Astraviator

SPACE WORKBOOK

UNIT 5 OF 8

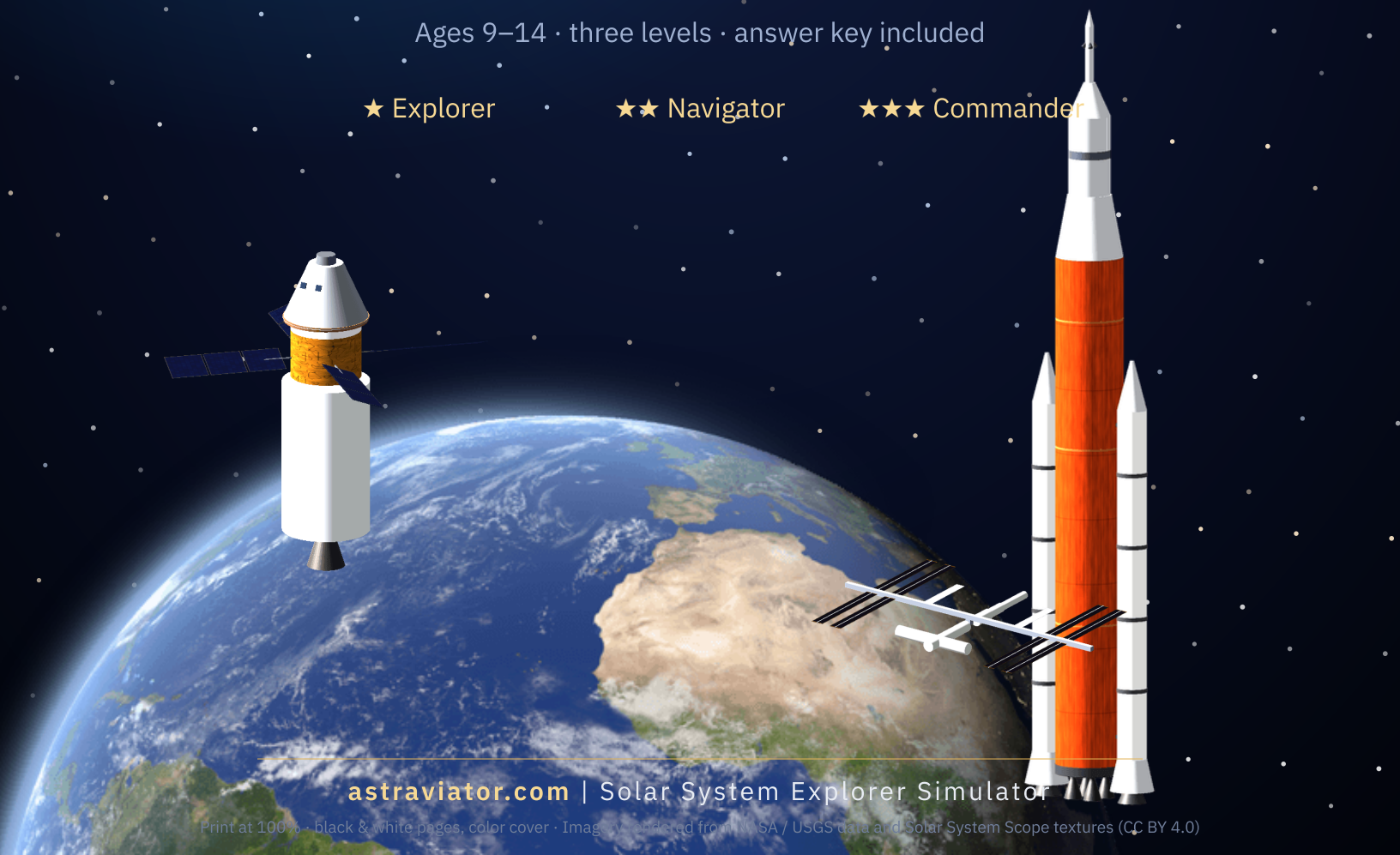
Rockets, Orbits & Missions

Launch · Orbit · Spacecraft · Mission control

Puzzles · Math labs · Coloring · Experiments · Games

Ages 9–14 · three levels · answer key included

★ Explorer · ★★ Navigator · ★★★ Commander



astraviator.com | Solar System Explorer Simulator

Print at 100% · black & white pages, color cover · Imagery adapted from NASA / USGS data and Solar System Scope textures (CC BY 4.0)

