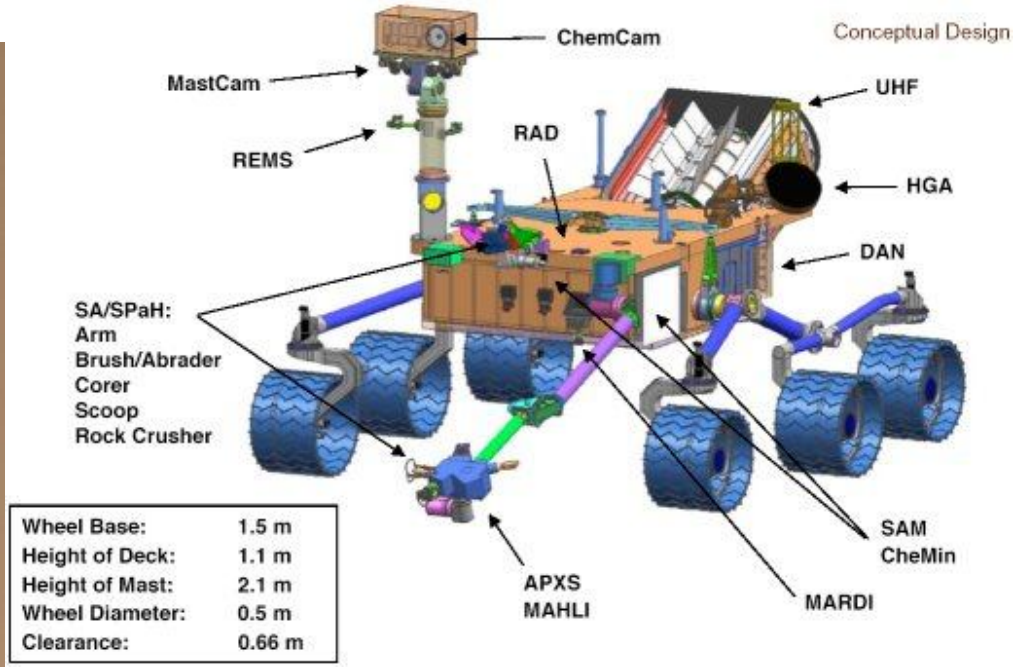
Mars Science Laboratory – Curiosity Rover 1:12 scale

The Mars Science Laboratory landed on Mars in August 2012 and will operate for at least one Mars year (approximately two Earth years). Launched in the fall of 2011, Mars Science Laboratory is part of NASA's Mars Exploration Program, a long-term effort of robotic exploration of the red planet. Mars Science Laboratory is a rover that will assess whether Mars ever was, or is still today, an environment able to support microbial life. In other words, its mission is to determine the planet's "habitability."

To find out, the rover carries the biggest, most advanced suite of instruments for scientific studies ever sent to the Martian surface. The rover will analyze dozens of samples scooped from the soil and drilled from rocks. The rover's onboard laboratory will study rocks, soils, and the local geologic setting in order to detect chemical building blocks of life (e.g., forms of carbon) on Mars and will assess what the Martian environment was like in the past.

Mars Science Laboratory relied on new technological innovations, especially for landing. The spacecraft descended on a parachute and then, during the final seconds prior to landing, lowered the upright rover on a tether to the surface, much like a sky crane. Now on the surface, the rover is able to roll over obstacles up to 75 centimeters (29 inches) high and travel up to 90 meters (295 feet) per hour.

The rover carries a radioisotope power system that generates electricity from the heat of plutonium's radioactive decay. This power source gives the mission an operating lifespan on Mars' surface of a full Martian year (687 Earth days) or more, while also providing significantly greater mobility and flexibility as well as a bigger science payload while not relying on varying seasonal sunshine for power.



Mars Science Laboratory – Curiosity Rover 1:12 scale

Assembly

Study the pictures and parts before beginning. A visit to the MSL site at http://marsprogram.jpl.nasa.gov/msl/ will also be helpful.

You'll need a craft knife or small scissors to cut out the parts, some kind of tool to score fold lines (marked with red arrows), and glue.

It's best to build in the order listed to build your skills and comfort level before assembling the more complex parts.

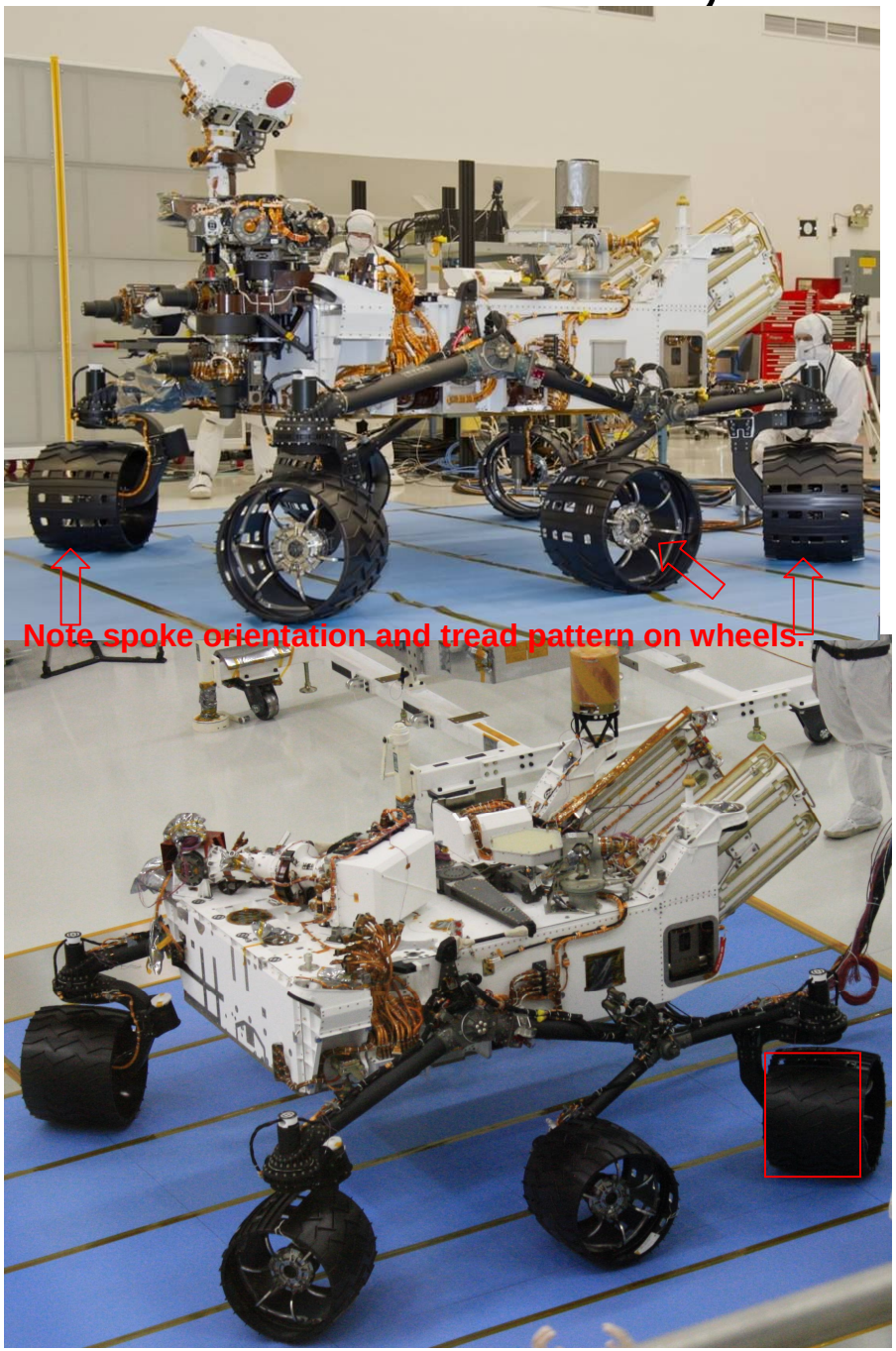
If you intend to use the detailed parts on page D, study them carefully before beginning to identify their location or parts they replace.

