Aerospace Technology I

8487 36 weeks

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Course Description

Suggested Grade Level: 10 or 11 or 12

Aerospace Technology I offers an introduction to the aerospace industry through a hands-on approach and exploration of topics such as flight, space, and supporting technologies. Students explore the aviation and space industries by examining the history of aviation, aerodynamics and aircraft components, flight conditions, airport and flight operations, space systems, rocketry, and living and working in space.

Task Essentials Table

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.

Task Number	8487	Tasks/Competencies	
Exploring the History of Aviation			
39	⊕	Identify the contributions of the pioneers of aviation.	
40	⊕	Create a flying device.	
41	⊕	Describe the construction and initial flight of the first powered aircraft.	
42	⊕	Construct helicopters.	
43	⊕	List major milestones in the development of aviation.	
44	⊕	Describe the effects of war on aviation technology and the growth of civil aviation.	
45	⊕	Describe how aviation has influenced the development of civilization since the advent of powered flight.	
46	⊕	Research industry trends in aviation.	
Applying Aerodynamics			
47	⊕	Describe the four forces of flight and how each affects an aircraft in flight.	
48	⊕	Apply Bernoulli's principle to flight.	
49	⊕	Apply Newton's laws to aerodynamics.	
50	⊕	Create virtual airfoils.	
51	⊕	Define common aerodynamics terms.	
52	⊕	Describe the concept of angle of attack and airfoil stall.	
53	⊕	Create a model airfoil.	

54	⊕	Design a model aircraft.	
55	⊕	Construct a model aircraft without an electric or gas engine.	
Exploring Aircraft Components			
56	⊕	Demonstrate an airplane moving about the center of gravity through each of the three axes of flight by operating the rudder, aileron, winglets, and elevator deflection.	
57	⊕	Categorize aircraft instrumentation.	
58	⊕	Summarize the operation of a turboprop and turbojet engine.	
59	⊕	Use flight instruments to simulate flight.	
60	⊕	Construct an aircraft powered by an electric or gas engine(s).	
61	⊕	Operate an aircraft.	
62	⊕	Describe the functions of, and the relationships among, the parts of an aircraft.	
63	⊕	Demonstrate the functions of the four major control surfaces of an airplane.	
Exploring Flight Conditions			
64	⊕	Identify atmospheric conditions and their effect on aircraft performance.	
65	⊕	Describe how heat, pressure, and the Earth's rotation interact to affect global wind patterns.	
66	⊕	Describe how temperature and moisture affect the stability of the atmosphere.	
67	⊕	Identify the characteristics of clouds and their effects on flight.	
68	○	Describe the characteristics of air mass boundaries.	
69	○	Analyze flight hazards caused by various atmospheric conditions.	
70	⊕	Chart atmospheric data.	
Examining Airport and Flight Operations			

71	⊕	Compare the function of air traffic control (ATC) in visual flight rules (VFR) and instrument flight rules (IFR) environments.	
72	⊕	Describe the layout and facilities of a typical airport.	
73	⊕	Identify the functions of the FAA.	
74	⊕	Describe the NAS and types of airspace.	
Exploring Space Systems			
75	⊕	Identify the role of NASA.	
76	⊕	Outline the history of the U.S. space program and international space program events.	
77	⊕	Describe how Earth's low, medium, and high orbits affect space mission operations.	
78	⊕	Identify components of orbital mechanics.	
79	⊕	Describe satellites and other space systems.	
80	⊕	Evaluate the commercialization of space.	
Exploring Rocketry			
81	⊕	Outline the evolution of rocketry.	
82	⊕	Apply Newton's three laws of motion to rocketry.	
83	⊕	Calculate the altitude of launched rockets.	
84	⊕	Demonstrate the function of rocket systems.	
85	⊕	Construct a one-stage rocket.	
86	⊕	Launch a rocket.	
Living and Working in the Space Environment			
87	⊕	Identify the effects of the space environment on manned operations.	
88	⊕	Identify applications of unmanned spacecraft.	
89	⊕	Examine hazards identified with space operations.	
90	○	Plan a space mission.	

Legend: ⊕Essential ○Non-essential ⊖Omitted

Curriculum Framework

Exploring the History of Aviation

Task Number 39

Identify the contributions of the pioneers of aviation.

Definition

Identification should include

- an outline of the history of aviation
- important inventors
- the development of technological advances that enabled humans to fly.

Process/Skill Questions

- Who were the earliest pioneers of aviation?
- What were the technological advancements of these contributors?

ITEEA National Standards

18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

4. The Cultural, Social, Economic, and Political Effects of Technology

6. The Role of Society in the Development and Use of Technology

7. The Influence of Technology on History

TSA Competitive Events

Flight Endurance

Task Number 40

Create a flying device.

Definition

Creation could include devices such as

- kites
- hot air balloons
- paper airplanes.

Process/Skill Questions

- What role did balloons and gliders play in early aviation?
- How did kites influence the work of the Wright brothers?
- How did hot air balloons contribute to flight?

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10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 41

Describe the construction and initial flight of the first powered aircraft.

Definition

Description should include

- the construction principles used in the Wright brothers' groundbreaking craft
    - wing structure and control
    - steering mechanisms
    - power plant
- the date and location of the first successful heavier-than-air flight.

Process/Skill Questions

- What components were necessary for successful sustained flight of a heavier-than-air aircraft?
- What research did the Wright brothers complete to prepare for the first flight?
- What invention did the Wright brothers build to test their design?
- What is lift?
- What is wing warping? Why is warping no longer used?
- Why is propeller pitch beneficial?
- How did the Wright brothers calculate lift for the airfoil shapes they developed?

