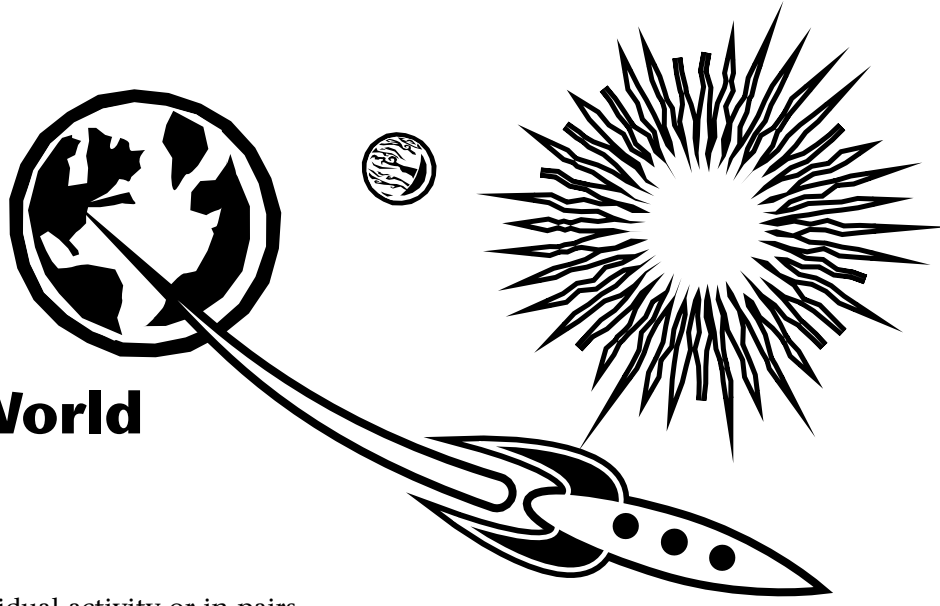
CLASSROOM ACTIVITY



Out of This World

General Information

★ Level: Grades 4, 5 and 6.

★ Students per group: Individual activity or in pairs.

★ How long: One or two 60-minute periods.

★ Where: In class.

★ When: Before or after visiting the Planetarium.

★ Type of activity: Problem solving.

★ Key words: Distance — speed — duration (time) — Moon — planets — space probe — solar system.

★ Skills honed: Estimating, calculating, rounding off, using numbers with decimals, using a calculator, seeking and interpreting data, predicting, deducing, and devising and testing theories.

Starting Point

If you took off from Earth at the speed of 40,000 km/h, how old would you be by the time you reached the Moon and the other planets in our solar system?

Preconceptions

Students often believe that the planets are the same distance apart and that this distance isn't very large. They might imagine that space probes take only days or weeks to reach the planets.

Basic Concepts

The solar system is extremely vast, and the planets occupy but a tiny fraction of its volume. The distances separating us from the Moon and the planets in the solar system are therefore enormous. This fact becomes clearer when we consider the time needed to cover these distances on foot, by car and by jet (see Appendix 1, "Flight Time in the Solar System").

The space probes we've launched toward the planets are the fastest man-made machines ever built. For example, the Voyager 2 probe is now zooming away from the Sun at more than 145,000 km/h. Despite this tremendous speed, the probe has taken over 20 years to reach the outer limits of the solar system. The speed of 40,000 km/h for the "Out of This World" exercise was chosen to reflect the average travelling speed of current space probes. Obviously, there's much more than duration to consider in interplanetary voyages, and so students might raise other questions. You can suggest they explore these questions while working on complementary research activities.

Since the answers to the first three calculations must be rounded off, you might begin the activity by explaining this notion to students. The final calculation (converting months to years) should be done without a calculator since the remainder will tell students the exact number of leftover months. This is a good example of when working with a calculator doesn't necessarily give the best answer. The second handout, "Special Delivery," lets students use the information gathered in the "Out of This World" exercise to solve a few brainteasers.

Before starting, remind students that an inner planet's orbit (Mercury to Venus) is contained within the Earth's orbit, while an outer planet's orbit (Mars to Pluto) is located beyond the Earth's orbit.

Goals

This fascinating exercise will help students grasp the solar system's true dimensions and hone their math skills (using fractions and decimals, dividing, rounding off, and converting units). Astronomy gives students an excellent opportunity to apply math to real problems. These activities are a good example of exploring mathematics with a specific aim in mind.

"Out of This World" is a wonderful complement to the activity "The Solar System in Your Neighbourhood," which involves building a scale model of the solar system. Indeed, both activities help students envision the enormous distances separating the planets in the solar system.

Steps in the Activity

Preparations

The time needed for this activity depends on how skilled the students are in math and whether they use a calculator. Students can work alone or in pairs to calculate the duration of the trip. They then figure out individually what age they'll be upon reaching their destination.