FREE SIMULATOR

Scan to fly to the Moon

SOLAR SYSTEM EXPLORER

astraviator.com/explore

Assemble the rocket, launch, cross to the Moon and explore real space data. Play the free simulator in your browser, on a phone, tablet or computer: no install, no account.

SAFETY FIRST Children should do the experiments with an adult, using ordinary household materials and eye protection when asked. Never look directly at the Sun, never cap a bottle that fizzes, and do not point anything at people or pets. Adults are responsible for supervision and for deciding whether an activity is suitable for the child.

Point your phone’s camera at the code and tap the link.

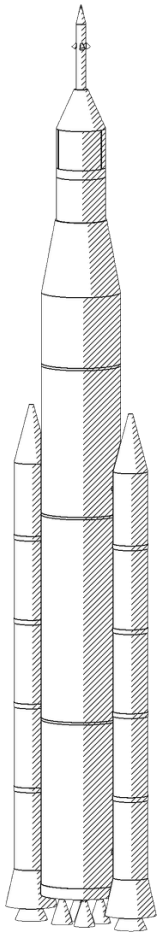
Mission Briefing: How Rockets Work ★ EXPLORER

To reach space, a rocket must beat **gravity**. It burns fuel and pushes hot gas downward; the gas pushes the rocket upward. That push is called **thrust**.

Big rockets are built in **stages**. Each stage drops away when its fuel runs out, so the rocket gets lighter and faster.

Getting into **orbit** is not about going up, but about going *sideways* very fast: about 17,500 miles per hour. Then the spacecraft keeps falling around Earth without hitting it.

The Artemis rocket, the **Space Launch System (SLS)**, is 322 feet tall. It carries the **Orion** capsule with four astronauts toward the Moon.

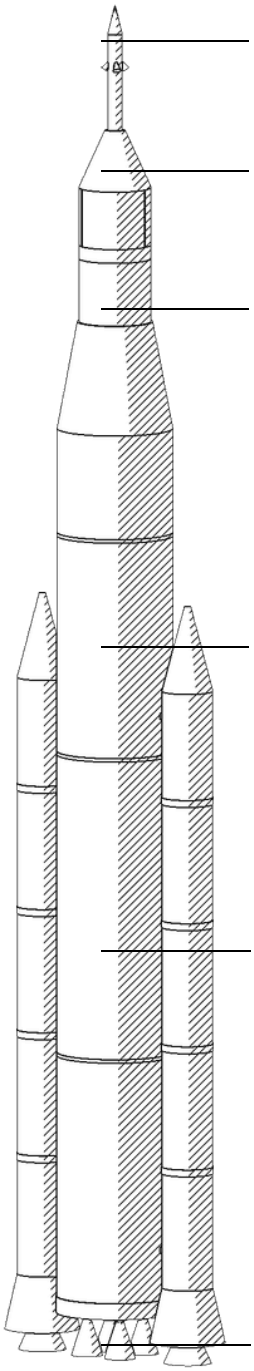


The SLS rocket

	SLS	Space Station (ISS)	Moon
Size	322 ft tall	357 ft long	238,855 mi away
Speed	liftoff to 17,500 mph	17,500 mph	–
Altitude	–	~250 mi	–

Vocabulary to spot: thrust · gravity · stage · capsule · orbit · probe · rover · telescope · mission control

Rocket Anatomy: Label & Stack ★ EXPLORER ★★ NAVIGATOR



Label the six parts of the SLS rocket with the names in the bank.