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18. Transportation Technologies

7. The Influence of Technology on History

TSA Competitive Events

Flight Endurance

Task Number 42

Construct helicopters.

Definition

Construction includes multiple helicopters with various propeller diameters and pitches. Construction also includes discussion of the effects of various pitches on height attained across multiple flight trials.

Teacher resource: Make a Bamboo Helicopter, Picklebums

Process/Skill Questions

- What are the results of the experiment? How does the data compare across multiple trials or helicopters?

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7. The Influence of Technology on History

TSA Competitive Events

Flight Endurance

Task Number 43

List major milestones in the development of aviation.

Definition

Listing should include events and activities that advanced aviation, such as

- first powered flight
- World War I (WWI)
- birth of civil aviation
- air mail service
- Golden Age of Flight
- World War II (WWII) development of the jet engine
- early space exploration
- balloon flight
- airships
- next-generation recoverable rocketry.

Process/Skill Questions

- What effect do technological pioneers have on the advancement of aviation?
- What were some legacies of the Golden Age of Flight?
- What were the effects of the development of jet engines?

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7. The Influence of Technology on History

TSA Competitive Events

Flight Endurance

Task Number 44

Describe the effects of war on aviation technology and the growth of civil aviation.

Definition

Description should include the effects of war as context and impetus for technological advancement:

- Creates a life-or-death pressure to achieve aviation superiority, adequate defense, and advances in weaponry
- Substantially increases funding for the development of new technologies
- Allows modifications to be rapidly field-tested, studied, and improved
- Spurs creativity and engineering by pooling resources from independent organizations and efficiently delegating authority in pursuit of a nationally unified outcome

Description should also include developments such as

- airport infrastructure
- aircraft carriers and condensed field operations
- jet and turbine propulsion.

Process/Skill Questions

- How did WWI result in the creation of airports?
- How has air power changed the face of modern warfare?
- Who was General Billy Mitchell, and how did he improve air power during WWII?
- Who was Glenn Curtis?
- What improvements in aviation technology took place as a result of WWII?

- What aircraft design characteristics can be identified based on cultural differences among countries?
- How did the development of radar help the Allies in WWII?

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18. Transportation Technologies

6. The Role of Society in the Development and Use of Technology

7. The Influence of Technology on History

TSA Competitive Events

Flight Endurance

Task Number 45

Describe how aviation has influenced the development of civilization since the advent of powered flight.

Definition

Description should include economic, social, and human needs for cheaper and more rapid travel between locations, and the results of pursuing those goals.

Description should also include the ramifications of

- international travel
- communication
- economic effects
- immigration trends
- disease outbreaks.

Process/Skill Questions

- What were some of the early non-military uses of aircraft and air travel that benefited communities?
- How did advances in aviation change business and leisure travel?
- How did advances in aircraft speed influence our society?
- How did advances in materials, like composites, change aviation?

- How did the need for aircraft landing areas create the need for more government regulations for pilots, aircraft, and airports?

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18. Transportation Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

7. The Influence of Technology on History

TSA Competitive Events

Flight Endurance

Task Number 46

Research industry trends in aviation.

Definition

Research may include

- airline consolidation
- major carriers, including cargo
- the effect of airline activity on airport infrastructure
- the effect of Internet and electronic commerce
- heightened competition (in aviation and space)
- small-scale aircraft
- unmanned aerial vehicles (UAV) and remote-piloted vehicles
- efficiency
- environmentally friendly technologies
- training and design (modeling and simulation software)
- the transition from mechanical to automated (digital) control
- the transition from ground- to satellite-based surveillance.

Process/Skill Questions

- What aviation trends should the U.S. government support, if any?
- What major shifts in the airline industry over the past 25 years are evident today?
- What trends are likely to affect government spending?
- What effect does competition have on the aviation industry?

- What are benefits of Automatic Dependent Surveillance-Broadcast (ADS-B)?
- How do renewable resources change aircraft (aspects such as power plant, structure, control, efficiency and safety)?

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3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

7. The Influence of Technology on History

TSA Competitive Events

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Applying Aerodynamics

Task Number 47

Describe the four forces of flight and how each affects an aircraft in flight.

Definition

Description should include the following:

- Thrust—generated by the power source, which acts along the engine's thrust vector
- Lift—acts on the vertical motion of the aircraft
- Drag—acts on the parallel motion of the aircraft
- Weight—acts on the aircraft's center of gravity, pulling it toward the center of the Earth

Description should also include how these forces affect aircraft maneuvering:

- In straight and level flight, lift is approximately equal to weight.

- If the aircraft is not accelerating, thrust is approximately equal to drag.
- In straight, climbing flight, thrust exceeds drag, and lift is approximately more than weight.
- In straight, descending flight, thrust is less than drag, and lift is approximately less than weight.
- In turning flight, lift exceeds weight.

Process/Skill Questions

- When the four forces are equal, how does the aircraft fly?
- When thrust exceeds drag, what happens to the aircraft?
- When weight exceeds lift, what happens to the aircraft?
- What component of force keeps the aircraft level in a turn?
- Why is it that pitch controls airspeed and power controls rate of climb or descent?

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Flight Endurance

Task Number 48

Apply Bernoulli's principle to flight.

Definition

Application requires a demonstration of the way low-viscosity flow occurs when an increase in the speed of the fluid (air) occurs simultaneously with a decrease in pressure. When air flow velocity increases over a wing, the lower pressure on the upper wing increases. Application should also include discussion of the biplane effect (inter-wing convergence and divergence) and lift vs. deflection.

