Astraviator

SPACE WORKBOOK

UNIT 2 OF 8

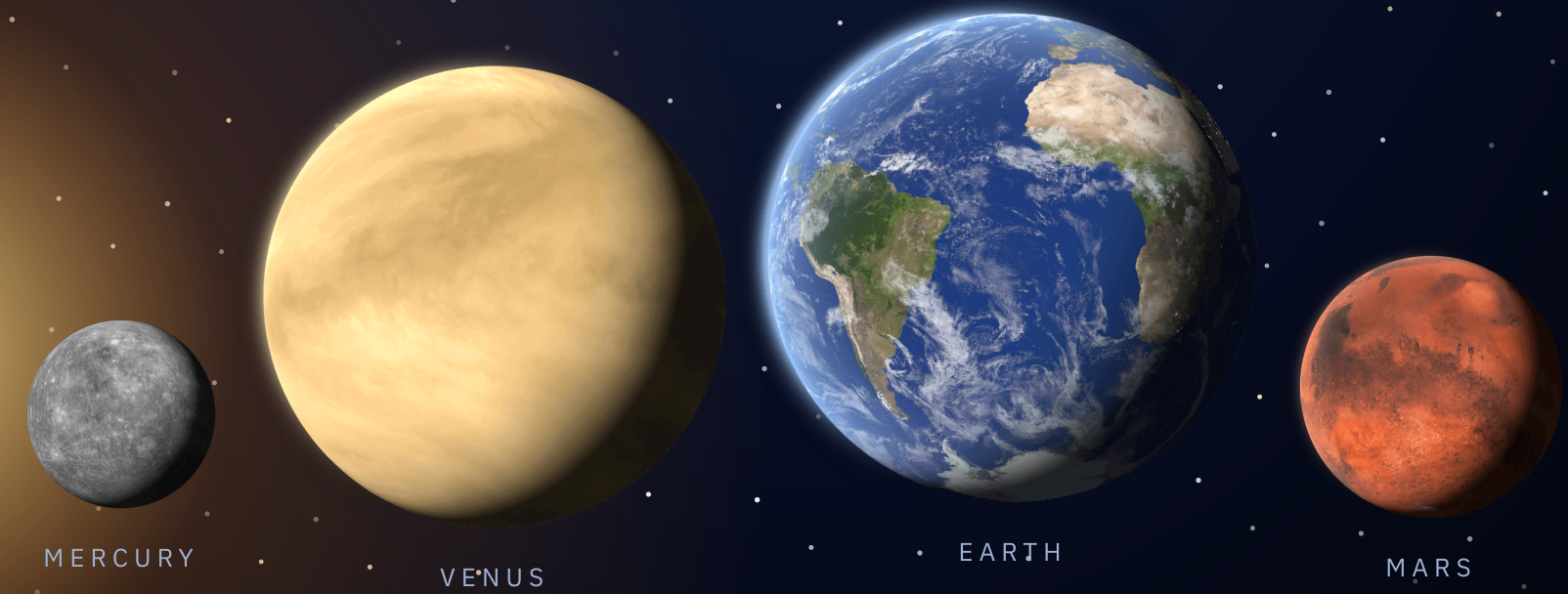
Rocky Planets

Mercury · Venus · Earth · Mars

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 rendered 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 ★ EXPLORER

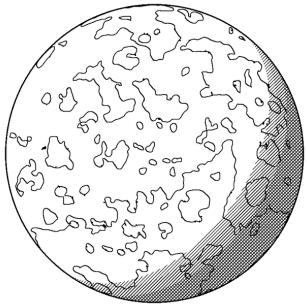
Four worlds, one family. **Mercury, Venus, Earth** and **Mars** are the **rocky planets**: they are made mostly of rock and metal, they have solid surfaces, and they circle closest to the Sun.

Mercury is the smallest planet and the fastest, racing around the Sun in just 88 days. With almost no **atmosphere** to hold in heat, its surface swings from about 800 °F in the day to −290 °F at night.

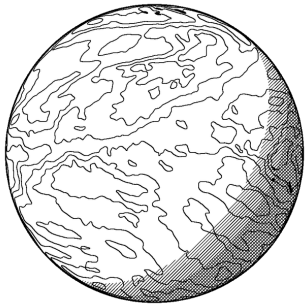
Venus is wrapped in thick clouds and a heavy atmosphere of carbon dioxide. This **greenhouse effect** traps heat and makes Venus the hottest planet, hot enough to melt lead! It also spins backward, so the Sun rises in the west.

