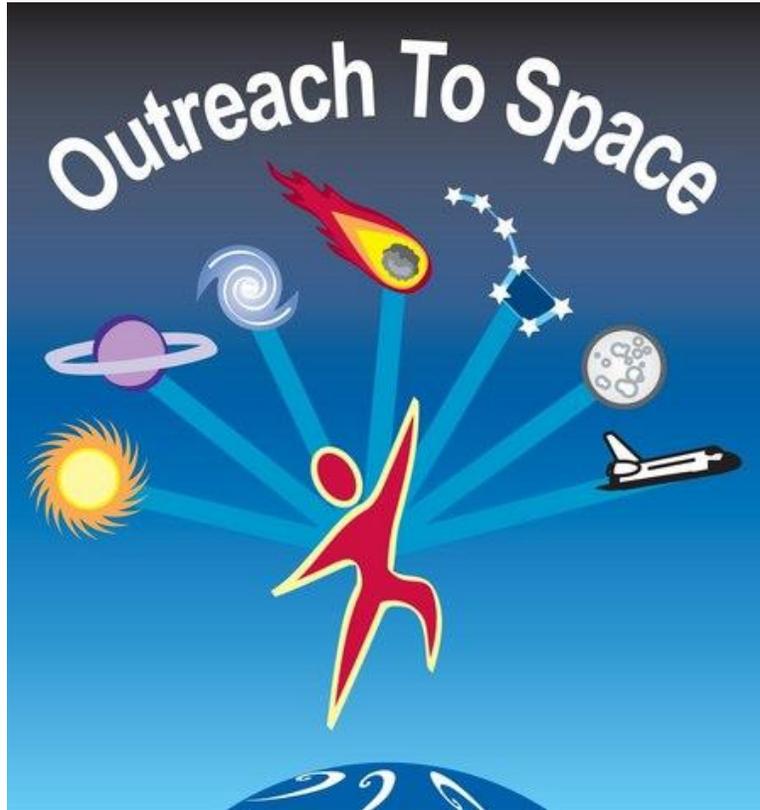


Outreach to Space Exhibit Manual



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www.scienceworksmuseum.org



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Exhibit Description

Outreach to Space provides cutting-edge space exploration content presented through fun and engaging exhibits. The eleven hands-on exhibits are professionally designed and expertly made, built to withstand the demands of open-ended experimentation by thousands of children and their families. Families explore together to learn about the concepts of outer space: what is out there, how we get to outer space, what life is like in space and what the future of space exploration holds.

Exhibit Components

The Outreach to Space exhibit includes eleven modules:

- **Aim for Orbit** demonstrates the balance of energy required to launch a spacecraft into orbit around the earth.
- **Big Dipper** shows how familiar constellations look very different from different parts of space.
- **Different Worlds Different Weights** allows children to feel how heavy an apple would be at different places in our solar system.
- **Gloves in a Box** lets you see some of the difficulties that astronauts face while working in a spacesuit.
- **Gravity Well** demonstrates the motion of objects in a gravitational field.
- **Mars Rocket** tests your timing as you land a spacecraft on Mars.
- **Pressure Suit** shows the importance of protective gear for astronauts in outer space.
- **Rocket Launch** demonstrates energy conversion as visitors launch a foam rocket with air pressure.
- **Space Colony** provides a creative way of exploring the needs of space vehicles and stations.
- **Star Spectrum** shows how astronomers can identify the composition of stars.
- **Steering with Thrust** allows visitors to pilot the Space Shuttle using thrusters.

Additional information on each of these modules appears in the following manual.

Aim for Orbit Maintenance Instructions

General Information: Aim for Orbit is a pinball-style game which demonstrates how energy input affects the trajectory of an object, and the difficulty involved in attaining an orbital trajectory. Visitors launch the ball toward a set of barriers. With too little or too much energy, the ball does not end up in “orbit” (between two barriers). At “escape velocity,” the ball’s trajectory takes it above the barriers.