Bernoulli's Equation: $P + 1/2\ \rho V^2 + \rho gh = constant$

P = pressure
ρ = air density in slugs

V = velocity
g = gravitational acceleration
h = elevation

Continuity Equation: $P_1 - P_2 = 1/2\ \rho(V^2_2 - V^2_1)$
$A_1 V_1 = A_2 V_2$

Process/Skill Questions

- How does Bernoulli's principle influence wing design?
- Why does the velocity change around an airfoil?
- How is Bernoulli's principle applied to short-takeoff and short-landing aircraft?
- What is ground effect, and does it help or hinder an aircraft takeoff or landing?
- Why do pilots flare when they land?

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Flight Endurance

Task Number 49

Apply Newton's laws to aerodynamics.

Definition

Application requires a demonstration of a design that meets the specific challenges of Newton's laws of motion and how, if the design does not abide by Newton's laws of motion, the aircraft will be unable to fly.

From Newton's second law:
F = ma

F = force of air on the airplane
m = mass of the airplane
a = acceleration of airplane

From Newton’s third law:
A plane is flying at constant speed. The direct pressure of the air pushing on the bottom of the wing keeps the plane in the air. As the wing pushes down on the air, the air pushes up with an equal and opposite force. Newton's third law states that forces always come in equal and opposite pairs. For instance, if you push on a wall, the wall pushes back with the same amount of force.

Therefore:
Action = Reaction
F = -F

Process/Skill Questions

- What are Newton’s three laws, and how are they applied to aerodynamics?
- Which of Newton’s laws is addressed by thrust?
- What are some methods of creating force to initiate and sustain flight?

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3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Flight Endurance

Task Number 50

Create virtual airfoils.

Definition

Creation includes changing variables including speed, temperature, altitude and even planet, to explore airfoil principles. Creation can be accomplished using the National Aeronautics and Space Administration (NASA) FoilSim software.

Process/Skill Questions

- How does altitude affect lift?

- How does temperature affect lift?
- How does angle of attack affect lift?

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10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 51

Define common aerodynamics terms.

Definition

Definitions should include

- *airfoil shape*
- *relative wind*
- *chord*
- *aspect ratio*
- *camber*
- *leading edge*
- *trailing edge*
- *angle of attack*
- *induced drag, parasite drag*
- National Advisory Committee for Aeronautics (NACA) numbers.

Process/Skill Questions

- How does each aerodynamics term relate to flight?
- How does angle of attack affect lift and drag?
- What is aerodynamics?
- What is the relationship between the leading edge and trailing edge?
- What are some examples of airfoils?
- How does thickness and camber of an airfoil affect lift?

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Flight Endurance

Task Number 52

Describe the concept of angle of attack and airfoil stall.

Definition

Description should include

- the definition of *stall* and *spin*
- the way that angle of attack may be increased to a point where lift is no longer created and stall occurs
- the effect of angle of attack
- stall recovery.

Process/Skill Questions

- Why were spins used in early aircraft?
- What are the indications of a stall, spin, aggravated stall, approach turn stall, skidded turn stall?
- What thrust-to-weight ratio must an aircraft achieve to avoid stall?
- How does a pilot recover from a stall?
- What happens when an airfoil exceeds the critical angle of attack?
- What are the most common situations in which aircraft stall?
- How does the use of flaps affect stall speed? Why is this important in take-off and landing?

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18. Transportation Technologies

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Flight Endurance

Task Number 53

Create a model airfoil.

Definition

Creation includes

- producing an airfoil from foam or other material
- testing an airfoil in a wind tunnel
- comparing results between simulation and wind tunnel.

Process/Skill Questions

- What differences exist between the simulation and the real airfoil?
- What is neglected in the simulation?
- What construction techniques affect the airfoil?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

TSA Competitive Events

Flight Endurance

Task Number 54

Design a model aircraft.

Definition

Design should follow the design process, identify safety concerns, and include the

- engine/propulsion system
- airframe system
- guidance system
- control system
- recovery system.

Design may include additional considerations, such as

- payload
- aerodynamics
- flight stability
- design tools available, such as software design applications.

Process/Skill Questions

- What are the steps in the design process?
- What are some technologies that have helped with glider innovation?

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12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 55

Construct a model aircraft without an electric or gas engine.

Definition

Construction should include

- determining components and materials
- determining tools and their uses

- following manufacturer and/or instructor guidelines
- completing all steps of the construction process.

Process/Skill Questions

- What safety concerns should be addressed in the design?
- How does the altitude and distance at which the aircraft needs to travel influence choices for materials used in its construction?

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12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Exploring Aircraft Components

Task Number 56

Demonstrate an airplane moving about the center of gravity through each of the three axes of flight by operating the rudder, aileron, winglets, and elevator deflection.

Definition

Demonstration should include

- using an aircraft flight simulator
- identifying the center of gravity as the point where the axes of flight rotate
- manipulating three axes of flight

- longitudinal axis—from the nose to the tail of the airplane (ailerons/roll)
- lateral axis—from wingtip to wingtip (elevators/pitch)
- vertical axis—from the bottom of the airplane to the top of the airplane (rudder/yaw).

Process/Skill Questions

- What are the three axes of flight?
- What is the center of gravity?
- What is the effect of the pedal movement on the rudder?
- When the left aileron goes up and the right aileron goes down, which way does the airplane turn?
- How does the center of gravity relate to the three axes of flight?
- What influence do winglets have on aircraft?
- What is cross control input?
- What are the effects of crossed controls?

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18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Flight Endurance

Task Number 57

Categorize aircraft instrumentation.

Definition

Categorization should include

- primary instruments
  - gyro
  - compass
  - altimeter
  - airspeed
- secondary instruments

    - vertical speed indicator
    - turn rate gyro (turn needle)
    - clock
- engine instrumentation
    - Global Positioning System (GPS)
    - Very High Frequency Omnidirectional Range (VOR)/ Very High Frequency Omnidirectional Range/Tactical Aircraft Control (VORTAC) systems
    - automatic direction finder (ADF)
    - instrument landing system (ILS).