Earth is our home: the only planet we know with liquid water on its surface, and with life. Its **magnetic field** and atmosphere protect us.

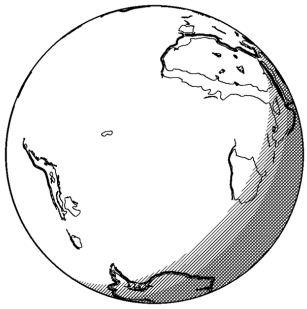
Mars is a cold, dusty desert. Rusty iron dust gives it the nickname *the Red Planet*. It has two tiny moons, polar ice caps, and signs of ancient rivers and lakes. Robot **rovers** explore it today.



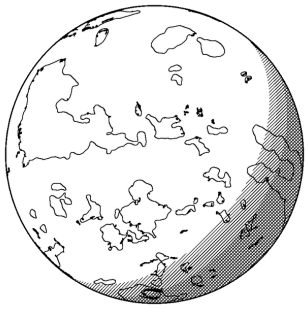
Mercury



Venus



Earth



Mars

Color the planets while you read. Use what the text tells you!

Planet snapshot

	Mercury	Venus	Earth	Mars
Width	3,032 mi 4,879 km	7,521 mi 12,104 km	7,918 mi 12,742 km	4,212 mi 6,779 km
One year (Earth days)	88	225	365	687
Gravity (Earth = 1)	0.38	0.90	1.00	0.38
Moons	0	0	1	2
Temperature	−290 to 800 °F	about 870 °F	about 59 °F (average)	about −81 °F (average)

Vocabulary to spot: rocky planet · atmosphere · greenhouse effect · magnetic field · rover · crater · gravity · orbit · crust · mantle · core

Planet Word Search ★ EXPLORER

Find the 14 hidden words. They run **across, down** and **diagonally** (down-right and up-right).

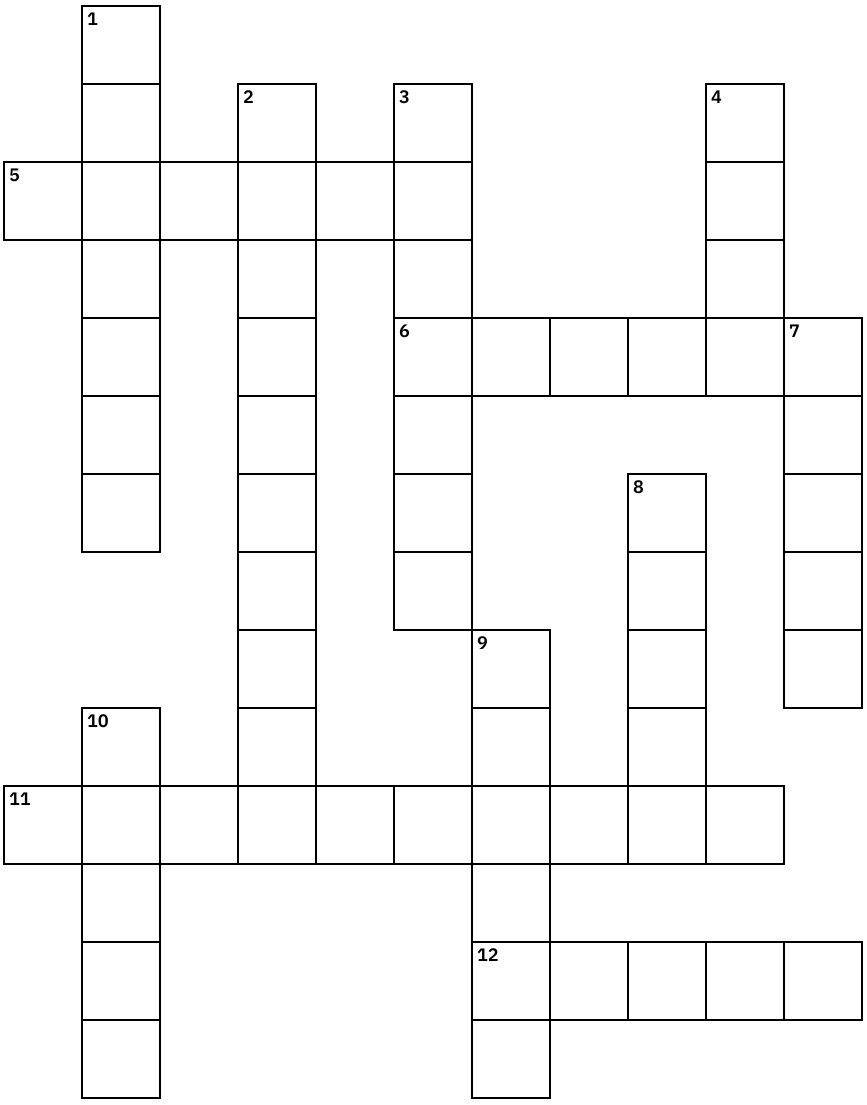
V D V J H D B A R O V E R P
Y L F E G P C O R E P E Y N
O U A T M O S P H E R E Q Y
K P K U D F R F C V E E A G
M A N T L E X O C R E W V W
N W I H M B B M I K A N F T
E Z L O E C A R B C G T U G
A A T I R R H V Q R R Y E S
R O V R C U H O Z L A A M R
T M Q O U S V L Z B V D S C
H M W N R T C C Q N I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

