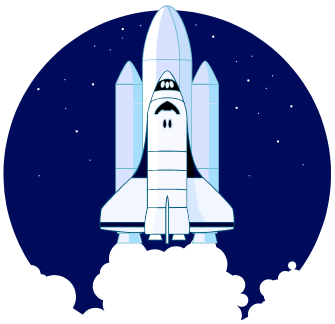
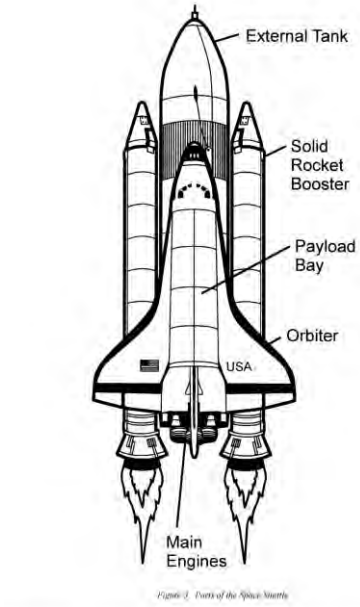
Civil Air Patrol's ACE Program



Rocketing to the Future

Grade 4 Academic Lesson #4



Topics: flight, sequencing, space shuttle, next generation space travel (science, language arts)

Length of Lesson: 45 minutes

Objectives:

- Students will learn about the history of the Space Shuttle program.
- Students will identify parts of the Space Transport System (STS).
- Students will describe how the STS launched and landed.
- Students will place events in order.
- Students will create and experiment flying a Rocket Plane.
- Students will discuss space craft of the future, comparing and contrasting with the STS.

Next Generation Science Standards:

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

CCSS ELA Standards:

- RI.4.10-By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4-5 text complexity band proficiently, with scaffolding as needed at the high end of the range.
- RI.4.7-Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages), and explain how the information contributes to an understanding of the text in which it appears.
- RI.4.4-Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.
- RI.4.1-Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

Background Information:

NASA: What Was the Space Shuttle? -->Part of NASA Knows! For grades K-4

NASA: Space Shuttle -->Check out the history of the program- and the videos.

NASA: Commercial Space Economy -->Current and future space program!

Virgin Galactic -->Space Rocket Plane!

This lesson is about the history of the Space Shuttle program, the fourth human spaceflight program carried out by the National Aeronautics and Space Administration (NASA), which accomplished routine transportation for Earth-to-orbit crew and cargo from 1981 to 2011. It is also about innovation following the Space Shuttle program, using the Rocket Planez provided by CAP for the students to discuss future space travel vehicles.

The Space Shuttle's official name, Space Transportation System (STS), was taken from a 1969 plan for a system of reusable spacecraft of which it was the only item funded for development. The shuttles were launched from Cape Canaveral, Florida, adjacent to Kennedy Space Center. The shuttle orbiter was a partially-reusable orbital space craft, a "space plane," that carried astronauts into space, conducted science experiments, helped build/maintain the International Space Station, and orbited Earth. The space shuttle was like a floating science lab, as astronauts did experiments there, while in the atmosphere of micro gravity.

The shuttle program involved 135 missions until the last flight on July 21, 2011. The shuttle program ended so that NASA could devote its resources to sending astronauts beyond low-Earth orbit, back to the moon, to an asteroid, and eventually, on to Mars. NASA is working with commercial space companies to develop new multi-purpose crew vehicles (MPCV) designed to take crews outward into the solar system, and also working on launch services with commercially-designed spacecraft to take astronauts to and from the ISS. The shuttle program was only the beginning of a routine space transport system to and from space on a regular basis.

The space shuttle was made of three main parts: the orbiter (or, the space plane), the external tank, and the solid rocket boosters. The names of the orbiters were Enterprise, Atlantis, Challenger, Columbia, Discovery, and Endeavour. A really cool thing about the shuttle is that it launched like a rocket, but landed like a glider! Two orbiters, Challenger and Columbia, were destroyed due to accidents. All of the shuttle missions combined lasted 1,322 days, 19 hours, 21 minutes, and 23 seconds-- a grand program, never to be forgotten.

Now, it is up to NASA, commercial space companies, and students, like yours, to design next generation spacecraft. Taking what was learned from the Space Shuttle program, hunankind now involves a race to be innovative and make space craft even better than ever!

