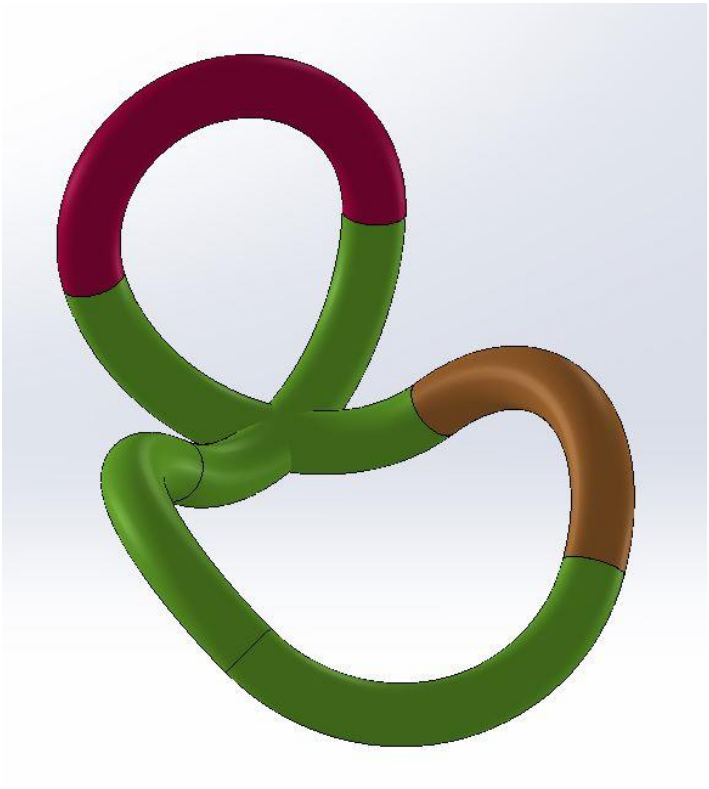
Given the **Torus fragment** (in brown) build the assembly above of four-torus connected by their circular bases.

This assembly clamps a cylinder as shown above.

The maximum diameter of the cylinder is:

ANSWER: .....

TORUS 3_2



SDW

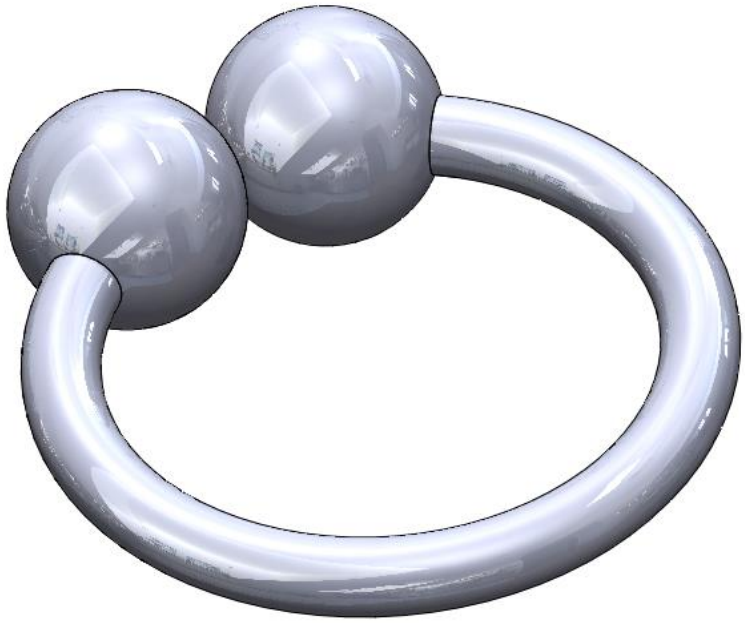
Given the **Tor fragment** (in brown) build the assembly of **five torus** (in green and brown) connectedby their circular bases. The revolution axes of the five torus form, between each other, angles of **60º**.

The assembly is completed by a **sixth Torus** (in red).

The radius of the circular axis of the **sixth Torus** is:

ANSWER: .....

TORUS 4



SDW

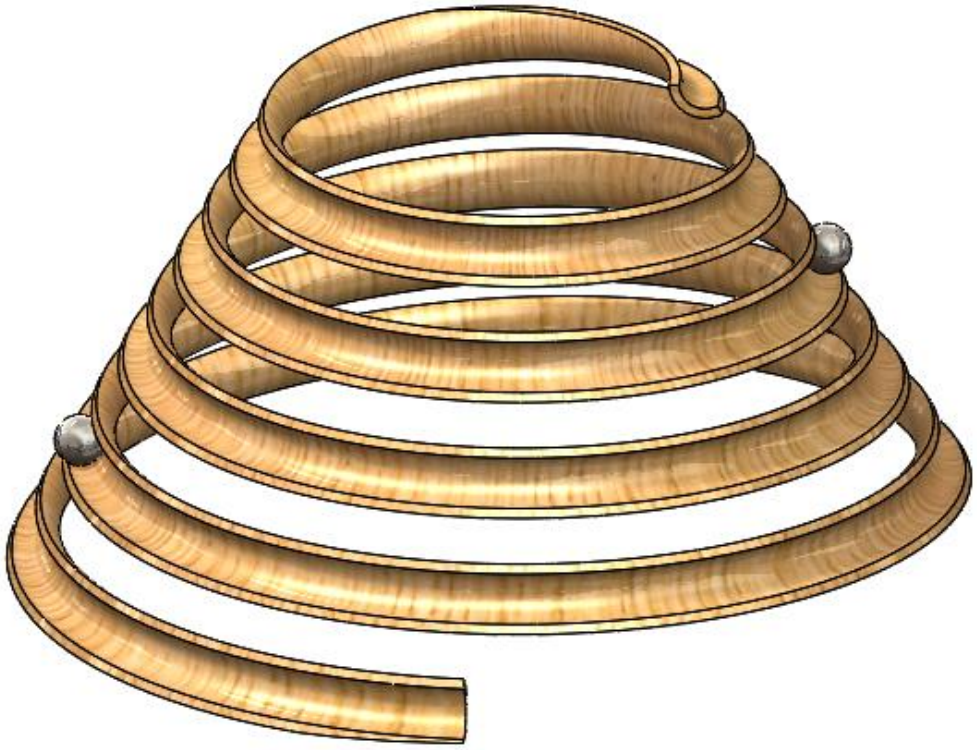
Given the a **sphere**, build the assembly of two spheres and a torus fulfilling the following conditions:

1. The two spheres contact each other **by a circle of diameter 10.**
2. The contact circle between the spheres forms part of the **Torus** Surface.
3. **The radius of the circular axis of the Torus is 40**.

Calculates the angle that covers the circular axis of the torus between the external contacts to the two spheres.

ANSWER: .....

ELICOID 1_1



STEP

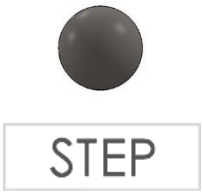
A spiral channel of circular section (in brown) is given.

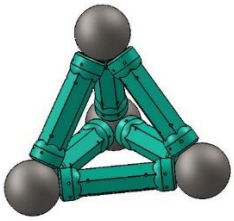
Along this channel, two steel balls descend. At a certain moment one has traveled 1/3 of the channel length and the other 2/3. The steel balls have the same diameter and are tangent to the inner face of the channel.

The minimum distance between the two balls at the described position is:

ANSWER: .....

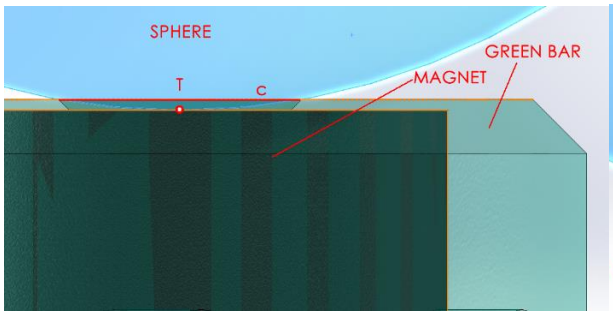
GEOMAG TETRAHEDRON

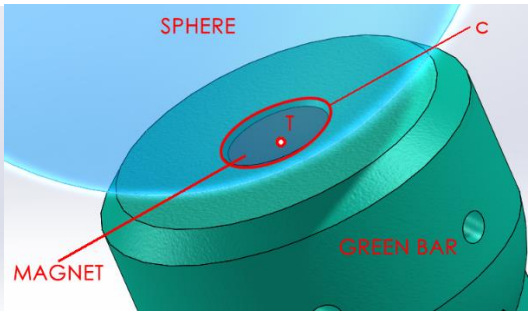




Given the steel sphere and the magnetized bar of a well-known game you have to build a tetrahedron.

The connection between the sphere and the magnetized bar is produced as follows:



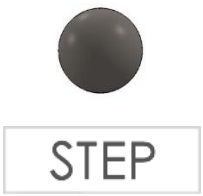


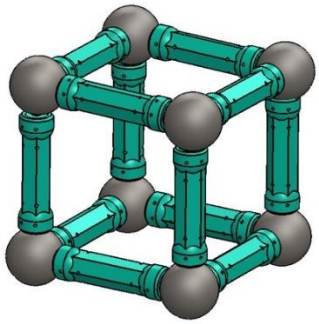
1. The circle **c** of the bar coincides with the surface of the sphere
2. The sphere is tangent to the magnet located inside the bar at point T.

Once the tetrahedron has been built, **its maximum height is**:

ANSWER: .....

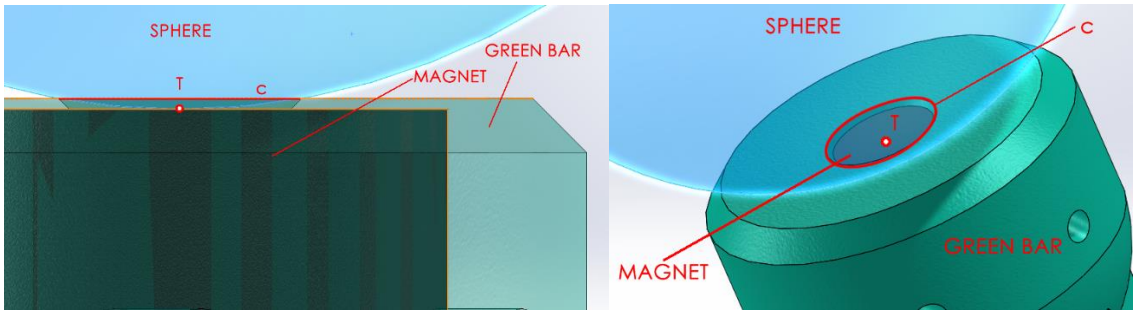
GEOMAG CUBE 1_1





Given the steel sphere and the bar magnetized a well-known game you have to build a Cube.

The connection between the sphere and the magnetized bar is produced as follows:

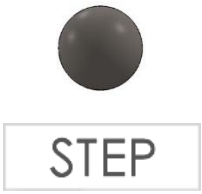


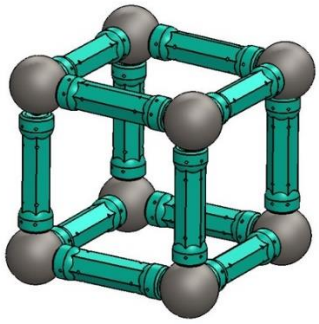
1. The circle **c** of the bar coincides with the surface of the sphere
2. The sphere is tangent to the magnet located inside the bar at point T.

Once built the cube, **the minimum distance between two opposite spheres by a main diagonal is**:

ANSWER: .....

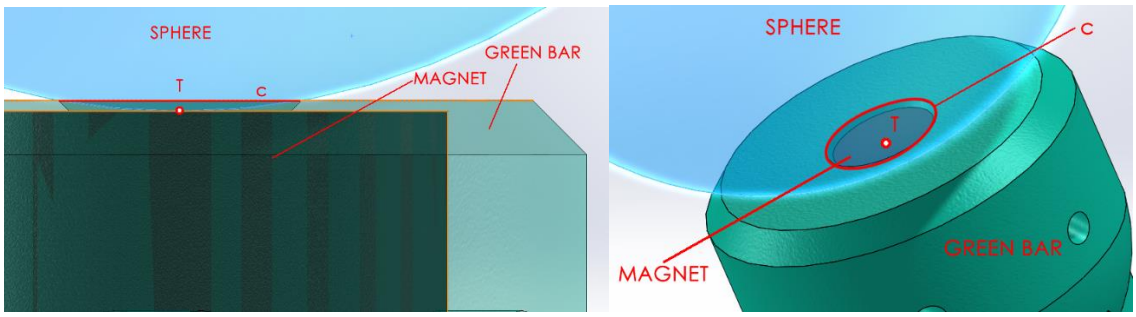
GEOMAG CUBE 1_2





Given the steel sphere and the bar magnetized a well-known game you have to build a Cube.

The connection between the sphere and the magnetized bar is produced as follows:



1. The circle **c** of the bar coincides with the surface of the sphere
2. The sphere is tangent to the magnet located inside the bar at point T.

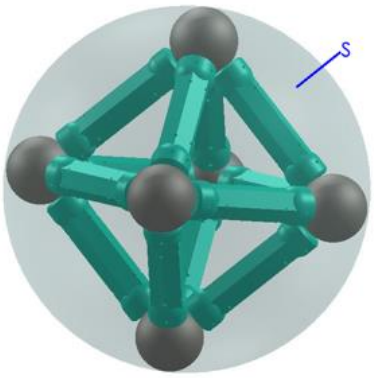
Once the cube is built, the maximum distance between two parallel prisms is:

ANSWER: .....

GEOMAG OCTAHEDRON 1

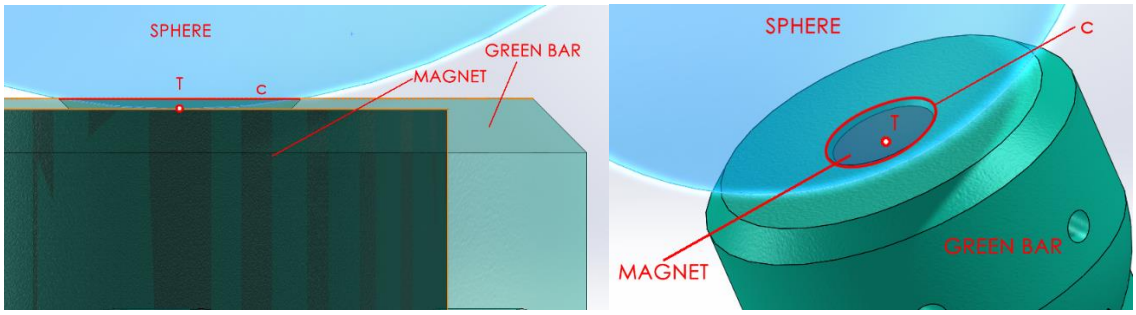
STEP

STEP



Given the steel sphere and the bar magnetized a well-known game you have to build an Octahedron.

The connection between the sphere and the magnetized bar is produced as follows:



1. The circle **c** of the bar coincides with the surface of the sphere
2. The sphere is tangent to the magnet located inside the bar at point T.

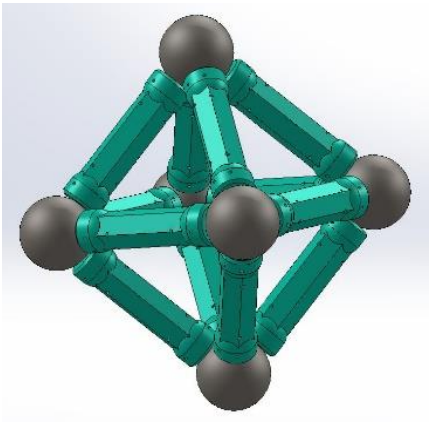
Once the Octahedron is built, calculate the diameter of the circumscrit sphere S (outer tangent to the spheres).

ANSWER: .....

GEOMAG OCTAHEDRON 2

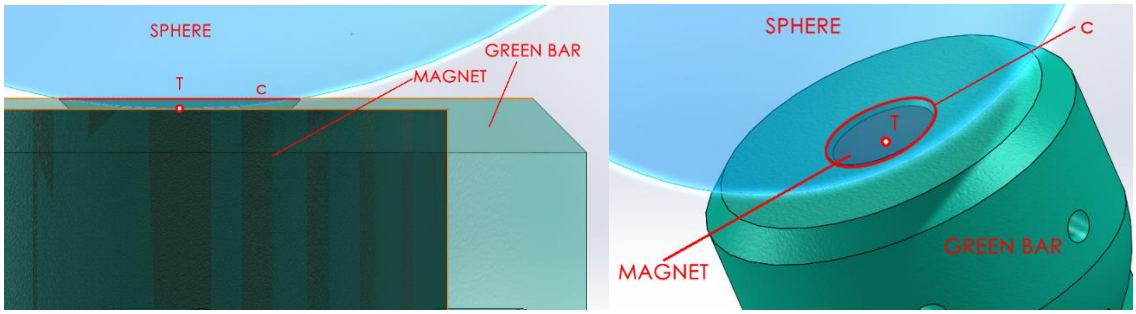
STEP

STEP



Given the steel sphere and the bar magnetized a well-known game you have to build an Octahedron.

The connection between the sphere and the magnetized bar is produced as follows:

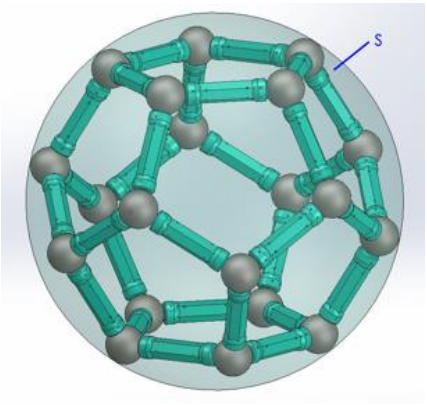


1. The circle **c** of the bar coincides with the surface of the sphere
2. The sphere is tangent to the magnet located inside the bar at point T.

Once the octahedron has been built, calculate the minimum distance between two opposing magnetized bars.

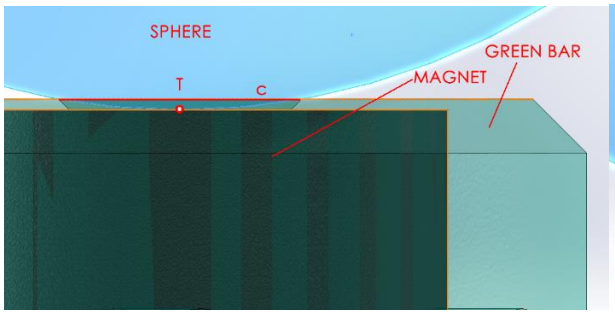
ANSWER: .....

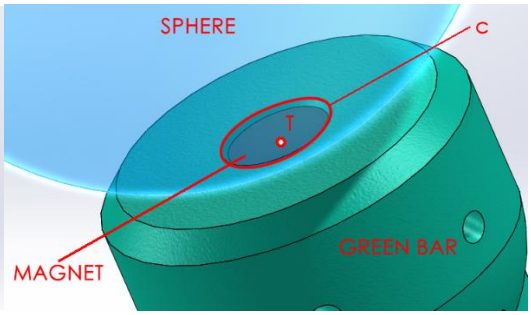
GEOMAG DODECAHEDRON



Given the steel sphere and the bar magnetized a well-known game you have to build a Dodecahedron.

The connection between the sphere and the magnetized bar is produced as follows:





1. The circle **c** of the bar coincides with the surface of the sphere
2. The sphere is tangent to the magnet located inside the bar at point T.

Once the dodecahedron is built, calculate the diameter of the circumscrit sphere s (outer tangent to the spheres).

ANSWER: .....

PROBLEMS

MECHANICS

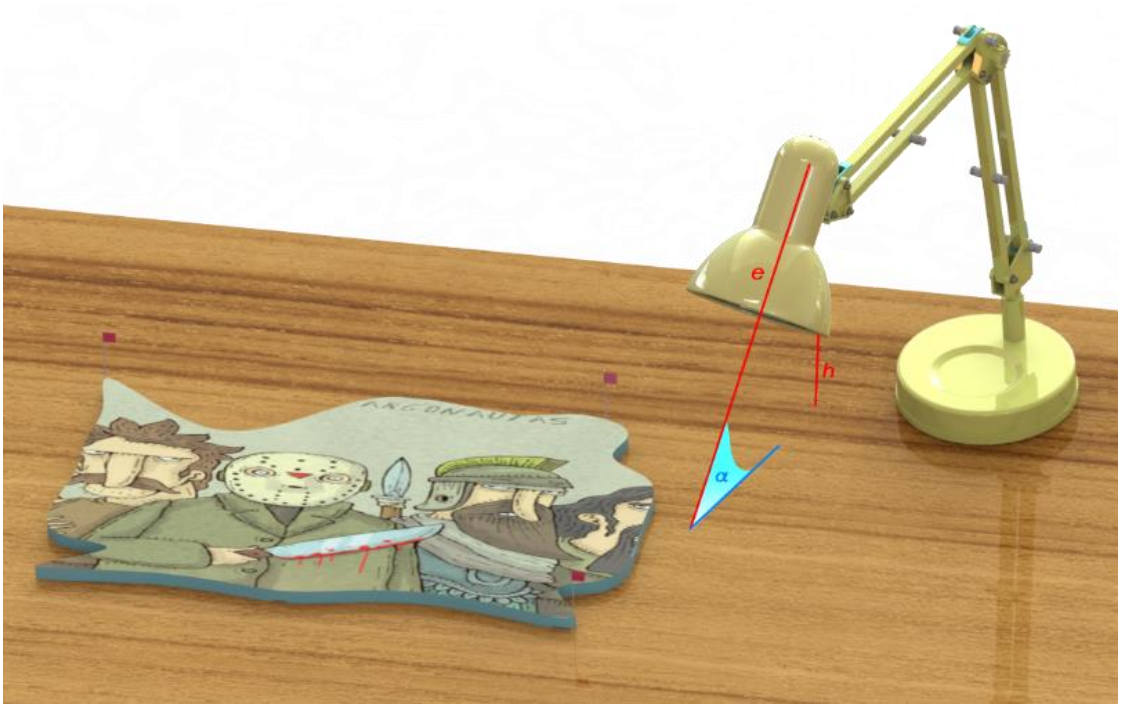
ERGONOMY

ILLUSTRATOR 1

The Argentinian illustrator MONTT is making an adaptation of his work "Jason and the Argonauts" on an irregular piece of wood.