- ☐ ATMOSPHERE
- ☐ CORE
- ☐ CRATER
- ☐ CRUST
- ☐ EARTH
- ☐ GRAVITY
- ☐ IRON
- ☐ MANTLE
- ☐ MARS
- ☐ MERCURY
- ☐ ORBIT
- ☐ ROVER
- ☐ VENUS
- ☐ VOLCANO

Bonus ★★: Pick any three words from the list and write a sentence for each one.

Rocky Planet Crossword ★★ NAVIGATOR

Use the clues to fill in the grid. Every answer is a word from this unit.



ACROSS →

5. The thick layer of hot rock between the crust and the core

6. A bowl-shaped hole made when something smashes into a planet

11. The ___ effect traps heat in the atmosphere of Venus

12. The curved path a planet follows around the Sun

DOWN ↓

1. The force that pulls objects toward the center of a planet

2. The blanket of gases around a planet

3. The smallest planet, and the closest to the Sun

4. The hot, metal center of a planet

7. A robot vehicle that drives across another world

8. The hottest planet; its day is longer than its year

9. The larger of the two moons of Mars

10. The thin, rocky outer layer of a planet

Name: _____

Scrambled & Missing Words ★ EXPLORER

A · Unscramble the words

1. CRMUYRE	_____	The planet closest to the Sun
2. UVNSE	_____	The hottest planet
3. MRSA	_____	The Red Planet
4. ACERTR	_____	A bowl-shaped hole made by an impact
5. ERRVO	_____	A robot that drives on another world
6. OTBIR	_____	The path of a planet around the Sun
7. NMTELA	_____	The thick layer of rock under the crust
8. IYVAGTR	_____	The force that pulls things down

B · Fill in the blanks

Word bank: **Venus · atmosphere · greenhouse · Red · rover · crater** (use each word once)

The rocky planets are Mercury, _____, Earth and Mars. Venus is the hottest of them because its thick _____ traps heat in a _____ effect. Mars is called the _____ Planet because of the rusty iron dust on its surface. A robot explorer that drives across Mars is called a _____. A bowl-shaped hole made by an impact is a _____.

C · Spot the mistake ★★

Each sentence has ONE wrong fact. Cross it out and write the right one.

1. Mercury is the biggest of the rocky planets.

_____

2. Venus is the coldest planet because it is covered in ice.

_____

3. Mars has no moons at all.

_____

4. A year on Earth lasts 88 days.

_____

D · Which planet am I?

1. I have two tiny moons and a red-orange color. **I am** _____
2. I am the smallest planet. I zip around the Sun in 88 days. **I am** _____
3. I spin backward, and my day is longer than my year. **I am** _____
4. I am the only world known to have life. **I am** _____

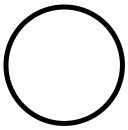
Math Lab 1 · Scale Models ★★ NAVIGATOR

Scientists use **scale models** to compare huge things. In our model, **1 inch = 5,000 miles**. Divide each planet's width by 5,000 to find its model size. Round to one decimal place.