Setup: For proper orientation, the exhibit should be set on a level, even surface.

Cleaning Instructions: The finished or painted surfaces of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner. The acrylic cover panel should be cleaned with a plastic cleaner and a soft wipe that will not leave scratches (we suggest Wipe-All™).

Notes: This exhibit does not easily balance on a hand truck. Use care when transporting it.



Big Dipper Maintenance Instructions

General Information: Big Dipper demonstrates that the constellations of the stars we see in the sky look different from different perspectives. Visitors can observe through the view port to see the constellation as we see it from Earth, or from another angle to observe the positions of the stars relative to each other.

Setup: For best operation, the exhibit should be installed out of direct sunlight.

Cleaning Instructions: The finished or painted surfaces of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner. The acrylic case should be cleaned with a plastic cleaner and a soft wipe that will not leave scratches (we suggest Wype-All™).

Star Positioning: Star positions may shift during transit. Remove the four M3 fasteners holding the acrylic case to the tabletop and remove the case. The stars may be adjusted by:

1. Bending the steel support wire. Adjust the wires accordingly.
2. Rotating the acrylic support plate. If the support plate has rotated, groups of stars will appear to be too far to the left or right of the graphic. Adjust the rotation of the support plate. Ensure that the plate's fastening screw is tightened before reinstalling the case.
3. Adjusting shaft collar height. Remove the two M6 fasteners on the back face of the exhibit using the included 4mm hex key, and slide the tabletop away and up from the exhibit to free it from the locating pins on the exhibit's front face. Loosen the shaft collar under the table, then shaft collar atop the table. Adjust the height of the wire, re-tighten the shaft collar atop the table, and finally re-tighten the shaft collar under the table. Reinstall the tabletop. Reinstall the case.

Notes: People love to put the small white balls from Gravity Well and Mars Rocket into the Big Dipper case. To get the balls out, detach the acrylic case with an Allen wrench. Try to display the Big Dipper exhibit away from those other two exhibits, so that the balls are not as easy a temptation.



Different Worlds Different Weights Maintenance Instructions

General Information: Different Worlds Different Weights shows how the weight of a standard object (apple) varies in different gravity fields. Changing the mass of each apple simulates different weights. Once the balance is stabilized, the planet and effective weight (in grams) may be read from the balance.

Setup: For best operation, the exhibit should be set on a level, even surface. Set the ten apples in their corresponding holes on the tabletop. If necessary, zero the balance by placing the Jupiter apple in the pan and adjusting the counterweight so that the scale reads accurately. Remove the Jupiter apple and place the Pluto apple in the pan and adjust the pointer so that the scale reads accurately.

Cleaning Instructions: The finished or painted surfaces of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner. The graphics should be cleaned with a plastic cleaner and a soft wipe that will not leave scratches (we suggest Wype-All™).

Zeroing Adjustments: Two adjustments are available for adjusting the balance zero and scale. Manipulate the counterweight position by loosening the M6 fastener on the backside of the balance and sliding the counterweight in its slot. Adjust the rotation of the pointer indicator by loosening the black shaft collar to which it is fastened (3/16" hex key, not provided), rotating the pointer to the desired position, and re-tightening.

Notes: The lighter apples are made of foam, and can get beaten up relatively easily.



Gloves in a Box Maintenance Instructions

General Information: Gloves in a Box demonstrates the difficulties that astronauts encounter when performing tasks in space suits. Visitors place their hands inside the gloves and can perform a seemingly simple task.

Cleaning Instructions: The finished or painted surfaces of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner. The acrylic cover panel should be cleaned with a plastic cleaner and a soft wipe that will not leave scratches (we suggest Wipe-All™). The interiors of the gloves should be checked regularly to ensure that they are free of debris and organic material. Pull the gloves inside-out to check for debris and allow them to dry overnight. To mitigate debris and residue inside the glove, glove liners should be made available to the visitors. One possibility is Grainger light cotton inspection gloves (part numbers 4JC97 and 4JC98).