Process/Skill Questions

- How are aircraft instruments classified?
- How do principles of physics relate to these instruments?
- What is the purpose of each of the aircraft instruments?
- How have aircraft instruments evolved?
- What are the minimum instruments required for VFR or IFR flight?

ITEEA National Standards

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 58

Summarize the operation of a turboprop and turbojet engine.

Definition

Summarization should include

- the concept that turbine/jet engines are more reliable and efficient than reciprocating engines
- differences between axial and centrifugal flow
- the jet cycle
- intake, compression, combustion (and various combustion chambers), and exhaust.

Process/Skill Questions

- What are the advantages and disadvantages of a turbojet engine?
- What are the different types of turbojet and turbofan engines?
- How is heat energy turned into thrust?
- How does a scramjet operate?
- What is a pure jet engine (ramjet)?
- What is a pulse jet?

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18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 59

Use flight instruments to simulate flight.

Definition

Use should include takeoff and landing using

- an aircraft flight simulator
- primary instruments
    - gyro
    - compass
    - altimeter
    - airspeed
- secondary instruments
    - vertical speed indicator
    - turn rate gyro (turn needle)
    - clock
- engine instrumentation
    - GPS
    - VOR/VORTAC systems
    - ADF
    - ILS.

Process/Skill Questions

- What procedures should be followed before takeoff?
- What is the purpose of each instrument?

ITEEA National Standards

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 60

Construct an aircraft powered by an electric or gas engine(s).

Definition

Construction should include

- determining components and materials
- determining tools and their uses
- following manufacturer and/or instructor guidelines
- completing all steps of the construction process.

Process/Skill Questions

- What types of aircraft are there?
- Why might one aircraft be better suited for constraints than another aircraft?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 61

Operate an aircraft.

Definition

Operation should include

- takeoff
- maneuvers
- landing.

Process/Skill Questions

- How does the aircraft perform?
- What happens if an aircraft is flown multiple times?
- How can data be gathered on flights?

ITEEA National Standards

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 62

Describe the functions of, and the relationships among, the parts of an aircraft.

Definition

Description should explain that aircraft are made up of parts that act together for the safe operation of the aircraft, including

- power plant—provides the thrust
- wings—provide lift (and often carry fuel)
- fuselage—carries pilot, passengers, and cargo
- empennage—provides longitudinal and lateral stability
- control surfaces—provide directional control.

Process/Skill Questions

- What are the functions of each component?
- How does the design of each component affect flight?
- How does the design of one component influence the design of the others?
- What is a P-factor?
- What is a torque factor?

ITEEA National Standards

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 63

Demonstrate the functions of the four major control surfaces of an airplane.

Definition

Demonstration should include adjusting ailerons, elevators, rudders, and flaps to allow the aircraft to take off, maneuver in the air, and land. Demonstration may also involve a discussion of the differences among traditional, slotted, and Fowler flaps as well as a discussion of trim tabs. Demonstration may involve using a flight simulator.

Process/Skill Questions

- What are the four major control surfaces?
- How does the location of controls affect the flight path?
- How does Bernoulli's principle apply to each of these controls?
- What is the primary purpose of flaps, spoilers, and leading edge slats?

ITEEA National Standards

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Exploring Flight Conditions

Task Number 64

Identify atmospheric conditions and their effect on aircraft performance.

Definition

Identification should include the effect of air pressure, temperature, and humidity on lift and on aircraft engine performance.

Process/Skill Questions

- How does increased humidity affect aircraft performance?
- Why can aircraft fuel consumption change between cold, dry air and hot, moist air?

ITEEA National Standards

18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

Task Number 65

Describe how heat, pressure, and the Earth's rotation interact to affect global wind patterns.

Definition

Description should include how

- solar heating causes the air to circulate in the atmosphere, which causes changes in pressure that make the air move over the earth
- air movement, coupled with the earth’s rotation, creates wind patterns that affect all aircraft operations.

Process/Skill Questions

- What is convection, and how does it make the air move in certain directions?
- What is the jet stream, and how does it affect flight planning?
- What three factors combine to create wind?
- What is the Coriolis effect, and how does it affect flight?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 66

Describe how temperature and moisture affect the stability of the atmosphere.

Definition

Description should include the concepts that

- higher-temperature air can hold more moisture than colder air
- when air is heated, it rises until condensation occurs, resulting in the formation of clouds
- the less moisture, the more stable the air; higher moisture is characteristic of unstable air.

Process/Skill Questions

- Why can warm air hold more moisture than cold air?
- How is aircraft performance affected by warm and humid air?
- Why is the air less stable at higher temperatures?
- What phenomenon occurs in cold air with 100 percent humidity?
- What type of adverse flight conditions might be expected if the temperature and dew point spread is low?

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3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 67

Identify the characteristics of clouds and their effects on flight.

Definition

Identification should include the families of clouds, cloud types, and the effects of each on flying:

- Family A—High > 20,000 feet
    - Form above 20,000 feet in the troposphere
    - Composed of ice crystals
    - Wispy, often transparent
    - Cloud types include the following:
        - Cirrus
        - Cirrostratus
        - Cirrocumulus
        - Pileus
- Family B—Middle, 6,000-20,000 feet
    - Composed of water droplets, frequently supercooled
    - Cumulus is the prevalent type; other types include the following:
        - Altostratus
        - Altocumulus
- Family C—Low < 6,500 feet
    - Flat
    - Cover the entire sky
    - Types include the following:

    - Stratus
    - Nimbostratus
    - Stratocumulus

Process/Skill Questions

- What are the three levels of clouds?
- What are the differences between cumulus and stratus clouds, and how does the surrounding air affect flight?