In order to obtain the best possible lighting on the work, it is intended to place an articulated lamp so that it illuminates on the wooden piece the points marked with the tip of three pins.

The lamp projects a **60º** of aperture cone of light.

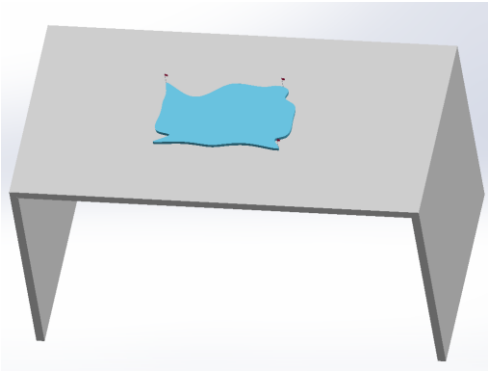


In order for the surface lighting to be as powerful as possible, the illuminated surface should not exceed these three points; and to avoid the lighting to generate more heat than necessary is precise that the screen of the lamp remains at a minimum distance **h** from the table (**h** = **200 mm**).

MONTT works with his right hand.

To solve the problem the following is given:

1. The table and the irregular wood with the three pins.
2. The articulated lamp.



STEP

STEP

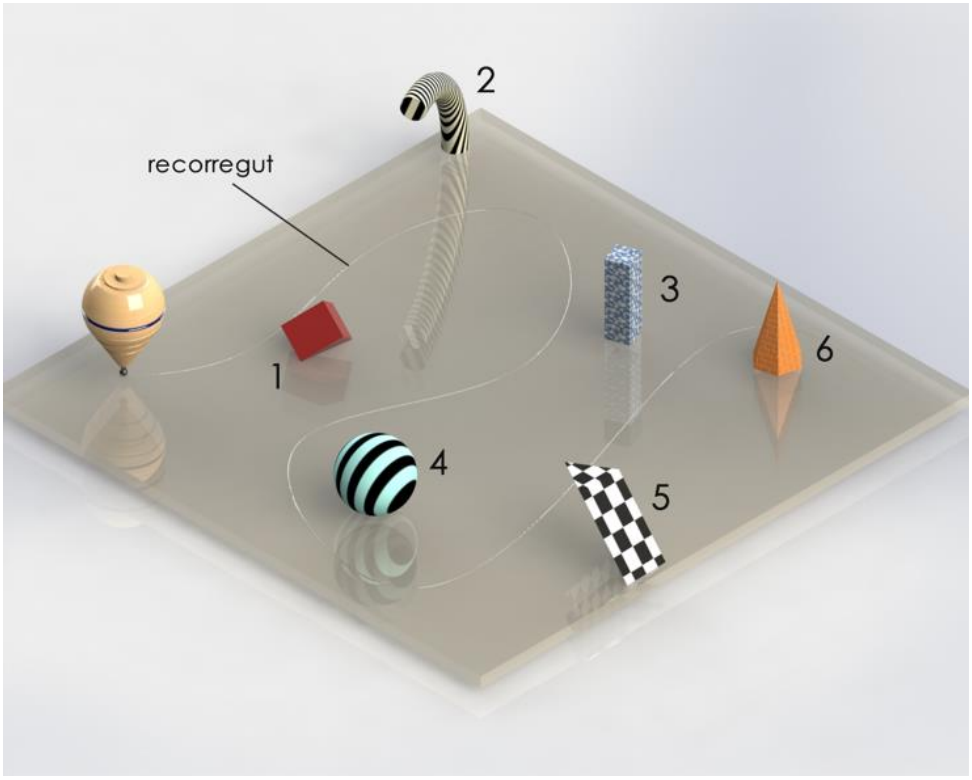
Calculate the angle **a** between the axis **e** of the lamp screen and the table surface.

ANSWER: .....

MOVEMENT

SPINNING TOP 1

A spinning top moves along a path on a plastic plate.



The scenario, the path and the spinning top are given.

STEP

STEP

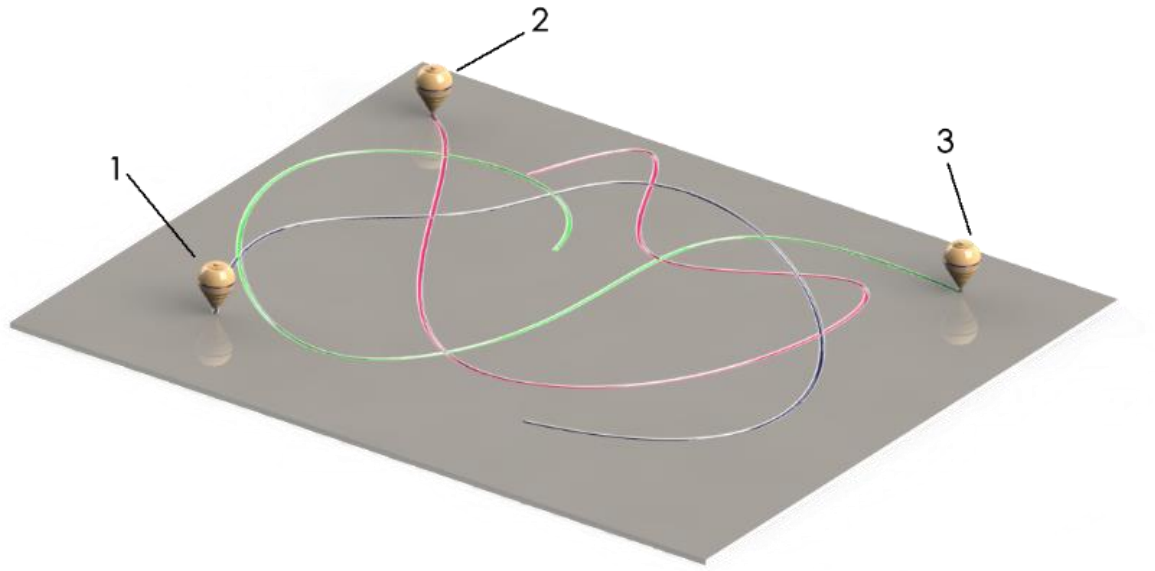
If the axis of the spinning top is kept at all times perpendicular to the base, the elements of the scenario that interfere with the spinning top are:

THE SOLUTION MUST BE EXPRESSED IN THE FOLLOWING WAY 1, 2, 3, ...; or 0 IF THERE IS NO INTERFERENCE.

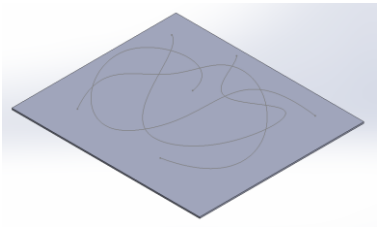
ANSWER: .....

SPINNING TOP 2_1

Three spinning tops are moved following three different trajectories on a plastic plate. The points of departure are the extremes of the trajectories as indicated image below.



The plate with the trajectories and the spinning top are given.



STEP

STEP

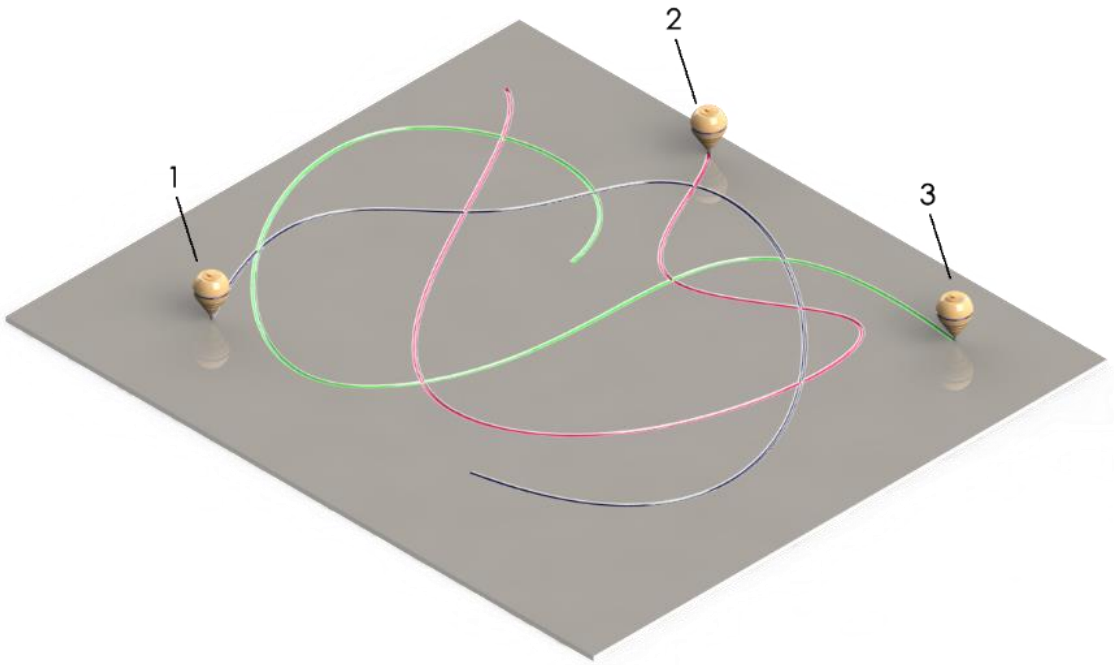
If the axes of the spinning tops are kept at all times perpendicular to the base, and the three spinning tops complete the circuit in the same time, the tops that impact to each other are:

THE SOLUTION MUST BE EXPRESSED IN THE FOLLOWING WAY 1, 2, 3, ...; 0 IF THERE IS NO IMPACT.

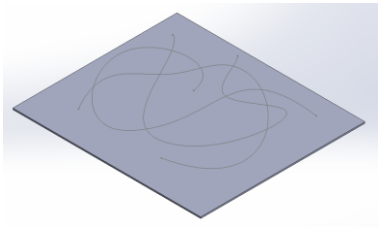
ANSWER: .....

SPINNING TOP 2_2

Three spinning tops move following three different trajectories on a plastic plate. The starting points are the extremes of the trajectories indicated in the image below.



The plate with the trajectories and the spinning top are given.



STEP

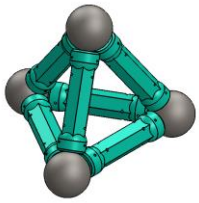
STEP

If the axes of the spinning tops are kept at all times perpendicular to the base, and the three spinning tops complete the circuit in the same time, the tops that impact to each other are:
THE SOLUTION MUST BE EXPRESSED IN THE FOLLOWING WAY 1, 2, 3, ...; 0 IF THERE IS NO IMPACT.

ANSWER: .....

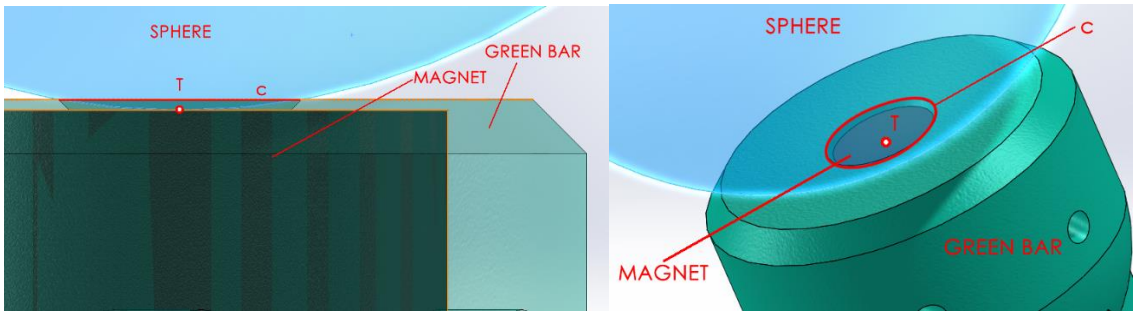
CONSTRUCTION

GEOMAG TETRAHEDRON



Given the steel sphere and the magnetized bar of a well-known game, you have to build a Tetrahedron.

The connection between the sphere and the magnetized bar is produced as follows:



1. The circle **c** of the bar coincides with the surface of the sphere
2. The sphere is tangent to the magnet located inside the bar at point T.

If the radius **SR** of the sphere is modified, the radius **c** of the contact circle with the bar needs to be simultaneously modified to maintain the tangency between the sphere and the magnet.

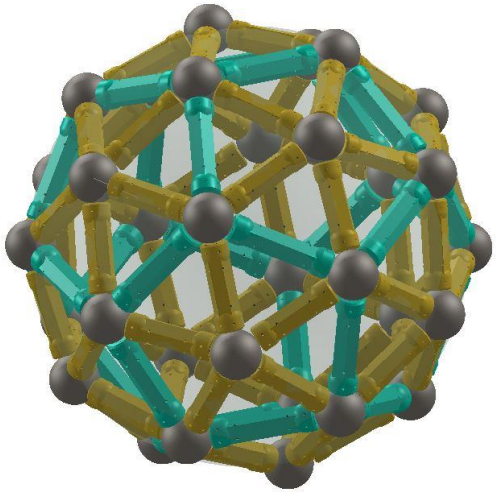
Calculate **the minimum radius SR** of the steel sphere and the **diameter of** circle **c** that allow the tetrahedron to be built without collisions between the bars.

The solution is expressed as follows: **radius SR of the sphere-diameter of the circle c**.

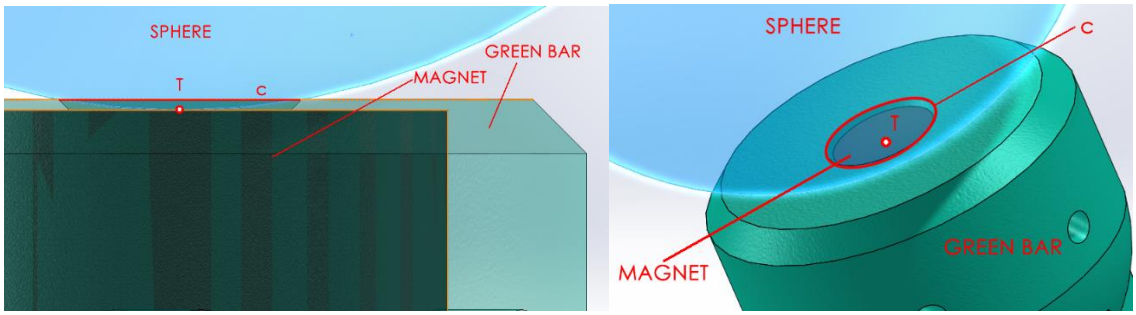
ANSWER: .....

GEOMAG GEODESIC 1

Geodesic constructions can be created from some regular polyhedra. The one of the following figure has been created from a dodecahedron. The dodecahedron is assembled by binding the green bars and the magnetized spheres. To complete the geodesic construction of the dodecahedron of the image more spheres and magnetized yellow bars should be added.



The connection between the sphere and the magnetized bar is produced as follows:



1. The circle **c** of the bar coincides with the surface of the sphere
2. The sphere is tangent to the magnet located inside the bar at point T.

Please bear in mind that:

- The centers of all spheres are located on the surface of a single sphere.
- The diameter of the circles **c** of the green and yellow bars is the same.

STEP

STEP

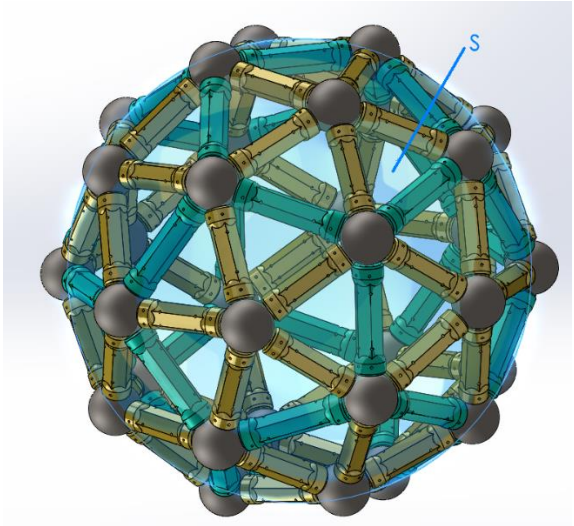
STEP

Given the dodecahedron, the sphere and magnetized green bar, **calculate the total length of a magnetized yellow bar.**

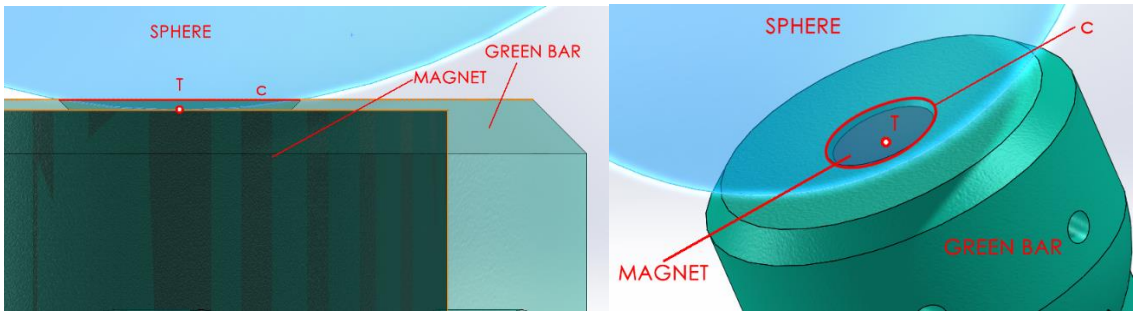
ANSWER: .....

GEOMAG GEODESIC 2

Geodesic constructions can be created from some regular polyhedra. The one of the following figure has been created from a dodecahedron. The dodecahedron is assembled by binding the green bars and the magnetized spheres. To complete the geodesic construction of the dodecahedron of the image more spheres and magnetized yellow bars should be added.



The connection between the sphere and the magnetized bar is produced as follows:



1. The circle **c** of the bar coincides with the surface of the sphere
2. The sphere is tangent to the magnet located inside the bar at point T.

Please bear in mind that:

- The centers of all spheres are located on the surface of a single sphere.
- The diameter of the circles **c** of the green and yellow bars is the same.

STEP

STEP

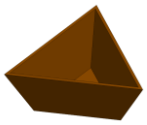
STEP

Given the dodecahedron, the sphere and a magnetized green bar, **calculate the diameter of the sphere S which passes through the centers of the steel spheres.**

ANSWER: .....

DESERT 1_1

A patiser wants to put together a combination of desserts consisting on the following elements:



Truncated regular pyramid black chocolate container

Lid of transparent candy of prismatic form

White chocolate egg

Pistachio cone

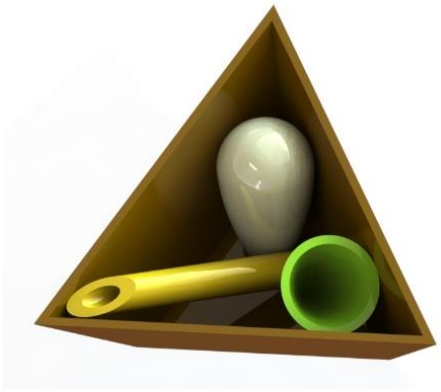
Hollow cylinder of vanilla

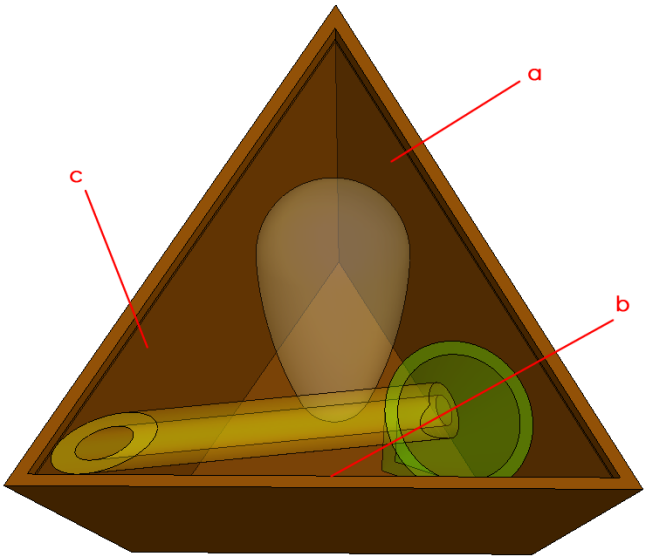
STEP STEP STEP STEP

The combination of the five components is shown in the image below, the components meet the following conditions:

1. The vanilla hollow cylinder contacts at a single point the egg and the cone, respectively.
2. The egg contacts with two of the faces of the prism at points that are located at the same distance from the base of the chocolate pyramid.
3. The cone contacts with two of the faces of the prism at points that are located at the same distance from the base of the chocolate pyramid.
4. The caramel lid adjusts with the chocolate pyramid maintaining three of its edges in contact with the inner faces of the pyramid.
5. The caramel lid contacts at a single point the egg and the pistachio cone.
6. The vanilla cylinder prevents the egg and the cone to slip leaving their contact with the caramel lid.
7. The top base of the vanilla cylinder fully contacts (according to an ellipse shape) the caramel lid and has a single point of contact with the inner face **c** of the chocolate pyramid.