Accessing the Inside of the Exhibit: The case top is removed for accessing the cabinet interior for servicing and for adding or removing activities. Remove the M6 fasteners on the top of the exhibit using the included hex key and lift the case top free.

Glove Replacement: The gloves used are McMaster-Carr 38 mil abrasive-blasting gloves (part number 55405T22, 6" hole, \$25.28 per pair). To replace a glove, first remove the case top. Loosen the four glove bezel fasteners and their respective cap nuts. Once free, the glove bezel should slide out of its side panel. Trim the new glove to the same length and opening shape and install onto the bezel. The flange will be a tight press-fit into the side panel. Once pressed in, the flange may be rotated to align the four holes.

Notes: The wrenches can be broken with rough use, and have to be removed by detaching the acrylic case.



Gravity Well Maintenance Instructions

General Information: Gravity Well demonstrates the motion of objects in a gravitational field. Visitors can try launching or spinning balls on different trajectories within the gravity well model.

Cleaning Instructions: The finished or painted surfaces of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner. The fiberglass gravity well should be cleaned with a plastic cleaner and a soft wipe that will not leave scratches (we suggest Wype-All™).

Ball Replacement: The ½” plastic balls that come with the exhibit may need to be replaced from time to time. They may be purchased from McMaster-Carr (www.mcmaster.com/#9613k24/=8m8sp1, part number 9613K24, \$11.77 per pack of 50). These are the same balls that are used in the Mars Rocket exhibit.

Ball Return: The tabletop is removed for accessing the ball return pipe and bracket for servicing. Remove the two M6 fasteners on the back face of the exhibit using the included hex key, and slide the tabletop away and up from the exhibit to free it from the locating pins on the exhibit's front face.

Notes: Periodically check the well for foreign objects, particularly LEGOs and coins. Occasionally, balls get stuck in the well; tip the exhibit forward to get them to roll into the ball platform.



Mars Rocket Maintenance Instructions

General Information: Mars Rocket demonstrates how the timing of a shuttle or rocket launch is critical to reaching its destination successfully. Visitors place a ball in the launch tube, attempting to time it correctly with the movement of the Mars target.

Setup: For best operation, the exhibit should be set on a level, even surface. Plug the exhibit in and turn it on. The circuit breaker switch is on the back face of the exhibit near the bottom. The exhibit may draw up to 5A @ 110 VAC under normal operating conditions. The exhibit uses a NEMA 5-15P to IEC 320-C13 power cord, similar to those used for powering desktop computer towers. This is the same power cord used in the Steering with Thrust exhibit.

Cleaning Instructions: The finished or painted surfaces of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner. The acrylic case should be cleaned with a plastic cleaner and a soft wipe that will not leave scratches (we suggest Wipe-All™).

Ball Replacement: The ½” plastic balls that come with the exhibit may need to be replaced from time to time. They may be purchased from McMaster-Carr (www.mcmaster.com/#9613k24/=8m8sp1, part number 9613K24, \$11.77 per pack of 50). These are the same balls that are used in the Gravity Well exhibit.

Ball Jams: The case is opened for accessing the ball drop and platens for servicing. Remove the six fasteners on the top of the case using the included hex key. If the balls are regularly becoming stuck inside the drop tube, loosen the corresponding M3 set screw by one quarter turn.

Accessing the Inside of the Exhibit: The tabletop is removed for accessing the exhibit interior for servicing. Remove the two M6 fasteners on the back face of the exhibit using the included hex key, and slide the tabletop away and up from the exhibit to free it from the locating pins on the exhibit’s front face. The ball return pipe and support bracket may impede movement of the tabletop—use care.

O-Ring, Bearing, and Motor Maintenance: The rotating platens are both driven by a single Pitman 12VDC gear motor. Power is transmitted from the motor to the platens by a pair of Buna-N O-rings. After removing the tabletop, remove the motor mount plate to access the O-rings. Further disassembly is required to access the four shielded ball bearings in the assembly. Two are pressed into the Mars Pulley assembly, and two are pressed into the Bearing Hub.