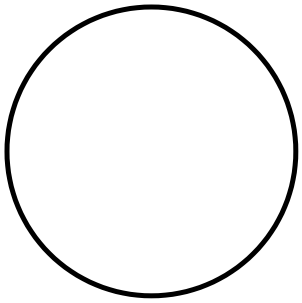
Planet	Real width (mi)	÷ 5,000 = model width (in)
Mercury	3,032	_____
Venus	7,521	_____
Earth	7,918	_____
Mars	4,212	_____

Draw to scale

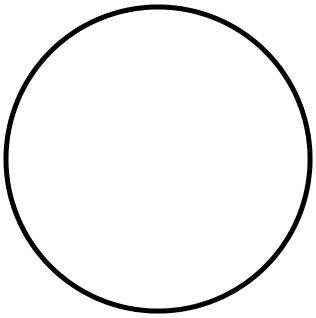
These circles are the planets at true model size (print at 100%). Which is which? Label them, then color.



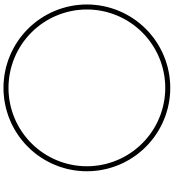
Planet: _____



Planet: _____



Planet: _____



Planet: _____

1. Which planet is the largest? _____ The smallest? _____

2. How much wider is Earth than Mercury? Show your work. _____ _____ miles

3. About how many Mars-widths fit across Earth? _____ (Earth width ÷ Mars width, rounded to the nearest whole number)

★★★ Earth is about 24,901 miles around. If you could drive around it at 60 miles per hour without stopping, how many hours would it take? _____ hours. How many days? _____

Math Lab 2 · Weight & Jump ★★ NAVIGATOR

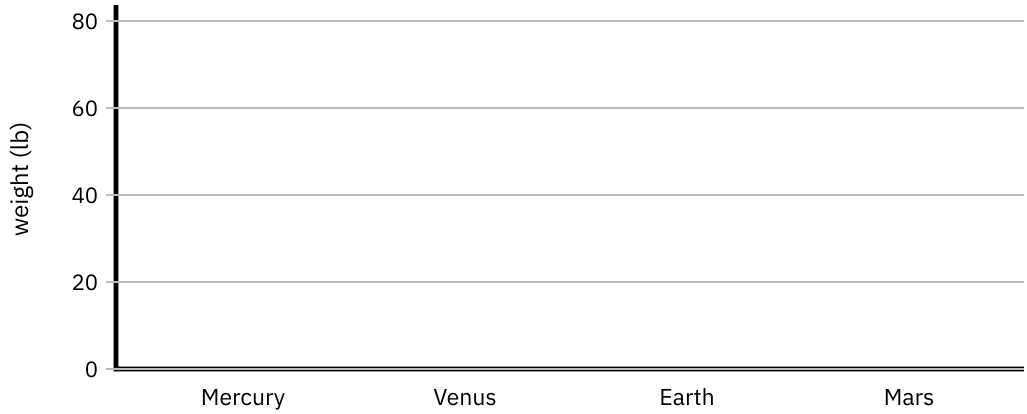
Gravity pulls on you. On a world with weaker gravity you would weigh less and jump higher! To find your weight on another planet: **weight on Earth × gravity**. To find your jump height: **jump on Earth ÷ gravity**.

Our astronaut weighs **80 lb** on Earth and jumps **2 ft** high.

Planet	Gravity (Earth = 1)	Weight (lb)	Jump (ft)
Mercury	0.38	_____	_____
Venus	0.90	_____	_____
Earth	1.00	_____	_____
Mars	0.38	_____	_____

Graph it

Draw a bar for each planet's weight.



1. A rover weighs 2,200 lb on Earth. How much does it weigh on Mars? _____ lb

2. An astronaut in a space suit weighs 300 lb on Earth. On Mercury she would weigh _____ lb.

3. Which two planets give the same weight? _____ and _____

4. ★★★ You can jump 3 ft high on Earth. How high could you jump on Mars? Show your work: _____ ft

5. Write one more question about weight or jumping on another world, then trade with a friend to solve it.

_____

_____

Math Lab 3 · Days, Years & Ages ★★★ COMMANDER

A planet's **year** is the time it takes to go around the Sun once. Mercury is close and fast; Mars is far and slow. Use the year lengths (in Earth days) to solve the puzzles. Round to one decimal.

	Mercury	Venus	Earth	Mars
Year (Earth days)	88	225	365	687

1. How many Mercury years fit in one Earth year? (365 ÷ 88) _____

2. **How old would a 12-year-old be on each planet?** Age on a planet = (12 × 365) ÷ the planet's year.

Mercury	Venus	Earth	Mars
_____	_____	12	_____
Now try your own age: _____ years → Mercury _____ Venus _____ Mars _____			

3. On Venus, one day (243 Earth days) is longer than one year (225 Earth days). How many days longer? _____

4. On Mercury, sunrise to sunrise takes 176 Earth days. Compare that with its 88-day year. A Mercury day is _____ times as long as its year.

