Extreme Exploration–Solar System Missions Timeline Activity

Objectives Students will:

- Make observations, collect data, and make simulated mission decisions as they depict robotic exploration.
- Identify planetary bodies in our solar system that are mission targets.
- Research solar system missions.
- Create a visual display of solar system bodies and related missions.

National Science Standards Addressed

Unifying concepts and processes in science: Evidence, models, and explanation
Science as Inquiry: Abilities necessary to do scientific inquiry
History and Nature of Science: Science as a human endeavor, Nature of science

Suggested Grade Level 5-8 (with adaptations K-12)

Lesson Length Activity One – 45 minutes – more if associated with Internet research
Activity Two – 40 minutes to one hour – more if extensive written or oral reports are assigned

Background

Right now, the most advanced scientific space fleet ever assembled is out there in space hammering away at life's biggest – and toughest – questions: Where do we come from? Where are we going? Are we alone?

"The key things we are trying to accomplish in solar system exploration are questions very close to home - understanding where Earth and our solar system come from and how we came to be here," explains Dr. Laurie Leshin, a planetary scientist.

Clues to these mysteries are scattered among the nine planets and the multitude of moons, comets and asteroids that make up our solar system. Just as paleontologists learn about dinosaurs from studying fossils on Earth, evidence of the earliest days of the solar system may exist in rocks on the cratered surfaces of Mercury, Mars and Earth's moon. Chemical clues to our origins could linger in the icy hearts of comets and distant Kuiper Belt objects or in the hazy atmosphere of Saturn's giant moon, Titan. A few of Jupiter's moons may even harbor oceans under their icy crusts. Water is a key ingredient for life.

The journey to these worlds is too dangerous for humans – for now. That's why we send robots. These exploring machines must survive extreme heat and cold and intense radiation during long journeys across mind-boggling distances. Even at speeds up to 80,400 kph (50,000 mph), a one-way ride to Pluto takes about 10 years. If all goes well – and there are no guarantees in space travel - we will be among the first humans to see Pluto up close. We will have to wait until at least 2016 for that particular view.

Fortunately, there's plenty to do – and to see – in the meantime.

About this lesson

This lesson contains two activities that allow students to depict, research and follow along with NASA's exciting missions to other planetary bodies in our solar system.

In the first activity, ***Strange New Planet***, students enact the missions that reflect the sequence NASA uses to robotically explore solar system bodies. Students view unusual planets in the classroom using ordinary cardboard tubes that simulate telescopes. They plan missions to examine these planets. Students will gather new information as they simulate fly-by, orbit, lander, and sample return missions. This activity demonstrates how planetary features are discovered and researched using remote sensing techniques.

The second activity, ***Extreme Exploration -- Solar System Exploration Missions with Timeline***, involves students in the wide range of mission events of 2003-2006. Using the Solar System Exploration Timeline 2003-2004 as a guide, student teams will research assigned missions and record events such as launch and landing, etc. They will be drawn into the mission events as they follow along with Solar System Exploration.

The class will place images of solar system bodies on a large bulletin board or wall. After researching the missions, teams will place appropriate symbols by the planetary body where the events will take place (example: a rocket = launch or a ring = orbit). Oral and/or written reports could enhance and reinforce the experience.

Vocabulary list
Launch, fly-bys, swingby, orbits, probes, encounters, landers, and sample returns.

Materials List (see each activity)

Activity 1 *Strange New Planet*

Students enact the missions that reflect the sequence NASA uses to robotically explore solar system bodies. Students view unusual planets in the classroom using ordinary cardboard tubes that simulate telescopes. They plan missions to examine these planets. Students will gather new information as they enact fly-by, orbit, lander, and sample return missions. This activity demonstrates how planetary features are discovered and researched using remote sensing techniques.

This activity is found on NASA's Mars Exploration Program Home Page at Jet Propulsion Laboratory, see Mars for Educators tab and click on Mars Activity Book http://mars.jpl.nasa.gov/classroom/

http://mars.jpl.nasa.gov/classroom/pdfs/MSIP-MarsActivities.pdf

Note ** Addendum to *Strange New Planet*
Mission 4: Sample Return (future Mars Sample Return mission –20??)