Materials:

- model or picture of shuttle (pictures included at end of lesson)
- Rocket Planez (The **Rocket Planez** are provided by CAP for the ACE Program; however, these can also be purchased from AeroRacers.)

*******NOTE: Rocket Planez assembly directions are found HERE. And, Rocket Planez curriculum guide, generously provided by AeroRacers, is found HERE.**

- tape
- scissors
- crayons or markers
- map (if one is not available, click on interactive map, if desired)
- Internet and projector (if needed)

Lesson Presentation:

NOTE: An option to role-playing the shuttle launch and landing is to distribute the shuttle sequence worksheet and guide the students through the steps. For this lesson, spend about 10 minutes going over how the shuttle launched and landed (steps 1-11). Next, spend about 15 minutes making the Rocket Planez. Allow students to spend about 5-10 minutes flying their Rocket Planez. Save about 5 minutes to summarize the lesson.

1. Show students a picture or model of the Space Transport System, commonly called the Space Shuttle. Show a video of a Space Shuttle Launch. Explain that NASA used these shuttles from 1981 – 2011 in order to launch astronauts, satellites, and other payloads into space. Astronauts conducted experiments in the orbiter and even took pieces of the International Space Station (ISS) to space using space shuttles. Tell students that space shuttles flew 135 missions during the program.

2. Tell students that just like they must do things in their day in a certain order, things happened in a certain order during a shuttle mission. Tell students that the shuttles launched from Cape Canaveral, Florida. Point to Florida on a map. Point to your location and help students with an idea of how far away they are from Cape Canaveral.

3. Tell students that some of them will help demonstrate a shuttle launch and landing to the class. To do this, at the front of the classroom, arrange four students in a shuttle stack formation (see labeled shuttle picture on first page of lesson). Stand one small student in front representing the orbiter; a very tall student in back to be the external tank (ET); and two medium-sized students on the sides to represent the solid rocket boosters (SRBs). Explain that the big orange external tank held fuel that the orbiter's three main engines used.

4. Tell students that the astronauts trained for a long time before they actually get to launch day. And, on that day, they got into the orbiter about two hours before the shuttle was scheduled to lift off.

5. See Close-out Team Video to show the process prior to and up to launch.

6. Tell students that the three main engines at the end of the orbiter came on about six seconds before the launch. Tell the student playing the role of the orbiter to march in place when the class gets to "6" in a countdown. Ask what should happen at "0." Confirm that the shuttle should lift off of the ground. (Another launch video.)

7. Have the class countdown starting with 10. Cue the orbiter to walk in place at "6." All of the students representing the major parts of the shuttle should jump at "0."

8. Tell students that the SRB engines worked with the orbiter's main engines to lift the shuttle into the sky, with the SRBs providing the large majority of the lifting power. (Suggest that the two SRB students flex their muscles.) The SRBs propelled the shuttle for about two minutes. At the end of two minutes, they separated from the shuttle stack and landed in the Atlantic Ocean where a boat was waiting to recover them. (Have the two SRB students move away from the orbiter and pretend they are parachuting into the ocean. Have two volunteers to come forward to "drag" them off of the stage to simulate the boats that picked up the SRBs to take them back to get ready for another mission. Then, have these students to be seated.) See separated SRBs landing in the ocean video.

9. Tell students that about nine minutes into the flight, the ET (external tank) came off the orbiter. All of its fuel had been used, and it was no longer needed. (Have the ET student move away from the orbiter.) Tell the class that the ET burned up as it fell back into the atmosphere and any remaining pieces of it landed in the Indian Ocean. (Show on map, if available.) (Have the ET student demonstrate burning up in Earth's atmosphere; then ask the student to be seated.)

10. Tell students that at this time, the orbiter continued on in the space mission. On a number of occasions, the orbiter docked with the International Space Station (ISS). Tell students that dock means "connect." (Have a student come forward to represent the ISS. Have the orbiter and ISS students connect by holding hands.) Oftentimes, the space shuttle would deliver materials for the ISS and the astronauts would work on the space station, as well. See ISS updates!

