



## AOPA 10<sup>th</sup> Grade Aviation STEM Curriculum Materials – Semester 1

### Materials needed throughout the semester (included in 4 lessons)

- Poster board or rolled paper
- Markers
- Scissors
- Paperclips
- Post-it notes
- Clear tape

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### Unit 2 – How Aircraft Are Made

- *Unit 2.A Lesson 1 – Manned Aircraft Components*

Modeling an Airplane's Components (per student)

- Cardboard
- Paper towel or toilet paper rolls
- Scissors
- Tape or Glue
- Markers

- *Unit 2.A Lesson 2 – Unmanned Aircraft Components*

Drone Flying Activity (one per class)

- Drone options for the classroom
  - Tello Quadcopter Drone- \$99 (Amazon)
  - SYMA X5C 2.4G 6 Axis Gyro HD Camera RC Quadcopter with 2.0MP Camera- \$36 (Amazon)
  - DROCON Drone For Beginners X708W Wi-Fi FPV Training Quadcopter With HD Camera - \$80 (Amazon)

- *Unit 2.B Lesson 1 – Aircraft Structural Materials*

Build-A-Plane Activity

- Rolled paper or poster board
- Markers



- *Unit 2.B Lesson 2 – Aircraft Safety Features*

Propose A New Safety Innovation Activity (per team)

- Poster board
- Markers
- Post-it notes

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## Unit 3 – Understanding Air

- *Unit 3.A Lesson 1 – Air is a Fluid*

Honey Demonstration (per class)

- Two jars of honey
- One or two large bowls

Viscosity Activity (per group)

- One marker
- One basin to catch fluids; the basin should be wide enough to hold the incline
- Vertical Support for incline (such as stack of books or a clamp and stand)
- One stopwatch
- Three different inclines, each approximately 15 cm wide x 50 cm long
  - One of the inclines should have a smooth surface, such as glass
  - One incline should mimic the smooth aluminum metal of airplanes (e.g. a sheet of aluminum from hardware store)
  - Other materials to consider include wood, sandpaper, aluminum foil, velcro, or plastic wrap
- Four different fluids for students to test (e.g. water, glue, syrup, oil)
- Four 100 mL beakers (or other small containers such as paper or plastic cups)

Honey Demonstration (per class)

- Strip of paper approximately 5 cm x 25 cm. The paper should not be too flimsy as it needs to hold a convex shape.
- Two paper, plastic, or foam cups
- Tape or glue
- Four long rubber bands



- *Unit 3.A Lesson 2 – Air Density*

Visualizing Density Demonstration (per class)

- Balance scale
- Metal counterweights
- Styrofoam cube or slab, at least 4 x 4 x 2 inches
- Large glass or clear plastic jar, at least 8 inches high (e.g. an empty pickle jar)
- Rocks of such a size to be able to fill the jar with 4 or 5 of them
- Small pebbles or river rocks (enough to fill the space between the larger rocks)
- Sand (enough to fill the space between the pebbles)
- Water (to fill the rest of the jar)
- Beaker graduated in liters

Layering Water Activity (per group)

- Two identical clear baby food jars
- Hot water (about 50 °C, colored red)
- Cold water (about 5 °C, colored blue)
- Water-resistant card (from a deck of cards or laminated index card)
- Paper towels
- Cookie sheet or something similar to catch drips and spills

- *Unit 3.B Lesson 1 – Density Altitude*

Flight Simulation Activity

- Computer with flight simulation software or flight simulator
- Joystick or yoke
- Optional: Throttle quadrant, rudder pedals, additional monitors

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## Unit 4 – Forces of Flight

- *Unit 4.A Lesson 1 – Understanding Motion*

Egg Inertia Demonstration (per class)

- One hardboiled egg
- One raw egg

Pop Can Hero Activity

- Empty aluminum pop cans with pull tabs intact (one per team)
- Carpenter nails
- Small nails
- String or fishing line (about 20 inches per team)
- Water tub (one or two per class)
- Towels

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- *Unit 4.A Lesson 2 – Four Forces*

Dart Paper Airplane Test (per team)

- Sheet of 8 ½" x 11" paper
- Paperclips
- Measuring tape
- Scissors

- *Unit 4.A Lesson 3 – Vectors of Flight*

Flight Vector Analysis Activity (per student)