Using the data collected by the previous missions and especially the lander missions, each team will decide on an appropriate sample return site and sampling technique. One sample per team is all that is allowed and remember the sample is going to be small, definitely no bigger than a small pinch! Examine the sample and complete your reports.

Activity 2
Extreme Exploration -- Solar System Exploration Missions Timeline

Extreme Exploration -- Solar System Exploration Missions Timeline, involves students in the wide range of mission events of 2003-2006. Using the Solar System Exploration Timeline 2003-2004 as a guide, student teams will research assigned missions and record events such as launch and landing, etc. They will be drawn into the excitement of mission events as they follow along with Solar System Exploration.

The class will place images of solar system bodies on a large bulletin board or wall. After researching the missions, teams will place appropriate symbols by the planetary body where the events will take place (example: a rocket = launch or a ring = orbit). Oral and/or written reports could enhance and reinforce the experience.

Objectives Students will:

- Identify planetary bodies in our solar system that are mission targets.
- Research solar system missions.
- Create a visual display of solar system bodies and related missions

Lesson Length: 45 minutes – more if extensive written or oral reports are assigned. Unit or semester projects could be planned around this Solar System Exploration theme if desired.

Materials List

- Images of nine planets, Sun, Earth's moon, Jupiter's moons, comets, asteroids
  Resource: Solar System Lithograph Set for Space Science, NASA Educational Product number LS-2001-08-002-HQ.
  Images may be downloaded from this NASA Spacelink site:

  http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Solar.System.Lithograph.Set/Solar.System.Lithograph.Set.pdf

  http://solarsystem.nasa.gov/planets/index.cfm
- Colored or construction paper for mission symbols, different color for each
- **Mission Event Symbols** template for mission symbols (found at the end of this activity)
- Scissors
- Markers or pens
- Solar System Exploration Timeline 2003-2006
  http://solarsystem.nasa.gov/
- **Mission Events Student Sheets** (at least one for every student – more if needed)
- Tape or mounting material to attach display to wall or bulletin board

Advanced Preparation

1. Read all parts of the lesson and decide how much time will be allotted to the activity. There are many ways a teacher could decide to do this activity involving students in as much or as little of the preparation as desired. Determine what parts the students will do and what parts the teacher will do prior to the activity

time. An example is whether students will download images of planets, if students will create their own images of the planets, or the teacher will provide images. Note that this could be a much longer unit or semester project if desired.

2. Determine if students will do research on the missions to planets and other solar system bodies or if the information included below will be given to the students to transfer to the event mission symbols. Mission event research by individuals or teams will require Internet computer access.
3. Assemble materials.
4. Preview the Solar System Exploration Timeline 2003-2006 found on the website. Print if desired.
5. Determine assignments for posting mission events on the Solar System display. See **Possible Team Research Assignments** page at the end of this procedure**.** Students may copy events from the listing provided in this lesson or they may research the missions on the NASA websites to find the events themselves. The Solar **System Exploration Mission Events by Planetary Body** listing is found at the end of the lesson.
6. Copy **Mission Events Student Sheets**

Classroom Procedure

1. Introduce the Solar System Exploration Timeline 2003-2006 and invite the students to research and follow along as we explore our solar system. Read or allow the students to read the *Join the Adventure* information found on the back of the Timeline.
2. Explain to the students that they will make a display of Solar System Mission Events using symbols to depict the various types of mission events. They will post exploration symbols for each mission event on the wall near the planet or solar system body where the event has or will take place. Launches always take place here on Earth but the launch symbol (rocket) should be placed near the target body. The rocket for a launch to Mars will be near the image of Mars.
3. Review types of mission events (flyby, orbit, probe, lander, rover, sample return) and indicate the symbol that represents each type of event.
4. Assign student teams (2-4 students per team) to specific solar system bodies (see list below entitled Possible Team Research Assignments).
5. Hand out Mission Events Student Sheets to each student. Students may request more sheets if they are representing several missions.
6. Instruct students to use the Solar System Exploration Timeline to find the events related to their assigned planetary body. Have students note the events on the Mission Events Student Sheets. If students use the Timeline only then proceed to step 7 below. Consider the options below to extend this lesson.
    a. Students may investigate events on the internet.
    b. Students may use the **Solar System Exploration Mission Events by Planetary Body** pages provided at the end of the lesson.
    c. Students may present oral or written reports on mission events, planetary bodies, or scientists or engineers involved in planetary missions.
7. Instruct each team to transfer the mission event data to symbols that represent the events. Indicate to students where the construction paper and symbol templates will be available.