Notes: Remember to turn the exhibit on/off as well as plugging it in. The on/off switch is slightly off-center from its access port at the bottom of the exhibit. If the ball gets stuck in the launch tube, it can often be freed by using a pipe cleaner to push it through.

(See pictures next page)

Mars Rocket continued



Pressure Suit Maintenance Instructions

General Information: Pressure Suit demonstrates how an astronaut's space suit protects him/her from the low-pressure environment of outer space. By using the pump on the exhibit, visitors can remove the air from the chamber to observe the effects of low pressure on a body. The air can then be let back into the chamber using the relief valve.

Setup: For proper operation, the exhibit should be set on a level, even surface.

Cleaning Instructions: The finished or painted surfaces of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner. The acrylic panels should be cleaned with a plastic cleaner and a soft wipe that will not leave scratches (we suggest Wipe-All™).

Notes: The pressure chamber generally reaches the equivalent of less than 30,000 ft. elevation.



Rocket Launch Maintenance Instructions

General Information: Rocket Launch is an energy conversion demonstration that uses pressurized air to launch a “rocket” from the exhibit. Two rockets are included with the exhibit, and visitors are encouraged to build their own using rocket body forms. After installing their rocket on the exhibit launch tube, the visitor pressurizes the exhibit by pumping air into the system using the attached pump. A step plate is mounted under the pump to stabilize the kiosk during pumping. Depressing the red button below the launch tube then launches the rocket.

Setup: For best operation, the exhibit should be installed on a level, even surface. Ideally, the exhibit should be used outside exclusively. Airspace above the exhibit should be free of fragile and sensitive fixtures (i.e., sprinkler heads or fluorescent lights). The launch tube angle may be varied between 0 and 22 degrees from vertical. Loosen the pivot bolt using an 8mm hex key, tip the launch tube to the desired angle, and re-tighten the pivot bolt.

Rocket Body Forms: Rocket body forms may be made from lengths of ½” PVC pipe (this size has an outer diameter of 0.84”).

Cleaning Instructions: The finished or painted surfaces and plastic components of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner.

Pneumatics: A relief valve is installed in-line with the pump so that the launch system reaches a maximum pressure of 20 psi. The red launch button actuates the brass solenoid valve mounted beneath the launch tube. At higher air pressures, the solenoid valve opens slowly, acting as an orifice, which limits the volume of air released during the launch period.

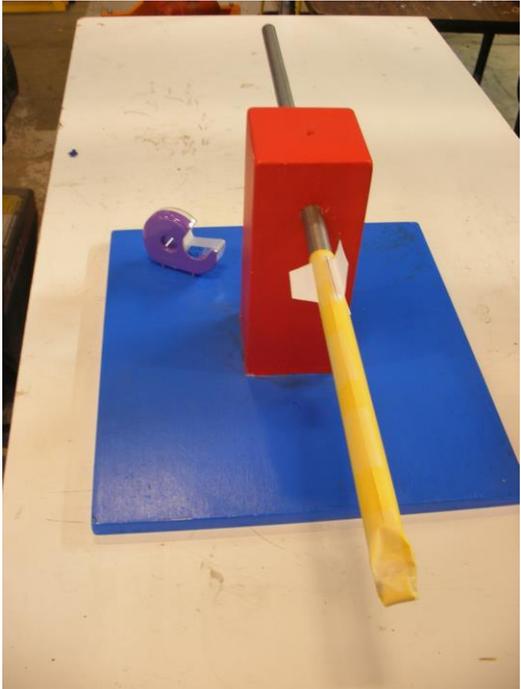
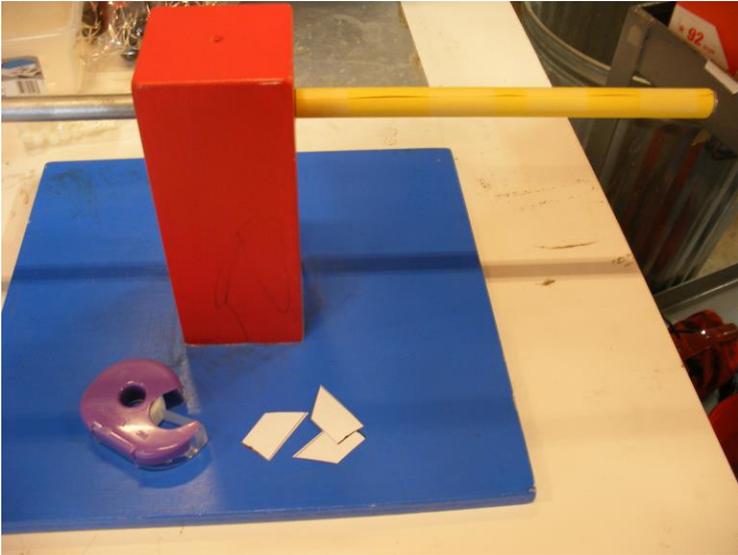
Replacement Rockets: The rockets used are Air Burst™ Rockets, attainable wholesale from the William Mark Corporation (909 608 7340, \$3.99 for pack of 2), or from Vision Forum (www.visionforum.com/search/productdetail.aspx?search=air+burst&productid=74504, part number 74504, \$7.00 for a pack of 2).