1. Print out the parts pages (marked **PRINT**) on 65lb or 110lb card stock.
2. Score the fold lines, then cut out the rover chassis box on page 4. Cut out the rover bottom on page 5 and the blue reinforcement parts on pages 7 and 8 (cut out the circles marked with a **red X**). Fold the chassis into a box and glue. Interlock the reinforcement pieces to make a grid structure and insert into the chassis box, making sure the arrows point to the front of the chassis (with the NASA, JPL, and MSL logos) and to the top. Fold the tabs on the edges of the chassis box down to secure the reinforcement grid, then glue the bottom in place – the front edge of the bottom is straight and should be even with the front of the chassis box. If you intend to build operating suspension – cut out the circles marked **S** for the main axle.
3. Score the fold lines and cut out the remaining chassis parts on page 5.
    1. Fold down the "ears" on parts G & H and glue, then fold the completed sides up. Fold the tops of the front corner brackets and glue in place inside the tops of parts G & H to form the structures. Glue to the chassis where indicated – referring to the included photos as needed. Fold the remaining front corner bracket parts (parts with the large circles on them) and glue to form a shelf, then glue that to the front of parts G & H (refer to photos page 22/23).
    2. Fold parts E & F into tall boxes and glue, then glue the long angled flap down to close the tops. Fold down the attachment structure that sticks out and glue (refer to photos). Glue to the chassis where indicated, taking care to align the parts with the chassis bottom and sides.
    3. Roll parts J & I into cylinders and glue, then fold down the disk to close the top of part J and glue. Glue the assemblies to parts E & F where indicated.
4. Score the fold lines and cut out the remaining parts on page 4. Also, score the folds and cut out the electronics box (part D) on page 8.
    1. Fold the three skyhook attachments – fold in the order indicated; middle first, then fold the sides up toward the rectangular base and glue. Glue the completed parts to the top of the chassis over the matching printed graphics.
    2. Fold the pyro control box part D and glue, then apply glue to the edges of the box and attach to the top of the chassis where indicated.
    3. Fold part 1 of the HGA into an irregular hexagonal box and glue (rectangular side panels next to the yellow side end up on the outside). Roll part 2 into a long cylinder and glue, then wrap/glue part 3 around the end of part 2 as depicted. Cut out the black circles (marked with a **red X**) on part 4, fold in half and glue together to make a two sided part, then fold at a 90 degree angle to make the HGA bracket. Roll part 5 into a cylinder and glue. Glue part 5 to the bottom of part 4 over the gray circle (refer to diagram). Insert the part 2/3 assembly through the hold in part 4, then carefully glue the small end of parts 2/3 to the gray circle on part 1. Set the completed HGA aside for later assembly.
    4. Fold/glue part A (front hazard cameras), then glue to the bottom/front of the chassis where indicated.

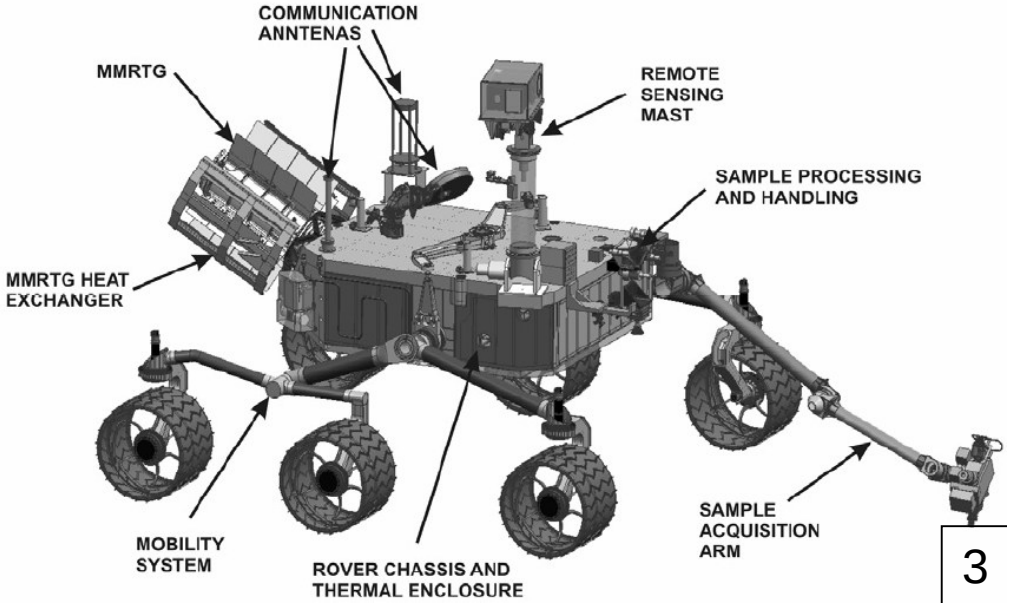
5. Score and cut out the RTG parts on pages 6 & 7.
    1. Fold the outside of the thermal shield and use the tab to glue the sides to the aft end to form the part's shape (printed side on the outside). Fold the inside of the thermal shield into the same shape (printed side on the inside) and glue inside the outer shield as shown in the diagram.
    2. Fold the two parts of the RTG body as shown in the diagram, then carefully glue the fins together (fins are the lighter colored parts). Form the RTG body into an octagonal column (see diagram of profile) with the small tabs on the inside of the structure. Glue those small tabs to form the center of the RTG and glue the last fins together. Fold/glue the unprinted sides of the RTG end cap together, then glue the end of the RTG with the fins to the gray octagon on the end cap. Fold in the small tabs on the end of the RTG without fins and use them to glue the RTG assembly to the gray octagon on the inside of the RTG thermal shield.
    3. Fold in the two tabs on the angled end of the RTG assembly and check that it fits between the chassis rear corner brackets. Then, use those tabs to glue the RTG assembly to the back of the chassis with the top edge of the mount even with the top of the chassis.
6. Score and cut out the remaining parts on page 8.
    1. Fold/glue the drill bit boxes (B & C) into tapered boxes, then glue to the front of the chassis where indicated.
    2. Fold/glue the mastcam base (K) into a square, then glue to the top of the chassis. The two lower, plain sides must align so the mastcam can fold diagonally back onto the top of the chassis (see pictures). Roll the lower mast erector joint into a cylinder and glue.
    3. Roll/glue the lower mast segment into a long cylinder, then insert its gray end into the lower mast erector joint cylinder and glue. Roll the band of the rotator joint into a ring and glue, then fold down the tabs and glue the top/bottom disks into place. Roll/glue the upper mast segment into a cylinder. Roll/glue the cable reel into a cylinder, then fold down and glue the end caps in place. Fold/glue the mast camera into a box.
    4. Glue the upper mast segment to the bottom of the mast camera over the blue circle. Glue the reel to the bottom of the mast camera along the gray line, the end cap should be flush with the outer edge of the camera box. Glue the rotator joint to the end of the upper mast segment, then glue the lower mast segment to the bottom of the rotator joint (the gray band is the bottom of the lower mast segment and fits into the base (K). Set the completed mastcam aside for later.
    5. If desired, fold the MARDI descent camera into a box and glue to the chassis over the printed graphic on the left front bracket (G)
    6. Score and cut out the organic sample check box (part M) from page 11. Fold into a box and glue. Glue the completed part to the front of the chassis where indicated.
7. For a more detailed model use the parts on page D to replace the corresponding parts. Additional detail parts are glued over the printed graphics on the rover.