8. The axis of the Vanilla Edge forms **30º** with the base of the pyramid and **20º** with the face **c**.



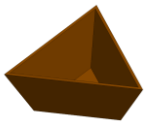


Given the first four elements **is asked to define the outer diameter of the vanilla hollow cylinder:**

ANSWER: .....

DESERT 1_2

A patiser wants to put together a combination of desserts consisting of the following elements:



Truncated regular pyramid black chocolate container

Lid of transparent candy of prismatic form

White chocolate egg

Pistachio cone

Hollow cylinder of vanilla

The combination of the five components is shown in the image below, the components meet the following conditions:

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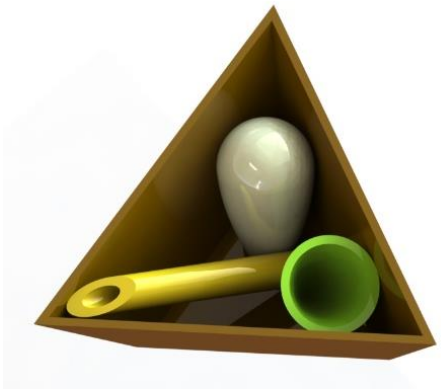
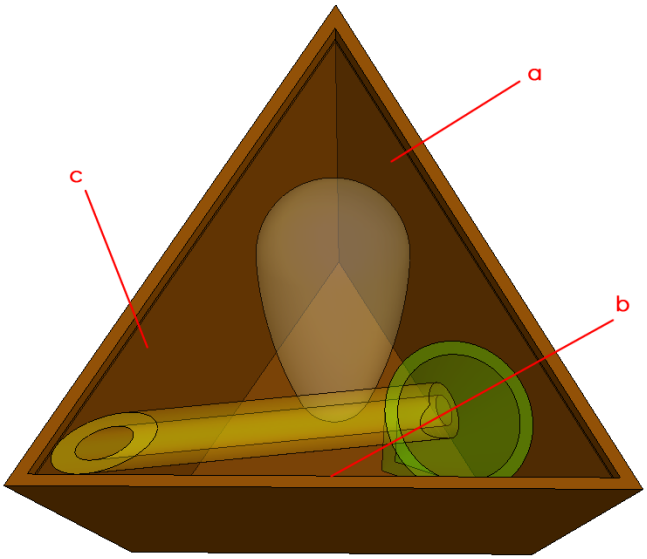
3. The cone contacts with two of the faces of the prism at points that are located at the same distance from the base of the chocolate pyramid.
4. The caramel lid adjusts with the chocolate pyramid maintaining three of its edges in contact with the inner faces of the pyramid.
5. The caramel lid contacts at a single point the egg and the pistachio cone.
6. The vanilla cylinder prevents the egg and the cone to slip leaving their contact with the caramel lid.
7. The top base of the vanilla cylinder fully contacts (according to an ellipse shape) the caramel lid and has a single point of contact with the inner face **c** of the chocolate pyramid.

8. The axis of the Vanilla Edge forms **30º** with the base of the pyramid and **20º** with the face **c**.





Given the first four elements **determine the distance between the top section of the vanilla hollow cylinder and the wall b of the prism**.

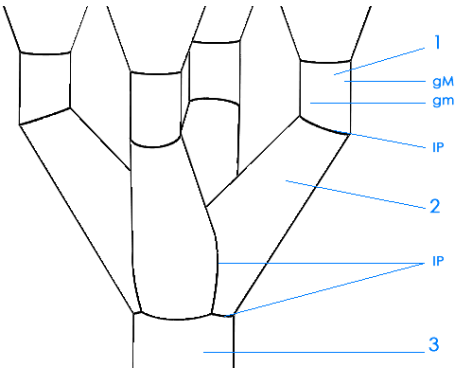
ANSWER: .....

MANIFOLD 1

The next assembly is designed for a small distributor of dried fruits. A 4x1 manifold is designed to concentrate the content of four equal hoppers. The hoppers contain crushed nuts that are mixed through the manifold. The proportion between the different components of the mixture will not be taken into account, for this reason the solution will only have a central dosifier located at the end of the central cylinder that collects the mixture.

Given one of the four hoppers build up the full assembly bearing in mind that the content from each one is distributed regularly and that **the minimum distance between the cylindrical tanks is 50**.

STEP



Legend of the graphic:

- **gM** = Longer generator of lower cylinder of the hoppers.
- **gm** = Shorter generator of the lower cylinder of the hoppers.
- **IP** = Flat Intersection.

The components of the manifold are:

1. CYLINDER OF THE HOPPER. This cylinder must be modified to connect it with component 2 given the conditions above.
2. CONE OF REVOLUTION. It links with flat intersections the bottom cylinder of the hoppers and the bottom cylinder of the manifold.
3. LOWER CYLINDER. Collects the mixture of products and channel them to the dispenser.

Addition constrains are:

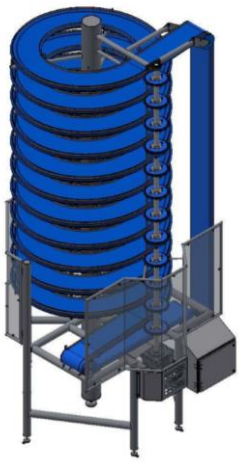
gM = 400; **gm** = 304,08; diameter of **3** is twice that of **1**.

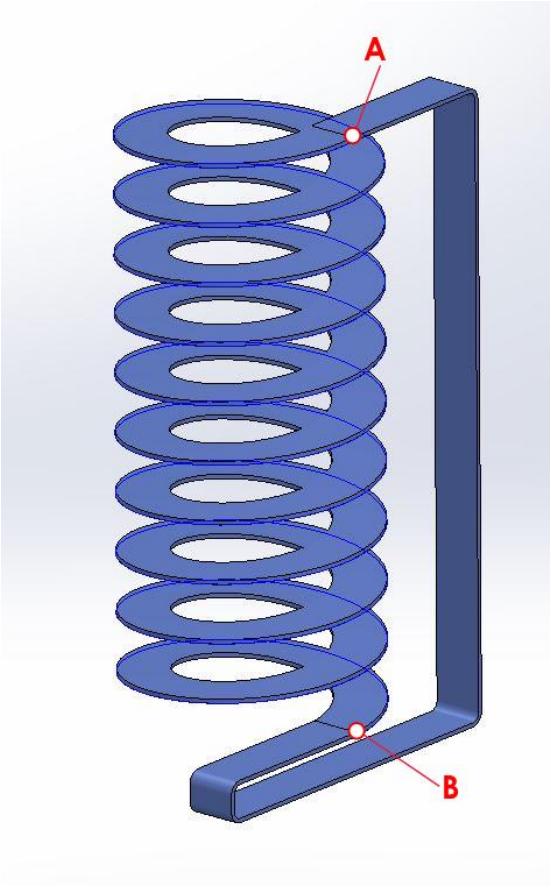
Calculate the minimum slope of the generatrix of the cone.

ANSWER: .....

LATERAL PANEL OF A CONVEYOR BELT 1

A conveyor belt, based on Kevin Vila's project, reaches **3.5 m** height and is designed to move food products.





To avoid products falling from the sides of the belt, it is proposed to place stainless steel protections on the inside and outside of it between points **A** and **B**.
The protections must exceed the upper surface of the tape in **25 mm.**

To improve the aesthetics of the conveyor belt all **the metal pieces are asked to be of the same length and that each one can cover one step of the trajectory**.

Choose the most suitable plate and calculate the proportion of used material expressed in %.

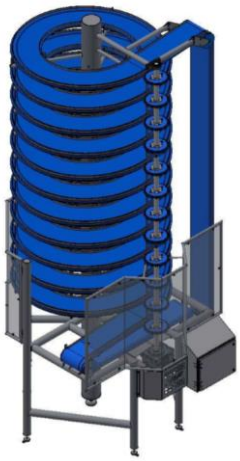
To solve the problem the following is given:

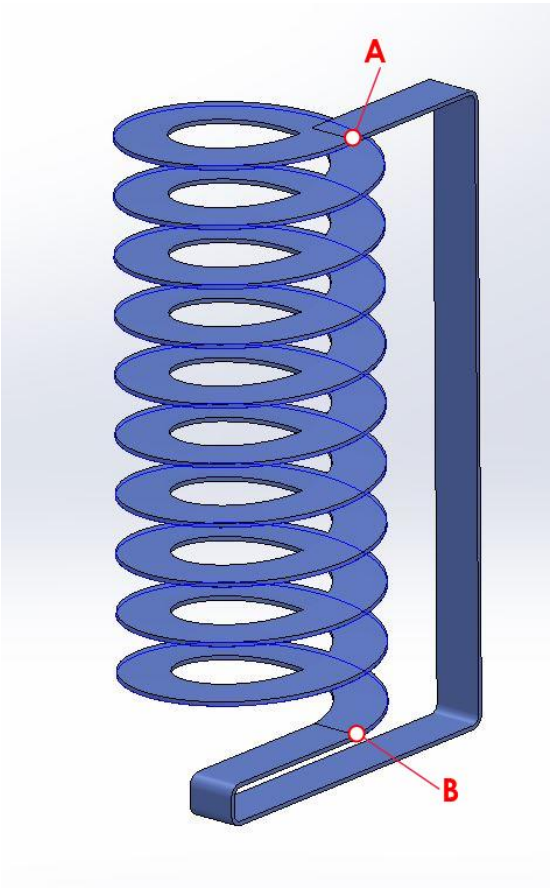
1. 3D model of the belt.
   STEP
2. Steel plates Catalague

ANSWER: .....

LATERAL PANEL OF A CONVEYOR BELT 2

A conveyor belt, based on Kevin Vila's project, reaches **3.5 m** height and is designed to move food products.





To avoid products falling from the sides of the belt, it is proposed to place stainless steel protections on the inside and outside of it between points **A** and **B**.
The protections must exceed the upper surface of the tape in **25 mm.**

To improve the aesthetics of the conveyor, belt all **the metal pieces are asked to be of the same length and that each one can cover one step of the trajectory**.

Choose the plate that best fits the quantity of material needed and define the number of identical installations that can solve maximizing this plate.

To solve the problem, the following is given:

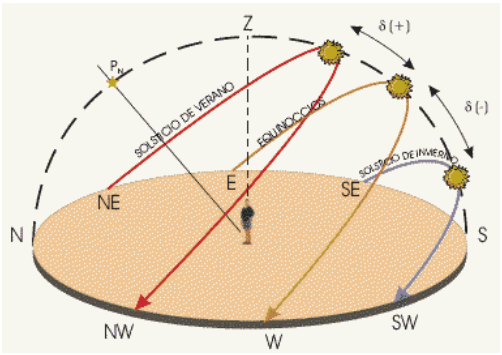
1. 3D model of the belt.
   STEP
2. Steel plates Catalague

ANSWER: .....

SOLAR SHADOWS 1

The sun's trajectory varies throughout the year, reaching its highest elevation in the summer solstice and the lowest in the winter solstice. When installing a solar-driven generation plant of parabolic trough collectors, their installation must be carried out ensuring that there is no shading from a row of collectors on the next one from 8 a.m. to 4 p.m. Consider that 12 a.m. corresponds with the position of highest elevation of the sun during the day.

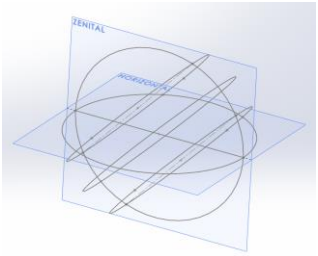
Take into account that the dimensions of any object on the Earth's surface are considered negligible with respect to the Earth-Sun distance. This means that the sun's rays hit these objects parallel to each other, while the incidence direction is defined by the line connecting the centre of both bodies: The Earth and the sun (or what is the same, the line which would link the position of the sun and the observer in this figure).



The following is ordered:

Calculate the elevation angle of the sun at 8 a.m. and 4 p.m. the day of the year when the shadows produced on any obstacle at that moment are the longest (length of the shadow on the ground).

To solve the problem, the solar model is given:



SDW

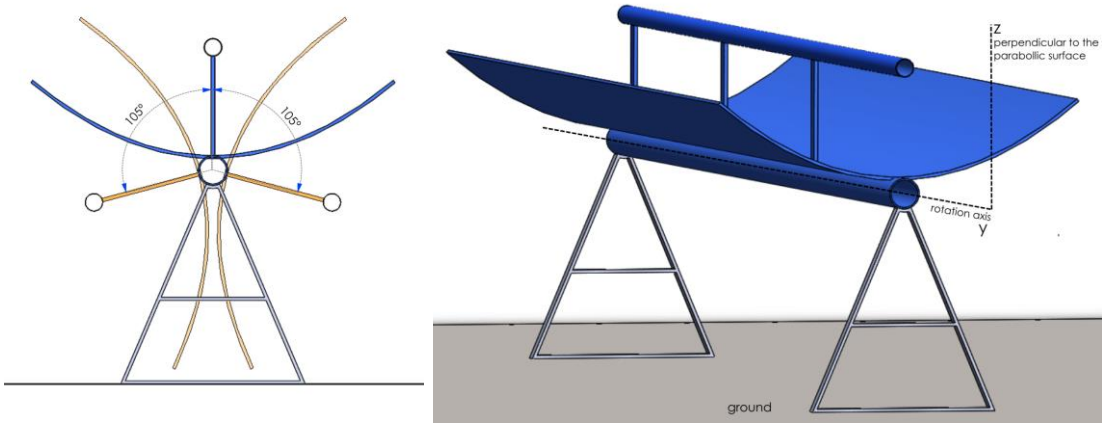
Sun's trajectories above the horizon at the chosen location (Latitude 40 °, Northern Hemisphere).

ANSWER: .....

SOLAR SHADOWS 2

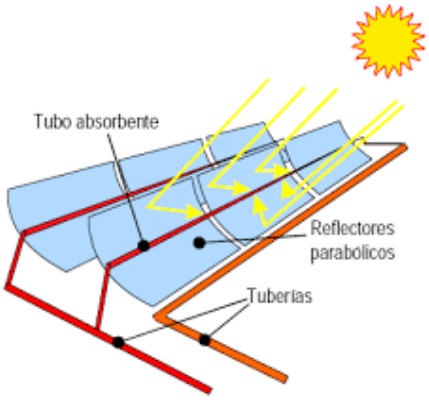
The solar thermo-electric generation plant in Villena is based on parabolic cylinder technology and is one of the largest built in the world in recent years.

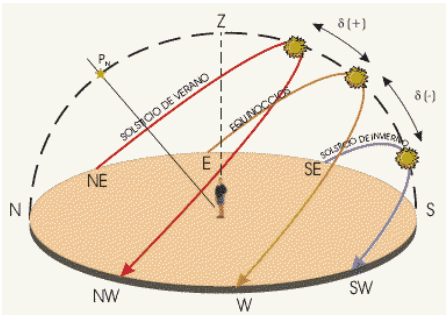
The parabolic cylinders are installed in rows of 20 (connected in series) and summing up a total of 20 rows, connected in parallel. The parabolic cylinders rotate with respect an axis parallel to the ground and which passes through the midpoint of the structure that holds the mirror, as indicated below.



To maximize the amount of energy from the sun that is collected on the cylinders, they must be positioned so that their longitudinal Y axis (its axis of rotation) is oriented North-South. The Y axis is a fixed axis with respect to the ground.

The plane of symmetry of the parabolic cylinders, containing their horizontal and vertical axis, is maintained in a plane parallel to the incident solar irradiation during daylight hours (always that this is possible) and being the maximum angle of rotation $\pm$ 105° from the vertical position.





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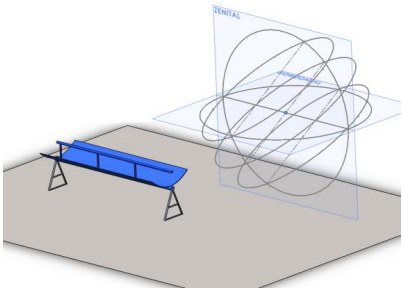
Knowing that the sun's trajectory varies throughout the year, reaching its highest elevation in the summer solstice and the lowest in the winter solstice, the installation of the parabolic trough collectors must be carried out ensuring that there is no shading from a row of collectors on the next one from 8 a.m. to 4 p.m. Consider that 12 a.m. corresponds with the position of highest elevation of the sun during the day.

The following is ordered:

Calculate the minimum distance at which two adjacent rows of collectors must be installed ensuring that there is no shading on the collectors at any time of the year from 8 a.m. to 4 p.m.

To solve the problem, **the SolidWorks Assembly File** of the parabolic cylinder and the absorber tube (through which the heat transfer fluid will circulate) with the sun's trajectories above the horizon at the chosen location (Latitude 40 °, Northern Hemisphere) is given:



SDW

ANSWER: .....

PRACTICES

ASSEMBLIES AND PLANS

VINTAGE STOOL
STATEMENT 1

DESCRIPTION

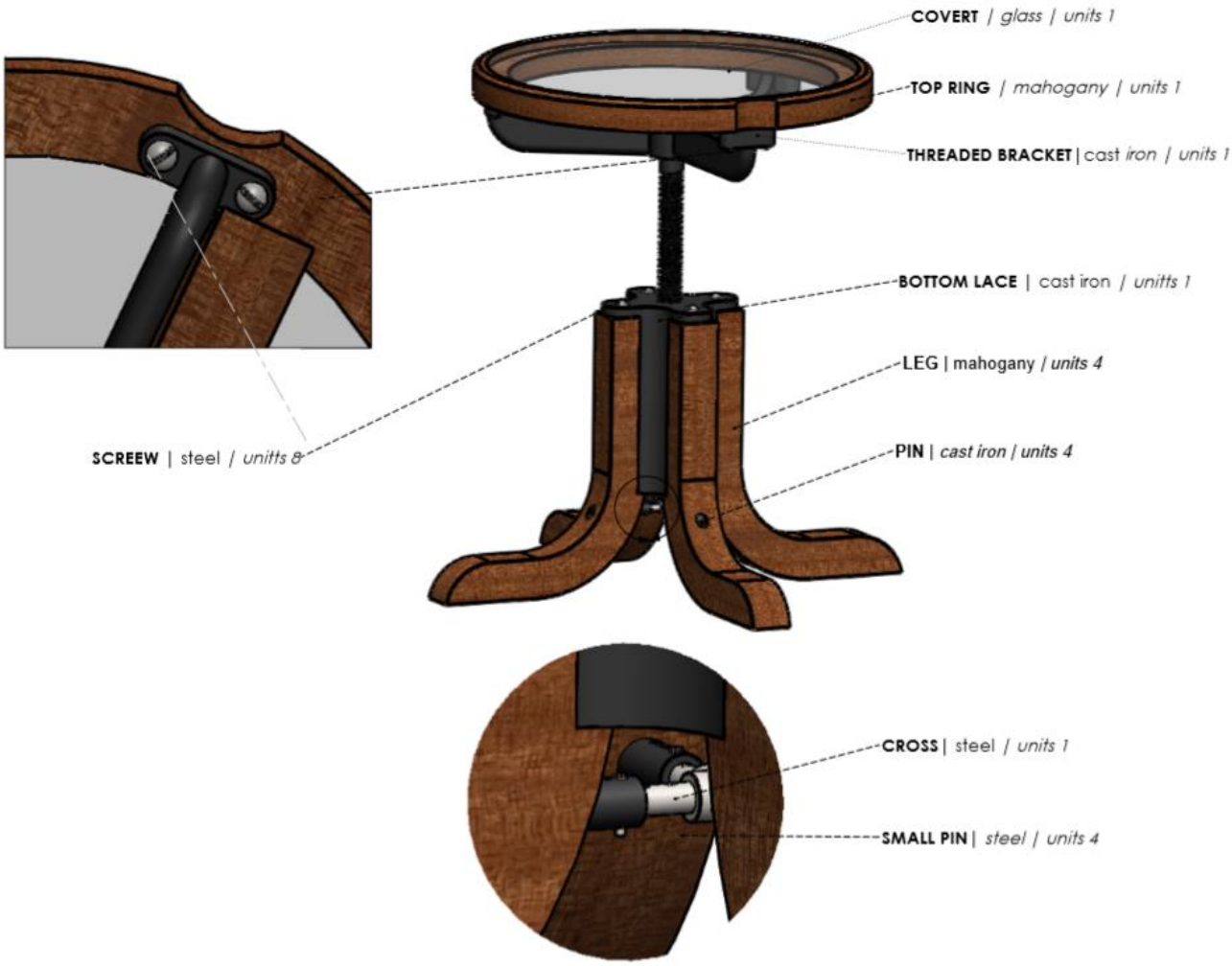
It is a work stool produced in the mid-twentieth century. The work stool consists of a cylindrical wooden platform at its top (which was originally to be completed with a leather and wood cushion), a casting iron structure that allows the regulation of the height, four legs made of wood, eight screws that link the pieces and a set of pins and a brass grate that prevents the legs from opening with the weight.

The original design has been modified as follows:

1. The seat has been converted to an auxiliary table. The cushion has been replaced by a cylindrical glass.
2. The grate has been replaced by a cross that links the four pins of the legs.
3. The shape of the threaded support arms has been simplified.
4. The rubber pins attached to the base of the legs have been removed.
5. They have replaced conic head screws with spherical head screws.

Except for the modified elements, the closest approach to the original materials and geometrys has been kept.