11. Tell students that when the orbiter undocked from the station, it began its voyage back to Earth. (Have the ISS student be seated.) Explain that the orbiter returned to the surface of Earth as a glider, not as a powered aircraft. It, therefore, only had one opportunity to land correctly, and it landed at about 200 miles per hour. The commander had much training in order to safely land the orbiter. (Have the student playing the role of the orbiter to glide to a fast landing.) That is the end of the shuttle program activities; so, prepare for the next generation of space flight!

12. Now, Meet Dream Chaser, The Next-Generation Space Plane | Countdown to Launch! This new space plane just got one step closer to liftoff, and it could change spaceflight to the ISS in years to come. Next, prepare to launch the Rocket Planez!

13. Tell students that they will get to design and launch a rocket plane today. Distribute scissors, tape, crayons or markers, and the Rocket Planez parts. Lead them through the process of assembling the flying Rocket Planez. (See assembly instructions HERE. There is also a curriculum guide provided by AeroRacers, HERE.)

14. Have students design and color their rocket plane. Have them put their name on their rocket plane before you go outside to launch!

15. **Discuss launching and safety instructions.** Then, follow these directions: *Wind the rubber band by spinning the propeller clockwise approximately 200 - 250 times. If the rubber band breaks, regular long rubber bands can be used. Launch vertically, providing a little boost upward upon releasing. When launching, do NOT hold the Rocket Planez below your face and look down at it. Hold the Rocket Planez out in front of your face. Launch with the wind blowing toward your back, not your face! No one wants a Rocket Planez to fly into his/her face.*

16. Ask students to come back in and talk through what observations they had from their launches. Set up two expert areas in the room (whiteboard, smartboard, or blank wall) and label each one with a topic title: launch and landing. Divide each into two sides: shuttle and rocket plane. Give students sticky notes to jot down what they learned about each topic, comparing/contrasting the shuttle and the rocket plane.

Summarization

Ask students to name at least two parts of the historic space shuttle. Ask students to tell, briefly, the process in launching the space shuttle. Ask students to tell what the space shuttle did when in space or how it was used. Ask students what we've learned from the space program, to include how we've learned from any mistakes in the space program. Remind students that the space shuttle is no longer being used, but it was an invaluable tool from 1981-2011. Allow them a chance to discuss the future of the space program and what commercial space travel already looks like, and will look like in the future. Discuss how rocket planes will also be a part of future space travel. Show the video, Richard Branson's Letter to His Grandchildren video, to allow the students to think about what they can do to help use their minds and knowledge to innovate the new rocket and/or space planes of the future.

Character Connection: Remind students that most of the time, things have to happen in a certain order. If steps are skipped, whatever we are trying to do may not work. For example, in life, if we try to take a test before we've studied, we may not do well. Oftentimes, skipping steps and trying to do things faster puts us and others in unsafe situations. Just like the astronauts had to be very particular about the steps they took to prepare for, launch, and bring back to Earth the space shuttle , we have to think about each part of our day (and life), & take our time to do things in the right order.

Drug Demand Reduction (DDR), a "Drug-free; Way to Be!" Connection for the Rocket Planez: See page 10.

Assessment:
• teacher observation of student discussions and participation
• shuttle sequence cards (included at end of lesson)

Additional activity ideas to enrich and extend the primary lesson (optional):

- Have students arrange the shuttle sequence cards in order. Students may cut the cards out and glue them in order on a sheet of construction paper.
- Have students write a sentence for each shuttle sequence card once the cards are correctly placed in order. Have students write an explanation for each event shown on the cards.
- Compare and contrast a space shuttle launch/landing to a rocket launch/landing.
- Allow students to get into small groups to role-play their own shuttle launch.
- Have students try to hit a target with their Rocket Planez or have contests as to who can fly theirs the highest or whose can stay aloft the longest.
- Have students watch commercial rocket plane for the future: Virgin Galactic's SpaceShip Two Rocket Plane launch

Associated Websites:

- Learn more about the shuttle at
  NASA: Space Shuttle
  NASA: Space Shuttle Videos
  NASA Videos: Watch Archive Footage of Space Shuttles, Hypersonic Jets and Flying Bathtubs on YouTube

ROCKET PLANEZ ACADEMIC CONNECTIONS

You may also wish to use this lesson to teach kinetic and potential energy and/or Newton's Laws of Motion.