Study the relevant math formulas with your students before they complete the handouts. The formula **speed x duration = distance**, is an important notion that students can use in various situations in everyday life. Within this activity, they'll use the formula as:

$$\text{duration} = \frac{\text{distance}}{\text{speed}}$$

It might be useful to teach students to drop an equal number of zeros from a fraction's numerator and denominator before dividing. If students work without calculators, this means they'll simply have to divide the distance by 4 after dropping four zeros from the numerator. For example:

$$\textbf{Duration of Earth-Moon trip} = \frac{\textbf{385 000 km}}{\textbf{40 000 km/h}} = \frac{\textbf{385 h}}{\textbf{40}} = \textbf{9,6 h} \approx \textbf{10 h}$$

For the "Special Delivery" handout, remind students that the trip isn't over till they've returned to Earth.

Supplies

For each student (or pair):

- "Out of This World" handout
- "Special Delivery" handout
- Calculator (optional)

Assignment

❶ Ask students to write their names and ages in years and months on the "Out of This World" handout.

❷ Ask them to estimate the time they'll need to travel to the Moon and the eight planets, to calculate the age they'll be upon reaching their destinations, and to write their answers in the last column of the table shown on the "Out of This World" handout.

❸ Suggest that they then use the formula $\textbf{duration} = \frac{\textbf{distance}}{\textbf{speed}}$ to calculate the duration of trips to the Moon and the eight planets.

- They first calculate the number of hours that the trip takes by dividing the distance from Earth by the speed of 40,000 km/h and by rounding off to the nearest hour.
- Next, they calculate the number of days by dividing the number of hours obtained in the previous step by 24 and by rounding off to the nearest day.
- They calculate the duration of the trip in months by dividing the number of days obtained in the previous step by 30 and by rounding off to the nearest month.
- Finally, they calculate the duration of the trip in years by dividing the number of months obtained in the previous step by 12 (without a calculator). The remainder of this division indicates the precise number of leftover months.

❹ Students then add their current age to the duration of the trip to obtain the age they'll be upon reaching their destination. Ask students to write their answer in the second to last column on the "Out of This World" handout.

❺ Ask students to compare their estimated ages and calculated ages for when they reach their destinations. Do the two figures match? Are students surprised how long interplanetary travel takes? What conclusions can they draw? Is the solar system bigger or smaller than they imagined?

❻ Suggest that students use the figures they've calculated for the duration of trips between the Earth and planets to answer the questions on the "Special Delivery" handout. Students can also create their own mystery journeys and exchange them with their classmates.

Wrap-up

Suggest that students draw up a list of essentials to take with them on a long interplanetary journey. Propose that they write a travel journal relating their imaginary adventures across the solar system.

For older students, suggest they calculate the speed at which they'd need to travel to cut their flight time between planets to a few days or hours. They can also use the speed of light (300,000 km/sec) to determine how long it would take light (or radio messages travelling between the Earth and their spacecraft) to cover the distances separating the planets in the solar system. To broaden their knowledge, try integrating the notions of fuel consumption (expressed in L/100 km) and energy use.

APPENDIX 1

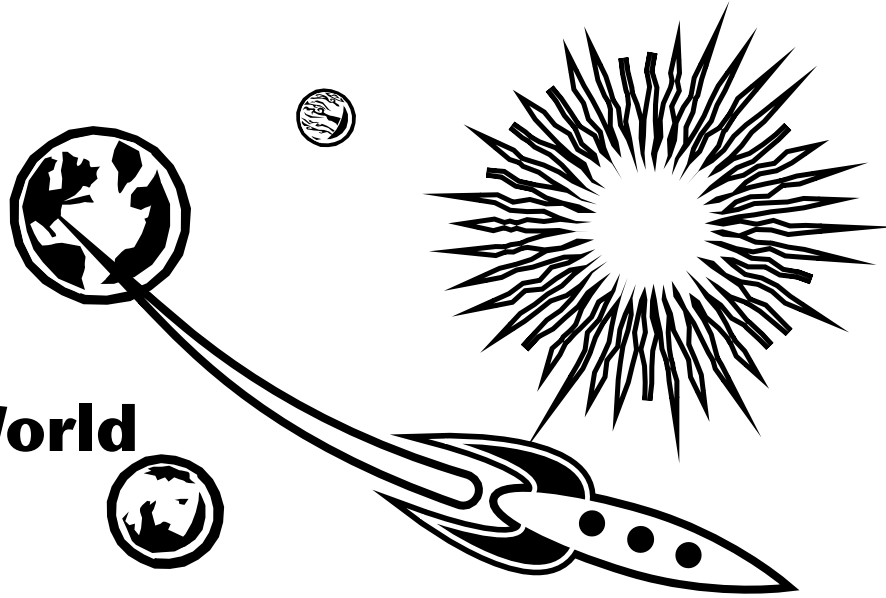
Flight Time in the Solar System

The huge distances separating the planets are hard to envision. But if we examine the time it would take to reach the Moon or planets on foot, by car or by jet, we can better grasp what an enormous undertaking interplanetary travel is