- Protractor

- *Unit 4.B Lesson 1 – Theories of Lift*

Floating Ball Demonstration (per class)

- Hair Dryer
- Ping pong ball
- Optional: one bendable straw and ping pong ball for each student

Magic Balloon Experiment (per team)

- Two balloons
- Two (2) 12" pieces of string
- Tape
- Straw

Airfoil Designs Test (per team)

- Several Pieces of 8 ½" x 11" paper
- Tape
- Plastic straw
- String
- Scissors
- Single-hole punch
- Electric box fan or other small variable speed fan (per class)

- *Unit 4.B Lesson 3 – Calculating Lift*

Lift Equation Scenarios (per student)

- Calculator

Airfoil Simulation Activity (each group)

- iPads with "Wind Tunnel" application downloaded (\$4.99)  
<https://itunes.apple.com/us/app/wind-tunnel-for-ipad/id450980034?mt=8>

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- *Unit 4.B Lesson 4 – Aerodynamic Stalls*

Adventures in Stalls Activity

- Markers and/or colored pencils
- Rolled paper or poster board (optional)

Flight Simulation Activity

- Computer with flight simulation software or flight simulator
- Joystick or yoke
- Optional: Throttle quadrant, rudder pedals, additional monitors

- *Unit 4.C Lesson 1 – Aircraft Weight and Balance*

Balancing Act Activity (per group)

- 12-inch ruler
- Three identical binder clips

Paper Airplane Balancing Activity (per group)

- 8 ½" x 11" piece of paper
- Four paper clips

Flight Simulation Activity

- Computer with flight simulation software or flight simulator
- Joystick or yoke
- Optional: Throttle quadrant, rudder pedals, additional monitors

- *Unit 4.D Lesson 1 – In Thrust We Trust*

As The Prop Turns Activity

- Rubber band-powered balsa wood airplane with wheels
- Recommendations - Guillow's Jet Stream (<https://www.guillow.com/jetstream.aspx>)
- Guillow's Balsa Wood Flying Machine Kit (<https://amzn.to/2QrnHRo>)

Gyroscopic Action Demonstration (Optional)

- Chair that swivels
- Bicycle wheel that students can grasp by the axle

Engineering a Jet Engine Activity

- iPads with "Rolls-Royce Trent XWB" application downloaded (free)  
<https://itunes.apple.com/us/app/rolls-royce-trent-xwb/id988798634?mt=8>



- *Unit 4.E Lesson 1 – What a Drag!*

Warm-Up Demonstration (per student)

- Two 8 ½ x 11-inch pieces of paper

Drag Race (Per Group)

- Rubber band-powered propeller assembly (recommend using the propellers and rubber bands from the balsa wood airplane activity in lesson 4.D.1)
- Size #117B rubber band (if not included in the assembly above)
- Two drinking straws (recommend not using flexible drinking straws)
- Cardstock or manila file folders cut to size
  - One (1) - 5" x 7"
  - One (1) - 1 ½ " x 7"
  - One (1) - 3" diameter circle
- One brass fastener (brad fastener) size 1"
- 1 hook or pin to secure far end of rubber band propeller assembly (can use a paperclip)
- Transparent or masking tape
- Ruler/straight edge
- Protractor
- Tape measure or meter stick
- 5 meters of fishing line
- Permanent marker
- Scissors
- Hole punch (one per class)

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## Unit 5 – Aircraft Stability and Control

- *Unit 5.A Lesson 1 – Stability in Aircraft Design*

Stability In Action Activity (Per Pair)

- Marble
- Bowl with a rounded bottom and curved sides (the bowl should not have a lip on bottom of the outside surface)
- A key with a hole in the top
- A 10-inch length of string

- *Unit 5.A Lesson 2 – Rotorcraft Lift and Stability*

Flight Controls Explanation

- Small Model Helicopter (Optional)

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- *Unit 5.B Lesson 1 – Primary Flight Controls*

Flight Simulation Activity

- Computer with flight simulation software or flight simulator
- Joystick or yoke
- Optional: Throttle quadrant, rudder pedals, additional monitors

- *Unit 5.B Lesson 2 – Secondary Flight Controls*

Explore the Effects of Secondary Flight Controls (Optional)

- iPads with “Wind Tunnel” application downloaded (\$4.99)  
<https://itunes.apple.com/us/app/wind-tunnel-for-ipad/id450980034?mt=8>