Launch abort system · Orion capsule + service module · Upper stage and adapter · Core stage (orange) · Solid rocket boosters · RS-25 engines

Stacking order (like in the Vehicle Assembly Building)

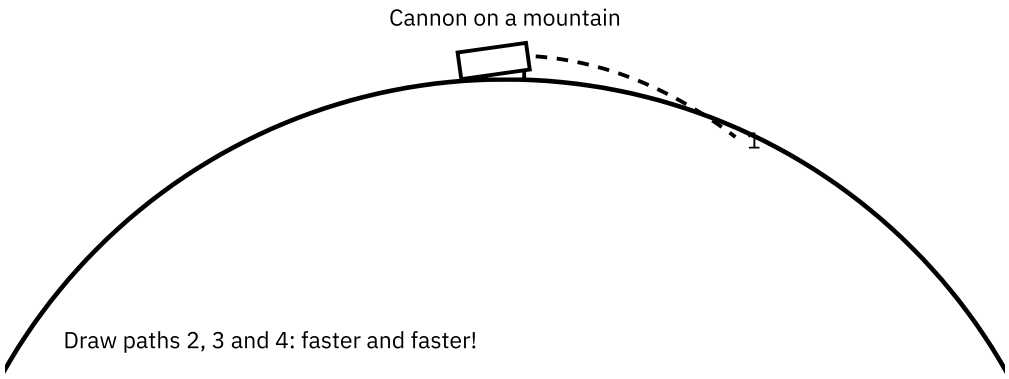
Rockets are built from the bottom up. Number the parts 1 to 8 in the order they are stacked.

_____	European Service Module
_____	Launch vehicle stage adapter
_____	Solid rocket boosters
_____	Orion crew capsule
_____	Upper stage (ICPS)
_____	RS-25 engines
_____	Launch abort system
_____	Core stage

★ Which part saves the crew in an emergency by pulling the capsule away? _____

Newton's Cannon & Orbit Math ★★ NAVIGATOR ★★★ COMMANDER

Isaac Newton imagined a cannon on a very tall mountain. A slow cannonball falls to the ground. A faster one lands farther away. If it is fast enough, the ground curves away as fast as the ball falls, and the ball **orbits**!



1. Which path shows a ball that **orbits**? _____

The Space Station

The ISS flies at 17,500 mph, about 250 miles above Earth. Earth's radius is 3,959 miles.

2. Radius of the orbit = 3,959 + 250 = _____ mi. Circumference = 2 × 3.14 × radius = _____ mi

3. Time for one orbit = distance ÷ speed = _____ ÷ 17,500 = _____ hours = _____ minutes

4. How many orbits does the ISS make in 24 hours? _____ So the crew sees about _____ sunrises every day!

5. How many miles does the ISS travel every second? (17,500 ÷ 3,600 = _____)

Mission Control Morse Code ★★ NAVIGATOR

Before voice radio, messages were sent in **Morse code**, with short signals (dots •) and long signals (dashes –). Use the chart to decode each message. A slash **/** separates words.

A •–	**B** –•••	**C** –•–•	**D** –••	**E** •	**F** ••–•	**G** ––•	**H** ••••	**I** ••	**J** •–––	**K** –•–	**L** •–••	**M** ––
N –•	**O** –––	**P** •––•	**Q** ––•–	**R** •–•	**S** •••	**T** –	**U** ••–	**V** •••–	**W** •––	**X** –••–	**Y** –•––	**Z** ––••

1. • •– •–• – •••• / –•–• •– •–•• •–•• •• –• ––• / –– •– •–• •••

2. •–• ––– •••– • •–• / •–•• •– –• –•• • –•• / ••• •– ••–• • •–•• –•––

3. •–•• •• •••–• – ––– •••–• •••–• / •• –• / – • –• / ••• • –•–• ––– –• –•• •••

4. **Your turn!** Write your first name in Morse code: _____

5. **Send it!** Tap the message on a table (short tap = dot, long tap = dash) for a friend to decode. What was the hardest letter? _____

> Fun fact: the distress signal SOS is • • • – – – • • • in Morse code.

Space Exploration Timeline

★ EXPLORER ★★ NAVIGATOR cut-out

Cut out the event cards, mix them up and put them in order from the oldest to the newest. Then glue them on the timeline.