COMPONENTS


COVERT / glass / units 1
TOP RING / mahogany / units 1
THREADED BRACKET | cast iron / units 1
BOTTOM LACE | cast iron / unitts 1
LEG | mahogany / units 4
PIN | cast iron / units 4
SCREEW | steel / unitts 8
CROSS | steel / units 1
SMALL PIN | steel / units 4

STATEMENT 1.1

Given the bottom part or **B** of the **stool build in 3D the top part o A** following the metric data provided on the next page.

PART A OR TOP OF THE STOOL

STATEMENT 1.2

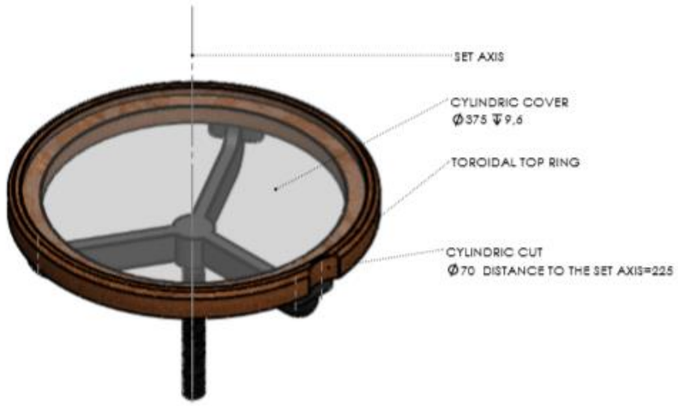
Given the bottom part or **B** of the stool **define this part in workshop plans according to the UNE, ISO or DIN regulations**.

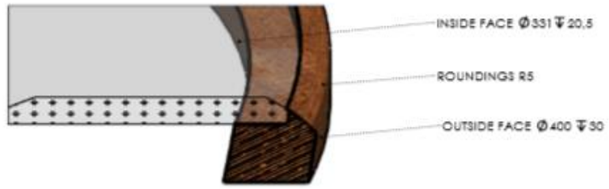
The solid model is provided in a restricted-access format. In order to obtain the necessary measurements to draw up the plans it is necessary to use measuring tools.

STEP

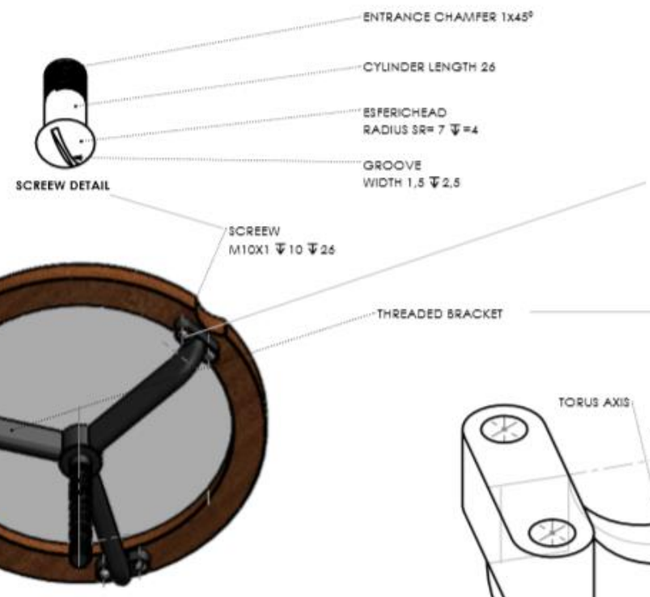
PART B OR BOTTOM OF THE STOOL

METRIC DATA OF THE PART A

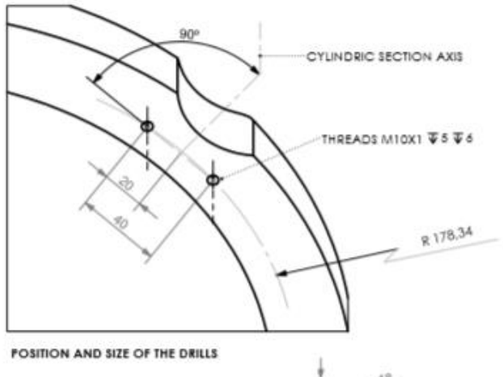




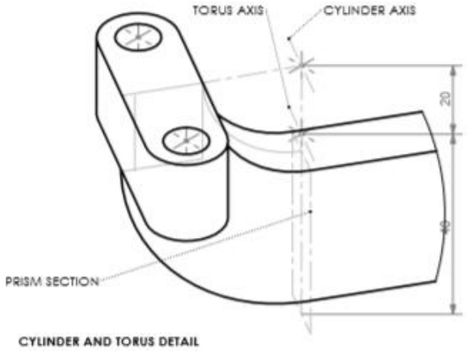
FIT BETWEEN THE LACE AND THE RING DETAIL,
METRIC DATA OF THE RING



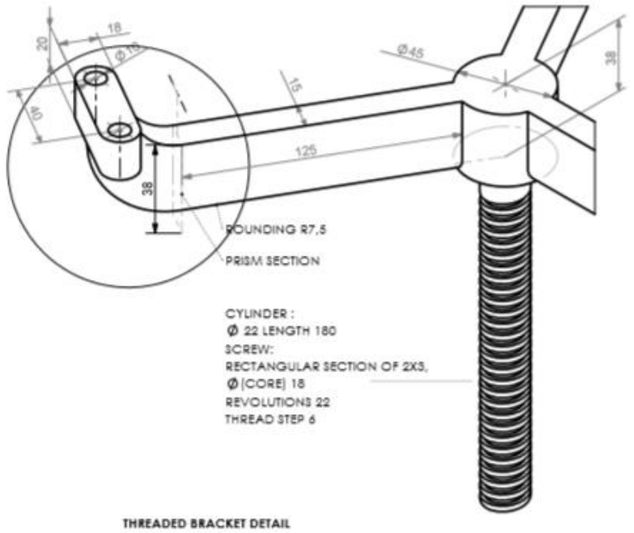
SCREEW DETAIL



POSITION AND SIZE OF THE DRILLS



CYLINDER AND TORUS DETAIL



THREADED BRACKET DETAIL

VINTAGE STOOL
STATEMENT 2

DESCRIPTION

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The original design has been modified as follows:

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TOP RING / mahogany / units 1
THREADED BRACKET | cast iron / units 1
BOTTOM LACE | cast iron / unitts 1
LEG | mahogany / units 4
PIN | cast iron / units 4
SCREEW | steel / unitts 8
CROSS | steel / units 1
SMALL PIN | steel / units 4

STATEMENT 2.1

Given the top or the stool o **A build in 3D the bottom or B** following the metric data provided on the next page.

PART B OR BOTTOM OF THE STOOL

STATEMENT 2.2

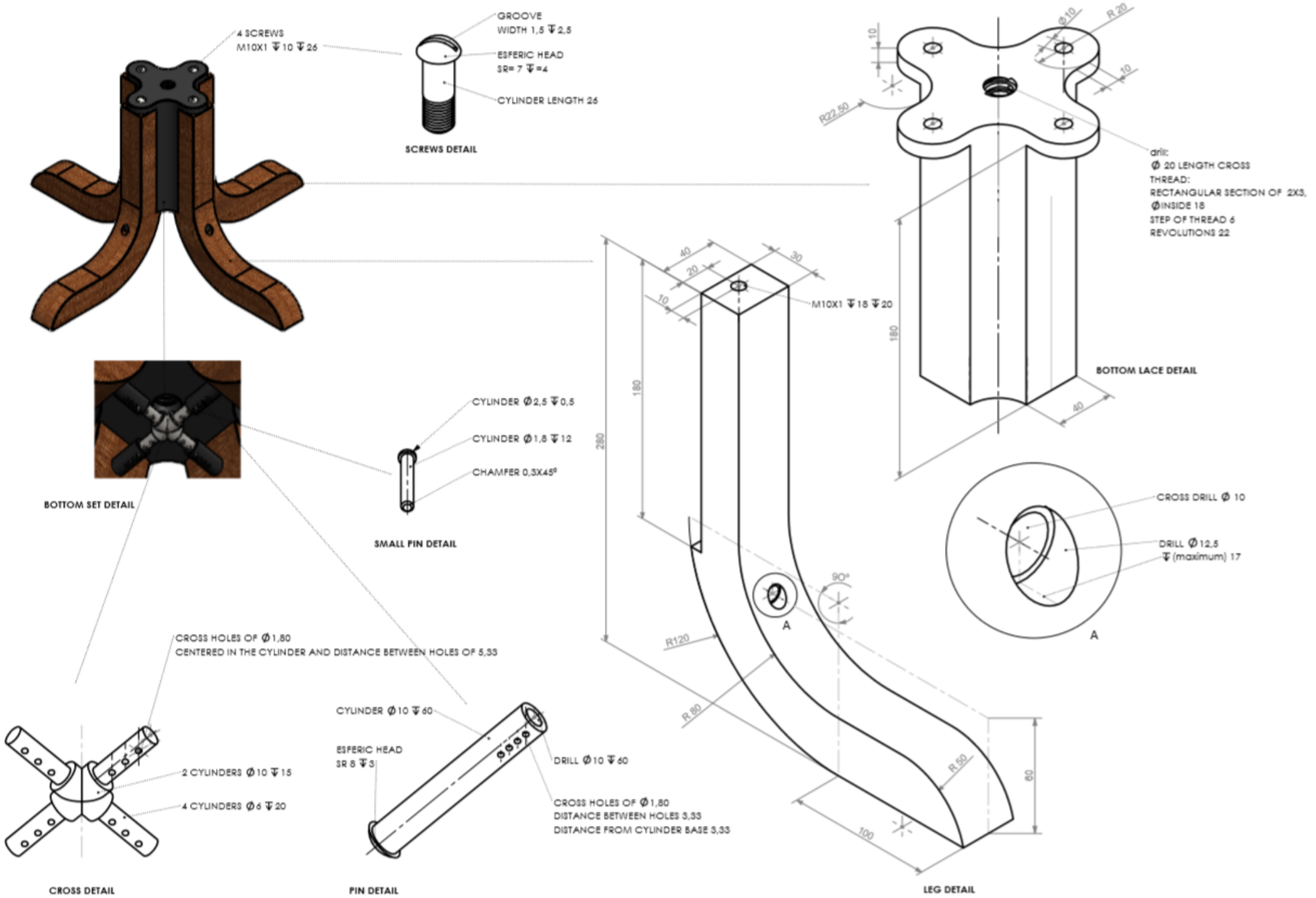
Given the Top part or **A** of the stool **define this part in workshop plans according to the UNE, ISO or DIN regulations**.

The solid model is provided in a restricted-access format. In order to obtain the necessary measurements to draw up the plans it is necessary to use measuring tools.

PART A OR TOP OF THE STOOL

STEP

METRIC DATA OF THE PART B



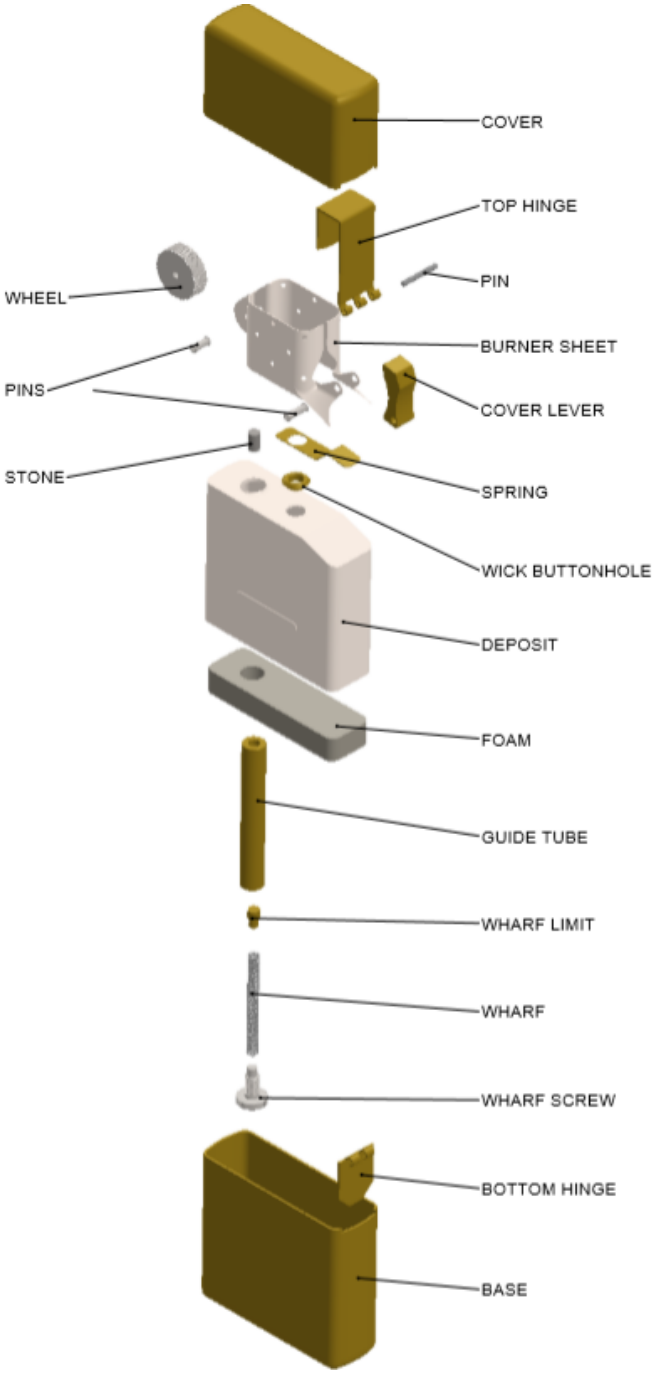
ZIPPO

STATEMENT 1

DESCRIPTION

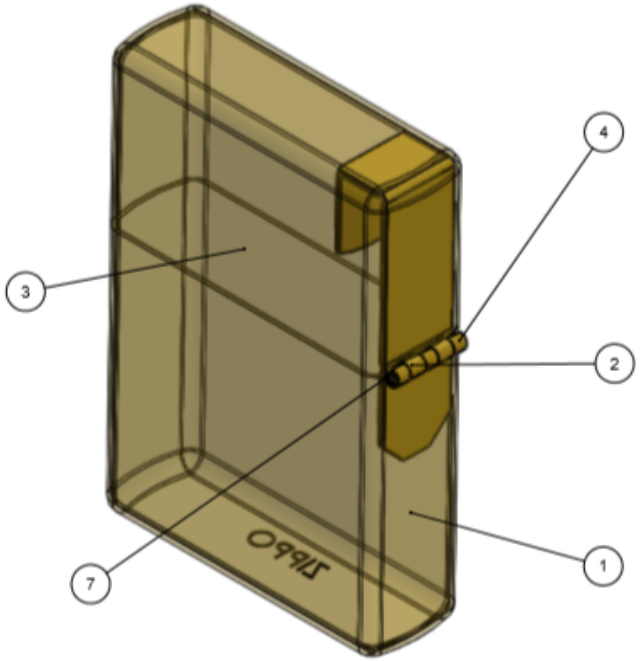
The Zippo is a lighter powered by gasoline and/or kerosene designed by George G. Braisdell and produced by Zippo Manufacturing Company (located in Bradford, Pennsylvania) since 1932. The lighter reproduction is made up of 19 parts. This reproduction does not exactly reproduce some of the components. The variations that have been incorporated are intended to simplify the process of defining some of the parts. This is the case of the metal sheet burner and the tank, which in reality are made up from a folded metal sheet and a top lid.

The 19 parts of this version of a Zippo are the following:



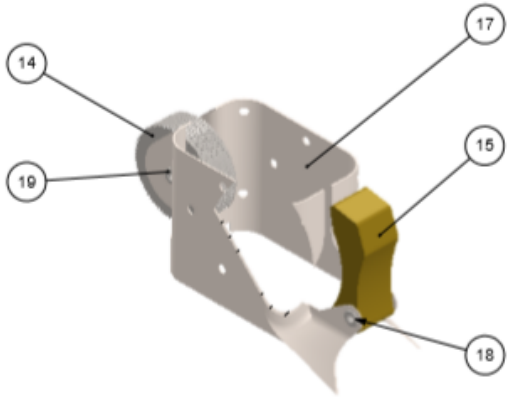
COMPONENTS

COVER



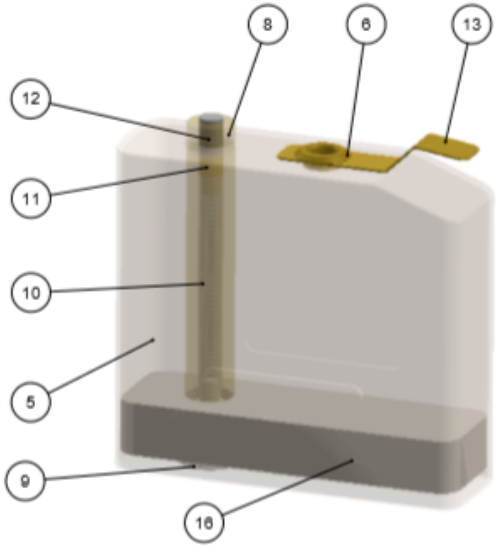
PEÇA	N.º	MATERIAL	DETALL	Q
BASE	1	BRASS		1
BASE HINGE	2	BRASS		1
COVER	3	BRASS		1
TOP HINGE	4	BRASS		1
PIN	7	BRASS		1

BURNER SET



PEÇA	N.º	MATERIAL	DETALL	Q
WHEEL	14	IRON		1
COVER LEVER	15	BRASS		1
BURNER SHEET	17	BRASS		1
PIN	18	BRASS		1
PIN	19	BRASS		1

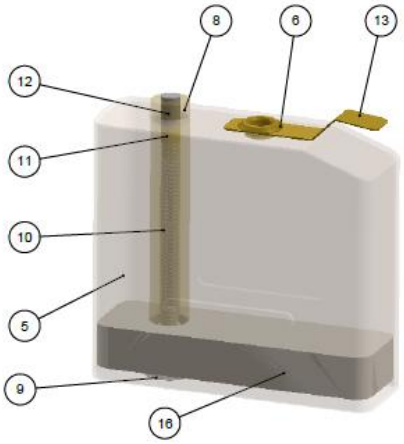
DEPOSIT SET



PEÇA	N.º	MATERIAL	DETALL	Q
DEPOSIT	5	BRASS		1
WICK BUTTONHOLE	6	BRASS		1
GUIDE TUBE	8	BRASS		1
SCREW	9	STEEL		1
WHARF	10	STEEL		1
WHARF LIMIT	11	BRASS		1
SPRING	13	BRASS		1
FOAM	16	COTTON		1
STONE	12	SILICON		1

STATEMENT 1.1

Given the cover of the Zippo or **part A build in 3D the module of the deposit or part B** following the metric data provided in the next page.

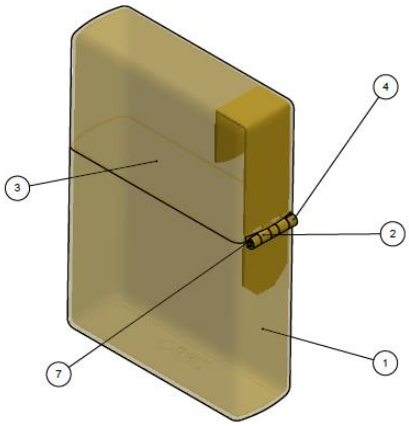


Part B or deposit of the Zippo

STATEMENT 1.2

Given the cover of the Zippo or **part A define this part in workshop plans according to UNE, ISO or DIN regulations.**

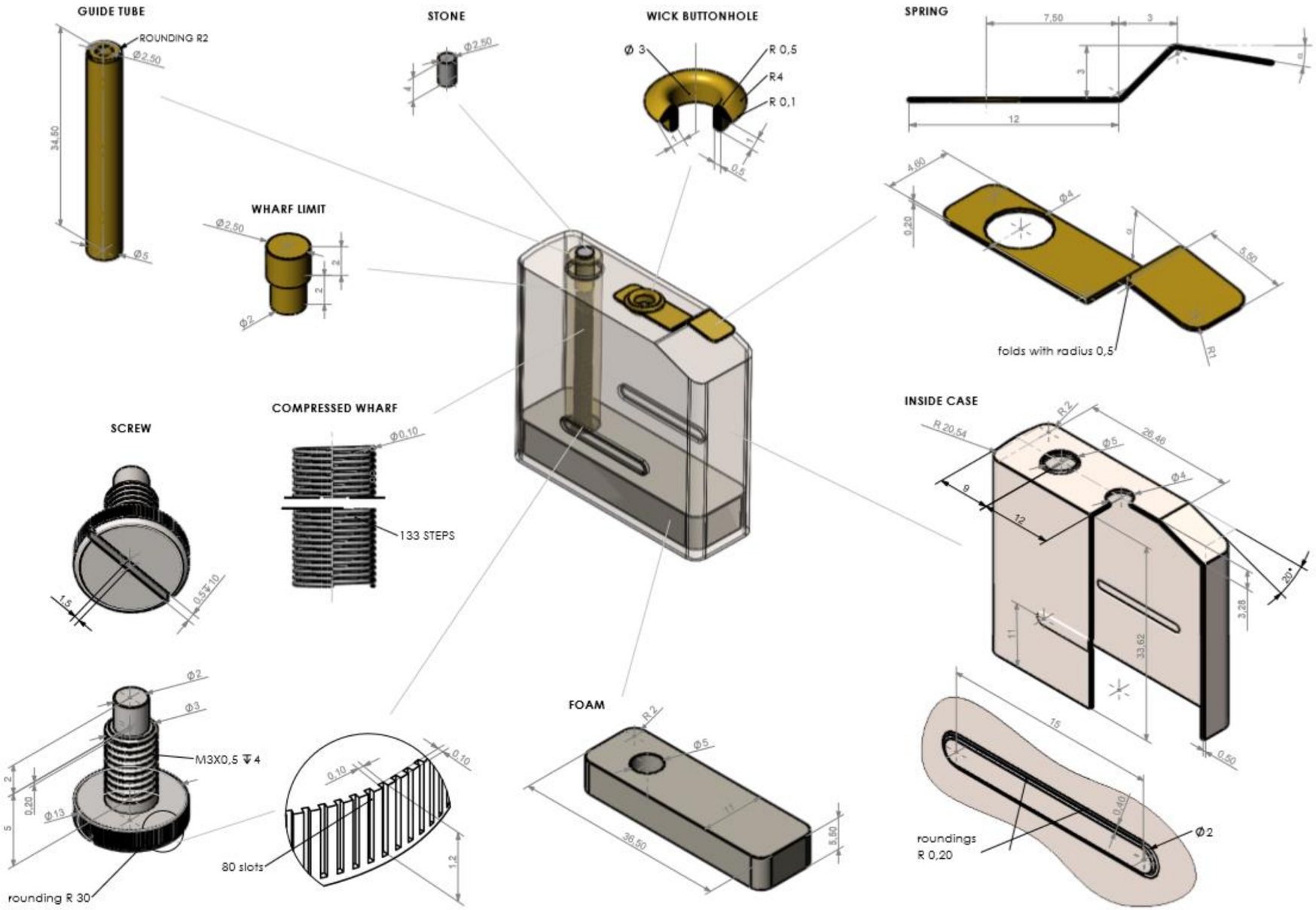
The solid model is provided in a restricted-access format. In order to obtain the necessary measurements to draw up the plans it is necessary to use measuring tools.