Mars Science Laboratory – Rover

1:12 scale



Wheel 50cm=19.7”=1.64 scaled inches



Mars Science Laboratory Chassis

Fold chassis box, insert inner reinforcement grid, glue on rear corners, then attach bottom

Center on bottom, front

HGA

Axle & motor overlay

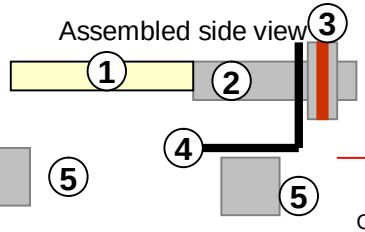
Bracket

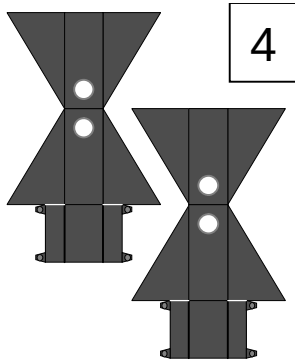
Base

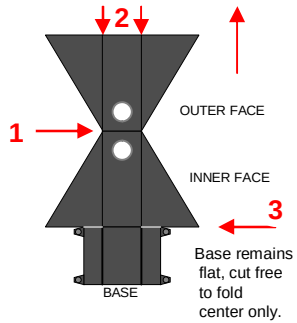
PRINT

Cut out black circles.

Assembled side view



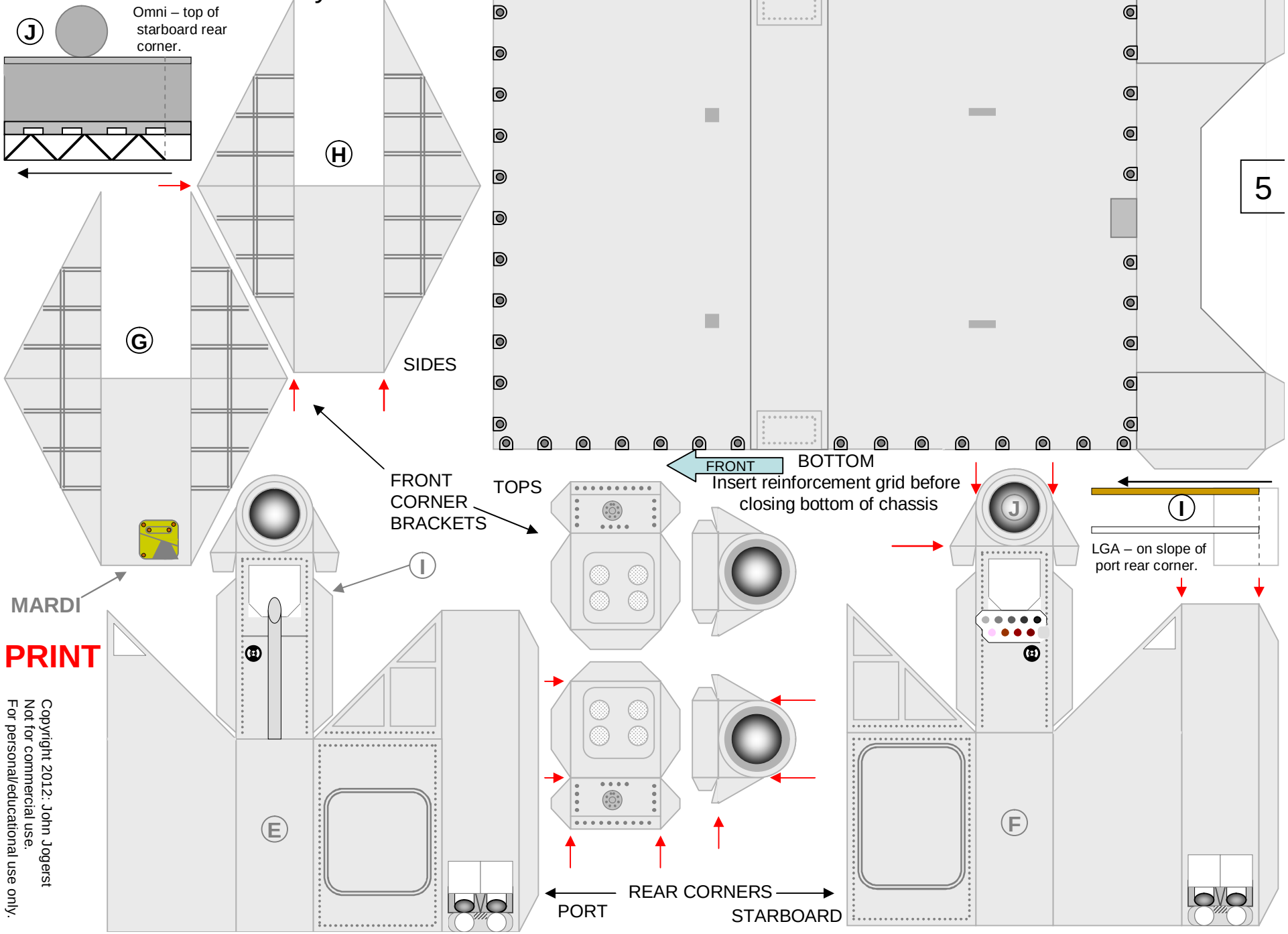




Base remains flat, cut free to fold center only.