5. **Road trip to Mars!** At its closest, Mars is about 33,900,000 miles away. A spacecraft flies in a straight line at 25,000 mph. Travel time in hours = distance ÷ speed. _____ hours = _____ days (divide by 24)

6. One Mars year is 687 Earth days. How many Earth years is that? _____ (687 ÷ 365)

7. Which planet has the **shortest** year? _____ The **longest**? _____ Why do you think the farther planets take longer?

_____

_____

Real spacecraft take about 7 months, because they follow curved paths and Mars is usually much farther than its closest approach.

Hot, Cold & Inside Earth ★★★ COMMANDER

A · Temperature converter

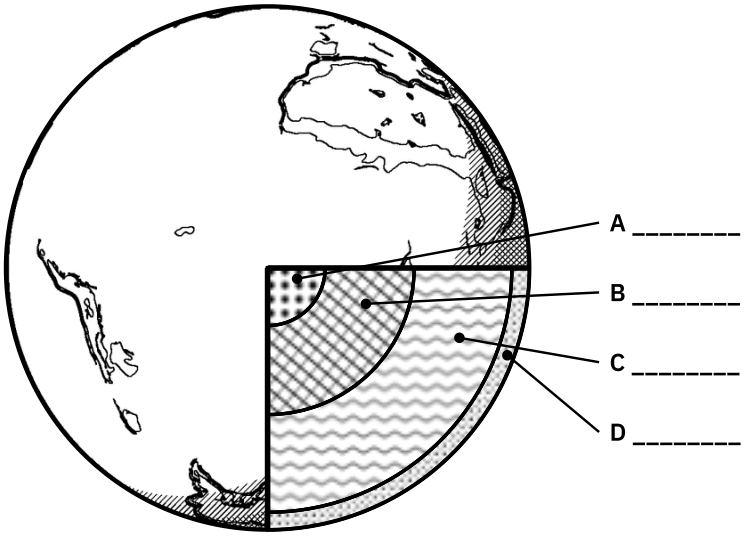
Scientists often use degrees Celsius (°C). Convert to Fahrenheit: **°F = °C × 9 ÷ 5 + 32**.

Place	°C	°F
Mercury, daytime	430	_____
Mercury, nighttime	-180	_____
Venus, surface	465	_____
Earth, average	15	_____
Mars, average	-63	_____

1. How big is Mercury's temperature swing between day and night? _____ °F

2. How much hotter is the surface of Venus than Earth's average? _____ °F

B · Inside a rocky planet



Rocky planets have layers. Label the diagram with the words below and **color** each layer.

Crust · Mantle · Outer core (liquid metal) · Inner core (solid metal)

★★★ Earth's layers are roughly: crust 20 mi + mantle 1,800 mi + outer core 1,400 mi + inner core 760 mi. Add them: _____ mi. Earth's radius is 3,959 mi. How close is your total? _____ mi off.

Color by Number · Mars ★ EXPLORER

Solve each problem. The answer is the number of that color. Then color every square with its number to reveal the picture.