Artemis I sends Orion around the Moon without a crew

Sputnik 1, the first satellite, orbits Earth

The first crew arrives at the International Space Station

The Hubble Space Telescope is launched

Perseverance lands on Mars; the James Webb telescope is launched

Voyager 1 and 2 are launched

Apollo 11 astronauts land on the Moon

Yuri Gagarin becomes the first human in space

1. How many years passed between Sputnik (1957) and the first human in space (1961)? _____

2. From Apollo 11 (1969) to Artemis I (2022): _____ years. Which came first: Voyager or Hubble? _____

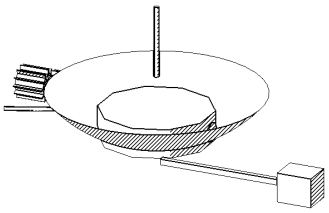
3. The ISS has had astronauts living on board since 2000. If today is 2026, for how many years? _____

Spacecraft Trading Cards (1)

★ EXPLORER cut-out & color

Cut out and color. Play: pick a number (year, weight…) and compare. Bigger wins, except for launch year: the earlier launch wins!

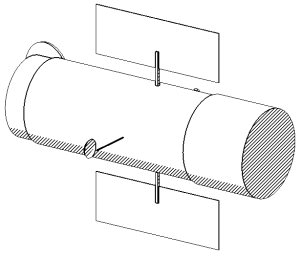
VOYAGER 1



Launched	**1977**
Weight	**1,592 lb**
Job	**Tour the giant planets**
Type	**Probe**

★ **First human-made object in interstellar space**

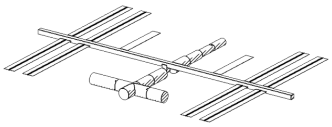
HUBBLE



Launched	**1990**
Length	**43 ft**
Weight	**24,500 lb**
Orbit height	**340 mi**

★ **A telescope that orbits Earth**

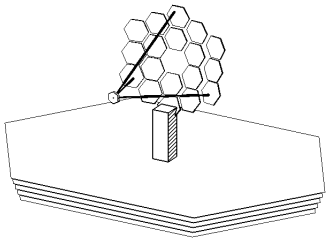
SPACE STATION (ISS)



First crew	**2000**
Length	**357 ft**
Speed	**17,500 mph**
Orbit height	**250 mi**

★ **A laboratory with astronauts on board**

JAMES WEBB



Launched	**2021**
Mirror	**21 ft**
Distance	**~1 million mi**
Looks at	**Infrared light**

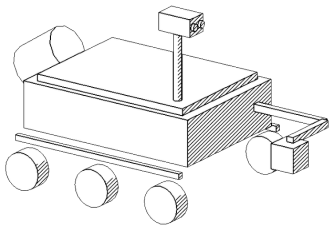
★ **Sees the first galaxies**

Spacecraft Trading Cards (2)

★ EXPLORER cut-out & design

Two more real spacecraft, plus two blank cards: invent your own spacecraft and fill in its card!

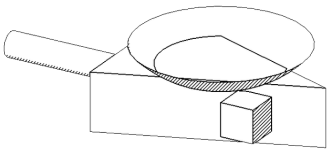
PERSEVERANCE



Landed	**2021 · Mars**
Weight	**2,263 lb**
Wheels	**6**
Place	**Jezero Crater**

★ Searches for signs of ancient life

NEW HORIZONS



Launched	**2006**
Weight	**1,054 lb**
Launch speed	**36,373 mph**
Visited	**Pluto, 2015**

★ Fastest launch of its time

YOUR SPACECRAFT

Draw it here

Name	_____
Launch year	_____
Weight	_____
Mission	_____

YOUR SPACECRAFT

Draw it here

Name	_____
Launch year	_____
Weight	_____
Mission	_____

Math Lab · Rocket Numbers ★★ NAVIGATOR ★★★ COMMANDER

Use a calculator. Round to one decimal.