Skyhook attachment

Mars Science Laboratory – Chassis

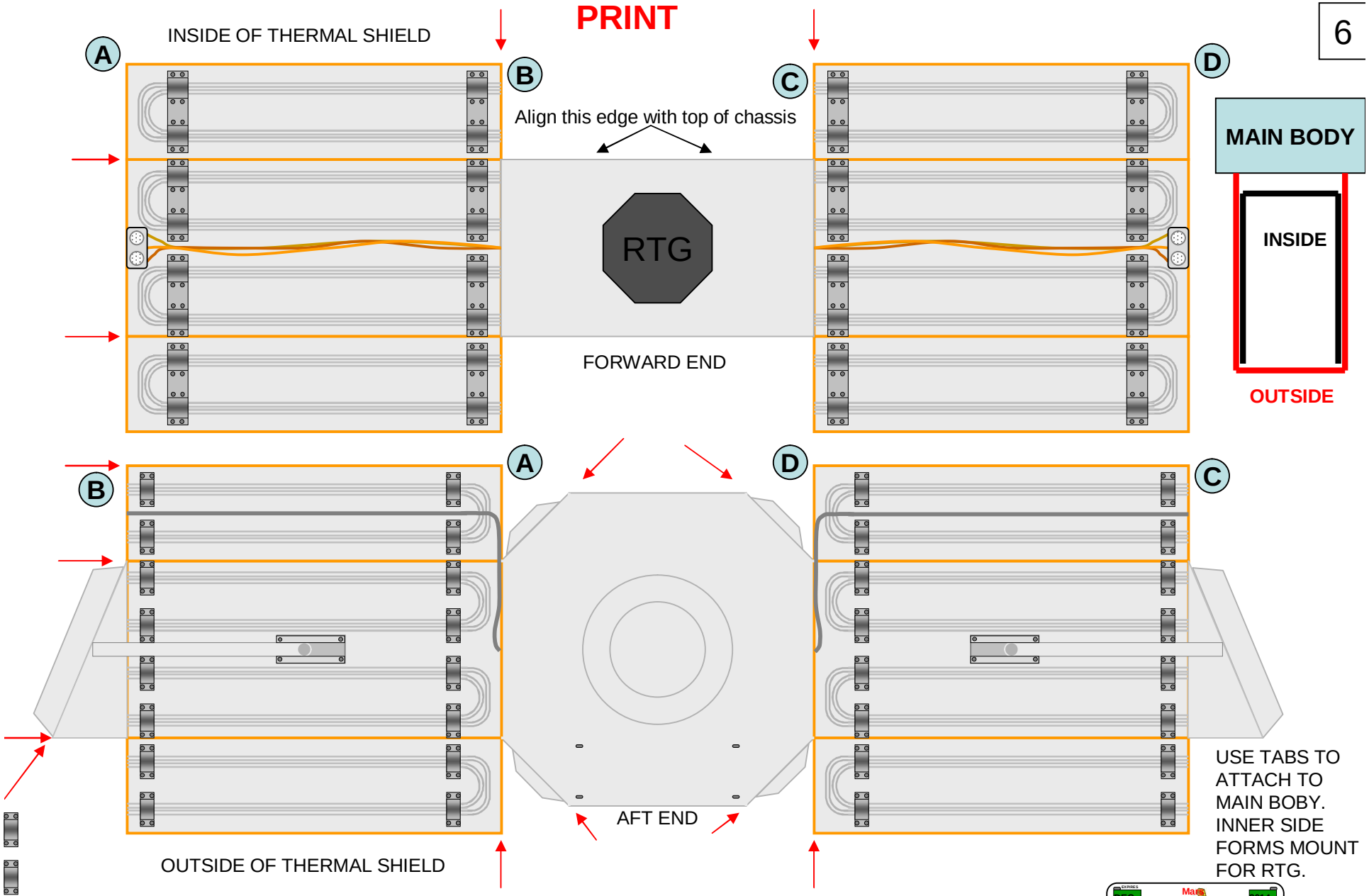


Eat my dust, SPIRIT !!

Mars Science Laboratory – RTG thermal shield

6

PRINT



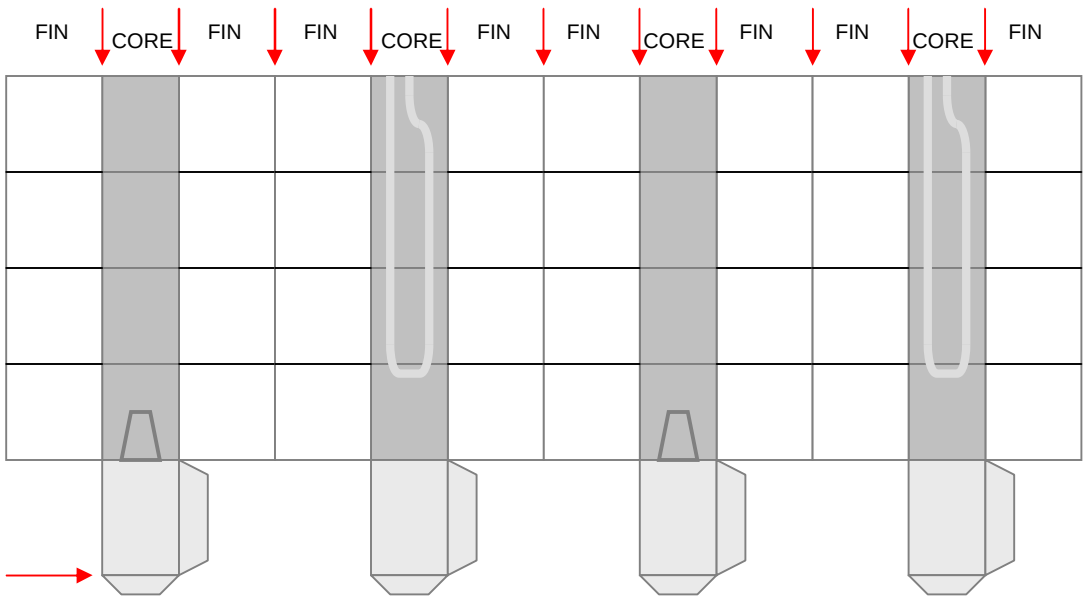
Fold outer shield and secure using small tabs on aft end. Fold inner shield into shape. Glue RTG in place to inner shield, then slip inner shield into outer and glue together.
Attach to chassis between rear corner parts using angled tabs.