➢ **Science: Kinetic & Potential Energy** (from What Makes Things Go?)

There are many different kinds of energy. Every kind of action needs energy to make it happen.

Potential energy, energy that is stored, has to do with the position or arrangement of the parts of an object. An object's potential energy increases as it is raised and stretched. A raised object has gravitational potential energy. The higher an object, the greater this potential energy. As an object falls or moves toward Earth, its potential energy is changed to kinetic energy.

A stretched rubber band has elastic potential energy. As the rubber band returns to its original shape, its potential energy changes to kinetic energy.

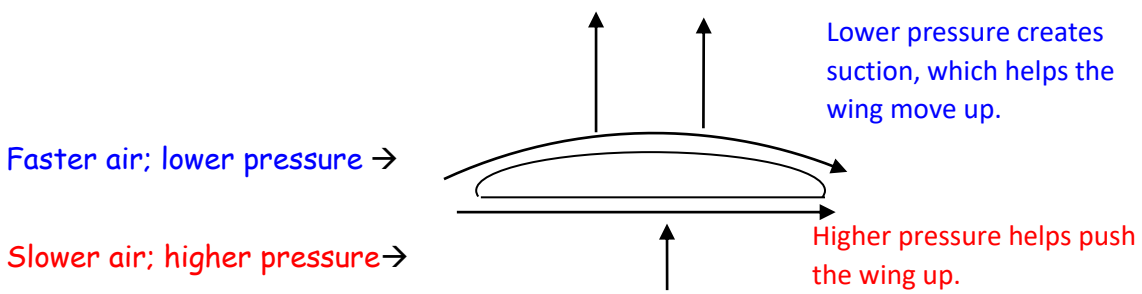
Kinetic energy is the energy an object has because of the motion of its mass. The faster something moves or the greater its mass, the greater its kinetic energy.

➢ *Kinetic & Potential Energy: Connection to Rocket Planez*

Winding the rubber band creates potential energy in the rubber band. After winding, allowing the rubber band to spin creates kinetic energy. This energy causes the propeller to turn. The propeller pushes air downward, and this helps thrust the Rocket Planez into the air!

➢ Science:Bernoulli's Principle

In the early 1700's, Daniel Bernoulli (pronounced "burr-new-lee") determined that faster moving air has a lower pressure than slower moving air. Slow moving air has a higher pressure. The lower pressure creates a suction effect while the higher pressure results in a push. This helps explain why the wings of an airplane lift into the air. Air moves faster over the top of the wing than air moving underneath the wing; therefore, there is a "push" occurring underneath the wing while there is a "pull" above the wing.



➢ *Bernoulli's Principle: Connection to Rocket Planez*

As the Rocket Planez lift off vertically in the air, lift and thrust act together in the same direction. (As the propeller spins, it generates thrust by pushing air downward, as opposed to a horizontal flying airplane's propeller that pushes air back behind the wing.) The blades of the propeller are airfoils, like those of airplane wings, which help to generate lift in exactly the same way as wings of an airplane. Additionally, lift is created as air moves over the wings of the Rocket Planez once the propeller stops and the Rocket Planez glide through the air to land. They are able to glide down rather than dart toward the Earth due to the design which allows air to flow appropriately over the wings generating lift.

➢ Science: Newton's Laws of Motion

In 1687, Isaac Newton published a book with his explanation of how an object, or matter, moves. The book, entitled "Principia," is important to science because in it he explained three laws of motion and the Universal Law of Gravity. Newton's Laws of Motion describe the relationships between motion, matter, and force.

Law	Also known as ...	Description
First law of motion	Law of inertia	An object that is not moving will not move until a force makes it move. An object that is moving will continue to move at a constant speed and direction until a force causes it to change.
Second law of motion	F=*ma*	The force of an object equals its mass times its acceleration.
Third law of motion	Law of action and reaction	For every action there is an equal and opposite reaction.

Newton's second law is a formula. If force equals mass times acceleration, acceleration equals force divided by mass. When the formula is written this way, it explains that an object's speed, or velocity, will depend on its mass and the force that is applied to it.

Visit NASA: Newton's Laws to see the information written above.