ITEEA National Standards

18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 68

Describe the characteristics of air mass boundaries.

Definition

Description should include cold fronts, warm fronts, stationary fronts, occluded fronts, and

- identification of air masses, such as
    - maritime tropical
    - maritime polar
    - continental tropical
    - continental polar
- the differences among air masses
- the changes in wind direction, temperature, and pressure that take place when air masses come together.

Process/Skill Questions

- What are the results of a cold air mass colliding with a warm air mass?
- What are the effects of fronts on flight?
- What are the differences between a stationary front and an occluded front?
- What are the origins of each type of air mass?
- How are these boundaries shown on a weather map?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 69

Analyze flight hazards caused by various atmospheric conditions.

Definition

Analysis should include

- describing hazards
    - thunderstorms
    - wind
    - low visibility
    - atmospheric turbulence
- identifying data and resources for pilots
    - the National Oceanic and Atmospheric Administration (NOAA)
    - the Federal Aviation Administration (FAA)
    - the Jeppesen Private Pilot Manual.

Process/Skill Questions

- What are the three stages of thunderstorms, and what are the hazards associated with each?
- What are the types of icing encountered by aircraft? Why is aircraft icing dangerous?
- Why is fog hazardous to aircraft moving about at an airport?
- Why is volcanic ash hazardous to flying?

ITEEA National Standards

18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 70

Chart atmospheric data.

Definition

Chart data should include

- temperature
- wind
- dew point
- barometric pressure
- comparison of data over time.

Process/Skill Questions

- What are the benefits to understanding atmospheric change?
- What will tracking this data provide for future weather forecasting?
- What atmospheric conditions may indicate the onset of severe weather?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Examining Airport and Flight Operations

Task Number 71

Compare the function of air traffic control (ATC) in visual flight rules (VFR) and instrument flight rules (IFR) environments.

Definition

Comparison should include

- the roles of tower, approach/departure, and en route controllers

- the various locations of personnel
- the definition of terms such as
    - *visual flight rules (VFR)*
    - *visual meteorological conditions (VMC)*
    - *instrument meteorological conditions (IMC)*
    - *instrument flight rules (IFR)*
- the ways that the conditions (VMC, IMC) dictate the application of flight rules (VFR, IFR).

Process/Skill Questions

- What are the differences between controlled and uncontrolled air space?
- What are the differences between control towers and radar facilities?
- What flight areas have the most control?

ITEEA National Standards

18. Transportation Technologies

TSA Competitive Events

Flight Endurance

Task Number 72

Describe the layout and facilities of a typical airport.

Definition

Description should include

- identification of all parts of an airport and facilities, such as
    - runways
    - taxiways
    - aprons
    - terminal buildings
    - aircraft hangars
- distinction among landside, terminal, and airside facilities
- explanation of the purpose of an airport layout plan (ALP).

Process/Skill Questions

- What is the difference between a runway and a taxiway?
- How are runways laid out and identified?
- How is a runway marked if it's no longer in use?
- How does pilot-controlled lighting work?
- What are some of the safety considerations of airport runway layout?
- What facilities would typically be located on the airside of an airport?
- How does the shift in magnetic North affect the runway numbering system?
- What is the importance of maintaining pavements, markings, and signs on an airfield?
- What are navigational aids (NAVAIDS), and how does this equipment facilitate the safe use of runways?
- What are some benefits of parallel runways?

ITEEA National Standards

18. Transportation Technologies

20. Construction Technologies

TSA Competitive Events

Flight Endurance

Task Number 73

Identify the functions of the FAA.

Definition

Identification should include that the FAA

- regulates U.S. commercial space transportation
- encourages and develops civil aeronautics, including new aviation technology
- regulates civil aviation to promote safety
- develops and operates a system of ATC and navigation for both civil and military aircraft
- researches and develops the National Airspace System (NAS) and civil aeronautics
- provides safety and regulatory oversight for over 3,300 airports that are part of the National Plan of Integrated Airport Systems (NPIAS)
- administers a grant funding program for airport improvements develops and carries out programs to control aircraft noise and other environmental effects of civil aviation.

Process/Skill Questions

- Why was the FAA created?
- How does the FAA regulate safety?
- What flight is not controlled by the FAA?
- How does the lack of federal control over local land use affect airspace around an airport?
- How is the growing use of UAVs affecting airspace around airports?
- What are the divisions or lines of business within the FAA?

ITEEA National Standards

18. Transportation Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Flight Endurance

Task Number 74

Describe the NAS and types of airspace.

Definition

Description should include the types or classification of airspace and what each means:

- Class A
- Class B
- Class C
- Class D
- Class E
- Class G
- Special-use airspace—not within FAA control
- Washington, DC, metropolitan special flight rules area and New York City special flight rules area (DC SFRA and NYC SFRA)
- Washington, DC, metropolitan flight restriction zone (DC FRZ).

Process/Skill Questions

- Which class of airspace is uncontrolled? Explain.
- Why must a pilot contact ATC to operate in certain airspace? Which classifications?
- What is a military operations area (MOA)?

- Which class of airspace can a small UAS (sUAS) be operated without approval from ATC if the operator has earned a remote pilot certificate?
- What is the difference between restricted airspace and alert airspace?
- What is a terminal radar service area (TRSA)?
- What are some reasons for a temporary flight restriction?
- What are examples of restricted and prohibited airspace volumes?
- What are warning areas and prohibited areas?
- What is due regard for safety?
- How do FAA rules compare to International Civil Aviation Organization (ICAO) standards?
- Why is night VFR flying not allowed under ICAO rules?
- What is a Notice to Airmen (NOTAM)?