Flight Time from Earth

Celestial Body	On foot *(4 km/h)*	By car *(100 km/h)*	By jet *(1 000 km/h)*
Sun	4,278 years	171 years	17 years
Moon	11 years	146 days	15 days
Mercury	2,624 years	105 years	10 years
Venus	1,169 years	47 years	5 years
Mars	2,225 years	89 years	9 years
Jupiter	17,939 years	718 years	72 years
Saturn	36,505 years	1,460 years	146 years
Uranus	77,715 years	3,109 years	311 years
Neptune	124,201 years	4,968 years	497 years
Pluto	164,442 years	6,578 years	658 years

TEACHER'S COPY



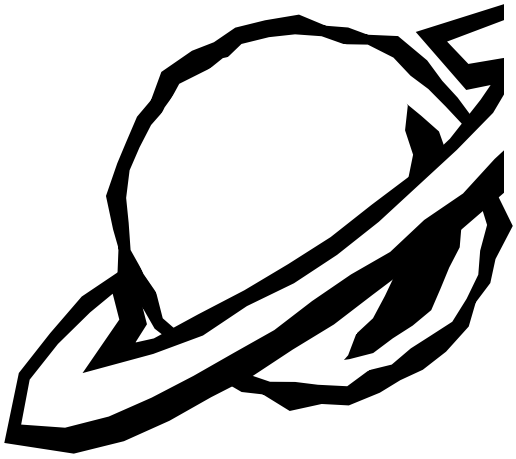
Out of This World

Space Traveller

Name: _____

Group: _____ **Date:** _____

Current age *Years*: _____ *Months*: _____



Average distance *(from Earth)*		hours = Distance / 40,000 *(nearest hour)*	Days = Hours / 24 *(nearest day)*	Months = Days / 30 *(nearest month)*	Years = Month / 12		Age calculated		Age estimated	
					Years	Months	Years	Months	Years	Months
150,000,000 *km*	Sun	3,750	156	5	0	5				
385,000 *km*	Moon	10	0	0	0	0				
92,000,000 *km*	Mercury	2,300	96	3	0	3				
41,000,000 *km*	Venus	1,025	43	1	0	1				
78,000,000 *km*	Mars	1,950	81	3	0	3				
629,000,000 *km*	Jupiter	15,725	655	22	1	10				
1,280,000,000 *km*	Saturn	32,000	1,333	44	3	8				
2,725,000,000 *km*	Uranus	68,125	2,839	95	7	11				
4,355,000,000 *km*	Neptune	108,875	4,536	151	12	7				
5,766,000,000 *km*	Pluto	144,150	6,006	200	16	8				

Special Delivery!

The Solar System Courier Service

Imagine that you work for the Solar System Courier Service. You must determine how long it'll take to make a few deliveries and return to Earth. Remember that the planets aren't aligned one behind the other in their orbits around the Sun. So you must always return to Earth to refuel between deliveries. Also, your trip isn't over till you've returned to Earth.

1 Deliver communication systems to Mercury and Jupiter.

Duration of trip: *4 years, 2 months*

(Earth to Mercury to Earth = 6 months; Earth to Jupiter to Earth = 3 years and 8 months)

2 Deliver pizzas to Venus and Mars.

Duration of trip: *8 months*

(Earth to Venus to Earth = 2 months; Earth to Mars to Earth = 6 months)

3 You travel to an outer planet and an inner planet and then return to Earth. Your trip lasts about 7 years and 10 months. Which planets did you visit?

Planetes : *Mercury and Saturn*

Duration of trip: *7 years, 10 moths*

(Earth to Mercury to Earth = 6 months; Earth to Saturn to Earth = 7 years and 4 months)

4 After leaving Neptune, you return to Earth and then deliver letters to Mars.

Duration of trip: *13 years, 1 months*

(Neptune to Earth = 12 years and 7 months; Earth to Mars to Earth = 6 months)

5 Invent a mystery journey to two planets. Don't forget you must always make a stop on Earth between planets. How long will your mystery journey last?

Duration of trip: _____

Exchange your mystery journey brainteaser with a classmate and try to solve his or her brainteaser.