Newton's Laws of Motion: Connection to Rocket Planez

Law	··· as it relates to the Rocket Planez
First law of motion	The force generated by the spinning propeller causes the Rocket Planez to go from a state of rest to motion. The Rocket Planez will eventually return to a state of rest when the force created by the spinning propeller stops.
Second law of motion	The speed at which the Rocket Planez fly is determined by its mass and the force of the spinning propeller.
Third law of motion	The action of the propeller pushing downward results in the Rocket Planez flying in the opposite direction, upward.

Shuttle on the crawler going to the launch pad.

Pictures from [NASA: Space Shuttle Multimedia Files](#).

Shuttle on the launch pad.

Cut out the shuttle sequence cards and glue them in order on a piece of construction paper.

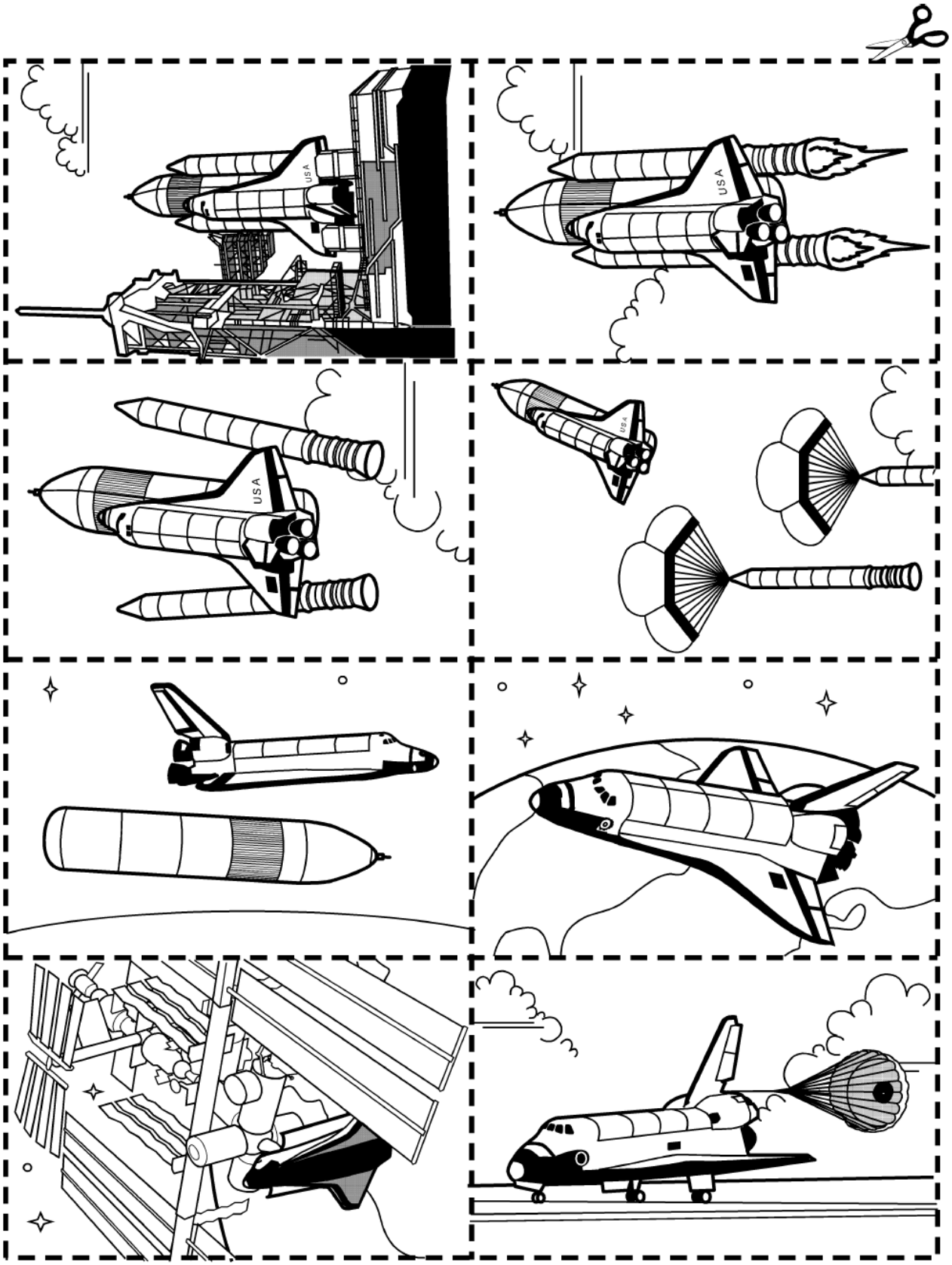
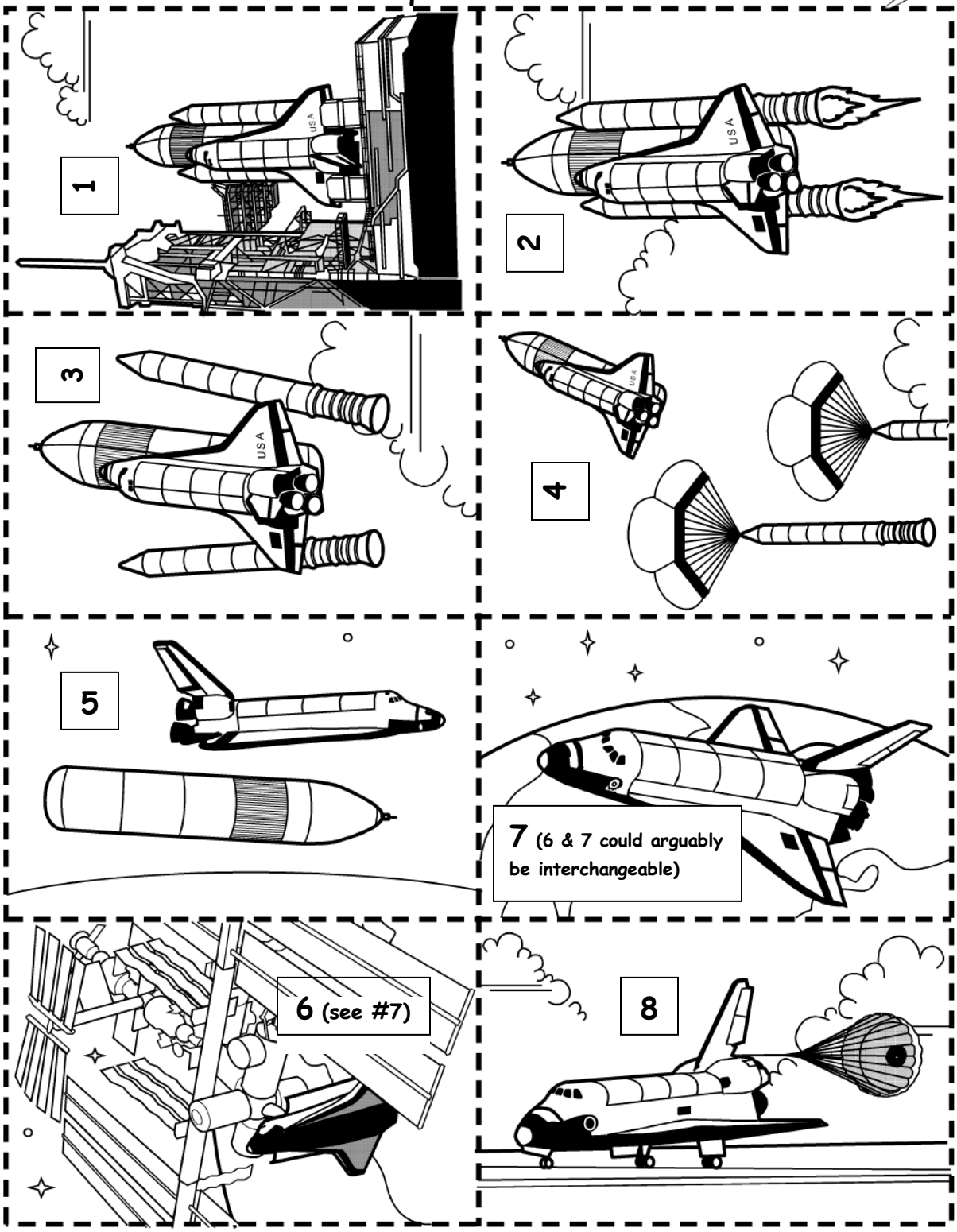


Figure 10. Shuttle Sequence Cards

Shuttle Sequence Card ANSWERS



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