Part A or cover of the Zippo

STEP

METRIC DATA OF THE PART B OR DEPOSIT



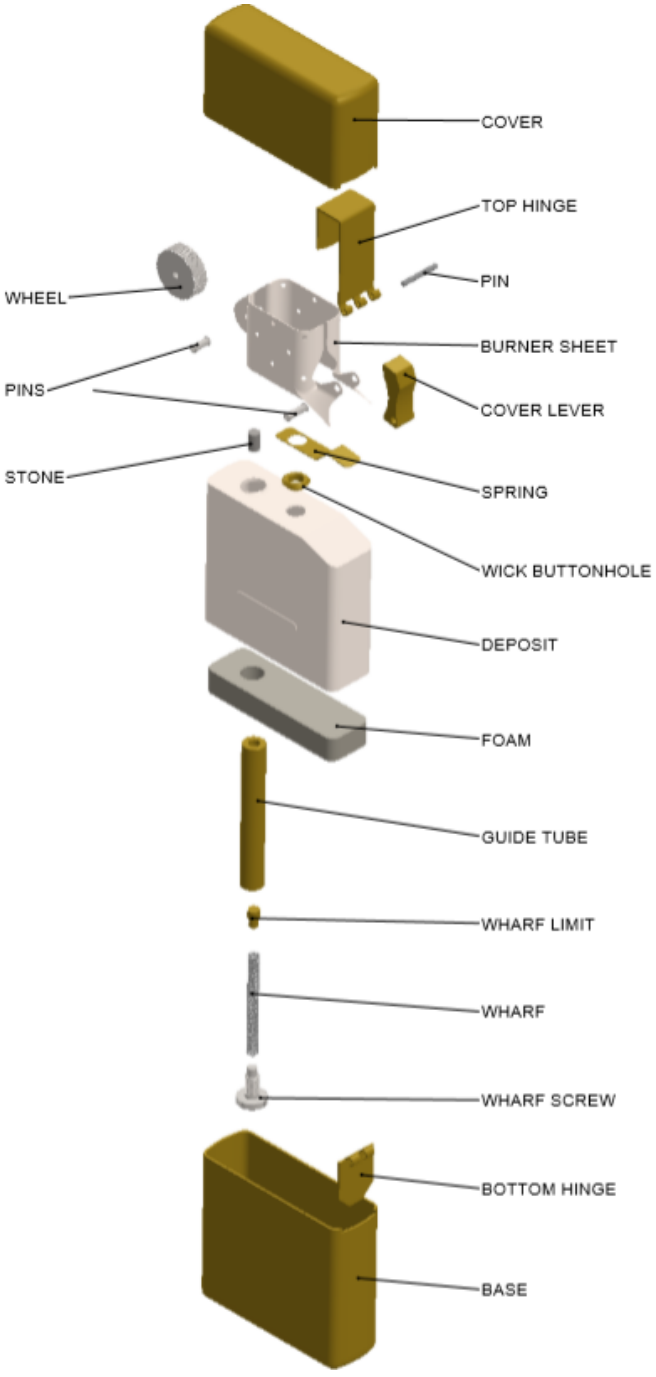
ZIPPO

STATEMENT 2

DESCRIPTION

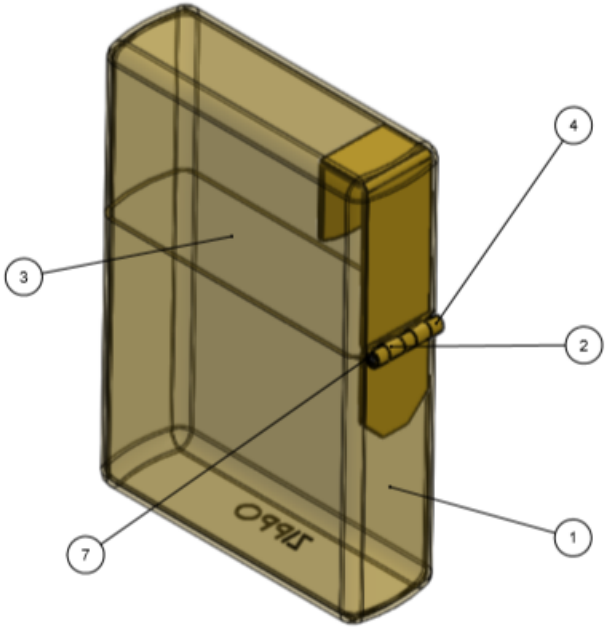
The Zippo is a lighter powered by gasoline and/or kerosene designed by George G. Braisdell and produced by Zippo Manufacturing Company (located in Bradford, Pennsylvania) since 1932. The lighter reproduction is made up of 19 parts. This reproduction does not exactly reproduce some of the components. The variations that have been incorporated are intended to simplify the process of defining some of the parts. This is the case of the metal sheet burner and the tank, which in reality are made up from a folded metal sheet and a top lid.

The 19 parts of this version of a Zippo are the following:



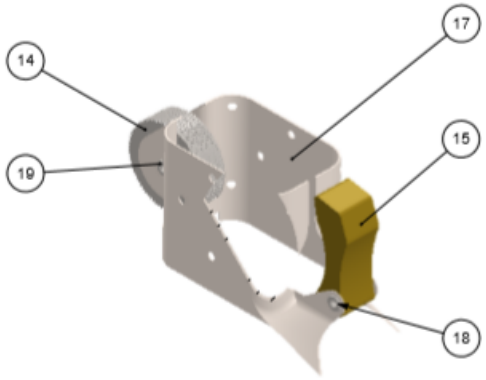
COMPONENTS

COVER



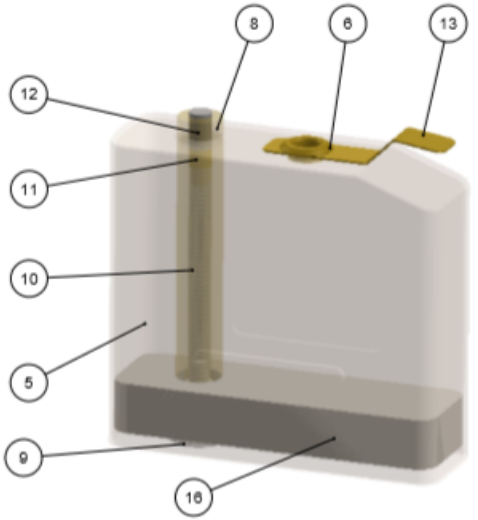
PEÇA	N.º	MATERIAL	DETALL	Q
BASE	1	BRASS		1
BASE HINGE	2	BRASS		1
COVER	3	BRASS		1
TOP HINGE	4	BRASS		1
PIN	7	BRASS		1

BURNER SET



PEÇA	N.º	MATERIAL	DETALL	Q
WHEEL	14	IRON		1
COVER LEVER	15	BRASS		1
BURNER SHEET	17	BRASS		1
PIN	18	BRASS		1
PIN	19	BRASS		1

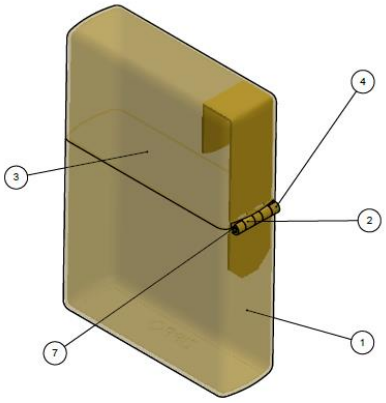
DEPOSIT SET



PEÇA	N.º	MATERIAL	DETALL	Q
DEPOSIT	5	BRASS		1
WICK BUTTONHOLE	6	BRASS		1
GUIDE TUBE	8	BRASS		1
SCREW	9	STEEL		1
WHARF	10	STEEL		1
WHARF LIMIT	11	BRASS		1
SPRING	13	BRASS		1
FOAM	16	COTTON		1
STONE	12	SILICON		1

STATEMENT 2.1

Given the deposit of Zippo or **part A build in 3D the module of the cover or part B** following the metric data provided in the following pages.

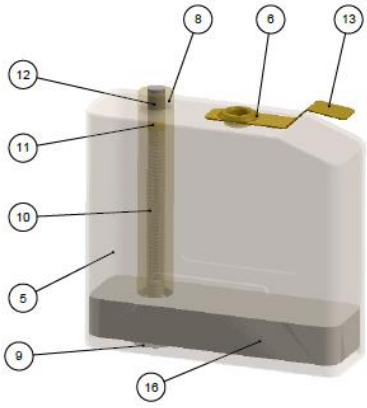


Part B or cover

STATEMENT 2.2

Given the deposit of Zippo or part A **define this part in workshop plans according to UNE, ISO or DIN regulations**.

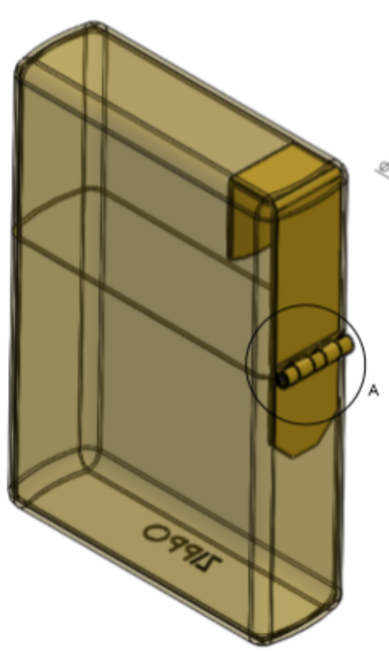
The solid model is provided in a restricted-access format. In order to obtain the necessary measurements to draw up the plans it is necessary to use measuring tools.

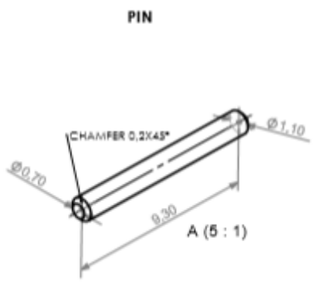


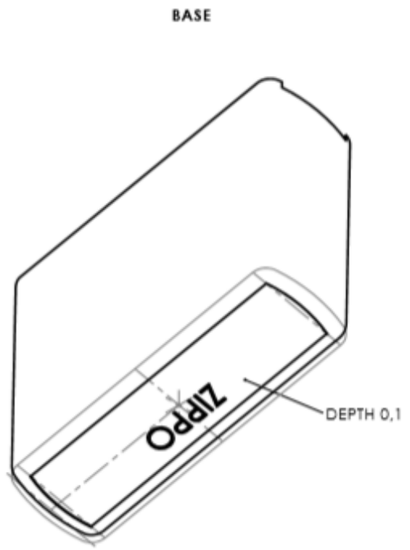
Part A or deposit

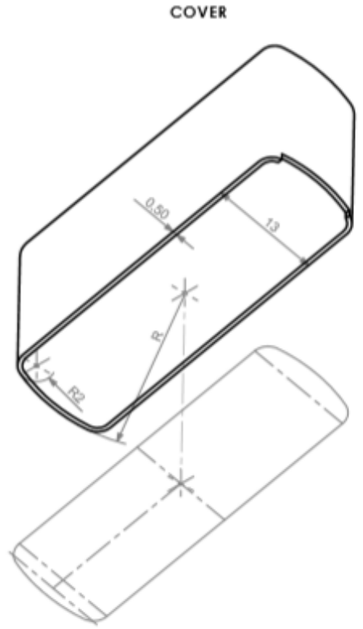
STEP

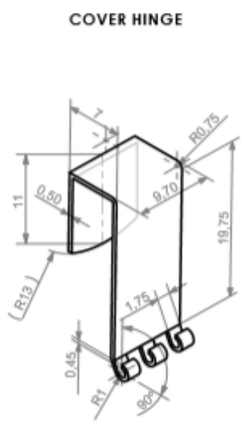
METRIC DATA OF THE PART B OR COVER

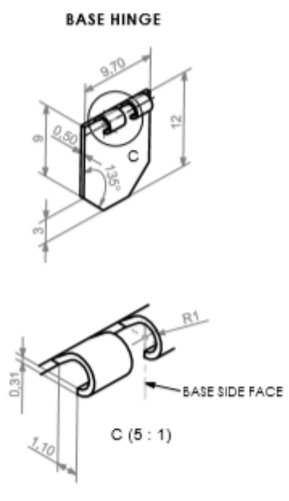


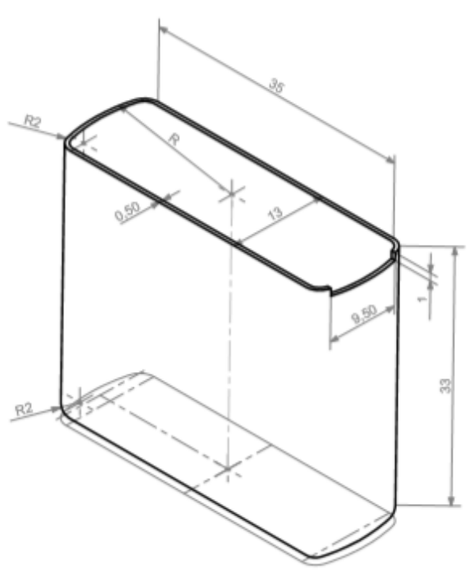


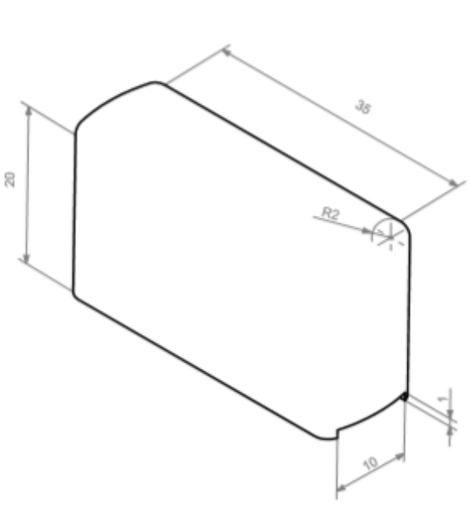












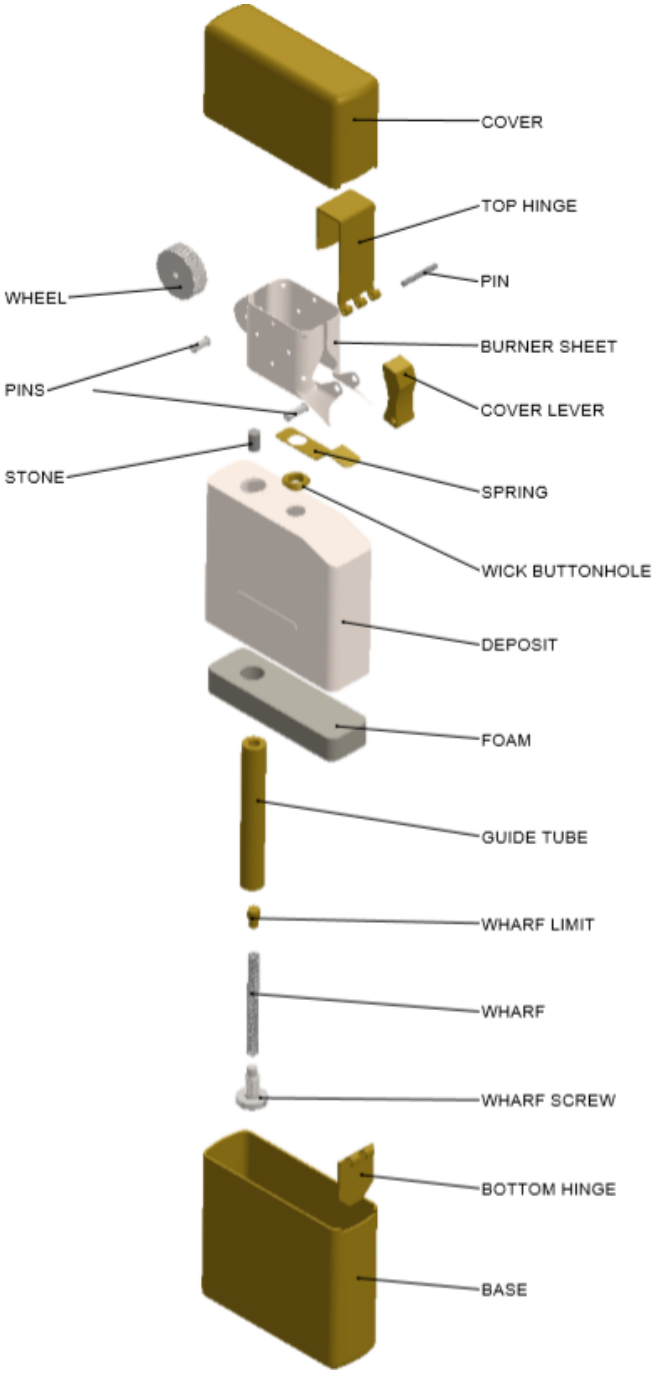
ZIPPO

STATEMENT 3

DESCRIPTION

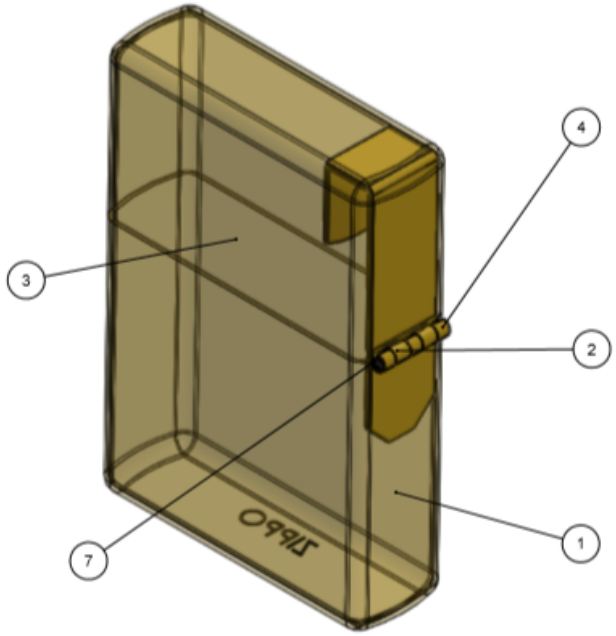
The Zippo is a lighter powered by gasoline and/or kerosene designed by George G. Braisdell and produced by Zippo Manufacturing Company (located in Bradford, Pennsylvania) since 1932. The lighter reproduction is made up of 19 parts. This reproduction does not exactly reproduce some of the components. The variations that have been incorporated are intended to simplify the process of defining some of the parts. This is the case of the metal sheet burner and the tank, which in reality are made up from a folded metal sheet and a top lid.