1. **Thrust-to-weight.** At liftoff the SLS weighs about 5,750,000 pounds and its engines push with 8,800,000 pounds of thrust. Thrust ÷ weight = _____ . A rocket can lift off only if this number is greater than ____ .

2. **Height.** The SLS is 322 feet tall. A 10-story building is about 100 feet. How many 10-story buildings stacked equal the SLS? _____

3. **Timing.** The side boosters separate 132 seconds after liftoff, and the core stage stops at 484 seconds. How many seconds does the core stage work alone? _____ How many minutes is 484 seconds? _____

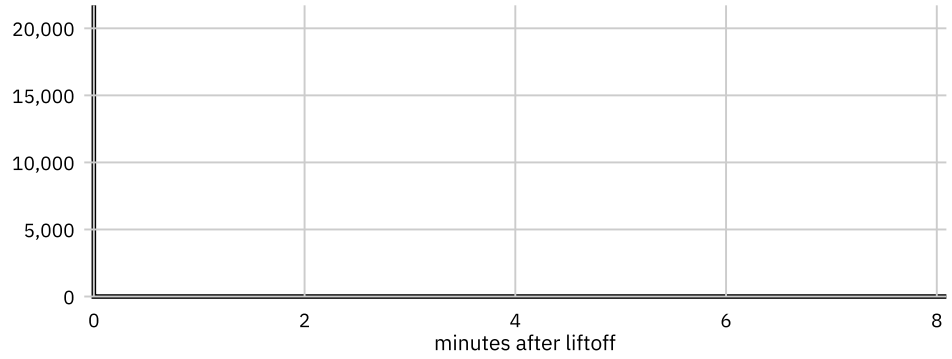
4. **Speed up!** A rocket reaches orbit speed (17,500 mph) in about 8 minutes. How many miles per hour does it gain each minute? (17,500 ÷ 8 = _____) mph

5. **Trip to the Moon.** The Moon is 238,855 miles away. Orion travels about 4 days outbound. Average speed = 238,855 ÷ _____ hours = _____ mph

6. **Escape!** To leave Earth completely, a spacecraft needs about 25,000 mph. How many times faster is that than a jet airliner (550 mph)? _____

Graph: speed of a rocket

Plot these points and join them with a line: 0 min → 0 mph · 2 min → 4,000 mph · 4 min → 8,500 mph · 6 min → 13,000 mph · 8 min → 17,500 mph.



Straw Rocket Lab ★★ NAVIGATOR

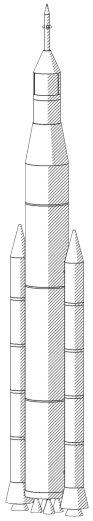
SAFETY Do this with an adult. Never aim the rocket at people, pets or faces, and wear eye protection. An adult handles the scissors.

You need

- A strip of paper (2 × 4 in)
- A straw (drinking straw)
- Tape and scissors
- A tape measure or yardstick

Build & launch

1. Roll the paper around the straw to make a tube and tape it. Pinch and tape one end closed: that is your rocket.
2. Slide the rocket on the straw and blow hard through the straw.
3. Measure how far it flew. Do 3 launches at each angle (30°, 45°, 60°).



Real rockets also need fins and a smooth shape.

Angle	Launch 1 (ft)	Launch 2 (ft)	Launch 3 (ft)	Average (ft)
30°				
45°				
60°				

1. Which angle sent the rocket farthest on average? _____

2. Why did you launch each angle three times?

_____

3. Change one thing (add fins, make it longer, use a heavier paper) and test again. What did you change and what happened?

_____

_____

Mission Control: Go or No-Go? ★★★ COMMANDER

Before a launch, each Mission Control station says **GO** (ready) or **NO-GO** (not ready). Use the clues to find out who says what. Write GO or NO-GO next to each station.

Flight	
Guidance	
Propulsion	
Weather	
Range Safety	
Crew	

Clues

1. Exactly two stations are No-Go.
2. If Weather is Go, then Range Safety is Go.
3. Flight and Crew give the same answer.
4. Either Propulsion or Guidance is No-Go, but not both.
5. Weather is No-Go.
6. Crew is Go.
7. Guidance is Go.