- *Unit 5.B Lesson 3 – Flight Controls for Unmanned Aircraft*

Drone Flying Challenge! Activity (one per class)

- Quadcopter drone and controller (with standard controls if possible) - drone options provided in Unit 2, Section A, Lesson 2
- 2 hula hoops (optional)

- *Unit 5.C Lesson 1 – Turns and Turning Flight*

Rate of Turn and Radius of Turn Equations (per student)

- Calculator

- *Unit 5.C Lesson 2 – Load Limits in Aircraft Design*

Simulating G-Forces Activity

- Small hanging scale (a scale for measuring fish or luggage is appropriate and affordable). Be sure to choose a scale that records the highest weight achieved between resets.
  - AccuDial No Batteries Accurate Easy Reading Analog Compact Handheld Luggage Scale (Amazon \$9.99)
  - Travel Smart by Conair Compact Luggage Scale (Amazon \$9.97)
- Object to serve as an approximately 1 lb. weight (such as a small bag of rice or sand)
- String or S-hook (for hanging the weight from the scale)

Teacher Demonstration: High G-Forces And A Pilot’s Blood Supply

- Water balloon, half-filled with water
- String or yarn
- Smartphone or camera with slow motion video capability
- Towel or paper towels (optional)



## Unit 6 – Career Skills

- *Unit 6.A Lesson 1 – Job Application Practice*

### Sample Job Application Activity

-One highlighter (per student)

- *Unit 6.A Lesson 3 – Building/Revising Your Career Portfolio*

### Portfolio Materials (each student)

-Three-ring binder

-Tabs (as needed per student based on table of contents)

-Plastic or vinyl sheet protectors

PROPRIETARY





## AOPA 10<sup>th</sup> Grade Aviation STEM Curriculum Materials – Semester 2

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### Unit 7 – Propulsion

- *Unit 7.A Lesson 1 – Reciprocating Engines*

Build a Stirling Engine

- 1 - Glass test tube, preferably 20 x 200mm (20 x 150mm may be substituted, if needed)
- 1 - Rubber test tube stopper with a hole in it
- 6 - Glass marbles to fit in the test tube (Note: They don't have to fit perfectly, as they are used for ballast.)
- Two-sided tape
- 1 - Glass Syringe, 5ml (Note: Using glass is essential.)
- 1 - Wood pencil with graphite lead
- 1 - Sterno (Note: A tea candle may be substituted, but may not provide enough heat.)
- 1 - Block of wood, approximately 6" x 3"
- 1 - Piece of clear acrylic tubing, 3" in length and measuring 9/32" OD x 5/32" ID
- 1 - Wire pant hanger, approximately 12" long (Note: Dry cleaner hangers work perfectly.)
- Pliers
- Ruler

- *Unit 7.A Lesson 3 – The Power Cycle – Intake Systems*

Venturi Model Activity (per group)

- Clear vinyl tubing 5/8" outside dimension, 1/2" inside dimension
- Two stainless steel adjustable hose clamps, 5/8" or larger
- Glass of water
- Screwdriver
- Coffee straw/stirrer (smallest straw you can find)
- Utility knife
- Ruler
- Awl or tool to create a hole in the tubing (as small as the straw)



- *Unit 7.A Lesson 4 – The Power Cycle – Combustion and Exhaust*

Air or Water? Activity (per group)

- Two small cups
- Two large cups (such that the small cups fit into the larger ones)
- Hot water
- Water at room temperature (may dye with food coloring)
- Two thermometers
- Stopwatch

- *Unit 7.A Lesson 5 – Turbochargers and Superchargers*

Air for Ignition Demonstration

- Lighter
- Candle that can stand on its own (votive, tea light, or pillar candles work well)
- Clear glass container large enough to completely cover the candle without touching the wick (A glass, jar, or vase will work well)
- Tongs or a hot pad that will allow the glass container to be placed over the candle and removed without burning the demonstrator
- Safety goggles

- *Unit 7.C Lesson 1 – UAS Engines and Fuel*

Build a DC Motor Activity (per group)

- Sandpaper
- Magnet
- Two (2) alligator clip electrical connections
- Wire cutters
- Drill with a 1/16 drill bit
- Two (2) paper clips
- Screwdriver with a thin shaft
- One (1) 12-inch piece of 20 gauge magnet wire
- One (1) AA battery (larger batteries such as C or D cells also work)
- Block of wood (recommend a 6-inch length of 2 x 4)