The 19 parts of this version of a Zippo are the following:



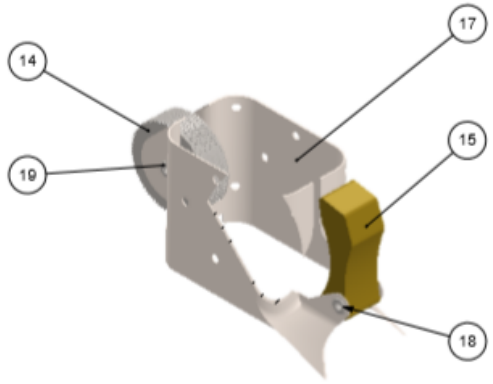
COMPONENTS

COVER



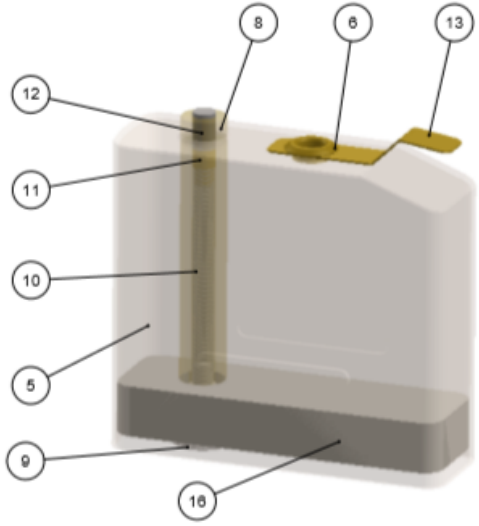
PEÇA	N.º	MATERIAL	DETALL	Q
BASE	1	BRASS		1
BASE HINGE	2	BRASS		1
COVER	3	BRASS		1
TOP HINGE	4	BRASS		1
PIN	7	BRASS		1

BURNER SET



PEÇA	N.º	MATERIAL	DETALL	Q
WHEEL	14	IRON		1
COVER LEVER	15	BRASS		1
BURNER SHEET	17	BRASS		1
PIN	18	BRASS		1
PIN	19	BRASS		1

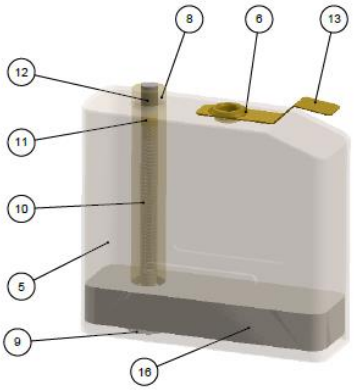
DEPOSIT SET



PEÇA	N.º	MATERIAL	DETALL	Q
DEPOSIT	5	BRASS		1
WICK BUTTONHOLE	6	BRASS		1
GUIDE TUBE	8	BRASS		1
SCREW	9	STEEL		1
WHARF	10	STEEL		1
WHARF LIMIT	11	BRASS		1
SPRING	13	BRASS		1
FOAM	16	COTTON		1
STONE	12	SILICON		1

STATEMENT 3.1

Given the Zippo burner or part **A build in 3D the module of the deposit or part B** following the metric data provided in the following pages.

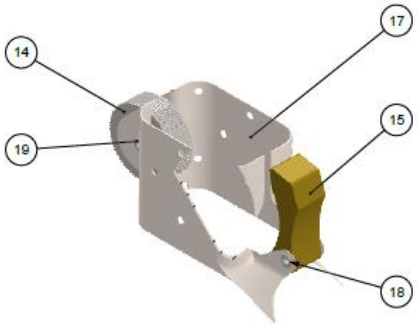


Part B or deposit

STATEMENT 3.2

Given the burner of Zippo or part A **define this part in workshop plans according to UNE, ISO or DIN regulations.**

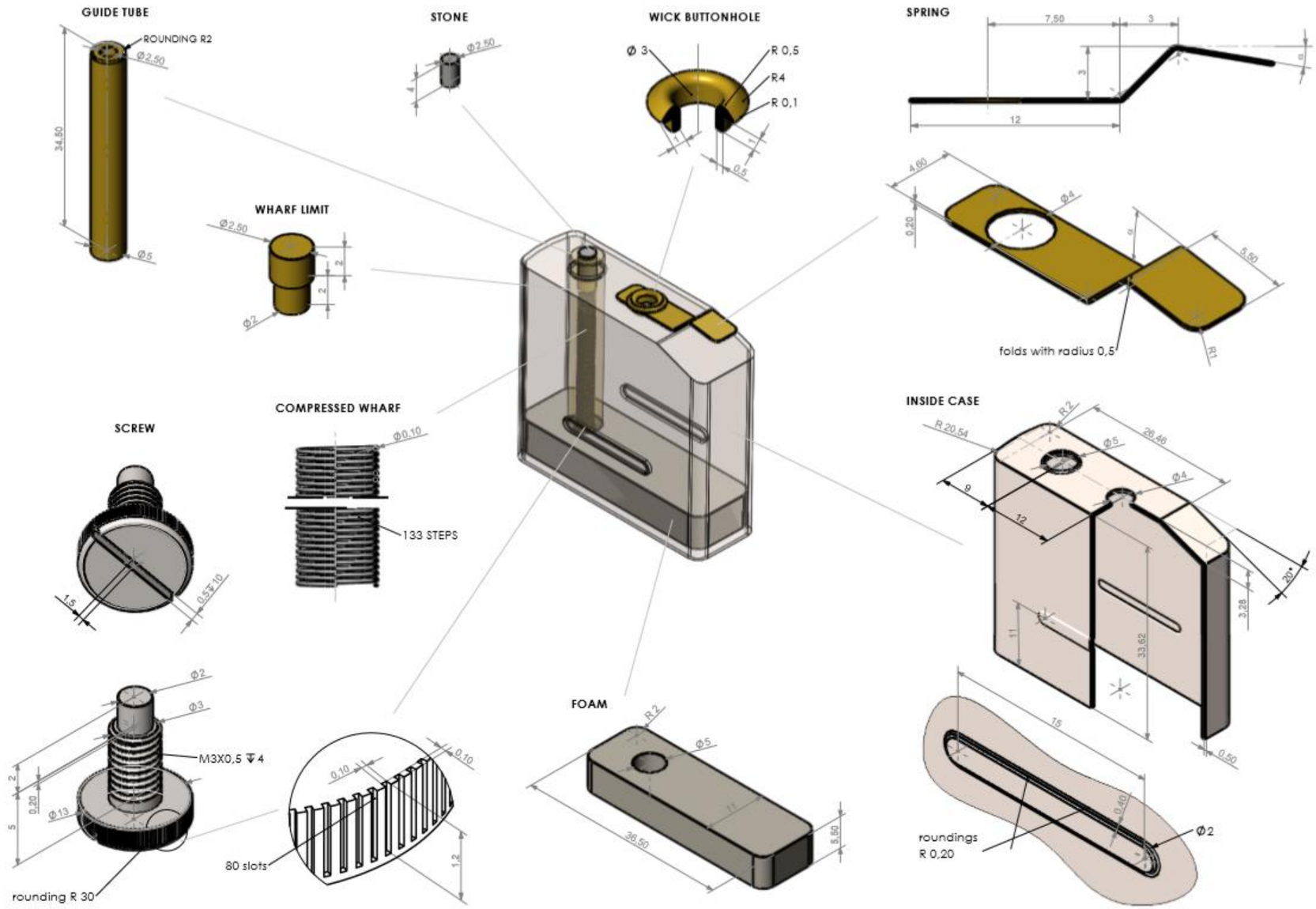
The solid model is provided in a restricted-access format. In order to obtain the necessary measurements to draw up the plans it is necessary to use measuring tools.



Part A or burner

STEP

METRIC DATA OF THE PART B OR DEPOSIT



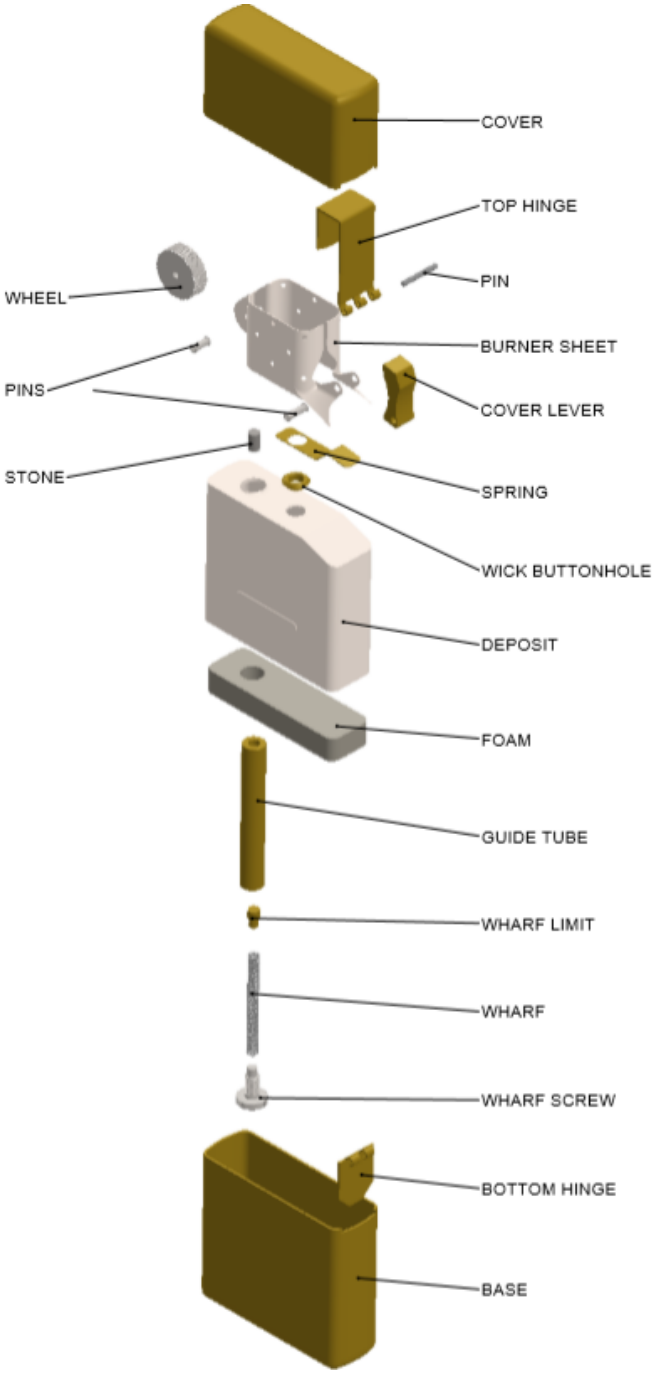
ZIPPO

statment 4

DESCRIPTION

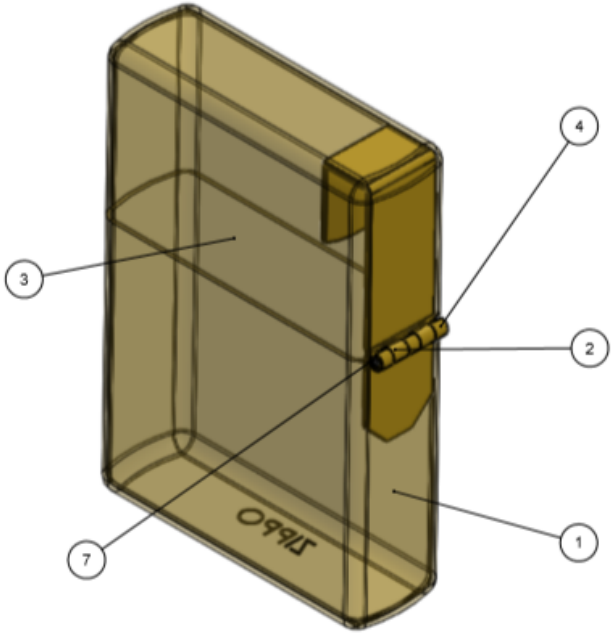
The Zippo is a lighter powered by gasoline and/or kerosene designed by George G. Braisdell and produced by Zippo Manufacturing Company (located in Bradford, Pennsylvania) since 1932. The lighter reproduction is made up of 19 parts. This reproduction does not exactly reproduce some of the components. The variations that have been incorporated are intended to simplify the process of defining some of the parts. This is the case of the metal sheet burner and the tank, which in reality are made up from a folded metal sheet and a top lid.

The 19 parts of this version of a Zippo are the following:



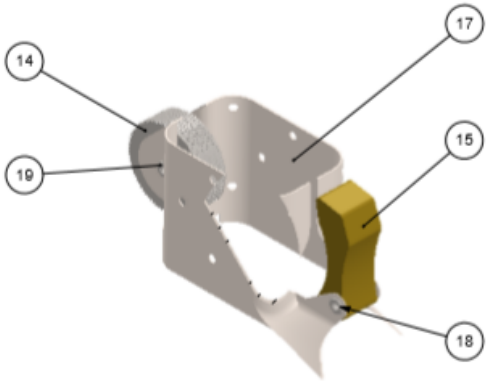
COMPONENTS

COVER



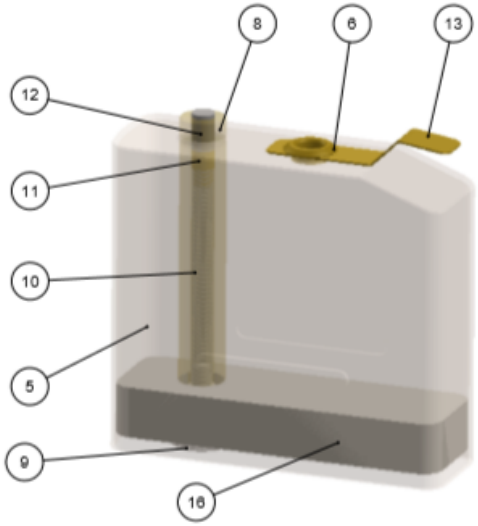
PEÇA	N.º	MATERIAL	DETALL	Q
BASE	1	BRASS		1
BASE HINGE	2	BRASS		1
COVER	3	BRASS		1
TOP HINGE	4	BRASS		1
PIN	7	BRASS		1

BURNER SET



PEÇA	N.º	MATERIAL	DETALL	Q
WHEEL	14	IRON		1
COVER LEVER	15	BRASS		1
BURNER SHEET	17	BRASS		1
PIN	18	BRASS		1
PIN	19	BRASS		1

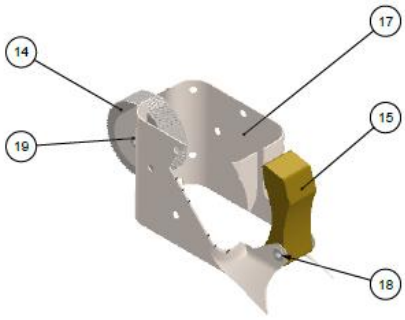
DEPOSIT SET



PEÇA	N.º	MATERIAL	DETALL	Q
DEPOSIT	5	BRASS		1
WICK BUTTONHOLE	6	BRASS		1
GUIDE TUBE	8	BRASS		1
SCREW	9	STEEL		1
WHARF	10	STEEL		1
WHARF LIMIT	11	BRASS		1
SPRING	13	BRASS		1
FOAM	16	COTTON		1
STONE	12	SILICON		1

STATEMENT 4.1

Given the deposit of Zippo or part A **build in 3D the module of the burner or part B** following the metric data provided in the following pages.

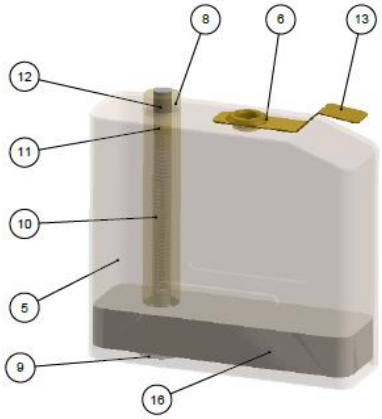


Part B or burner

STATEMENT 4.2

Given the deposit of Zippo or part A **define this part in workshop plans according to UNE, ISO or DIN regulations.**

The solid model is provided in a restricted-access format. In order to obtain the necessary measurements to draw up the plans it is necessary to use measuring tools.



Part A o deposit

STEP

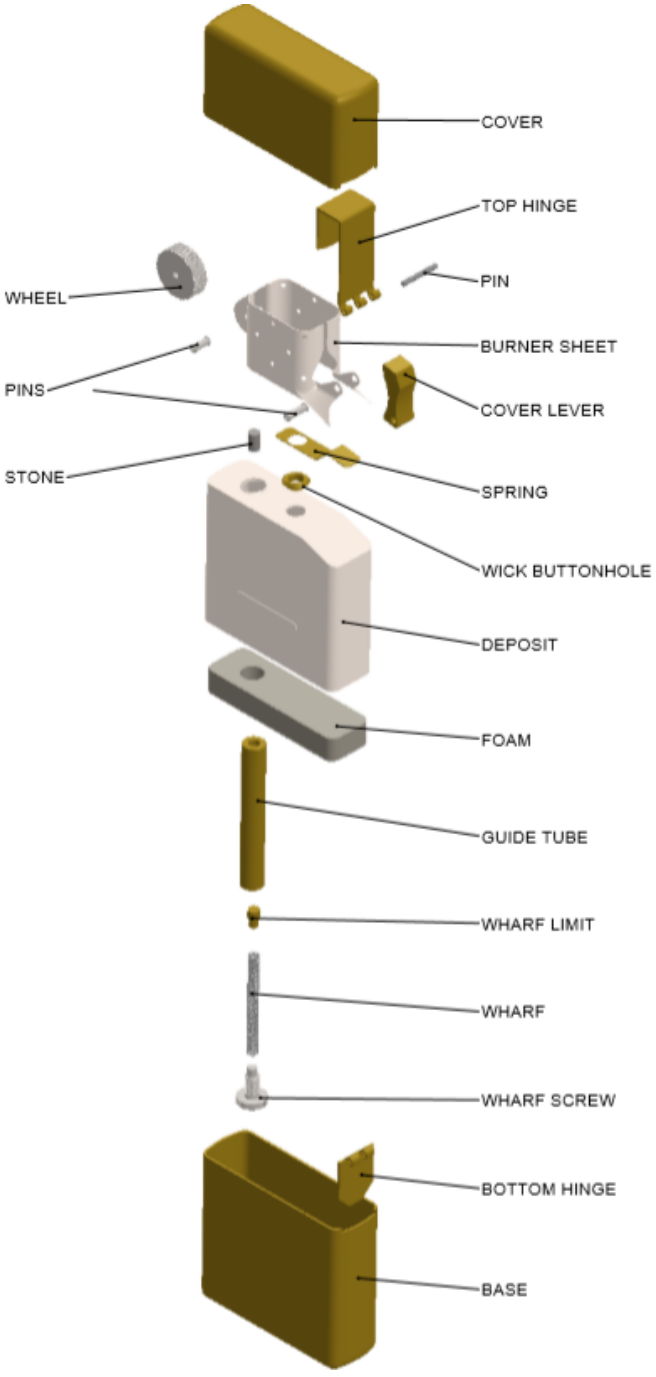
ZIPPO

STATEMENT 5

DESCRIPTION

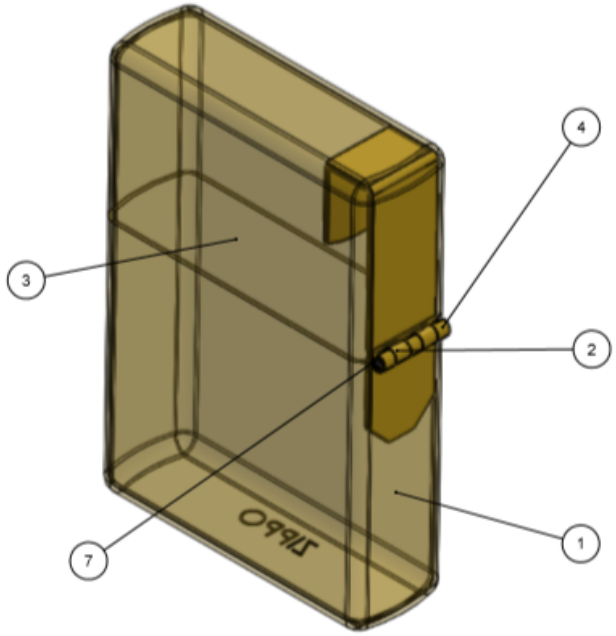
The Zippo is a lighter powered by gasoline and/or kerosene designed by George G. Braisdell and produced by Zippo Manufacturing Company (located in Bradford, Pennsylvania) since 1932. The lighter reproduction is made up of 19 parts. This reproduction does not exactly reproduce some of the components. The variations that have been incorporated are intended to simplify the process of defining some of the parts. This is the case of the metal sheet burner and the tank, which in reality are made up from a folded metal sheet and a top lid.

The 19 parts of this version of a Zippo are the following:



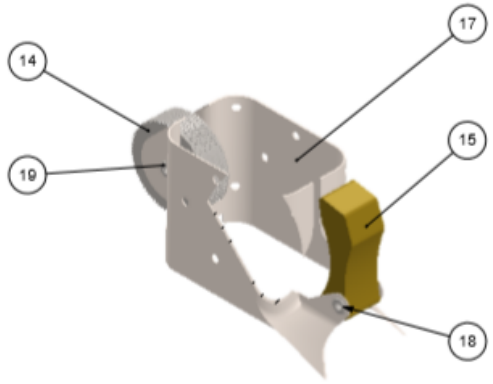
COMPONENTS

COVER



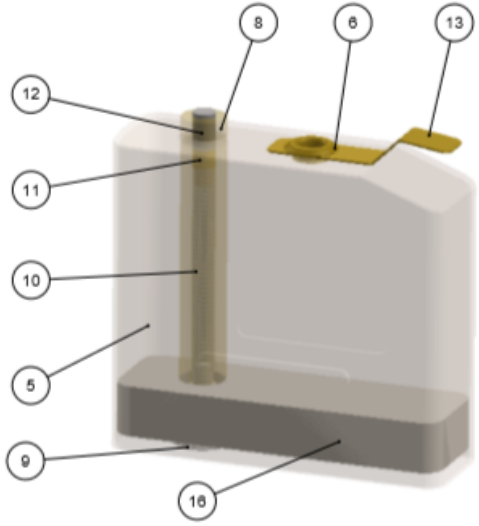
PEÇA	N.º	MATERIAL	DETALL	Q
BASE	1	BRASS		1
BASE HINGE	2	BRASS		1
COVER	3	BRASS		1
TOP HINGE	4	BRASS		1
PIN	7	BRASS		1

BURNER SET



PEÇA	N.º	MATERIAL	DETALL	Q
WHEEL	14	IRON		1
COVER LEVER	15	BRASS		1
BURNER SHEET	17	BRASS		1
PIN	18	BRASS		1
PIN	19	BRASS		1

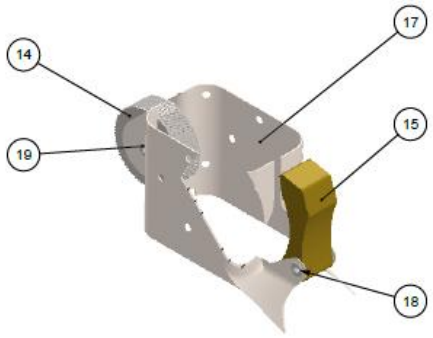
DEPOSIT SET



PEÇA	N.º	MATERIAL	DETALL	Q
DEPOSIT	5	BRASS		1
WICK BUTTONHOLE	6	BRASS		1
GUIDE TUBE	8	BRASS		1
SCREW	9	STEEL		1
WHARF	10	STEEL		1
WHARF LIMIT	11	BRASS		1
SPRING	13	BRASS		1
FOAM	16	COTTON		1
STONE	12	SILICON		1

STATEMENT 5.1

Given the cover of the Zippo or part A **build in 3D the module of the burner or part B** following the metric data provided in the following pages.