STUDENT'S COPY

Out of This World

Space Traveller

Name: _____

Group: _____ **Date:** _____

Current age *Years*: _____ *Months*: _____

Average distance *(from Earth)*		hours = Distance / 40,000 *(nearest hour)*	Days = Hours / 24 *(nearest day)*	Months = Days / 30 *(nearest month)*	Years = Month / 12		Age calculated		Age estimated	
					Years	Months	Years	Months	Years	Months
150,000,000 *km*	Sun									
385,000 *km*	Moon									
92,000,000 *km*	Mercury									
41,000,000 *km*	Venus									
78,000,000 *km*	Mars									
629,000,000 *km*	Jupiter									
1,280,000,000 *km*	Saturn									
2,725,000,000 *km*	Uranus									
4,355,000,000 *km*	Neptune									
5,766,000,000 *km*	Pluto									

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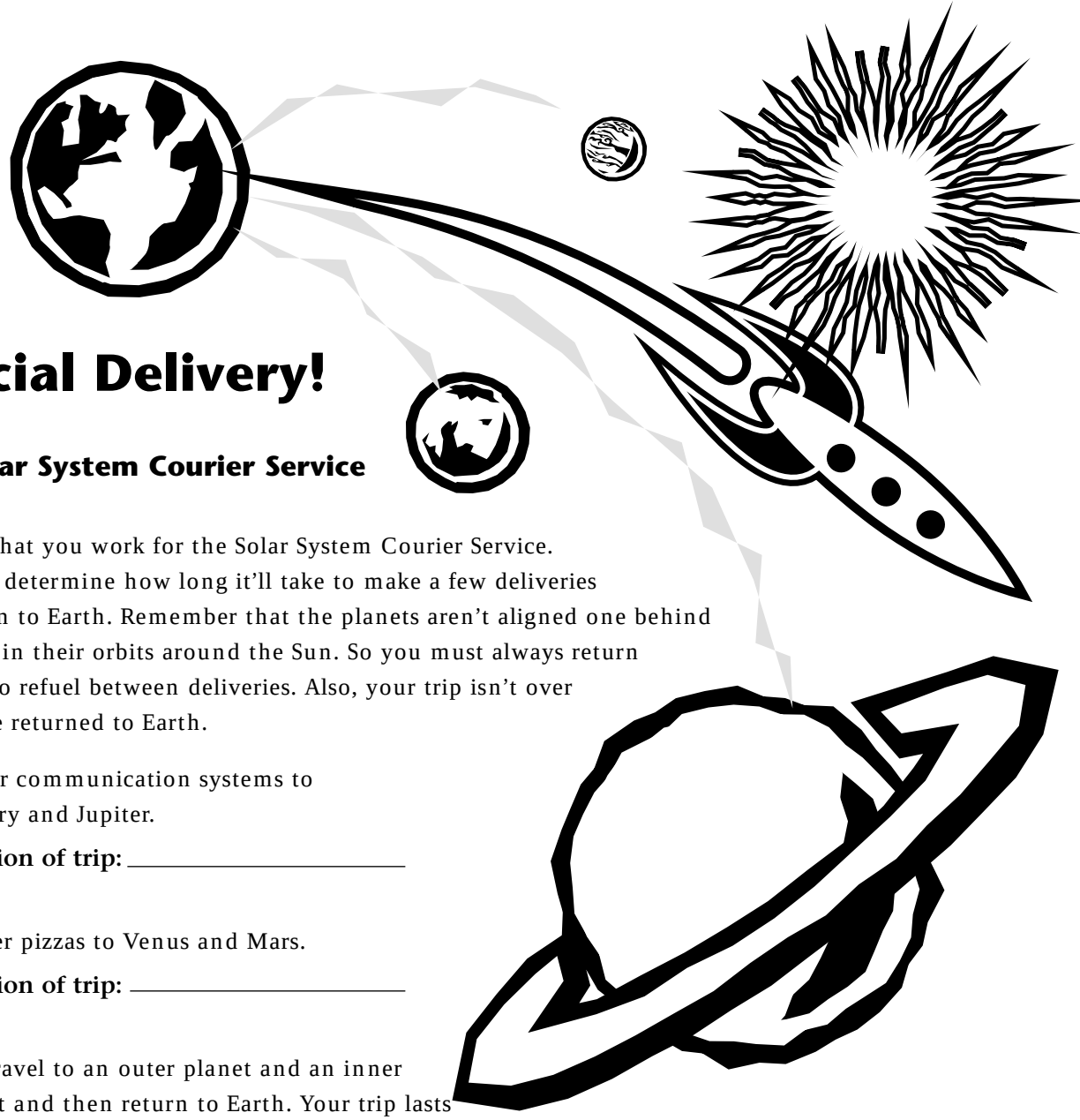

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3 You travel to an outer planet and an inner planet and then return to Earth. Your trip lasts about 7 years and 10 months. Which planets did you visit?

Planetes : _____

Duration of trip: _____

4 After leaving Neptune, you return to Earth and then deliver letters to Mars.

Duration of trip: _____

5 Invent a mystery journey to two planets. Don't forget you must always make a stop on Earth between planets. How long will your mystery journey last?

Duration of trip: _____

Exchange your mystery journey brainteaser with a classmate and try to solve his or her brainteaser.