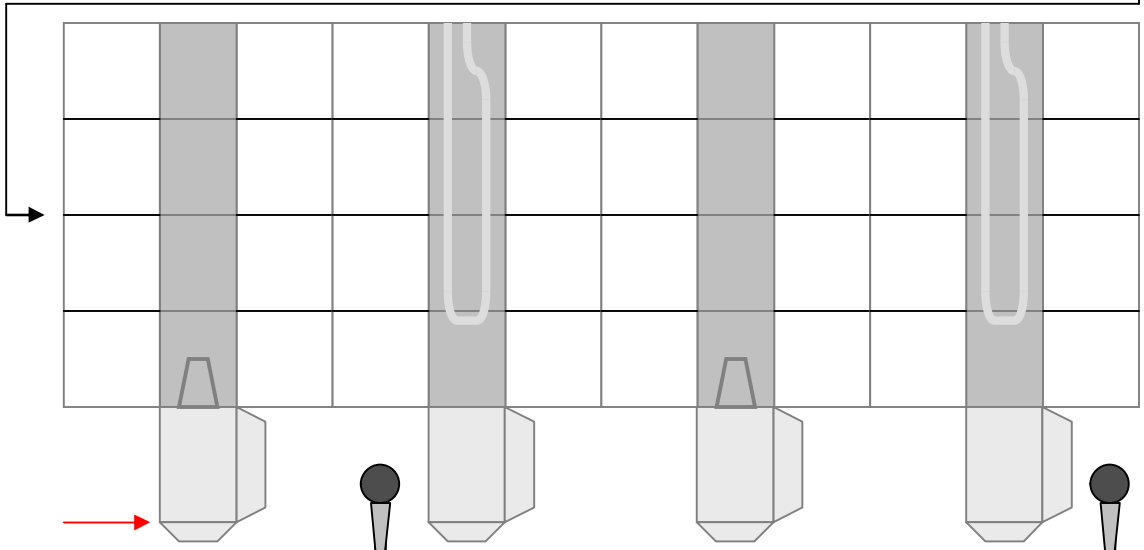
DEC MSL R04 2014
The Extreme Planet

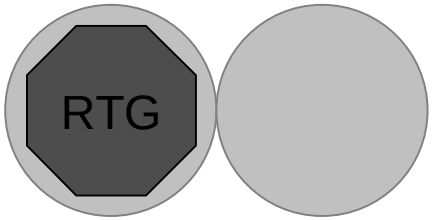
We brake for Aliens

Mars Science Laboratory – RTG core

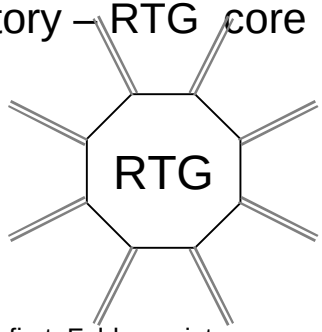
RTG BODY



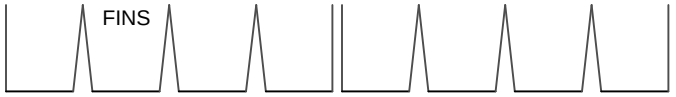




RTG END CAP

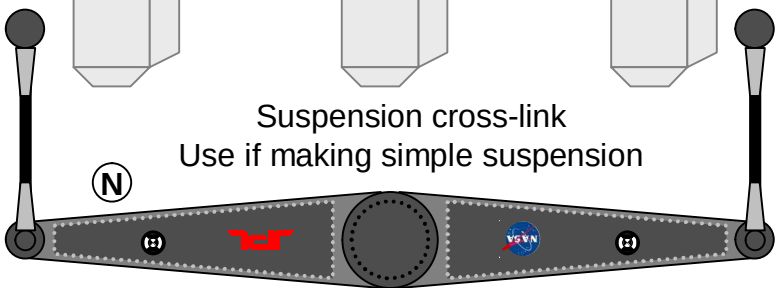


Fold RTG body, forming the fins first. Fold core into an octagon and secure using fins and tabs at base.



FOLDING DIAGRAM

Chassis inner reinforcement cross pieces

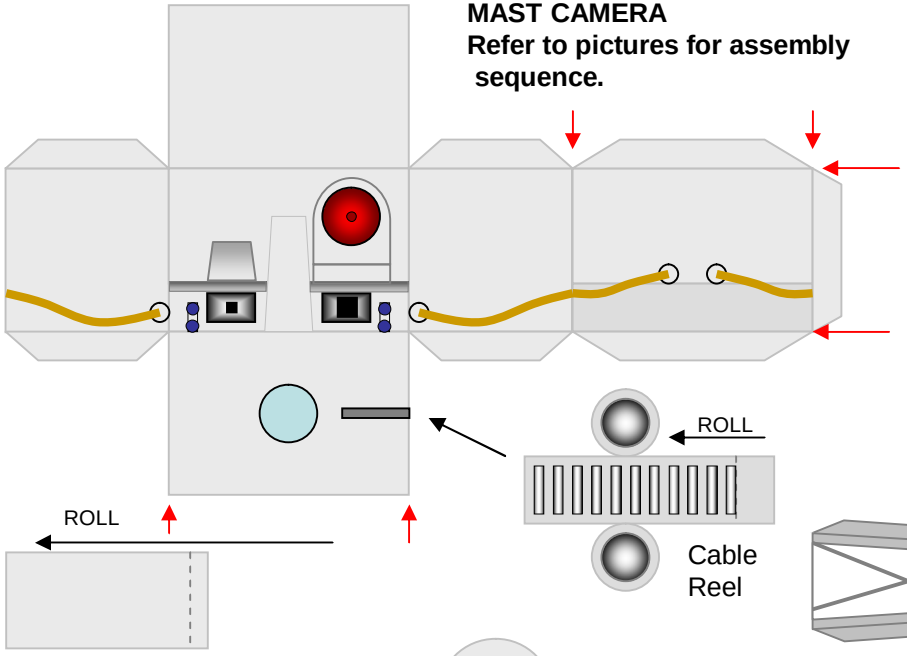


Suspension cross-link
Use if making simple suspension

PRINT

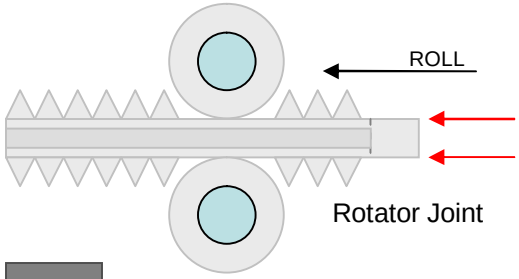
Mars Science Laboratory - instruments

MAST CAMERA
Refer to pictures for assembly sequence.



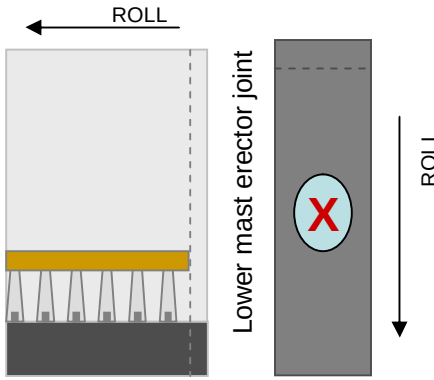
Upper mast segment.