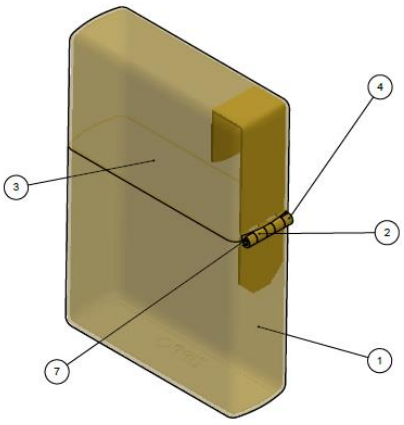


Part B or burner

STATEMENT 5.2

Given the cover of the Zippo or part A **define this part in workshop plans according to UNE, ISO or DIN regulations.**

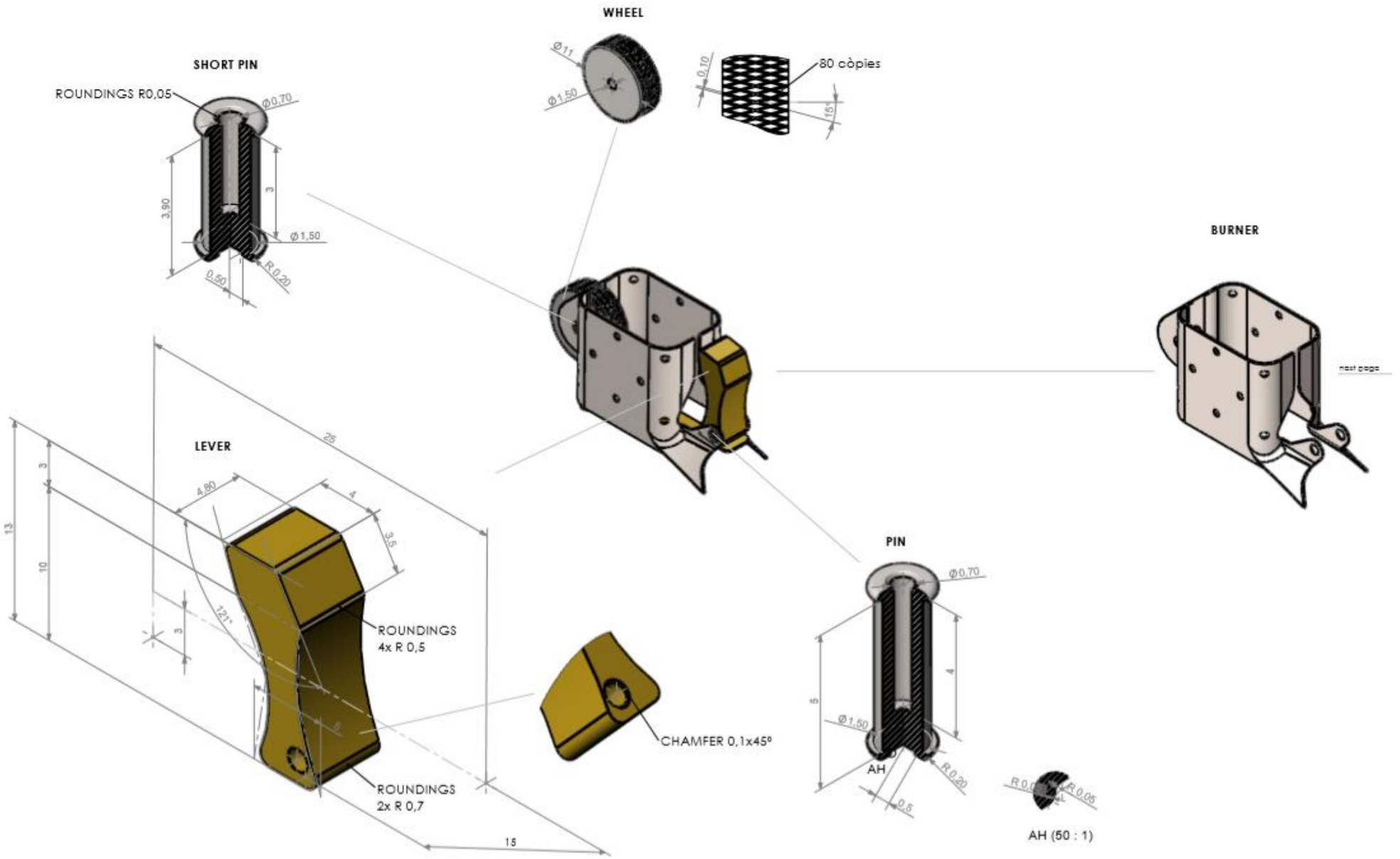
The solid model is provided in a restricted-access format. In order to obtain the necessary measurements to draw up the plans it is necessary to use measuring tools.

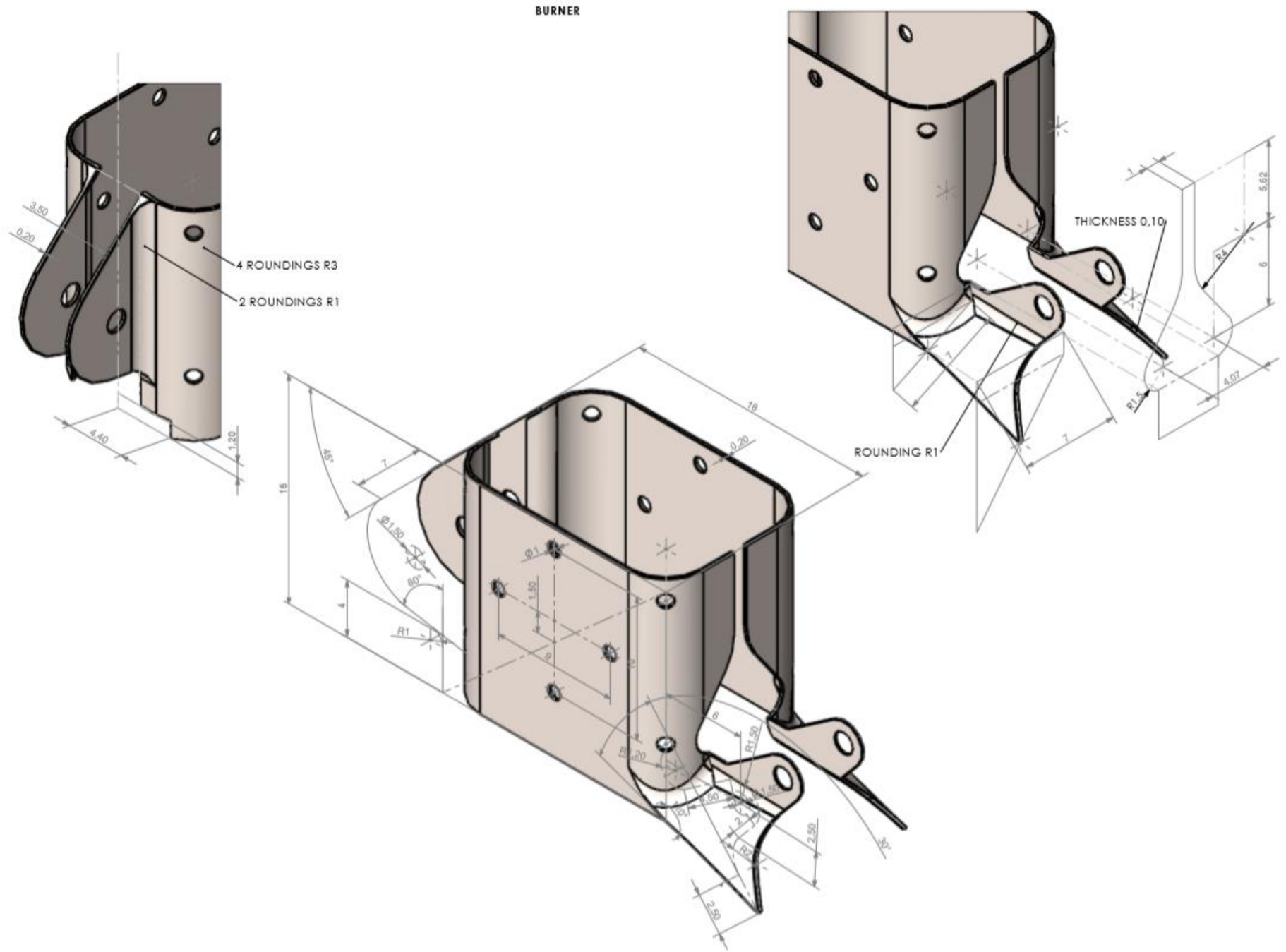


Part A or cover

STEP

METRIC DATA OF THE PART B OR BURNER




BURNER
4 ROUNDINGS R3
2 ROUNDINGS R1
THICKNESS 0,10
ROUNDING R1
3,50
0,20
4,40
1,20
18
0,20
16
45°
7
Ø1,50
80°
R1
1,50
2,50
30°
5,62
6
R4
4,07
R1,5

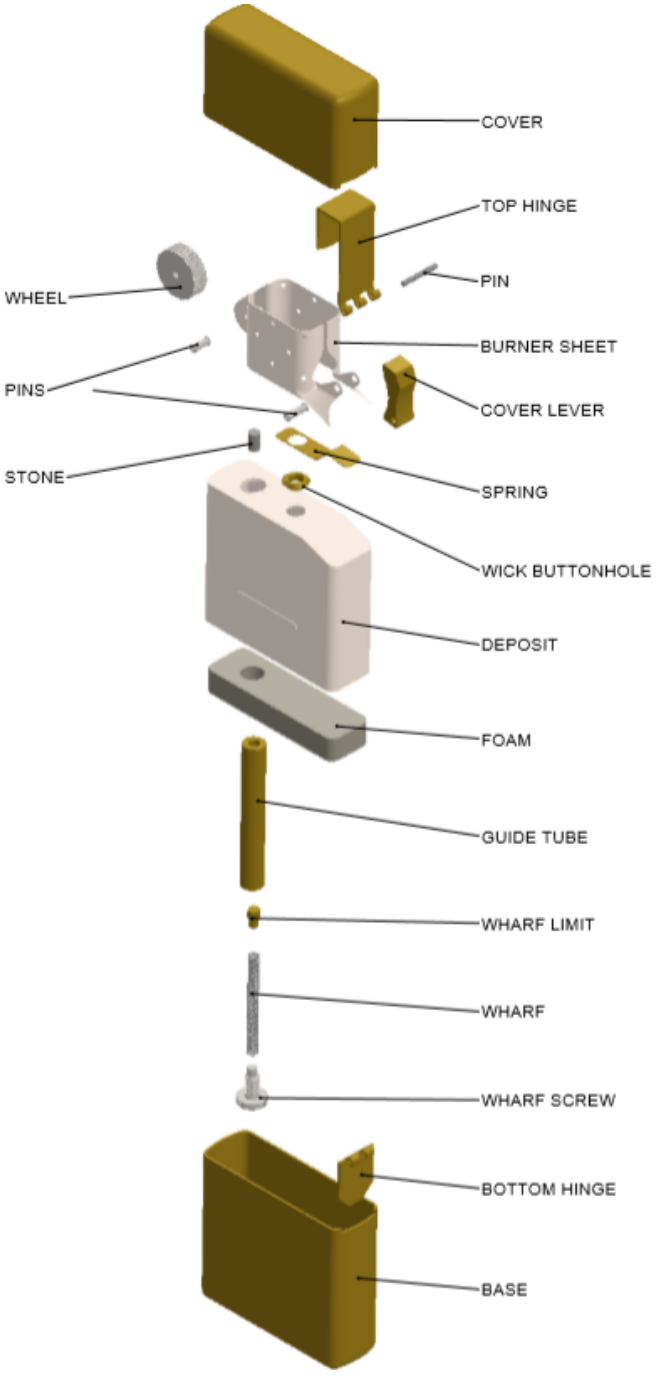
ZIPPO

STATEMENT 6

DESCRIPTION

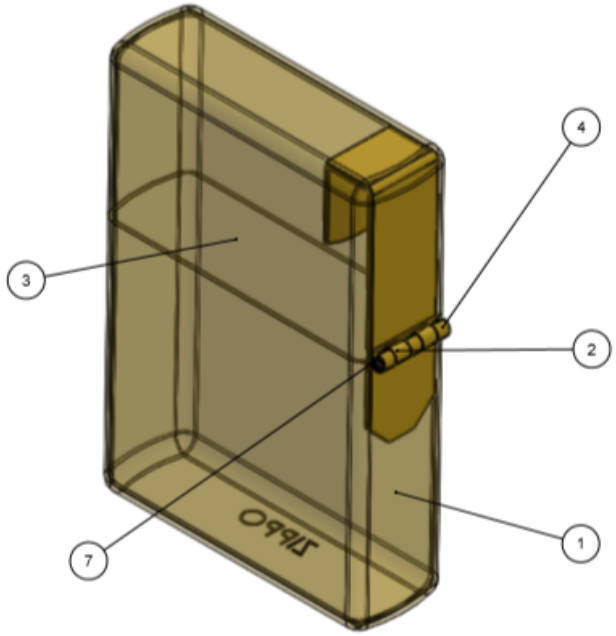
The Zippo is a lighter powered by gasoline and/or kerosene designed by George G. Braisdell and produced by Zippo Manufacturing Company (located in Bradford, Pennsylvania) since 1932. The lighter reproduction is made up of 19 parts. This reproduction does not exactly reproduce some of the components. The variations that have been incorporated are intended to simplify the process of defining some of the parts. This is the case of the metal sheet burner and the tank, which in reality are made up from a folded metal sheet and a top lid.

The 19 parts of this version of a Zippo are the following:



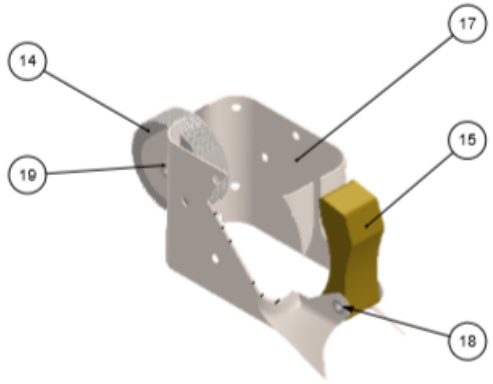
COMPONENTS

COVER



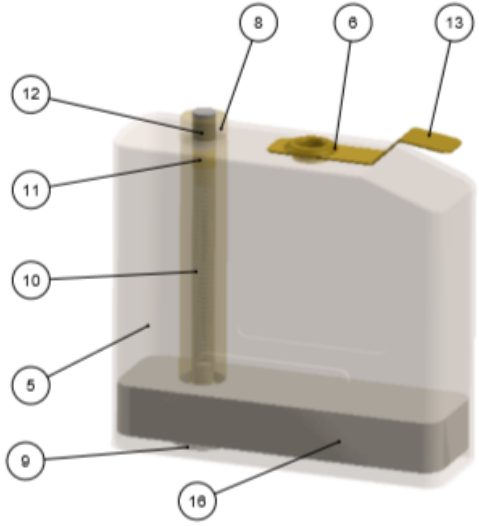
PEÇA	N.º	MATERIAL	DETALL	Q
BASE	1	BRASS		1
BASE HINGE	2	BRASS		1
COVER	3	BRASS		1
TOP HINGE	4	BRASS		1
PIN	7	BRASS		1

BURNER SET



PEÇA	N.º	MATERIAL	DETALL	Q
WHEEL	14	IRON		1
COVER LEVER	15	BRASS		1
BURNER SHEET	17	BRASS		1
PIN	18	BRASS		1
PIN	19	BRASS		1

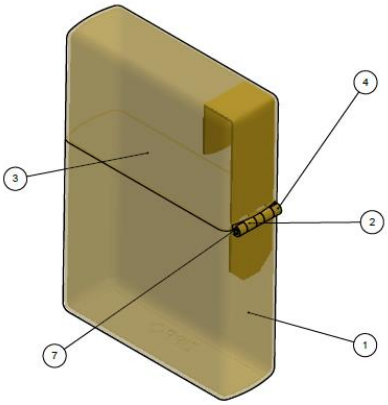
DEPOSIT SET



PEÇA	N.º	MATERIAL	DETALL	Q
DEPOSIT	5	BRASS		1
WICK BUTTONHOLE	6	BRASS		1
GUIDE TUBE	8	BRASS		1
SCREW	9	STEEL		1
WHARF	10	STEEL		1
WHARF LIMIT	11	BRASS		1
SPRING	13	BRASS		1
FOAM	16	COTTON		1
STONE	12	SILICON		1

STATEMENT 6.1

Given the Zippo burner or part **A build in 3D the module of the cover or part B** following the metric data provided in the following pages.

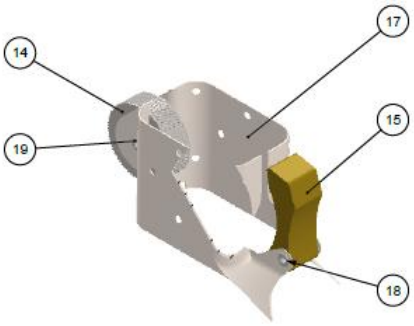


Part B or cover

STATEMENT 6.2

Given the cover of the Zippo or part A **define this part in workshop plans according to UNE, ISO or DIN regulations.**

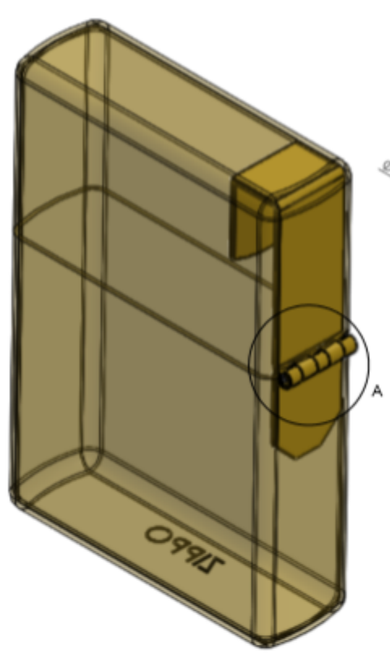
The solid model is provided in a restricted-access format. In order to obtain the necessary measurements to draw up the plans it is necessary to use measuring tools.

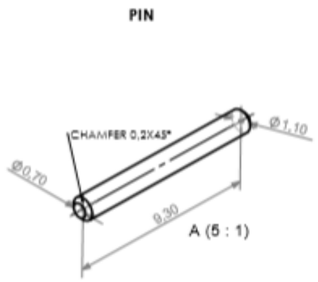


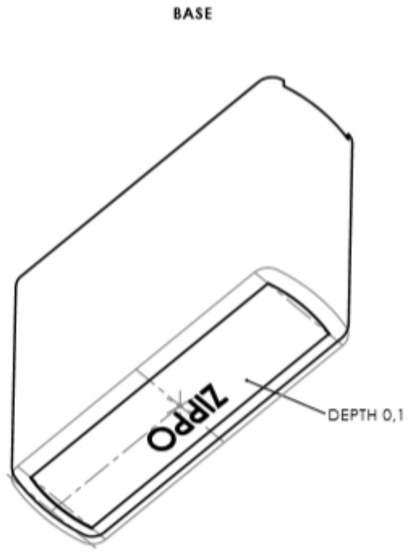
Part A or burner

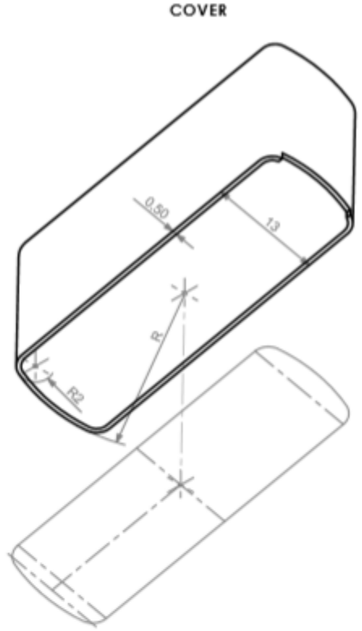
STEP

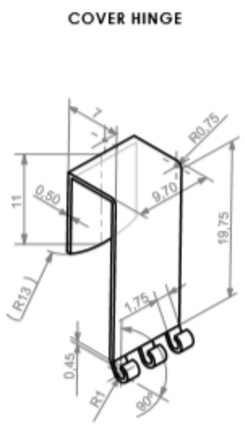
METRIC DATA OF THE PART B OR COVER

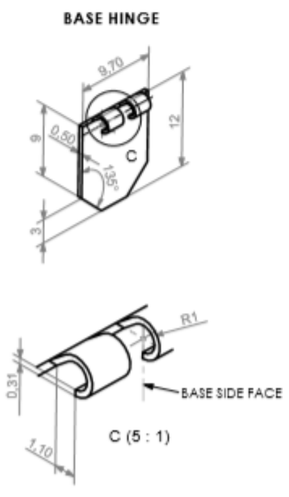


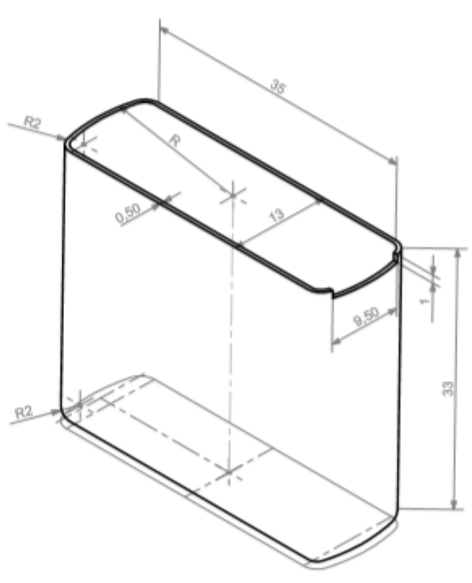


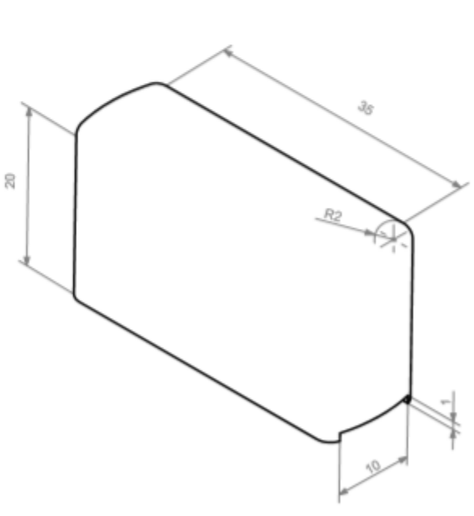












PROPOSALS

1 IMPLEMENTATION OF THE NY BALL IN BARCELONA

APPROACH

The Barcelona City Council wants to install a replica of the "New York End of the Year Ball" in the city. The City Council wishes this construction to be located at an emblematic place in the city and its design, inspired by the American model, to be as innovative as possible.