Black (space)
9 − 8 = _____

Light orange (the surface of Mars)
12 ÷ 6 = _____

Brown (dark regions)
5 − 2 = _____

White (the polar ice cap)
2 × 2 = _____

Gray (craters)
20 ÷ 4 = _____

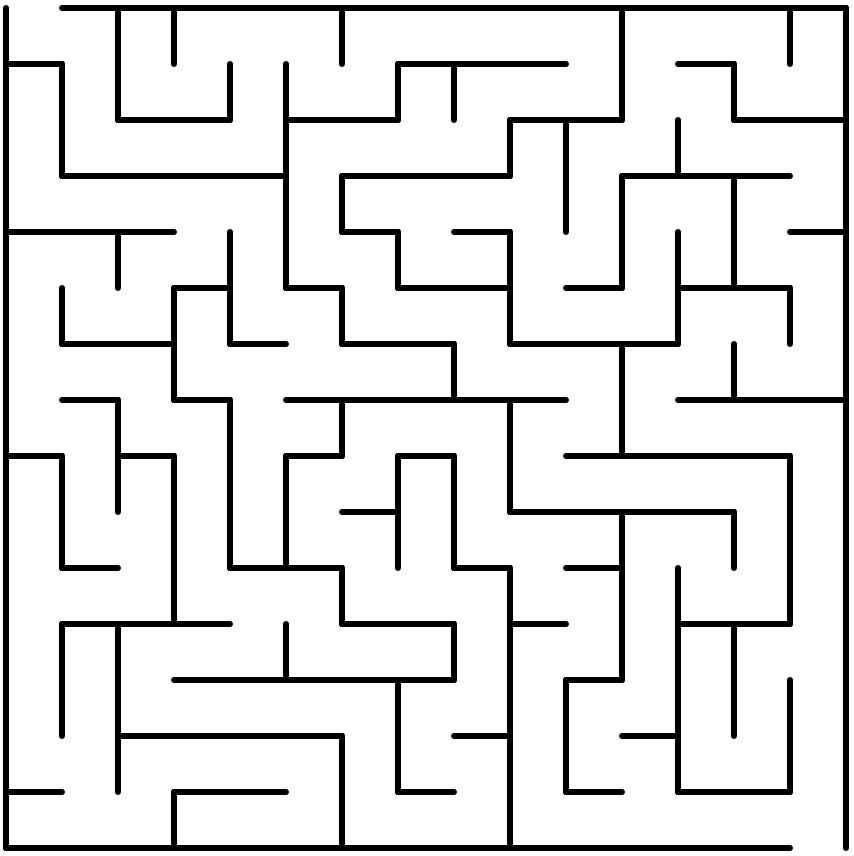
Yellow (stars)
3 + 3 = _____

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1
1	1	1	1	1	1	4	4	4	4	4	4	4	4	6	1	1	1	1
1	1	1	1	4	4	4	4	4	4	4	4	4	4	4	4	1	1	1
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6	1	2	2	2	2	2	2	2	2	2	5	5	5	2	2	2	2	1
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1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	6
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1	1	2	2	2	5	5	5	3	3	3	2	5	5	5	3	3	3	1
1	1	2	2	2	5	5	5	3	2	2	5	5	5	5	5	3	3	1
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1	6	1	1	2	2	2	2	2	3	3	3	3	3	3	3	1	6	1
1	1	1	1	1	1	2	2	3	3	3	3	3	3	6	1	1	1	1
1	1	6	1	1	1	1	1	1	3	3	1	1	1	1	1	1	1	1
1	1	1	1	1	1	6	1	1	1	1	6	1	1	1	1	1	1	1

Rover Maze & Planet Sudoku ★ EXPLORER ★★ NAVIGATOR

A · Guide the rover to the ice

The rover starts at the top-left. Find the path to the ice at the bottom-right.



B · Planet sudoku

Fill the grid so that each row, each column and each 2×2 box has **all four planets once**: **Me** = Mercury, **Ve** = Venus, **Ea** = Earth, **Ma** = Mars.

	Ve	**Ma**	**Ea**
	Ea		**Ve**
	Ma		**Me**
Ve			

Secret Mission Messages ★★ NAVIGATOR ★★★ COMMANDER

A · Decode it ★★

Mission Control sent a coded message! Each letter was moved **5 places forward** in the alphabet (A → F, B → G, …). Use the strips to decode it.

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

top row = real letter · bottom row = coded letter

B F Y J W T S H J K Q T B J I T S R F W X

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

B · Crack it ★★★

This one has a **secret shift** you must discover. Hint: the most common letter in English is **E**. Which coded letter shows up most often? Try shifts until the words make sense!

A O L Y V C L Y M V B U K Y V J R Z

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

M Y V T H U H U J P L U A Y P C L Y

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

The shift was _____ places. (Write the message on the lines below.)

_____

_____

C · Your turn ★★

Write a secret message about space (shift **3**: A → D, B → E…) for a friend to decode.