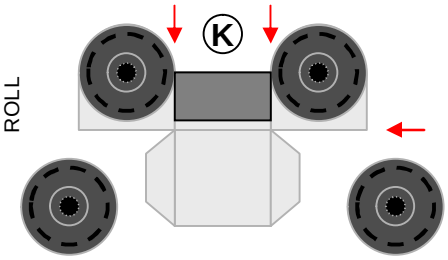
Cable Reel



Rotator Joint

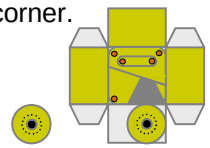
Lower mast segment



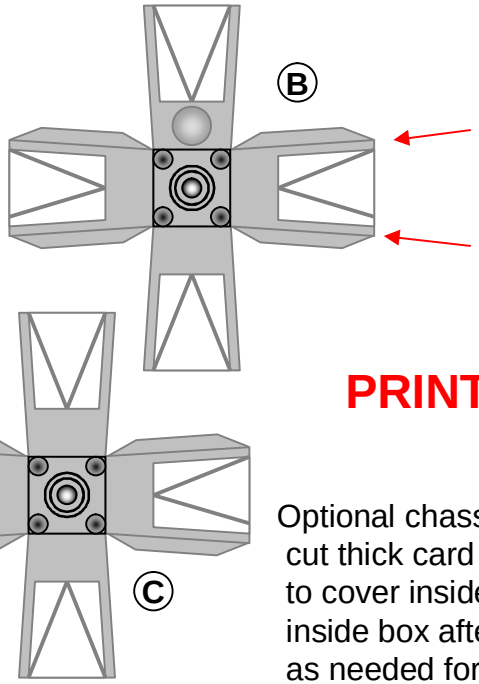


Mast base (K) w/ extra end caps for 3-D lamination

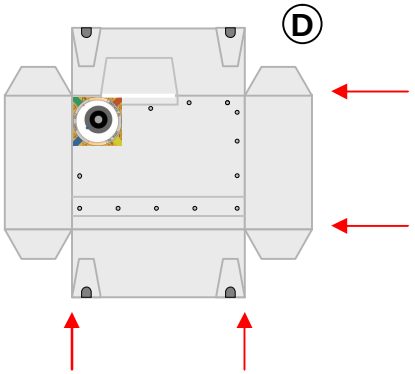
MARDI – port front corner.



Drill bit boxes - front starboard of chassis

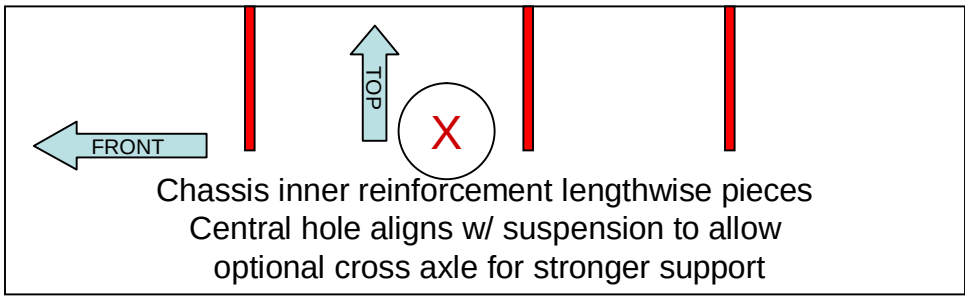


Pyro control box - aft starboard on top of chassis

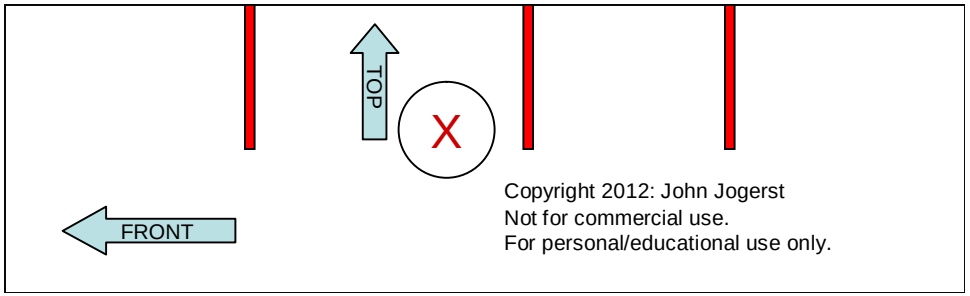


PRINT

Optional chassis box reinforcement:
cut thick card panels
to cover inside of top, sides and front. Laminate inside box after folding; trim inner reinforcement as needed for clearance; then secure bottom.



Chassis inner reinforcement lengthwise pieces
Central hole aligns w/ suspension to allow optional cross axle for stronger support



Mars Science Laboratory Chassis

Sample tray on lower drill bit holder

Starboard wiring Just aft of mast

Arm joint motors-slip over axle to replace wrapped overlays.

Optional detailing parts. D

Arm wiring

MAHLI cal target

Arm stowed supports

FOLD CENTRAL BOX; FOLD END FLANGES UP.

L

R

CLOSED

OPEN

Sample Inlets

Sample Inlets

Port side bay fwd of pivot

RAD Cover

Organic check blocks mount on chassis with box centered on the M.

Mastcam head & navcams.

Aft HAZCAMs. Fold side under lens covers.