REQUIREMENTS

The high installation costs want to be quickly amortized increasing its use. For this reason, it is necessary to respond to the following needs:

1. Ornamental motifs can be adapted to different celebrations.
2. The installation must be portable, transportable or of easy installation.

ORDER

Design the components and the full assembly of an adaptation of the NY ball and implement its installation in Barcelona. The solution must be operative and transportable. For this reason, the following elements should be considered for the solution:

1. The reason for the celebration. It's originally New Year's Eve, but you can choose another celebration of the city.
2. Urbanistic plan for its implantation. Potential locations and definitive location for the pilot test.
3. The formal and artistic design of the full assembly and in particular that of the ball.
4. The mechanical system that executes the movement of the mobile elements.
5. Industrial installations needed (electrical, water, …)

RESOURCES

1. Institut Cartogràfic i Geològic de Catalunya

2 CONTROL CENTER

APPROACH

A company dedicated to private surveillance aims to improve its performance by redesigning the Control Center's workstations.

Control Centre workers must provide surveillance of all activity in a geographic area by means of monitoring the images on various screens.

A geographic area is monitored by two workers who share the same workstation: a working table and a number of screens. Each worker has a keyboard on the table that allows him or her to act in different ways on the information displayed on the screens. Workers sit on ergonomic chairs with wheels.

REQUIREMENTS

The improvements to be implemented are the following:

1. Optimize the number of screens per worker and the dimension of each of them so that the information to which has access each worker is the maximum possible.
2. Enable a single keyboard per employee for the control of all screens.
3. Access to the keyboard and to the display of the screens must be performed with the rotation of the worker's chair by impulses of the feet or hands, so that the impulses are caused without losing contact with the ground (in the case of the feet) or with the table (in the case of the hands).

ORDER

Design the complete workstation of two workers. Each one of the workers in the same unit must be able to see the screens of the other and act, if necessary, on any part of the system of the unit.

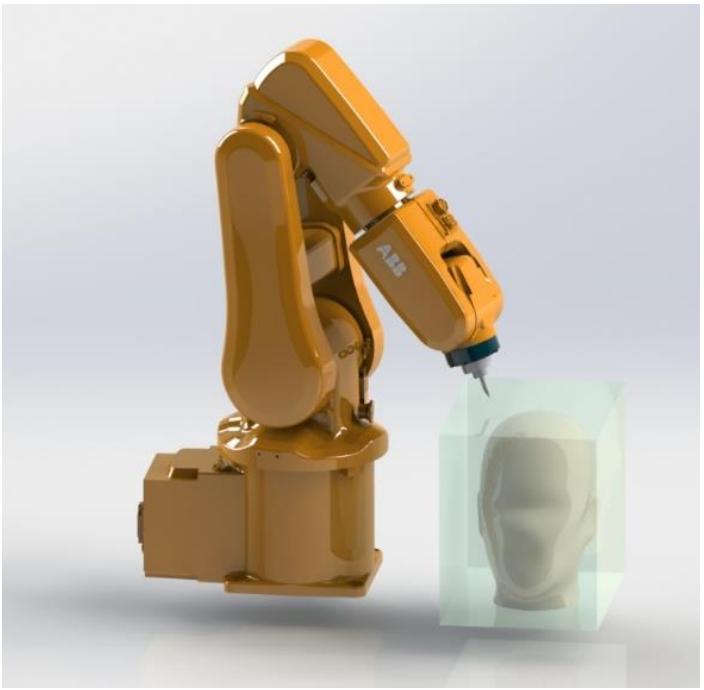
The following items are considered parts of this design:

1. Table design.
2. Designing the layout and number of screens.
3. Adaptation of the chair.
4. Adaptation of the keyboard or keyboards.
5. Design of the space for 10 units of 2 workers.

RESOURCES

1. Antropometric Study
2. 3D models of:
    a. A male 3D model 1,77 heigth. Variations to female standards must be established from this model.
    b. A 3D model of a chair with weels.

3 ROBOT. SET FOR MODELLING A MANNEQUIN HEAD



APPROACH

The ABB Robot IRB120 is intended to be adapted so that it can mill the head of a mannequin from a block of plastic material.

REQUERIMENTS

1. The components of the robot shouldn't be modified, if possible.
2. The robot's movement limitations need to be set.
3. The amount of material waste should be minimized.

ORDER

1. Choose the right tool to perform this task and its positioning on the head of the robot.
2. Design the table that positions the robot and the material block.
3. Define the dimensions of the block of material that should be mechanized.
4. In case there is no solution for the configuration given, determine the new conditions making the task possible.

RESOURCES

1. Robot technical specifications
2. 3D set with the robot and the mannequin head

4 Z CHAIR by Carla Ripoll

APPROACH

Based on the design of the **Chair 280 ZigZag by Rietveld**, Carla Ripoll develops in 2017 an alternative that optimizes the consumption of material and that can be mounted and dismounted without the use of tools.

The solution does not contemplate the changes due to continued use in the characteristics of the wood material, and for this reason it is considered that the solution is limited in time.

REQUERIMENTS

In order to optimise the design and increase its resistance, the following alternatives must be evaluated:

1. Adapt the solution to other, and more resistant, material.
2. Add a metallic element to strenghten the joints between the parts.

ORDER

Design the components that can increase the life span of the chair and identify until which extend these new parts could be applied to other types of chairs.

RESOURCES

3. Reference of the original chair **280 ZigZag**

   Name: 280 ZigZag **Author/Producer:** Gerrit Thomas Rietveld for Cassina.

   Mecanism:

   It has a very simple way in zig zag. It is composed of two plates forming a right angle which make up the backrest and the seat. Joint tothe front part of the seat there is another plate,which will form together with a parallel platform to the floor the legs of the chair. These last two plates form an angle of 45°.

   Material: Wood **Price:** 1.300€

4. Carla Ripoll Project Memory
5. Original set by Carla Ripoll

4 CAMPARI LAMP

APPROACH

The Campari lamp was designed by Raffaelle Celentano in 2002. The lamp is consisting of 10 bottles of Campari soda. The design is inspiring and allows us to devise other solutions based on it. One of the drawbacks of the implementation of the Campari lamp is the weight of the 10 bottles, that moves away from the features of the lamp screens with light weight and that forces a robust clamping system to be in place.

REQUERIMENTS

1. The proposed solutions must be easy to assemble.
2. The solution must be robust and offer standard safety guarantees at the site of the installation.

ORDER

3. Define a model application. This application does not have to be oriented to define another lamp.
4. All elements of the solution must be fully defined.

RESOURCES

5. Inho Maurer Description

5 APPLIYING THE DESIGN OF THE LAMP DOME

DOME IN THE ATENEU BARCELONES

APPROACH

The DOME lamp is a design by Benedetta Tagliabue which can be found at the entrance of the Ateneu Barcelones. It is composed of more than 170 pieces of wood, fitted or sewn together. The lamp was handcrafted in the facilities of BOVER Barcelona.

REQUERIMENTS

1. The proposal should be based on the main elements of the original design.
2. The final shape of the new solution should remind the original design.
3. If appropriate, some of the elements that assemble the different parts can be replaced by others.

ORDER

1. Define an application with a different use than lighting.
2. All elements of the solution must be fully defined.

RESOURCES

1. Bover Description and Models

6 LEGO SOLUTION FOR THE TATU LAMP

APPROACH

The TATU lamp is a design by André Ricart (1972) which has been reissued by Santa and Cole recently. It is an armadillo solution that allows different types of use. The compact design of the lamp allows to devise other proposals of implementation.

REQUERIMENTS

1. The proposal must maintain the shape and size of the original design.
2. The proposal must be fully functional.
3. The proposal should allow the same movements as the original.

ORDER

1. Solve the Tatu lamp with LEGO bricks.
2. Special parts such as those owned by LEGO robots can be designed.
3. All the parts of the proposal should be assembled with Solidworks.

RESOURCES

1. Santa y Cole Technic Description
2. LEGO
    a. LEGO BUILDER
    b. Video Tutorial

7 FOLDING STAIRCASE

Frankfurt calle Paris con Enrique Granados

APPROACH

The folding staircase of the image facilitates access to the mezzanine of a bar in the center of Barcelona. There are numerous proposals for this type of access on the market. Most of them fit standard dimensions, are for single person access or are adapted or manufactured to suit particular needs.

REQUERIMENTS

1. The proposal should be based on easy-to-manufacture or prefabricated components.
2. The solution must be modular, so that it is quick and easy to adapt it to the characteristics of the premises.
3. The amount of materials waste should be minimized.

ORDER

1. Design the components of a folding staircase that can be used simultaneously by two users or by a user and a large package.

RESOURCES

8 STRUCTURAL PASSAGE FOR THE UPC

Sant Pau Hospital, Sant Quintin Street, Barcelona

APPROACH

The passage of the image connects two modern buildings of the Hospital de Sant Pau in Barcelona. The structure has been solved with irregular rhomboid modules that allow to model different curvatures.

REQUERIMENTS

1. The proposal should define the number of people who can make simultaneous use of the passage.
2. The proposal should use structural features similar to those of the model in order to assess its versatility.
3. The adaptation must be carried out taking into account the pedestrian flow needs.

ORDER

1. Adapt the solution used in Sant Pau to two UPC buildings.

RESOURCES

9 ESFERIC

Installation of ESFERIC, Plaza de la Virreina, Barcelona

APPROACH

ESFERIC specializes in the manufacturing and installation of Domes and other wooden structures for events. The design of the components of the ephemeral installations should facilitate the assembly.

REQUERIMENTS

1. The proposal must use recyclable or biodegradable materials.
2. The storage of the disassembled cupula should require as little space as possible.
3. The potential application of a Part Assembly System based on Carla Ripoll's design for the Z chair will be assessed.

ORDER

1. Design the components of a particular Dome providing some functional improvement.

2. Attempt to define a Dome edge bonding system that prevents the use of metals.

RESOURCES

1. ESFERIC
2. Carla Ripoll's Z Chair

10 CARDAN FOR CYCLES

Cardan by BEIXO

APPROACH

The application of Cardan transmissions has been one of the recent innovations of the Duch company BEIXO. The solution is successfully applied on city bikes.

REQUERIMENTS

1. Play the 3D elements of the Beixo transmission for city bikes.
2. Evaluate the possibility of incluing the gearbox into the assembly.
3. The proposal must contain those elements that justify the suitability of the adaptation.

ORDER

1. Adapt the transmission to a child's bike or to any other means of transport using a transmission chain.
2. The proposal must contain those elements that justify the formal suitability of the adaptation.

RESOURCES

1. BEIXO

11 NAUTICAL CLAMPING SYSTEM

NORTH SAILS, Consell de Cent Street, Barcelona

APPROACH

The nautical clamping system of the image was photographed in a shop in Barcelona. The set of pieces in the image keeps the reception table suspended (dark color with metallic frame).

The person on one side of the reception wears a pair of shoes of size 38 of the brand MUNICH.

REQUERIMENTS

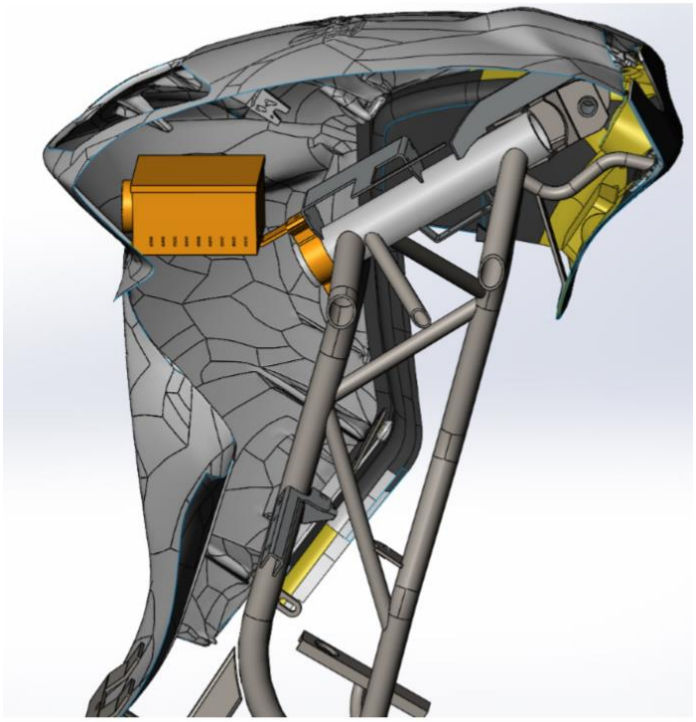
1. The techniques used to obtain the metric information of the set from the image shall be assessed.
2. The materials used for each of the components shall be specified.

ORDER

3. Adapt this solution to another ephemeral facility solution.

RESOURCES

12 PORTABLE SOUND MODULE FOR ELECTRIC VEHICLES



Sound module for eCooltra by María Yañez

APPROACH

Acoustic Vehicle Alerting Systems AVAS is a European standard approved in 2010, according to it electric vehicles must have a sound system capable of alerting pedestrians and other vehicles of their presence.

REQUERIMENTS

1. The proposal must be transportable and adaptable to the most common city electric vehicles.
2. Where possible, components available on the market must be integrated in the solution.
3. The solution should be based on mobile phone capabilities.

ORDER

1. Design a portable sound system for electric vehicles.
2. The solution should be applicable to light city vehicles (such as scooters, bicycles and wheelchairs, among others).
3. All elements in the assembly shall be referenced.

RESOURCES

1. EC Directives and regulations on motor vehicles, their trailers, systems and components.
2. María Yañez design

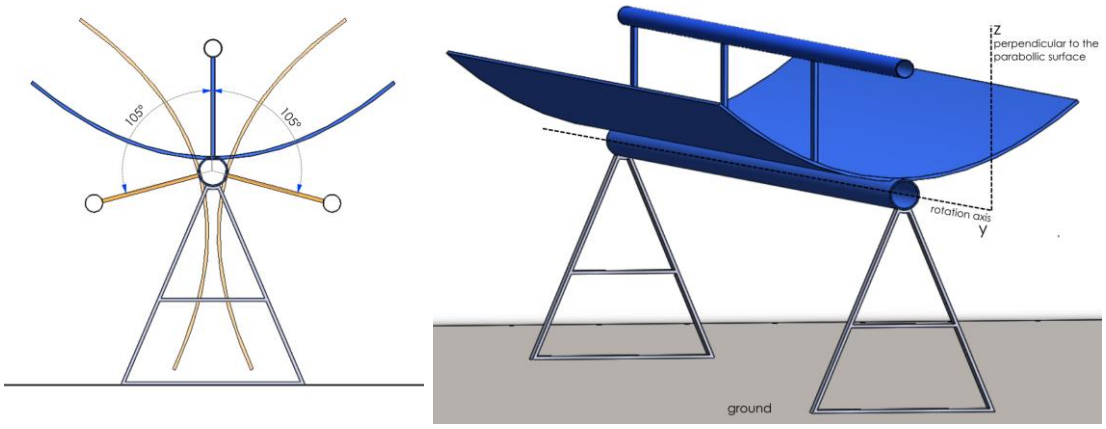
13 SOLAR PLANT INSTALATION

The solar thermo-electric generation plant in Villena is based on parabolic cylinder technology and is one of the largest built in the world in recent years.

The plant is formed by 400 parabolic cylinders, which acting as mirrors of the solar field are responsible for concentrating the incident solar radiation on an absorber tube located at the focal line of the collectors. The solar incident radiation will be concentrated 80 times, as detailed by the Valencian Energy Agency (AVEN). Through the absorber tubes, a heat transfer fluid (HTF) will circulate, in a closed circuit, carrying the absorbed heat towards a heat exchanger. The HTF is heated up to approximately 400 °C due to the concentrated solar radiation. The hot liquid will be pumped to a central block of the plant, in this block the hot liquid will circulate through heat exchangers to generate water vapor, which in turn moves a turbine generating electricity.

APPROACH

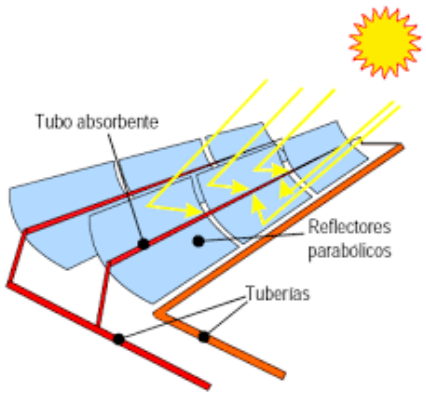
The parabolic cylinders are installed in rows of 20 (connected in series) and summing up a total of 20 rows, connected in parallel. The parabolic cylinders rotate with respect an axis parallel to the ground and which passes through the midpoint of the structure that holds the mirror, as indicated below.



To maximize the amount of energy from the sun that is collected on the cylinders, they must be positioned so that their longitudinal Y axis (its axis of

rotation) is oriented North-South. The Y axis is a fixed axis with respect to the ground. The parabolic cylinders should also be separated a minimum distance (between rows) to avoid shading.

The plane of symmetry of the parabolic cylinders, containing their horizontal and vertical axis, is maintained in a plane parallel to the incident solar irradiation during daylight hours (always that this is possible) and being the maximum angle of rotation ± 105° from the vertical position.



REQUIREMENTS

It is necessary to design the support structure (fixed and mobile parts), which ensure the structural stability of the collectors and allow their rotation as previously described.

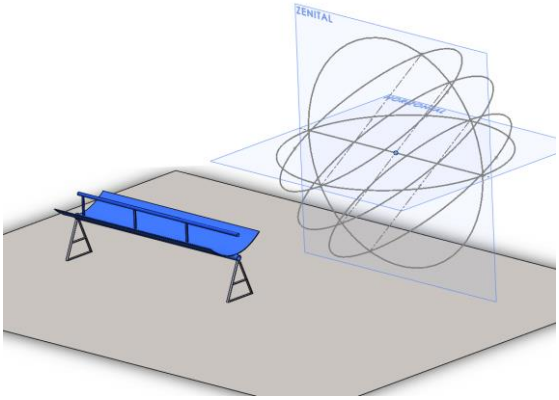
ORDER

The following is ordered:

1. Design the support structure of an individual parabolic cylinder and define the construction materials.
2. Generate the plans necessary for the commissioning of the construction of said the structure.

RESOURCES

1. Assembly SolidWorks File of the parabolic cylinder, the absorber tube (through which the heat transfer fluid will circulate) and the solar model.



References

YouTube channels and lists:

- Geometría Métrica
- Metric Geometry
- Diseño y Tecnología

Knowing authors and teams

- Joaquin Fernandez
- Alba Ramos Cabal
- LAM
- ETSEIB
- UPC

Contents of the same programme

1. Basic Metric Geometry. UPC 2019.
2. Solids of Revolution. Procedures. UPC 2019.
3. Exercises, Problems and Practices. UPC 2019.

Acknowledgements

We appreciate the legacy of all those teachers who have preceded us and who managed to convey to us the pleasure of Geometry and the illusion of creating and continuously improving what has already been created.

Memories to Francesc Compta, Mariano Domingo, Jordi Mestres and Xavier Codina,

We thank Alex Trejo and Josep Maria Monguet for the possibility of using their teaching materials that allow us to orient these basic contents in the direction of the Graphic Techniques applied to Industrial Design.

We appreciate the support of those teachers who accompany us in the teaching task: Arantza Villa, Francesc Alpiste, Miguel Brigos, Jordi Torner and José Luis Lapaz.

We thank Joaquim Minguella and the management of our Engineering School for their help and kindness, which allowed us to tailor our efforts to a larger and more complex goal.

Finally, we appreciate the patience of family and friends who have been taken away from our leisure time.

Joaquín Fernández and Alba Ramos Cabal, Barcelona, August 2019.