Notes:

1. The pump sometimes takes a few tries before it begins to build up pressure; pumping quickly helps with this.
2. When using a plastic rocket, wrap duct tape around the join between the foam “nose cone” and the rocket body to securely attach the foam; without this, the foam is easily broken off and the rocket’s hard plastic nose is potentially dangerous on reentry.
3. If the launch tube is positioned all the way forward, the rocket may sometimes hit the back of the exhibit.
4. When using the frame to make paper rockets, do not wrap the paper extremely closely around the pipe; it will not quite fit onto the launcher. See pictures on next page for how to make paper rockets.
5. Paper rockets are recommended for indoor use. Consider goggles for safety.

(continued next page)

Rocket Launch continued



Space Colony (LEGO Table) Maintenance Instructions

General Information: Space Colony allows visitors to create a space structure using building blocks. This exhibit allows visitors to creatively explore the needs and requirements of building a space vehicle or station.

Setup: For proper orientation, the exhibit should be set on a level, even surface.

Cleaning Instructions: The finished or painted surfaces and plastic building blocks of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner.

Storage Access: The base of this exhibit may be used for storage. Remove the brick storage bin from the tabletop to gain limited access. The exhibit tabletop may be removed by opening the three draw latches that secure it to the base. Use care to align all three draw latches before closing them when reinstalling the exhibit tabletop.

Building Block Replacement: The plastic building blocks may need to be replenished from time to time. The starter sets that came with the exhibit are the LEGO brand Journey Into Space sets (available from Learning Services, 1 800 877 9378, www.learningservicesus.com/home/ls2/page_5073_449/lego_journey_into_space_set.html, part number 779320, \$74.95)

Notes: Set out three or four chairs around the table for visitors. LEGOs tend to migrate from the exhibit. To more easily transport the exhibit, remove the tabletop.



The storage area in the base of the exhibit holds the lid to the LEGO bin, and is also a good place to keep the bin for storing the apples from Different Worlds Different Weights.

Plexi domes are available to cover habitats in an “oxygenated environment.”

Star Spectrum Maintenance Instructions

General Information: The spectral emission of each gas is observed by holding down the corresponding button while cranking the generator. The spectrum of the gas's glow may be observed through the diffraction grating framed by the red bezel. This reveals the specific wavelengths in the visible spectrum to the visitors.

Setup: For best operation, the exhibit should be installed on an even surface and out of direct sunlight.

Cleaning Instructions: The finished or painted surfaces of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner. The acrylic panels should be cleaned with a plastic cleaner and a soft wipe that will not leave scratches (we suggest Wype-All™).