8. Facilitate the construction of the planetary display and the posting of their results in the form of annotated symbols.
9. Allow student teams to report their findings to the class.

Assessments

1. Use or develop a rubric to assess the oral or written reports.
2. Assess the individual Mission Events Student Sheets.

Name _____

Mission Events Sheet

Mission: _____

What is the planetary body that is the target of this mission?
_____

Mission Website: _____

Launch Date:
_____

List the Mission Events and dates. Describe each event.

What is this mission exploring?

What are the science questions?
There are many science and technology goals on a single mission. For complete information, you can research on-line.

What do you think? What are your questions?

What were the results? Attach news articles and make notes as you hear news of this mission.

Possible Team Research Assignments

Classroom Strategy Suggestions for teams or groups.

The list below is a suggestion on how the research and mission events could be evenly distributed to teams in a typical classroom. Another strategy could be to have each student take an individual mission.

	Planetary Body	Number of missions	Number of Events
Team 1	Mercury	1	7
Team 2	Sun, Venus, Moon	3	6 or 7
Team 3	Mars	5 (past and present)	11 major events
Team 4	Mars	5 (future)	10
Team 5	Asteroids Jupiter	2 2	8 4
Team 6	Saturn	1	6
Team 7	Uranus, Neptune, Pluto	2	6
Team 8	Comets	3	8

See listing of Solar System Exploration Mission Events by Planetary Body on the next page.

Solar System Exploration Mission Events by Planetary Body

(Mission event dates may change – check updates on the websites)

Planetary Body	Mission	Events
Sun	***Genesis***	**Launch Date:** 08-Aug-2001 (16:13:40 UT) **Arrival at Lagrange Point (L1):** 16-Nov-2001 (19:04:15 UT) **Solar Wind Collection:** 03-Dec-2001 - April 2004 **Solar Wind Sample Return:** 08-Sep-2004 **Status:** Collecting Solar Wind Samples
		http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Sun
Mercury	***Messenger***	**Launch Date:** 11-May-2004 - 22-May-2004 **Venus Flyby 1:** 02-Nov-2004 **Venus Flyby 2:** 28-Aug-2005 **Venus Flyby 3:** 22-Oct-2006 **Mercury Flyby 1:** 16-Oct-2007 **Mercury Flyby 2:** 07-Jul-2008 **Enter Mercury Orbit:** 02-Jul-2009
		http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Mercury
Venus	***Venus Express***	**Launch Date:** November 2005 **Venus Arrival:** April 2006 **Status:** In Development
		http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Venus
Earth	Note: Earth missions are the focus of a different part of NASA – Office of Earth Science.	
		http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Earth
Moon	***SMART-1***	**Launch Date:** 27-Sep-2003 (23:14 UTC) **Moon Arrival:** February 2005 **Status:** Testing Ion Engines
		http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Moon
Mars	***Mars Global Surveyor***	**Launch Date:** 07-Nov-1996 (17:00:49 UT) **Arrival at Mars:** 11-Sep-1997 **Mapping Operations:** March 1999 - April 2002 **Data Relay Mission:** April 2002 - February 2004 **Status:** Extended Mission in Progress
		http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Mars
	Nozomi	**Launch Date:** 03-Jul-1998 (18:12 UT) **First Earth Swingby:** 20-Dec-1998 **Second Earth Swingby:** 20-Dec-2002