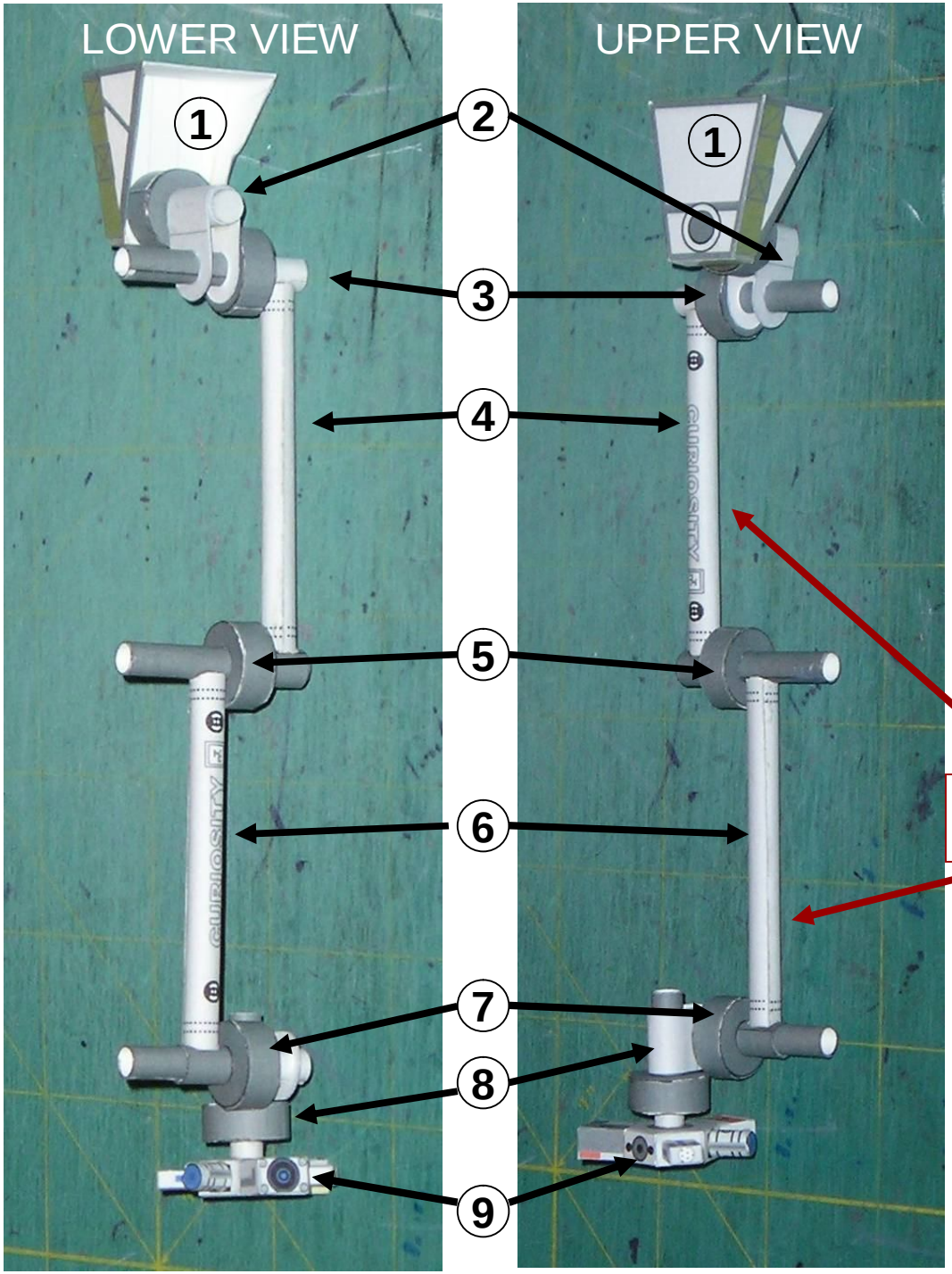
Side bays aft of pivot

Upper mast segment.

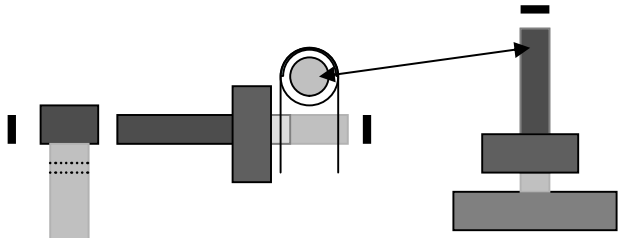
Cable Reel bracket/optional

7. Study the pictures of the completed sampling arm, then score and cut out the parts for the sampling arm on page 11.
    1. Fold the inner face of the mounting bracket (1) down and glue, leaving the small tab bent up. Fold/glue the trapezoidal sections into a box and secure against the inner face using the small tab. Then, fold in the sides and glue to complete the bracket. Glue the marked face of the bracket to the chassis where indicated.
    2. Pin and first joint: roll/glue the larger rectangle into a long cylinder, then carefully roll the smaller rectangle around the first cylinder and carefully glue into a cylindrical sleeve (do not stick the cylinders together – the outer cylinder must rotate freely). Separate the two cylinders, then glue the longer one – the bracket pin – into the hole in the bottom of the mounting bracket. Carefully bend the fitting (long rectangle with two pierced “ears”) around the short cylinder, then glue the short cylinder inside the fitting to make the sleeve for the fitting. Slip the completed fitting over the bracket pin and make sure it pivots smoothly. Carefully glue the small gray circle over the bottom of the bracket pin to secure the fitting – be careful not to get glue on the fitting so it will turn.
    3. Roll/glue the joint axle into a long cylinder. Roll/glue the gray strip around the light gray portion of the axle for form the motor section.
    4. Arm segment and end sleeve. Roll/glue the gray arm segment into a long/thin cylinder. Roll the smaller, dark rectangle around the axle from step 3 and carefully glue to form the sleeve – taking care not to glue the two cylinders together. Slip the sleeve off of the axle. Glue the sleeve to one end of the arm segment (it may be easier to glue if you notch the end of the arm segment). Then, glue the other end of the arm segment to the light gray end of the axle from step 3, making sure the sleeve and axle are parallel to each other. See diagram on page 10.
    5. Repeat step 3 for the next axle/motor assembly.
    6. Repeat step 4 to complete the second arm segment.
    7. Repeat step 3 for the next axle/motor assembly.
    8. Sampling head joint: roll/glue the larger rectangle into a long cylinder, then carefully roll the smaller rectangle around the first cylinder and carefully glue into a cylindrical sleeve (do not stick the cylinders together – the outer cylinder must rotate freely). Separate the two cylinders. Roll/glue the gray strip around the light gray portion of the axle for form the motor section. Carefully bend the fitting (long rectangle with two pierced “ears”) around the short cylinder, then glue the short cylinder inside the fitting to make the sleeve for the fitting. Slip the completed fitting over the pin and make sure it pivots smoothly. Carefully glue the small black patterned circle over the bottom of the bracket pin to secure the fitting – be careful not to get glue on the fitting so it will turn.
    9. Sampling head: fold the main head into a hexagonal box and glue with the unprinted gray tabs inside. Fold/roll the instruments into four small boxes and one cylinder. Glue these to the hexagonal box over the matching printed graphics. The one side without a part is the drill – punch three small pieces of stiff wire into the three black dots if desired for form the locating pins and drill bit. Glue the pin assembly from step 8 to the gray circle on top of the sampling head.
    10. Assembly – refer to the photos and diagrams to slip the arm segments and joints together. Cap the ends of the axles with the small black patterned disks.