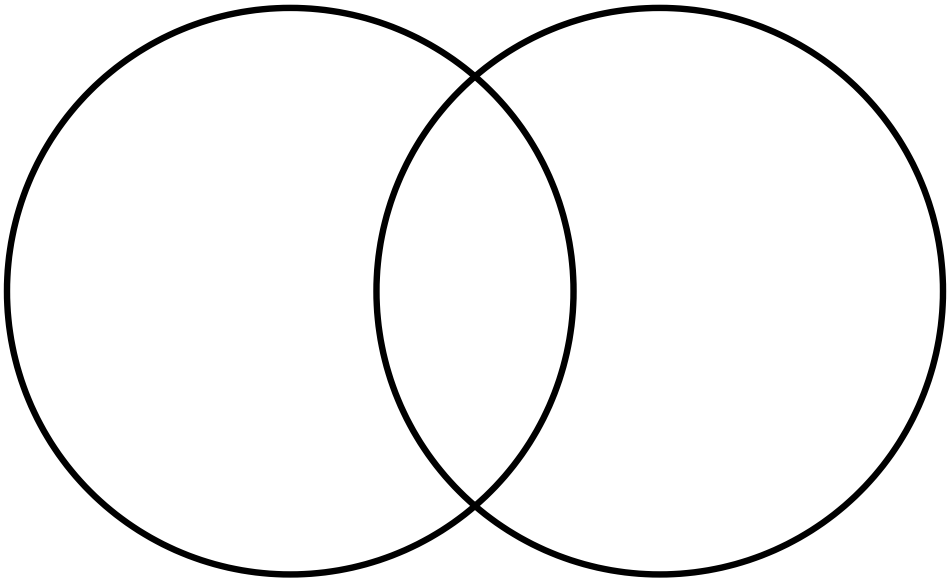
Message: _____

Coded: _____

Compare & Contrast · Earth vs Mars ★★ NAVIGATOR

Cut out the fact strips, or write each letter in the right place. Put a fact in **Earth**, **Mars**, or the overlap (**both**).

EARTH ONLY **BOTH** **MARS ONLY**



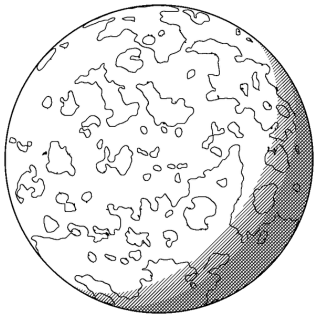
A Has polar ice caps	**B** Is a rocky planet	**C** Has seasons
D Has volcanoes (active or extinct)	**E** Has liquid water on its surface	**F** Has clouds in its atmosphere
G Has one large moon	**H** A day lasts about 24 hours	**I** Average temperature is far below freezing
J Only robots have visited so far	**K** Atmosphere is mostly nitrogen and oxygen	**L** Has two tiny moons

Which fact surprised you most? _____

Rocky Planet Trading Cards ★ EXPLORER cut-out & color

Cut along the dashed lines. Color the planets. Play with a friend: pick a number, compare cards, and the higher (or lower!) number wins the round.

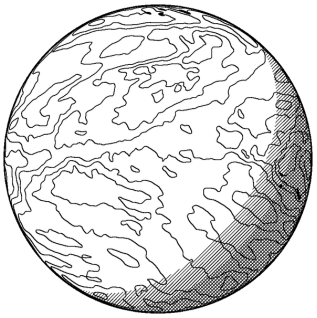
MERCURY



Width	**3,032 mi**
Day	**176 Earth days**
Year	**88 days**
Gravity	**0.38 g**
Moons	**0**
Temp	**−290 to 800 °F**

★ Smallest planet

VENUS



Width	**7,521 mi**
Day	**243 Earth days**
Year	**225 days**
Gravity	**0.90 g**
Moons	**0**
Temp	**about 870 °F**

★ Spins backward

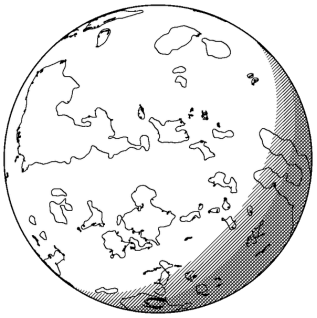
EARTH



Width	**7,918 mi**
Day	**24 hours**
Year	**365 days**
Gravity	**1.00 g**
Moons	**1**
Temp	**about 59 °F**

★ Home of life

MARS



Width	**4,212 mi**
Day	**24 h 37 min**
Year	**687 days**
Gravity	**0.38 g**
Moons	**2**
Temp	**about −81 °F**

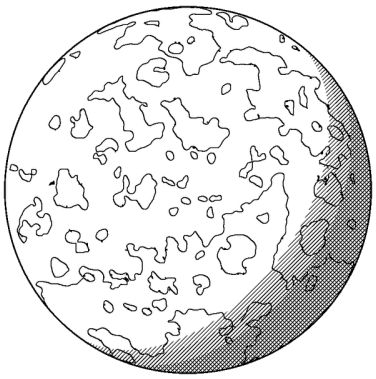
★ The Red Planet

Crater Lab · Hands-On Experiment ★★ NAVIGATOR

SAFETY Do this with an adult. Drop the balls gently, keep your face back from the flour, and pick up any that roll away.

