AOPA 10th 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

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

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● Unit 2.B Lesson 2 – Aircraft Safety Features

Propose A New Safety Innovation Activity (per team)
-Poster board
-Markers
-Post-it notes

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

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- **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

- **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)
  

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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
- Guillow’s Balsa Wood Flying Machine Kit (https://amzn.to/2QrnHRo)

**Gyrovscopic 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)

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- **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
  - 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)

- **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)

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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

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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)

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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)

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● 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

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

Updated 6.4.2019
● **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/](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 Airfoil Labs ($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)

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)