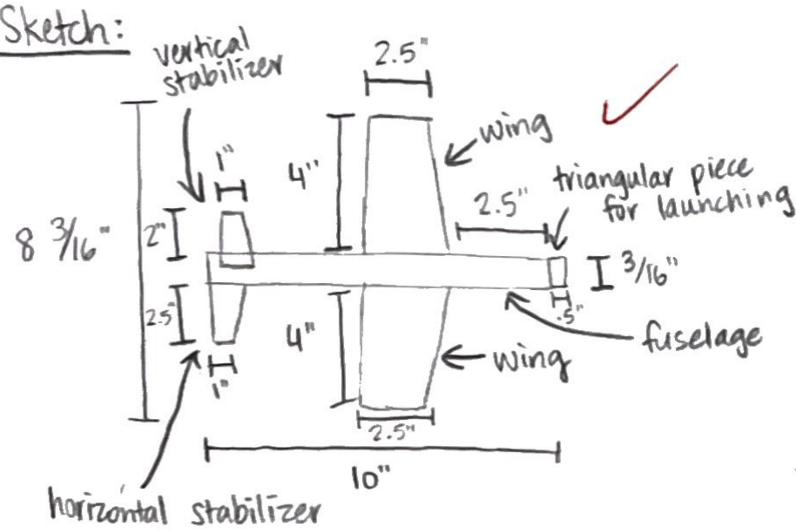
TITLE

Balsa Wood Glider

9/7/22

Design Brief: We are going to design, build, and test a Balsa wood glider with a fuselage, wings, and horizontal and vertical stabilizer. We will use a Balsa wood plank that is 18" x 3" x $\frac{1}{8}$" and a Bass wood stick that is $\frac{3}{16}$" x $\frac{3}{8}$" x 24". This project will be completed by ✓ Tuesday, September 27, 2022.

Initial Sketch:



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width of fuselage: 3/8"

function: When the glider is launched from the triangular piece on the fuselage, it will glide straight and smooth.

math: N/A ✓

Group Discussion:

similarities:

- same shaped wings
- dimensions for wings
- triangular piece at tip of fuselage ✓
- horizontal stabilizer at end of fuselage

differences:

- length of glider and width
- size and shape of both stabilizers
- wood stick in horizontal/vertical positions
- wings placed at different places on fuselage
- vertical stabilizer at different positions

decisions:

- The vertical stabilizer will be 2" x 1" with an angle, placed at tip of fuselage to line up w/ horiz.
- The wings will be 4" x 2.5" at a slight angle because we shared that idea.
- The fuselage will be 9.5" long to save wood.
- The wood for the fuselage will be placed vertically with a width of 3/16".
- The wings will be placed 2.5" back from the tip of fuselage to make for more room.
- The horizontal stabilizer will be 3" x 1.5' with a slight angle, placed at the end of fuselage because we want to create more lift.

DESIGNED BY: Audrey Wiebe | DATE 9/8/2022

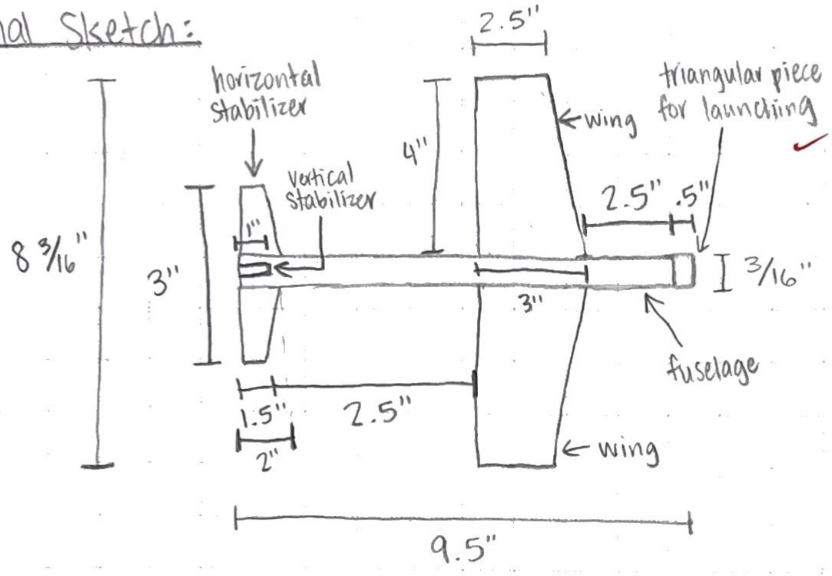
WITNESSED BY: Bella [illegible] | DATE 9/8/2022

PROPRIETARY INFORMATION

TITLE

Balsa Wood Glider (2)

Final Sketch:



height of fuselage: 3/8"
height of vertical stabilizer: 2"
height of wings, horiz. stabilizer: 1/8"
width of vertical stabilizer: 1/8"

Math: N/A

function: When the glider is launched from the triangular piece on the fuselage, it will glide straight and smooth.