Planetary Body	Mission	Events
		Earth/Moon Swingby: 19-Jun-2003 - 20-Jun-2003
		Arrival at Mars: 01-Jan-2004 **Status:** In Flight
	Mars 2001 Odyssey	**Launch Date:** 07-Apr-2001 (15:02 UT) **Mars Orbit Insertion:** 24-Oct-2001 (02:30 UT) **Science Mission:** January 2002 - June 2004 **Data Relay Mission:** February 2004 - May 2004 **Status:** In orbit at Mars
	Mars Express & Beagle 2	**Launch Date:** 02-Jun-2003 (17:45 UTC) **Interplanetary Cruise Phase:** 01-Jul-2003 - 21-Nov-2003 **Mars Orbit Insertion:** 22-Nov-2003 - 24-Dec-2003 **Orbiter Science Operations:** 24-Dec-2003 - 30-Nov-2005 **Beagle 2 Landing:** 24-Dec-2003 **Beagle 2 Mission:** 24-Dec-2003 - 10-Mar-2004 **Status:** En route to Mars
	Mars Exploration Rovers	**Launch Date:** Spirit (MER-A): 10-Jun-2003 (13:58 EDT) Opportunity (MER-B): 7-Jul-2003 (23:18:15 EDT) **Surface Operations:** January 2004 - April 2004 **Landing (Spirit):** 03-Jan-2004 (11:35 p.m. EST) **Landing (Opportunity):** 25-Jan-2004 (12:05 a.m. EST) **Status:** En Route to Mars
	Mars Reconnaissance Orbiter	**Launch Date:** August 2005 **Mars Orbit Insertion:** March 2006 **Science Mission:** March 2006 - July 2008 **Data Relay/Navigation:** July 2008 - February 2010 **Status:** Under study
	Phoenix	**Launch Date:** Before Dec. 31, 2007 **Status:** Mission Proposal
	Mars Science Laboratory	**Launch Date:** 2009 **Status:** Under study
	Mars Sample Return Lander	**Launch Date:** October 2011 **Mars Landing:** September 2012 **Launch from Mars:** December 2012

		Earth Return: September 2014 **Status:** Under study
	Mars Scout 2	**Launch Date:** October 2011 **Mars Arrival:** September 2012 **End of Prime Mission:** December 2012 **Status:** Under study

Planetary Body	**Mission**	**Events**
Asteroids	***Hayabusa***	**Launch Date:** 09-May-2003 **Arrival at (25413) 1998SF36:** October 2005 **Sample return to Earth:** June 2007 **Status:** En route to Asteroid 1998SF36

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Asteroids&Era=Present

	Dawn	**Launch Date:** 27-May-2006 **Vesta Arrival:** 30-Jul-2010 **Vesta Departure:** 03-Jul-2011 **Ceres Arrival:** 20-Aug-2014 **Ceres Departure:** 26-Jul-2015 **Status:** Planning stages

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Asteroids&Era=Future

Jupiter	***Galileo***	**Launch Date:** 18-Oct-1989 (16:53:40 UT) **Venus Flyby:** 10-Feb-1990 **Orbiter Arrival at Jupiter:** 07-Dec-1995 **Impact into Jupiter:** 21-Sep-2003 **Status:** Mission Complete
	Jupiter Icy Moons Orbiter	**Launch Date:** 2011 or Later **Status:** Proposed Mission

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Jupiter

Saturn	***Cassini and Huygens Probe***	**Launch Date:** 15-Oct-1997 (04:43 EDT) **Jupiter Swingby:** 30-Dec-2000 **Cassini Arrival at Saturn:** 01-Jul-2004 **Titan Flyby 1:** 26-Oct-2004 **Titan Flyby 2:** 13-Dec-2004 **Release of Huygens Titan Probe:** 25-Dec-2004 **Huygens Probe Descends to Titan:** 14-Jan-2005 **End of Cassini Mission:** 30-Jun-2008 **Status:** En route to Saturn

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Saturn

Uranus	***Voyager 2***	**Launch Date:** 20-Aug-1977 **Jupiter Encounter:** 09-Jul-1979 **Saturn Encounter:** 26-Aug-1981 **Uranus Encounter:** 24-Jan-1986 **Neptune Encounter:** 24/25-Aug-1989 **Status:** Interstellar mission in progress