1 Should the launch proceed? _____ Which system needs repair? _____

2 **Your turn.** Write 3 clues for a new Go/No-Go puzzle for a friend.

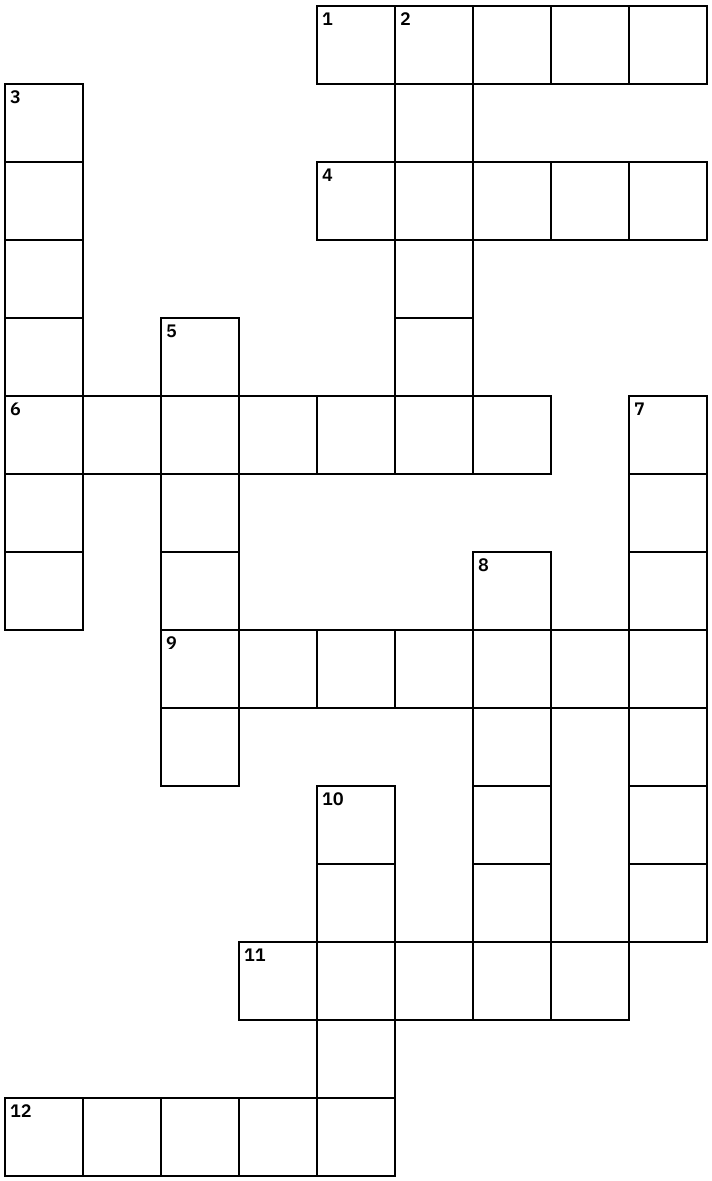
_____

_____

_____

Rocket Crossword ★★ NAVIGATOR

Every answer is a word from this unit.



ACROSS →

1. A rocket section that falls away when its fuel is used up

4. The path of a spacecraft around a planet

6. The force that pulls a rocket back down

9. The part of the rocket where the crew rides

11. A robot that drives on another world

12. Code of dots and dashes

DOWN ↓

2. The push that lifts a rocket

3. Probe now in interstellar space

5. To blast a rocket into the sky

7. NASA program to return people to the Moon

8. Space telescope launched in 1990

10. A robotic spacecraft that explores the solar system

Launch Day Sequence ★ EXPLORER cut-out

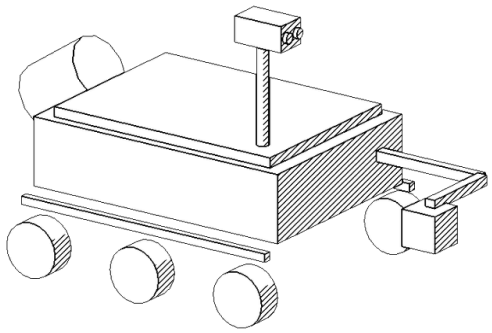
Cut out the cards, shuffle them and put them in the correct order from the morning of the launch until Orion reaches orbit.