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Simulation Notes:

- Stabilizer was too small, so we increased fuselage length to 10"
- still wouldn't fly, moved wings 1" from front of fuselage
- vertical tail was too large and not enough lift, moved wings forward .5"
- didn't work, made horiz. Stabilizer 4" and vertical 1" high
- vertical tail is good. center of gravity is behind neutral point
- moved wings back to 2.5" from front of fuselage and decreased nose mass to 2g
- won't fly, moved wings 2" from front of fuselage
- changed wingspan to 9" 9/12/22
- changed vertical tail to 2" high
- changed horizontal span to 3"
- we changed nose mass to 3.5g and wingspan to 10"
- we changed the root chord from 3" to 2" 9/13/22
- changed end of wing to 2.25" - wing needs to be increased
- changed nose mass to 2.41 g
- changed wingspan to 10.2"
- changed nose mass to 3g

DESIGNED BY: Audrey Wiebe
DATE: 9/13/2022
WITNESSED BY: Bellacrivero
DATE: 9/15/2022

PROPRIETARY INFORMATION

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TITLE

Balsa Wood Glider (3)

Simulation Notes (cont.):

- moved wings 2.75" from front of fuselage
- changed nose mass to 3.5 g
- changed horizontal stabilizer span to 3.3"
- it will fly

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Wing Span: 25.91 cm
Planform Area 127.46 cm^2
Wing Root Chord: 5.72 cm
Wing Taper Ratio: 0.72
Wing Tip Chord: 4.12 cm
Wing Tip Sweep Distance: 1.49 cm
Wing Leading Edge Sweep Angle: 6.54 degrees
Wing Aspect Ratio: 5.27
CL,alpha: 4.33 1/radian

Stabilizer Span: 8.39 cm
Planform Area 22.55 cm^2
Stabilizer Root Chord: 3.20 cm
Stabilizer Taper Ratio: 0.68
Stabilizer Tip Chord: 2.18 cm
Stabilizer Tip Sweep Distance: 1.01 cm
Stabilizer Leading Edge Sweep Angle: 13.51 degrees
Stabilizer Aspect Ratio: 3.12
CL,alpha: 3.46 1/radian

Vertical Tail Height: 5.07 cm
Planform Area 13.95 cm^2
Vertical Tail Root Chord: 2.99 cm
Vertical Tail Taper Ratio: 0.84
Vertical Tail Tip Chord: 2.51 cm
Vertical Tail Tip Sweep Distance: 0.48 cm
Vertical Tail Leading Edge Sweep Angle: 5.39 degrees

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Dimensions & Statistics

Aery Evaluation Number: 144
Fuselage Length: 25.38 cm
Wing Location: 6.99 cm
Stabilizer Location: 22.18 cm
Vertical Tail Location: 22.39 cm
Mass at Nose: 3.49 g

Center of Gravity Location: 9.64 cm
Neutral Point Location: 10.08 cm
ESTIMATED Mass: 13.65 g
Wing Loading 0.107 g/cm^2

Throwing Velocity: 18.61 km/hr
Flight Angle of Attack: 8.30 degrees
Stabilizer Incidence Angle: -2.21 degrees (positive upward)
ESTIMATED Stall Angle: 9.44 degrees
ESTIMATED Stall Velocity: 16.81 km/hr
ESTIMATED Glide Angle: 4.03 degrees (positive downward)
ESTIMATED CDo: 0.017

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DESIGNED BY: Audrey Wiebe DATE 9/15/2022

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Simulation Notes:

- changed velocity from 18.61 km/hr to 20 km/hr.
- changed leading edge sweep angle (stabilizer) to 13.72
  - changed glide angle to 3.94°

what did these change? -k

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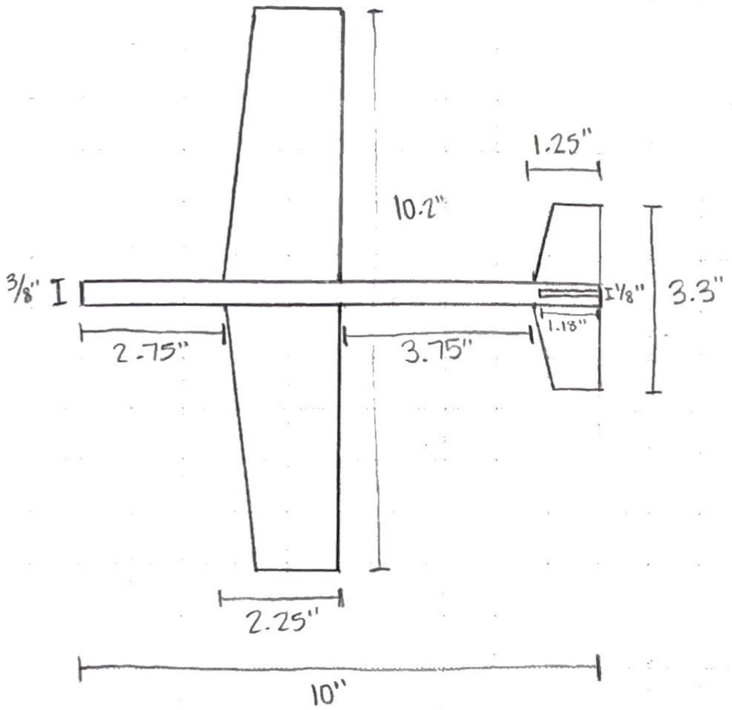
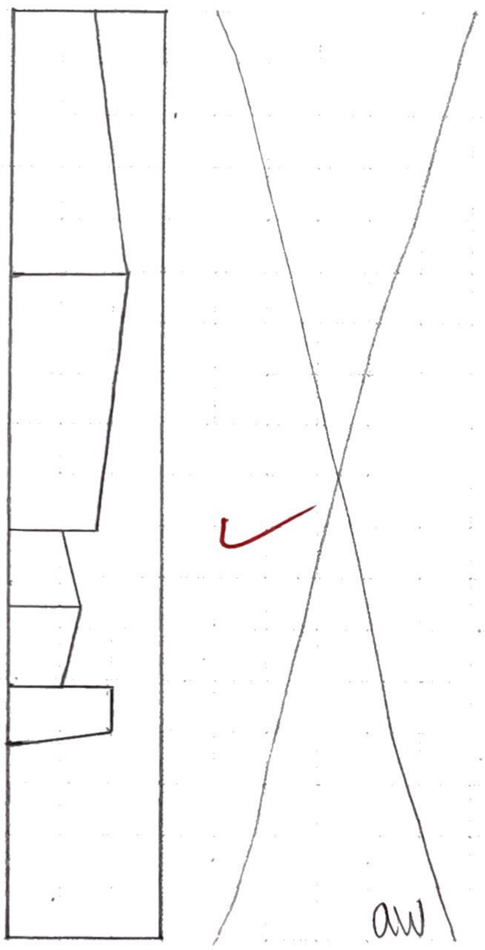
Scaled Drawing:

Scale 1 box : 1 inch





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Build Notes:

- we sketched out the wings, horizontal, and vertical stabilizer on the balsa wood plank using a ruler and pencil
- we drew each piece at the bottom of the plank and had the edges against each other so we didn't have to cut as many lines
- we measured all leading edge sweep angles with a protractor and drew the straight lines using a ruler

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DATE: 9/20/2022
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DATE: 9/20/2022

TITLE

Balsa Wood Glider (5)

Build Notes (cont.):

- we used an x-acto knife and cutting mat to cut out each part, dragging the knife against a ruler to keep straight lines
- we put little pressure on the knife, going over the cuts multiple times
- we got the fuselage cut to 10" with a larger, manual blade (and the triangular piece)
- we measured the placement of the wings, stabilizer, and vertical tail on the fuselage and marked each point with a pencil
- we placed a small amount of tacky glue on the fuselage where the wings and horizontal stabilizer go, and then put the balsa wood pieces on the glue, holding them for a few seconds until they stuck.
- we lined up the wings and horizontal stabilizer with the cutting mat and a ruler to make sure they were straight
- we placed glue on top of the horizontal stabilizer and put the vertical stabilizer on top, also lining it up with the ruler and holding it for a few seconds to make sure it stuck
- we placed glue on top of the triangular piece (on one flat side) and stuck it underneath the very front of the fuselage, having the other flat side face the back of the plane.
- we placed a spare piece of wood under the front of the fuselage to keep the triangular piece off the mat, and let the whole glider dry