## Unit 8 – Airframe Systems

- *Unit 8.A Lesson 2 – Electrical Systems*

Build a Model Electrical System (per group)

- Ten (10) alligator leads
- One (1) sheet of florist foam (approximately 1" x 12" x 18")
- Seven (7) greening pins (or similar metal pin; metal must be exposed or insulation removed)
- Three (3) 2"-long pieces of 12 gauge (or thinner) solid copper wire
- One (1) small electric drone motor (with propeller)
- Two (2) LED bulbs
- Two (2) AA batteries
- Battery holder with leads for two AA batteries
- Multimeter capable of reading 2000u amp

- *Unit 8.A Lesson 3 – Hydraulics and Landing Gear*

Syringe Hydraulics Activity (per group)

- 2 plastic syringes
- Plastic tubing of a size to fit snugly on the syringe nozzle
- Colored water

Build a Hydraulic System Activity (per group)

- 2 plastic syringes
- Plastic tubing of a size to fit snugly on the syringe nozzle
- Colored water
- Cardboard
- 8 thick popsicle sticks
- 8 small dowel rods
- 16 beads that fit on the dowel rods
- 8 plastic straws, cut down to fit
- Needle or drill
- Hot glue gun and glue sticks
- Scissors

Hydraulic Car Jack Demonstration (Optional)

- Hydraulic car jack
- Something heavy to lift (cinder blocks or a box of books)



- *Unit 8.B Lesson 2 – Anti-Icing Systems*

Ice in Flight (per group)

- 2 small, inexpensive model gliders, foam or balsa wood will work
- water
- sink sprayer or water bottle
- access to a freezer
- a scale

Deice, Ice Baby (per group)

- 4 large ice cubes
- 3 bowls
- water
- glycol or antifreeze
- plate
- moderately heated surface, such as coffee warmer, candle warmer, or crockpot

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## Unit 9 – Avionics and Flight Instruments

- *Unit 9.A Lesson 1 – Altimeter and VSI*

Flight Simulation Activity

- Flight simulator capable of inputting different altimeter settings

- *Unit 9.A Lesson 2 – Airspeed Indicator*

Balloon Warm-Up Demonstration

- One (1) latex balloon per student

Flight Simulation Activity

- Flight simulation equipment



- *Unit 9.B Lesson 1 – Gyroscopic Instruments*

Make a Bottle Gyroscope (per student or group)

- 2 plastic soda bottles (1–2 liters) with smooth sides
- Sharp knife or scissors for cutting the bottle
- Cutting surface
- Electrical tape
- Ruler
- Safety glasses

Flight Simulation Activity

- Flight simulator capable of simulating failures of gyroscopic instruments
- Stopwatch

- *Unit 9.B Lesson 2 – The Magnetic Compass*

Warm-Up

- Several magnetic compasses (1 per group)
- Several handheld magnets (1 per group)

Induce Compass Errors

- Sealed magnetic compass (1 per group) (can reuse from Warm-Up)

Flight Simulation Activity

- Flight simulator with magnetic compass
- Stopwatch or timing device

- *Unit 9.C Lesson 1 – Electronic Flight Displays*

Flight Simulation Activity: Electronic Flight Displays Student Activity 2 (optional)

- Flight simulator capable of displaying both analog and electronic flight instruments
- Clock, timer, or stopwatch



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## Unit 10 – Required Documentation

- *Unit 10.A Lesson 3 – Inspections*

Inspections Student Activity 4

-Cessna 172 Skyhawk Sample Preflight Inspection Checklist; samples can be found online, including at <http://www.freechecklists.net/> or purchased through Amazon (\$9) or any pilot supply shop

Flight Simulation Activity (optional)

-Flight simulation software with add-on for walkaround preflight inspection, such as X-Plane Cessna 172SP Skyhawk, designed by AirfoilLabs (\$34.95)  
[https://store.x-plane.org/Cessna-172SP-Skyhawk\\_p\\_401.html#tab-1](https://store.x-plane.org/Cessna-172SP-Skyhawk_p_401.html#tab-1)

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## Unit 11 – End of Semester Project and Career Development

- *Unit 11.A Lesson 1 – Design an Airplane*

Formative Assessment

-Poster board  
-Poster-making supplies (e.g., markers, colored pencils, construction paper, tape, glue)