Accessing the Inside of the Exhibit: The cover panel is removed for accessing the gas tubes for servicing. Remove the eight fasteners on the perimeter of the acrylic cover panel using the included hex key. The glow tubes may be removed by gently pulling their ends free from the bus clips. The tabletop is removed for accessing the exhibit interior for servicing. Remove the two M6 fasteners on the back face of the exhibit using the included 4mm hex key, and slide the tabletop away and up from the exhibit to free it from the locating pins on the exhibit's front face.

Electronics: The glow tube wiring is located under the acrylic plate on the back of the lamp case. The generator and button electronics are located under the tabletop.

Spectrum Tubes: Spectrum tubes are available from Electro-Technic Products, Inc., 4642 N. Ravenswood, Chicago, IL 60640-4510, phone 773 561 2349, fax 773 561 3130.

Notes: The spectrum tubes have small labels indicating the gases contained; turn the tubes so that these labels are not visible. Current (August 2010) gases are helium, mercury, and neon.



Steering with Thrust Maintenance Instructions

General Information: Steering with Thrust demonstrates the maneuvering of an object in space using thrusters. Visitors steer the model space shuttle using air jets to align it with the “space station dock,” a proximity sensor which lights a red LED.

Setup: For proper operation, the exhibit should be set up on a level, even surface. Check that the air nozzles are aligned—they are delicate, and may shift during transport. Plug the exhibit in and turn it on. The circuit breaker switch is on the back face of the exhibit near the bottom. The exhibit may draw up to 7A @ 110VAC under normal operating conditions. The exhibit uses a NEMA 5-15P to IEC 302-C13 power cord, similar to those used for powering desktop computer towers. This is the same power cord used in the Mars Rocket exhibit.

Cleaning Instructions: The finished or painted surfaces and stainless steel components of the exhibit may be cleaned with a mild soap solution or general-purpose cleaner. The acrylic panels should be cleaned with a plastic cleaner and a soft wipe that will not leave scratches (we suggest Wipe-All™).

Accessing the Inside of the Exhibit: The case is removed for accessing the shuttle platen for servicing. Remove the two M5 fasteners on the front of the acrylic case using the included 3mm hex key. The tabletop is removed for accessing the exhibit interior for servicing. Remove the two M6 fasteners on the back face of the exhibit using a 4mm hex key, and slide the tabletop away and up from the exhibit to free it from the locating pins on the exhibit’s front face. Avoid moving the tabletop too far from the base, as the proximity sensor wires, LED indicator wire pair, push-button wire pair, and compressed air line all tether the tabletop to the base.

Pneumatic System: If the exhibit electrical system is functional but the compressor will not start, bleed the air out of the pneumatic system by holding both finger valves open. If the finger valves become stuck open or closed, remove the compressor hose from one of its fittings and put a few drops of airline lubricant (we suggest Fuchs Lubritech Airlube 10W/NR) into the line. Reinstall the hose on its fitting and purge the system of the lubricant.

Bearing Maintenance: The shuttle turntable operates on two flanged oiled ball bearings (McMaster-Carr part number 4262T17). Remove the turntable assembly from the tabletop (single M8 fastener under the table), the three fasteners retaining the shuttle to the turntable, and the turntable from the standoff (single M6 fastener atop the turntable). Bearings may then be pressed out of the turntable for replacement.

Electronics: The electronics in Steering with Thrust are the most complex of the Outreach to Space set. If the exhibit ceases to function, check all of the wiring connections before beginning work on the components. After removing the tabletop, check:

1. That the inner timer relay is fully mounted in its socket.
2. That the air compressor and DC power supply are fully plugged into the duplex outlet.

(Continued next page)

3. That the wires to the tabletop (LED, pushbutton, proximity sensor) are connected at the tabletop and at the base.

Notes: Be sure to turn the exhibit on/off as well as plugging it in. It shuts off automatically until the red start button is pushed again.