9/21/22
- we added two small rectangles of balsa wood, 3 paper clips and a plastic baby to the nose to make the nose mass greater. ✓
- we attatched the extra wood and paper clips with painters tape, and used tacky glue to attach the baby

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- we balanced the glider on a vertical piece of balsa wood, and the center of gravity was 1 cm off from the center of gravity in the program

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DESIGNED BY: Audrey Wiebe DATE 9/22/2022

WITNESSED BY: Ella Rivera DATE 9/26/22

PROPRIETARY INFORMATION

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Dimensions & Statistics

Aery Evaluation Number: 146
Fuselage Length: 25.38 cm
Wing Location: 6.99 cm
Stabilizer Location: 22.18 cm
Vertical Tail Location: 22.39 cm
Mass at Nose: 3.49 g

Center of Gravity Location: 9.64 cm
Neutral Point Location: 10.08 cm
ESTIMATED Mass: 13.65 g
Wing Loading 0.107 g/cm^2

Throwing Velocity: 19.99 km/hr
Flight Angle of Attack: 7.19 degrees
Stabilizer Incidence Angle: -1.92 degrees (positive upward)
ESTIMATED Stall Angle: 9.44 degrees
ESTIMATED Stall Velocity: 16.78 km/hr
ESTIMATED Glide Angle: 3.94 degrees (positive downward)
ESTIMATED CDo: 0.017

Wing Span: 25.91 cm
Planform Area 127.46 cm^2
Wing Root Chord: 5.72 cm
Wing Taper Ratio: 0.72
Wing Tip Chord: 4.12 cm
Wing Tip Sweep Distance: 1.49 cm
Wing Leading Edge Sweep Angle: 6.54 degrees
Wing Aspect Ratio: 5.27
CL,alpha: 4.33 1/radian

Stabilizer Span: 8.39 cm
Planform Area 22.55 cm^2
Stabilizer Root Chord: 3.20 cm
Stabilizer Taper Ratio: 0.68
Stabilizer Tip Chord: 2.18 cm
Stabilizer Tip Sweep Distance: 1.02 cm
Stabilizer Leading Edge Sweep Angle: 13.72 degrees
Stabilizer Aspect Ratio: 3.12
CL,alpha: 3.46 1/radian

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Vertical Tail Height: 5.06 cm
Planform Area 13.92 cm^2
Vertical Tail Root Chord: 2.99 cm
Vertical Tail Taper Ratio: 0.84
Vertical Tail Tip Chord: 2.51 cm
Vertical Tail Tip Sweep Distance: 0.48 cm
Vertical Tail Leading Edge Sweep Angle: 5.40 degrees

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WITNESSED BY: Bella [illegible] DATE 9/26/22

TITLE
Balsa Wood Glider (7)

Test Notes:
- we lightly threw the glider at about a 3ft distance
- for the first 5 throws, it went to the right

9/23/22
- then, we threw it with less velocity and the glider flew straight + smooth

test 1: (with shooter)
- the glider flew straight and smooth at a slow speed and slowly approached the ground

test 2:
- we angled the glider higher and at a faster speed, it dove to the ground, but still flew straight

test 3:
- we angled the shooter straight and the glider flew straight, but flew up and hit the ceiling

test 4:
- we angled it straight again, and it flew straight up to the ceiling
- we added more tape to the nose for more mass

test 5:
- the glider flew straight and very smooth, lightly hitting the ground after gliding

test 6:
- we used more velocity, and the glider went straight and smooth, not heading in any direction, and slowly approaching the ground

9/26/22
Conclusion:
We designed, built, and tested a Balsa wood glider out of a Balsa wood plank and bass wood stick. We used Aery32 to design and modify the glider and make sure it would fly. We ended up with a 10" by 10.2" glider that ended up flying smooth and straight. To make the glider fly, we changed the sizes and shapes of the wings and horizontal stabilizer and their positions on the fuselage. After constructing the glider, we added more nose mass with tape so the glider would stop flying

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WITNESSED BY: Ella Olivera DATE 9/22/22

in an upward direction. We also had to reglue the vertical stabilizer because it came off during one of our tests. After these modifications, the glider flew straight, but could be improved. We could change the shape of the wings so that the glider flies smoother and doesn't hit the ground as quickly. We could also slightly decrease the nose mass so the glider has a softer landing, and to avoid breaking off any parts while landing.

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DESIGNED BY: Audrey Wiele DATE 9/26/2022

WITNESSED BY: Bella Rivera DATE 9/27/2022