ITEEA National Standards

18. Transportation Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Flight Endurance

Exploring Space Systems

Task Number 75

Identify the role of NASA.

Definition

Identification should include that NASA is a U.S. government agency that is responsible for science and technology related to air and space. The agency was created to oversee U.S. space exploration and aeronautics research.

Process/Skill Questions

- What is the future of NASA?
- What role does NASA play in commercial space flight operations?
- What technologies have come from space exploration?
- How has the role of NASA evolved since it was established?

ITEEA National Standards

18. Transportation Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

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Task Number 76

Outline the history of the U.S. space program and international space program events.

Definition

Outline should include

- the major milestones and influences on the advancement of the U.S. space program, including NASA missions (e.g., Apollo, Gemini, Mercury, space shuttle operations)
- significant international historical events and technological advances (e.g., International Space Station).

Process/Skill Questions

- What roles did the Mercury, Gemini, and Apollo programs play in putting humans on the moon?
- What role has disaster played in the advancement of the space program?
- Who were American space pioneers?
- What effect did the advent of the space shuttle have on the space program?
- What are examples of items developed for space exploration in everyday use?

ITEEA National Standards

18. Transportation Technologies

7. The Influence of Technology on History

Task Number 77

Describe how Earth's low, medium, and high orbits affect space mission operations.

Definition

Description should include the unique characteristics of each orbit and how each is used for various space mission operations.

Process/Skill Questions

- How are the three orbits delineated?
- What mission requirements determine the choice of a low, medium, or high orbit?
- Which orbit is used for communication satellites?

ITEEA National Standards

18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 78

Identify components of orbital mechanics.

Definition

Identification should include

- Kepler’s three laws
- conic sections
- escape velocity.

Process/Skill Questions

- What is the law of ellipses?
- What is the law of equal areas?
- What is the law of harmonies?

ITEEA National Standards

18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 79

Describe satellites and other space systems.

Definition

Description should include the following types of satellites:

- Communications
- Navigational
- Surveillance
- Observational (weather)
- Command Control Communications and Intelligence (C3I) Defense

Description of other space systems should include the following:

- International Space Station(s)
- Space shuttle program

Process/Skill Questions

- How does the space industry affect everyday life?
- What is the definition of *satellite*?
- What objects currently orbit Earth?
- How, and by whom, are objects orbiting the Earth tracked?
- What role do satellites play in the growth of GPS for aircraft?

ITEEA National Standards

18. Transportation Technologies

Task Number 80

Evaluate the commercialization of space.

Definition

Evaluation should include potential benefits to

- U.S. political relationships
- travel, tourism, and recreation industries
- employment and the economy.

Process/Skill Questions

- How has space exploration benefited humankind?
- How might the privatization of space travel affect NASA's operational goals?
- How does the balance of funding for space exploration compare with the funding of projects to benefit the public here on earth? Should more be spent in one area or the other?
- How might space travel change over the next 50 years?

ITEEA National Standards

13. Assess the Impact of Products and Systems

Exploring Rocketry

Task Number 81

Outline the evolution of rocketry.

Definition

Outlining should include historical milestones, technological advances, and emerging technologies in rocketry.

Process/Skill Questions

- Who is considered the father of American rocketry?

- What are two classifications of rockets?
- What role did the Germans play in the development of rockets during WWII?
- Why is it important to stay abreast of emerging technologies?

ITEEA National Standards

18. Transportation Technologies

7. The Influence of Technology on History

Task Number 82

Apply Newton's three laws of motion to rocketry.

Definition

Application requires an understanding that design must address the challenge of Newton's laws of motion for a rocket to operate. Newton's laws include the following:

- A physical body will remain at rest or continue to move at a constant velocity, unless an outside net force acts upon it.
- The rate of change of momentum is proportional to the resultant force producing it and takes place in the direction of that force.
- To every action there is an equal and opposite reaction.

Process/Skill Questions

- What considerations must be taken when designing rockets to overcome the laws of motion?
- How is Newton's second law applied to rocketry?
- How is the application of Newton's laws to rocketry similar to the same application to aviation?

ITEEA National Standards

18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 83

Calculate the altitude of launched rockets.

Definition

Calculation should be based upon the Malewicki equations (or Fehskens-Malewicki equations) for subsonic, endo-atmospheric rocket flight.

Process/Skill Questions

- How can the altitude of a launched rocket be calculated?
- What role does ambient wind have in predicting recovery area/landing zone?
- Who calculated the trajectories of NASA's early space launches?

ITEEA National Standards

18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 84

Demonstrate the function of rocket systems.

Definition

Demonstration should include systems such as

- airframe
- propulsion
- guidance
- control.

Process/Skill Questions

- What is the purpose of each system?
- How does a change in airframe size affect propulsion and control systems?
- What are the consequences of form drag?
- How has each type of system evolved since its inception?

ITEEA National Standards

11. Apply the Design Process

12. Use and Maintain Technological Products and Systems

18. Transportation Technologies

Task Number 85

Construct a one-stage rocket.

Definition

Construction should include a

- propulsion system (e.g., gas heating, electrical, chemical)
- control system
- recovery system
- housing/fuselage.

Process/Skill Questions

- What are the main internal and external components of a rocket?
- What are types of propulsion systems?
- What are types of recovery systems?
- What are the different phases of a model rocket's flight? How does a model rocket motor work?
- What are the engine classifications for model rocket motors?
- How does center of gravity and center of pressure affect flight?

ITEEA National Standards

11. Apply the Design Process

12. Use and Maintain Technological Products and Systems

18. Transportation Technologies

Task Number 86

Launch a rocket.