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Uranus

Planetary Body	**Mission**	**Events**
Neptune	***Voyager 2***	See above

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Neptune

Pluto	***New Horizons***	**Launch Date:** 13-Jan-2006 - 26-Jan-2006 **Jupiter Flyby:** March 2007 **Pluto Arrival Window:** 17-Nov-2016 - 11-Jul-2017 **Flyby of Kuiper Belt Objects:** 2018 - 2022 **Status:** In Development

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Pluto

Comets	***Stardust***	**Launch Date:** 07-Feb-1999 (21:04:15UT) **Asteroid Annefrank Flyby:** 02-Nov-2002 (04:50 UT) **Comet Wild 2 Encounter:** 02-Jan-2004 **Earth Sample Return:** 15-Jan-2006 **Status:** In flight

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Comets

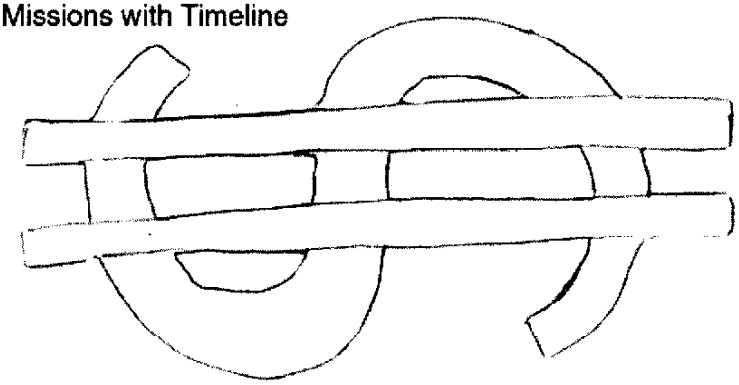
	Rosetta	**Launch Date:** February 2004 **Comet Churyumov-Gerasimenko Arrival:** November 2014 **Status:** Preparing for Launch

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Comets&Mission=Rosetta

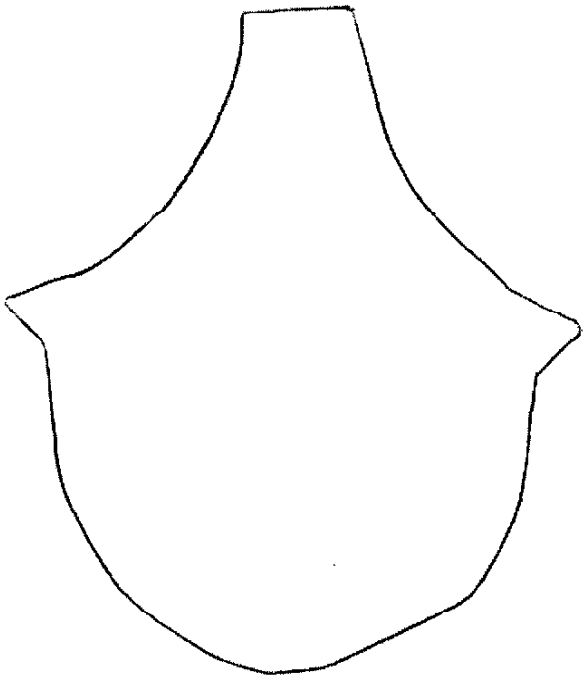
	Deep Impact	**Launch Date:** 30-Dec-2004 **Comet Tempel 1 Impact:** 04-Jul-2005

http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Planet&Object=Comets&Mission=DeepImpact