- ☐ Boosters ignite: LIFTOFF!
- ☐ Orion reaches orbit around Earth.
- ☐ The crew wakes up and eats breakfast.
- ☐ The crew climbs into the Orion capsule.
- ☐ The crew puts on their orange launch suits.
- ☐ Mission Control polls every station: Go or No-Go.
- ☐ The solid boosters separate (about 2 minutes up).
- ☐ The countdown reaches T−10 seconds.
- ☐ The core stage shuts down (about 8 minutes up).
- ☐ The crew rides to the launch pad.

1 How many seconds are there in the last 10 seconds of the countdown? _____ In 1 minute? _____ In 10 minutes? _____

Create · Design Your Rover

★ EXPLORER ★★ NAVIGATOR



Perseverance: a real rover on Mars

A rover needs wheels to drive, cameras to see, a robot arm to touch rocks, an antenna to talk to Earth, and power. Design your own rover to explore another world.

DRAW your rover here and label at least four parts

1. Name: _____ Destination: _____

2. What question about that world will your rover answer?

_____

_____

Unit Review · Mission Check

★ EXPLORER ★★ NAVIGATOR ★★★ COMMANDER

1. **Match** (write the letter): thrust ___ orbit ___ stage ___ probe ___
   A. a rocket section that drops away · B. the push that lifts a rocket · C. a robotic explorer · D. the path around a planet

2. **Why** does a spacecraft in orbit not fall to the ground?

3. **Calculate.** The ISS orbits in about 90 minutes. How many orbits in one day (1,440 minutes)? _____

4. **Decode** this Morse message: • • • – – – • • • = _____

5. **Order** from oldest to newest: Hubble · Sputnik · Perseverance · Apollo 11:

6. **True or false?** a) Rockets are built in one piece. T / F b) The ISS stays in orbit because it moves sideways very fast. T / F c) Voyager 1 is an orbiter of Mars. T / F

7. **Compare.** How are a rover and a probe alike and different?

8. **Decide.** Which spacecraft would you like to build and why?

Mission Log ★ EXPLORER

Check the boxes when you can do each one. Color a star for each section you enjoyed.

☐ I can name the main parts of a rocket.

☐ I can explain how thrust beats gravity.

☐ I can explain why an orbit is falling around Earth.

☐ I can calculate orbit times and speeds.

☐ I can decode and write Morse code.

☐ I can put space history events in order.

☐ I can compare real spacecraft.

☐ I can design a rover for another world.

My favorite activity was

Something new I learned

A question I still have about space

UNIT 5
ROCKETS & MISSIONS
★ ★ ★
MISSION COMPLETE

Signed: _____
Date: _____

The Space Workbook series

You have **Mission 5**. There are **8 missions** in all: each one is a complete set of puzzles, math labs, games and experiments, and each works on its own.

1	**Earth, Moon & Sun** Phases, time zones, seasons, eclipses, tides	☐
2	**Rocky Planets** Mercury, Venus, Earth and Mars	☐
3	**Giant Planets** Jupiter, Saturn, Uranus and Neptune	☐
4	**Moons, Dwarf Planets & Small Bodies** Pluto, Ceres, comets, asteroids and icy moons	☐
5	**Rockets, Orbits & Missions** SLS, orbits, Morse code, spacecraft	**★ YOU ARE HERE**
6	**Stars, Constellations & Galaxies** Light-years, star maps, galaxies, black holes	☐
7	**Life Beyond Earth** Habitable zones, extremophiles, exoplanets	☐
8	**Astronaut Life** Training, spacewalks, food, living in orbit	☐
+	**Field Guide** The 29 destinations of the Solar System Explorer	in the Complete Workbook

Want them all in one file? The Complete Space Workbook has all 8 missions, the Field Guide and every answer key. Download it free at **astraviator.com/explore**

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