Definition

Launch should include

- ensuring all safety procedures, including National Association of Rocketry (NAR) safety procedures, are followed
- performing altitude calculations
- adding the launch system.

Process/Skill Questions

- What are the safety distances for each of the model rocket motors?
- Why is it important to obey safety rules?
- What factors influence altitude calculation?
- What are the components and types of launch systems?
- How can the flight stability of a rocket design be determined before flight?
- What is the NAR, and how is it important to rocketry?
- What are the NAR safety codes?

ITEEA National Standards

18. Transportation Technologies

Living and Working in the Space Environment

Task Number 87

Identify the effects of the space environment on manned operations.

Definition

Identification should include

- various environmental elements, such as weightlessness, solar wind, and extreme temperatures and their influence on human activity in space
- psychological effects
- physical stresses
- aerospace medicine.

Process/Skill Questions

- What is a manned operation?
- What is microgravity?
- Why is sanitation important in a space environment?
- What types of food sources are appropriate on a manned operation?
- What are two effects of the space environment on manned operations? How can the effects of the space environment be minimized?
- How does the solar wind affect manned operations?

ITEEA National Standards

18. Transportation Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

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Task Number 88

Identify applications of unmanned spacecraft.

Definition

Identification should include military and civilian applications and missions that can be accomplished more efficiently and/or more safely by unmanned spacecraft, such as

- surveillance
- mapping
- communications
- weather
- navigation
- control systems
- space reconnaissance
- exploration (by telescope of planetary or visiting space objects or other space occurrences)
- rescue and recovery
- future uses.

Process/Skill Questions

- Why were prior missions to Mars unmanned?
- What types of missions are not safe for manned spacecraft?
- Why are unmanned spacecraft more efficient than manned spacecraft for certain applications?

ITEEA National Standards

18. Transportation Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

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Task Number 89

Examine hazards identified with space operations.

Definition

Examination should include dangers posed by the space environment, rocket systems, computer systems, and human error, such as

- sanitation issues
- sickness and contamination
- mechanical failure
- catastrophic failure
- radiation
- temperature issues
- space debris
- maintenance concerns
- meteorites
- political consequences.

Process/Skill Questions

- What dangers are associated with radiation?
- What considerations must be made for high-speed re-entry into Earth's atmosphere?
- What precautions can be taken to minimize dangerous collisions with manufactured and natural objects in space?
- What are some notable aerospace accidents or tragedies? What lessons were learned as the result of each?

Task Number 90

Plan a space mission.

Definition

Planning should include

- setting the goals and objectives of the mission
- differentiating between manned and unmanned space operations and the considerations for each
- analyzing mission requirements and how they affect the design of the spacecraft
- forecasting technical considerations
- projecting the duration and cost of the project
- assessing required resources
- setting timelines and deadlines.

Process/Skill Questions

- What are the factors involved in the planning of a space mission?
- Why is it important to continue space exploration?
- What is the role of technology in space exploration?
- What are the challenges of intergalactic travel and how can they be overcome?

SOL Correlation by Task

39	Identify the contributions of the pioneers of aviation.	English: 10.5, 10.6, 10.7, 11.5, 11.6, 11.7, 12.5, 12.6, 12.7 History and Social Science: VUS.9, VUS.11, VUS.12, VUS.14, WHII.10, WHII.11, WHII.12, WHII.14
40	Create a flying device.	
41	Describe the construction and initial flight of the first powered aircraft.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.8, VUS.9
42	Construct helicopters.	History and Social Science: VUS.12
43	List major milestones in the development of aviation.	English: 10.5, 10.6, 10.7, 11.5, 11.6, 11.7, 12.5, 12.6, 12.7

		History and Social Science: VUS.9, VUS.11, VUS.12, VUS.14, WHII.10, WHII.11, WHII.12, WHII.14
44	Describe the effects of war on aviation technology and the growth of civil aviation.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.12, WHII.12
45	Describe how aviation has influenced the development of civilization since the advent of powered flight.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WHII.14
46	Research industry trends in aviation.	English: 10.8, 11.8, 12.8 History and Social Science: VUS.14, WHII.14
47	Describe the four forces of flight and how each affects an aircraft in flight.	English: 10.5, 11.5, 12.5 Science: PH.4, PH.5
48	Apply Bernoulli's principle to flight.	English: 10.5, 11.5, 12.5 Mathematics: AII.3 Science: PH.5
49	Apply Newton's laws to aerodynamics.	English: 10.5, 11.5, 12.5 Mathematics: A.4, MA.7 Science: PH.5
50	Create virtual airfoils.	History and Social Science: VUS.12, VUS.14
51	Define common aerodynamics terms.	English: 10.3, 11.3, 12.3
52	Describe the concept of angle of attack and airfoil stall.	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5
53	Create a model airfoil.	English: 10.5, 11.5, 12.5
54	Design a model aircraft.	English: 10.5, 11.5, 12.5
55	Construct a model aircraft without an electric or gas engine.	English: 10.5, 11.5, 12.5
56	Demonstrate an airplane moving about the center of gravity through each of the three axes of flight by operating the rudder, aileron, winglets, and elevator deflection.	
57	Categorize aircraft instrumentation.	English: 10.5, 11.5, 12.5
58	Summarize the operation of a turboprop and turbojet engine.	English: 10.5, 11.5, 12.5
59	Use flight instruments to simulate flight.	