You need

- A shallow baking pan or box lid
- Flour (about 1 inch deep) and cocoa powder to dust on top
- 2 balls of different sizes (marble and golf ball)
- A ruler and newspaper under the pan



Mercury is covered with craters like the ones you will make!

Do it

1. Smooth the flour and sprinkle cocoa on top.
2. Drop the small ball from **1 ft**. Remove it. Measure the crater's **width** across.
3. Repeat from **2 ft** and **3 ft**. Smooth the surface between drops.
4. Repeat with the large ball.

Predict: What will happen to the crater when you drop the ball from higher up?

_____

Ball size	Height	Crater width (in)	Rays / splash? (draw or describe)
small	1 ft	_____	
small	2 ft	_____	
small	3 ft	_____	
large	1 ft	_____	
large	2 ft	_____	
large	3 ft	_____	

1. Did higher drops make bigger craters? _____ Did bigger balls? _____

2. Why do you think the Moon and Mercury have so many craters, while Earth has few? (Hint: wind, water and plants change Earth's surface.)

_____

_____

Safety: do this on a floor you can sweep, and wash hands afterward.

Create · Postcard from Mars ★ EXPLORER

Imagine you are an astronaut who has just landed on Mars. Draw the view on the front. Write your message on the back.

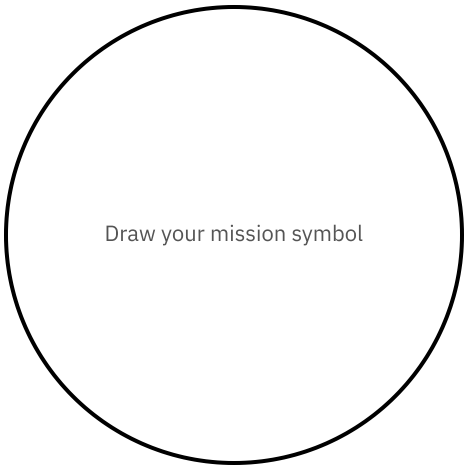
FRONT · draw what you see on Mars

STAMP

Dear _____,

From _____

Design your mission patch



Real crews design a patch for every mission. Include:

- A planet or rocket
- A short mission name
- The names of your crew

Mission name: _____

Unit Review · Mission Check

★ EXPLORER ★★ NAVIGATOR ★★★ COMMANDER

1. **Match** each planet to its clue (write the letter).
   Mercury ____ Venus ____ Earth ____ Mars ____
   A. Has liquid water and life · B. Smallest planet · C. Has two tiny moons · D. Spins backward

2. **Put in order** from **closest to the Sun** to farthest: _____ → _____ → _____ → _____

3. **True or false?** Fix each false statement.
   a. Venus is hotter than Mercury. T / F because _____
   b. Mars has more moons than Earth. T / F because _____
   c. A crater is made by a volcano only. T / F because _____
   d. Gravity on Mars is stronger than on Earth. T / F because _____

4. **Odd one out.** Circle it and explain: Mercury · Venus · Jupiter · Mars. _____

5. **Calculate.** A 100 lb student visits Mars (gravity 0.38). Weight on Mars: _____ lb

6. **Explain.** Venus is farther from the Sun than Mercury, yet it is hotter. Why?

7. **Label.** Name the three main layers of a rocky planet, from the outside in: _____, _____, _____

8. **Decide.** You can send one rover to one rocky planet. Which would you choose and why? Use at least two facts.

Mission Log ★ EXPLORER

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

☐ I can name the four rocky planets in order from the Sun.

☐ I can explain why Venus is the hottest planet.

☐ I can describe how a crater forms.

☐ I can use gravity to find my weight on another planet.

☐ I can convert °C to °F.

☐ I can name the layers inside a rocky planet.

☐ I can compare Earth and Mars using facts.

☐ I can solve a code using a pattern.

My favorite activity was

Something new I learned

A question I still have about space

UNIT 2
ROCKY PLANETS
★ ★ ★
MISSION COMPLETE

Signed: _____
Date: _____

The Space Workbook series

You have **Mission 2**. 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	**★ YOU ARE HERE**
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	☐
6	**Stars, Constellations & Galaxies** Light-years, star maps, galaxies, black holes	☐
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