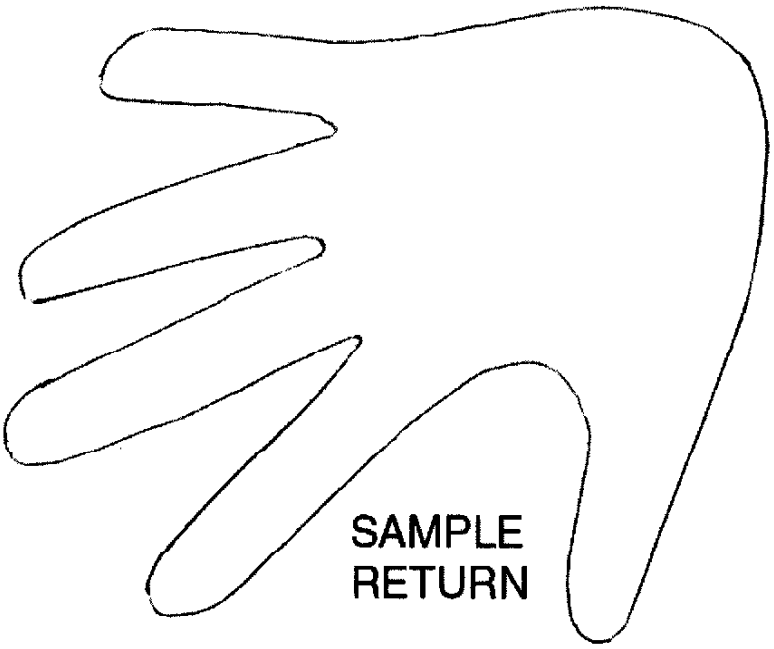
Extreme Exploration--Solar System Exploration Missions with Timeline