60	Construct an aircraft powered by an electric or gas engine(s).	English: 10.5, 11.5, 12.5
61	Operate an aircraft.	
62	Describe the functions of, and the relationships among, the parts of an aircraft.	English: 10.5, 11.5, 12.5
63	Demonstrate the functions of the four major control surfaces of an airplane.	English: 10.1, 10.5, 11.1, 11.5, 12.1, 12.5
64	Identify atmospheric conditions and their effect on aircraft performance.	English: 10.5, 11.5, 12.5
65	Describe how heat, pressure, and the Earth's rotation interact to affect global wind patterns.	English: 10.5, 11.5, 12.5 Science: ES.12
66	Describe how temperature and moisture affect the stability of the atmosphere.	English: 10.5, 11.5, 12.5 Science: ES.12
67	Identify the characteristics of clouds and their effects on flight.	English: 10.5, 11.5, 12.5 Science: ES.12
68	Describe the characteristics of air mass boundaries.	English: 10.5, 11.5, 12.5 Science: ES.12
69	Analyze flight hazards caused by various atmospheric conditions.	English: 10.5, 11.5, 12.5
70	Chart atmospheric data.	Mathematics: A.9, AII.9 Science: ES.12
71	Compare the function of air traffic control (ATC) in visual flight rules (VFR) and instrument flight rules (IFR) environments.	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5
72	Describe the layout and facilities of a typical airport.	English: 10.5, 11.5, 12.5
73	Identify the functions of the FAA.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WHII.14
74	Describe the NAS and types of airspace.	English: 10.5, 11.5, 12.5
75	Identify the role of NASA.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.12, VUS.13, VUS.14
76	Outline the history of the U.S. space program and international space program events.	English: 10.6, 10.7, 11.6, 11.7, 12.6, 12.7 History and Social Science: VUS.12, VUS.13, VUS.14 Science: ES.3

77	Describe how Earth's low, medium, and high orbits affect space mission operations.	English: 10.5, 11.5, 12.5
78	Identify components of orbital mechanics.	English: 10.5, 11.5, 12.5 History and Social Science: WHII.4 Mathematics: T.9, AII.6, MA.6, MA.7
79	Describe satellites and other space systems.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WHII.14 Science: ES.3
80	Evaluate the commercialization of space.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WHII.14 Science: ES.3
81	Outline the evolution of rocketry.	English: 10.6, 10.7, 11.6, 11.7, 12.6, 12.7 History and Social Science: VUS.12, VUS.14, WHII.12, WHII.14
82	Apply Newton's three laws of motion to rocketry.	English: 10.5, 11.5, 12.5 History and Social Science: WHII.14 Mathematics: AII.6, MA.7 Science: PH.5
83	Calculate the altitude of launched rockets.	Mathematics: AII.6, MA.7
84	Demonstrate the function of rocket systems.	
85	Construct a one-stage rocket.	
86	Launch a rocket.	
87	Identify the effects of the space environment on manned operations.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WHII.14
88	Identify applications of unmanned spacecraft.	English: 10.5, 11.5, 12.5

		History and Social Science: VUS.14, WHII.14 Science: ES.1
89	Examine hazards identified with space operations.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WHII.14
90	Plan a space mission.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.14, WHII.14

Teacher Resources

Instructional Resources for Aerospace Technology

- **Federal Aviation Administration**
  The FAA site contains information helpful to students. Visit the Aviation and Space Education section (http://www.faa.gov/education/) for additional resources for classroom use.
- **Mars One**
  Mars One is a non-profit organization that intends to establish a human settlement on Mars. The site summarizes the aerospace technology that the mission will require and outlines its feasibility and risks.
- **NASA**
  The site offers the latest news on NASA projects and missions, as well as resources for both educators and students.

U.S. Department of Transportation: K-12 Education and Training

The Center for Transportation Workforce Development supports efforts to build awareness and interest in future careers in transportation among K-12 students. Programs and products help provide the skills necessary to succeed as members of tomorrow's transportation workforce. Learn more.

Design Brief: Exploring Aviation History

CHALLENGE:
Students will research and present on aviation history. Each group of students will be assigned a different segment of aviation history (of six). The instructor can add additional segments (e.g., balloons, gliders, myths) as needed.

OBJECTIVES:
Students will work in groups of two, presenting on historical events and their economic and social effects. Presentations should

- explore the progression of aviation technologies
- draw connections to any effect(s) on economy, war efforts, communication, transportation, etc.

MATERIALS:

Materials needed include

- Internet
- computer
- projector.

SECONDARY AREA:

Exploring History

Steven Wagner, Chesterfield County Public Schools, Lloyd C. Byrd High School

Entrepreneurship Infusion Units

Entrepreneurship Infusion Units may be used to help students achieve additional, focused competencies and enhance the validated tasks/competencies related to identifying and starting a new business venture. Because the unit is a complement to certain designated courses and is not mandatory, all tasks/competencies are marked “optional.”

Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- College and Work Readiness Assessment (CWRA+)
- Customer Service Specialist (CSS) Examination
- National Career Readiness Certificate Assessment
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: *A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.*

- Aerospace Technology II (8488/36 weeks)

Career Cluster: Science, Technology, Engineering and Mathematics	
Pathway	**Occupations**
Engineering and Technology	**Aeronautical Drafter** **Aerospace Engineer** **Aerospace Engineering Technician** **Electro-Mechanical Technician** **Electronics Engineering Technician** **Engineer** **Engineering Technician** **Human Factors Engineer** **Power Systems Engineer** **Quality Engineer**
Science and Mathematics	**Atmospheric Scientist** **Materials Scientist**

Career Cluster: Transportation, Distribution and Logistics	
Pathway	**Occupations**
Facility and Mobile Equipment Maintenance	**Aircraft Mechanic and Service Technician** **Aircraft Structure, Surfaces, Rigging, and Systems Assembler**
Transportation Operations	**Air Traffic Controller** **Flight Engineer** **Pilot** **Transportation Manager**
Transportation Systems/Infrastructure Planning, Management and Regulation	**Traffic Engineer** **Traffic Technician** **Transportation Manager**