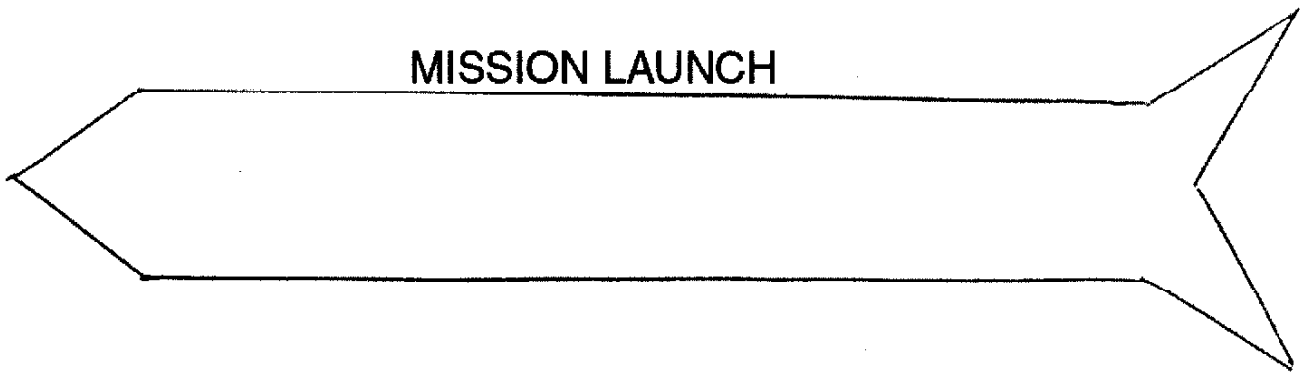
FUTURE MISSION



PROBE or
ENCOUNTER

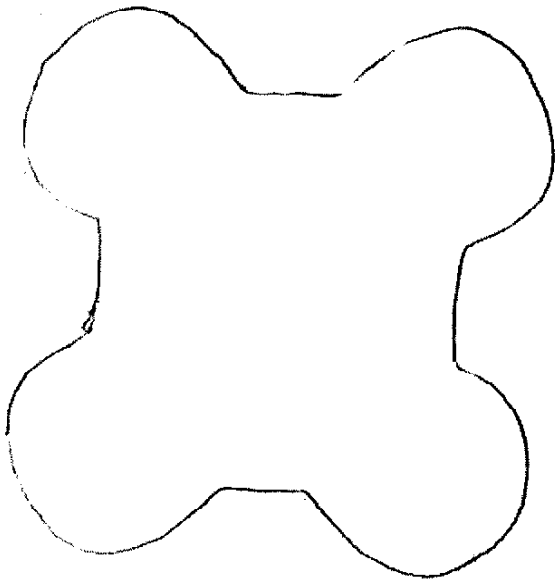


SAMPLE
RETURN

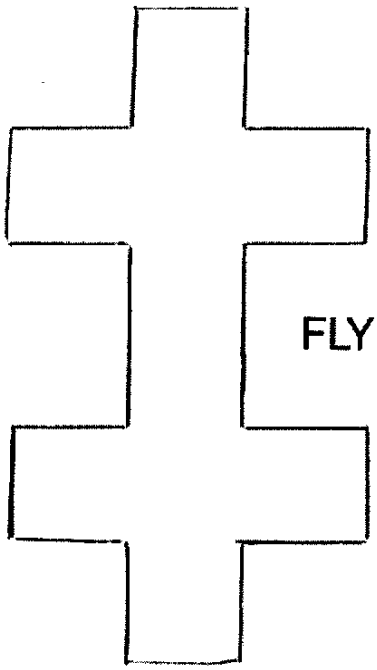


MISSION LAUNCH

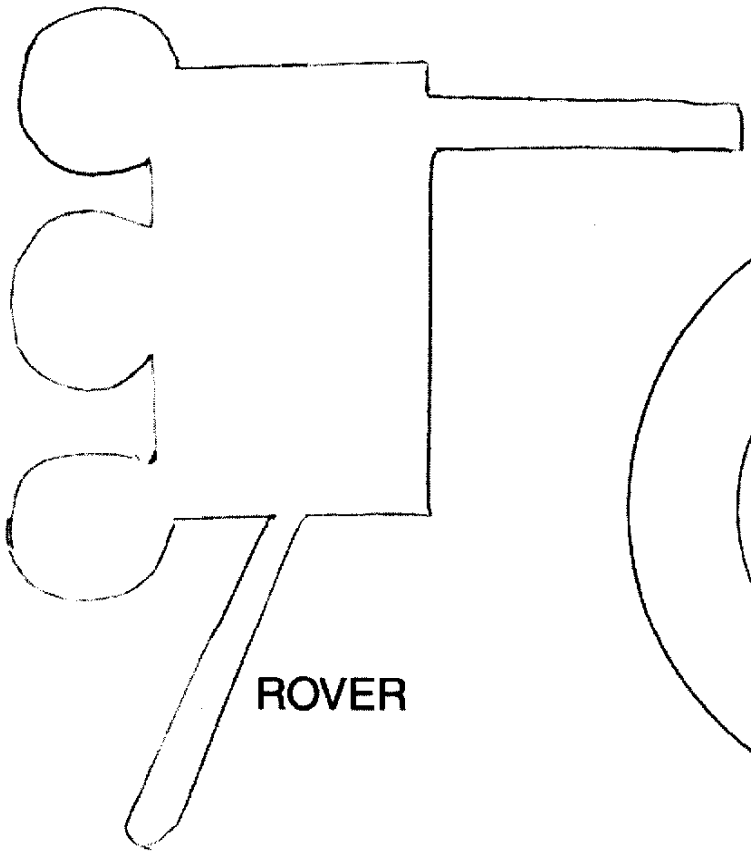
Extreme Exploration--Solar System Exploration Missions with Timeline



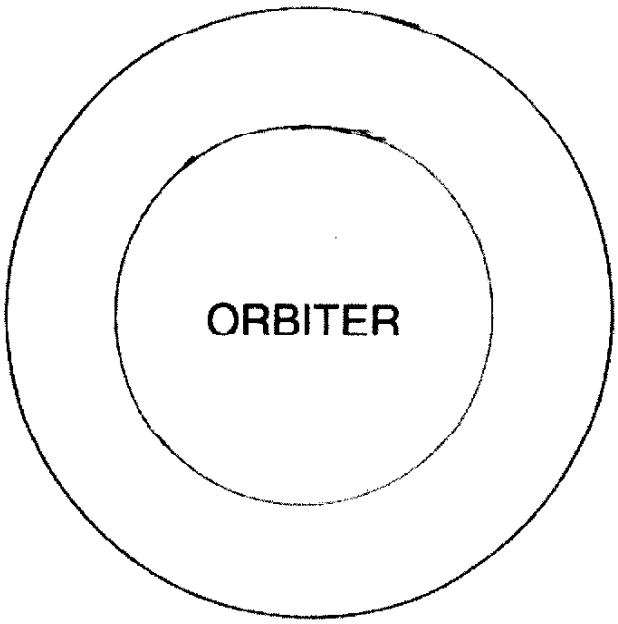
LANDER



FLYBY



ROVER



ORBITER