Assembly diagram for detailed arm based on Curiosity Mars photos

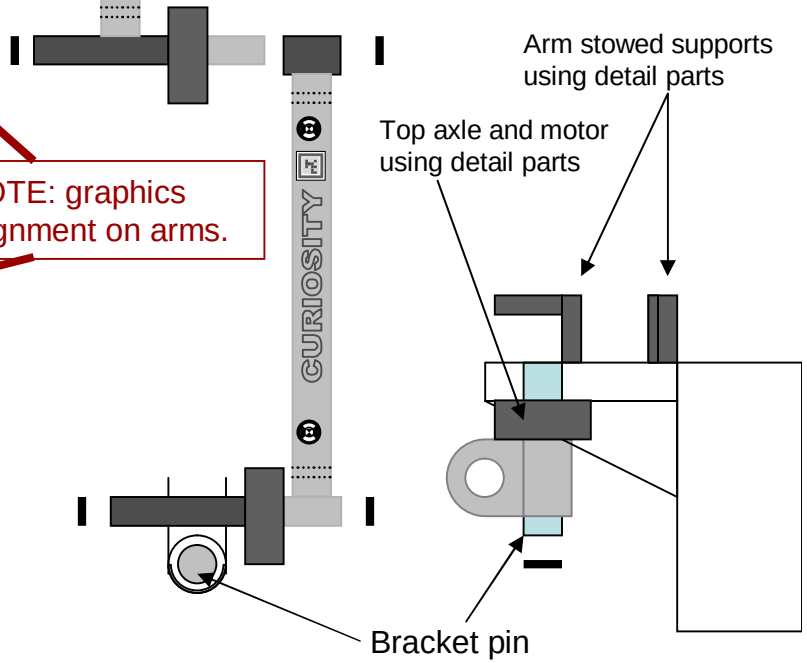


NOTE: graphics alignment on arms.



Sampling head.

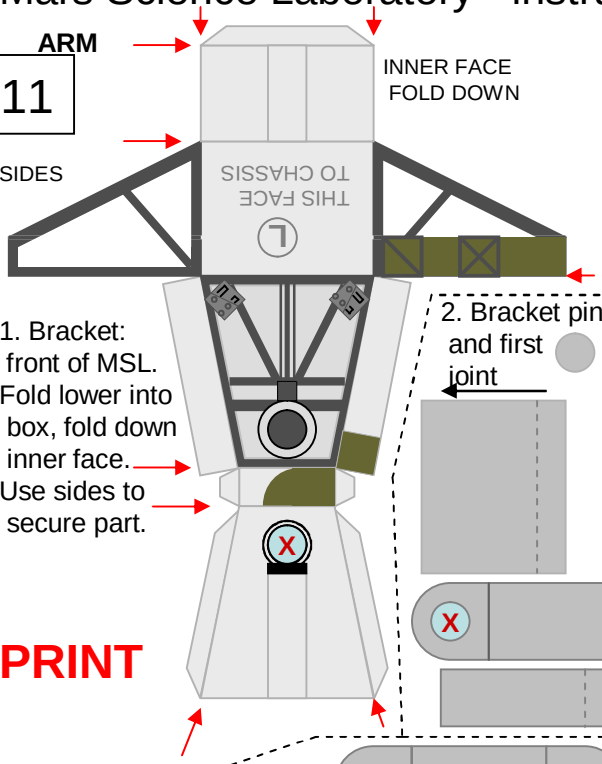
NOTE: graphics should be visible on top of **folded** arm.



Mars Science Laboratory - instruments

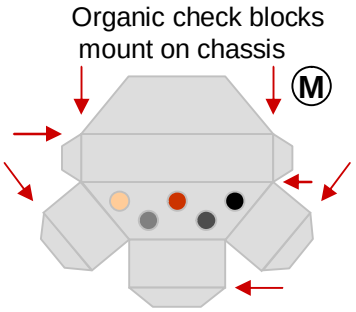
ARM

11



1. Bracket: front of MSL. Fold lower into box, fold down inner face. Use sides to secure part.

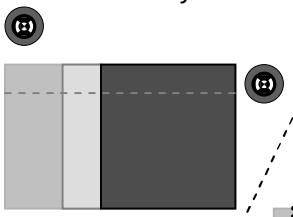
PRINT



2. Bracket pin and first joint

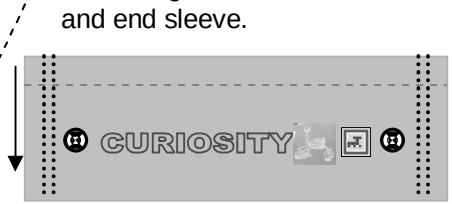
Glue a sleeve inside each of the end fittings – axles go thru the "ear" holes, pin and sampling head slip into sleeve

3. Joint axle and motor overlay

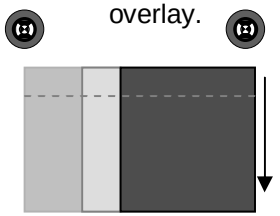


For more accurate motor disks at arm joints use the parts on page D.

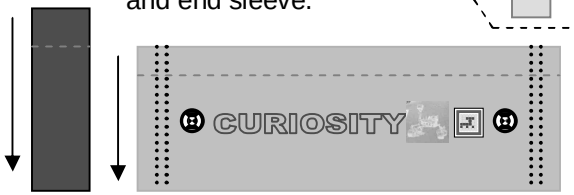
4. Arm segment 1 and end sleeve.



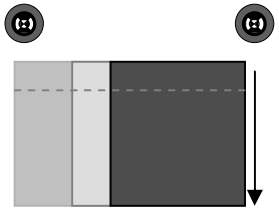
5. Axle 1 and motor overlay.



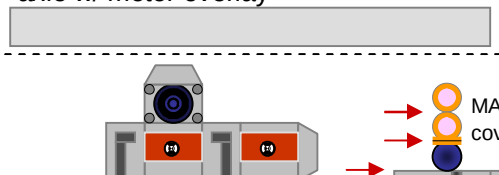
6. Arm segment 2 and end sleeve.

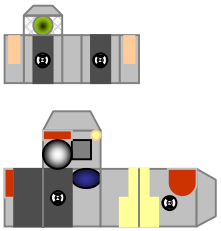


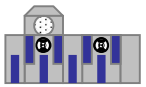
7. Axle 2 and motor overlay

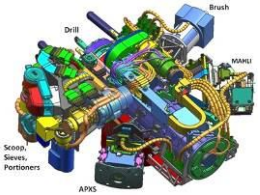


8. Sampling head joint and axle w/ motor overlay

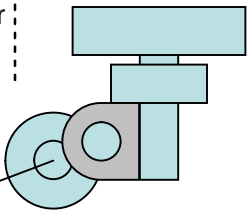


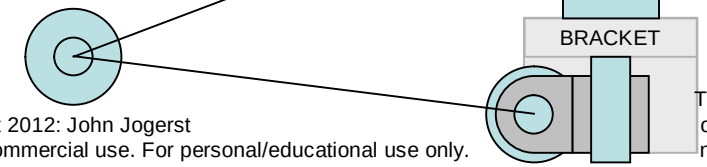


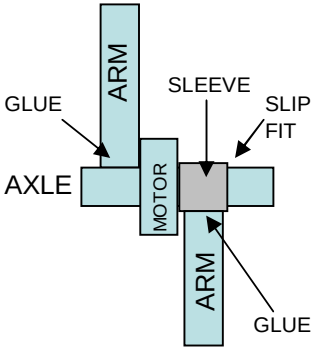




9. Sampling head

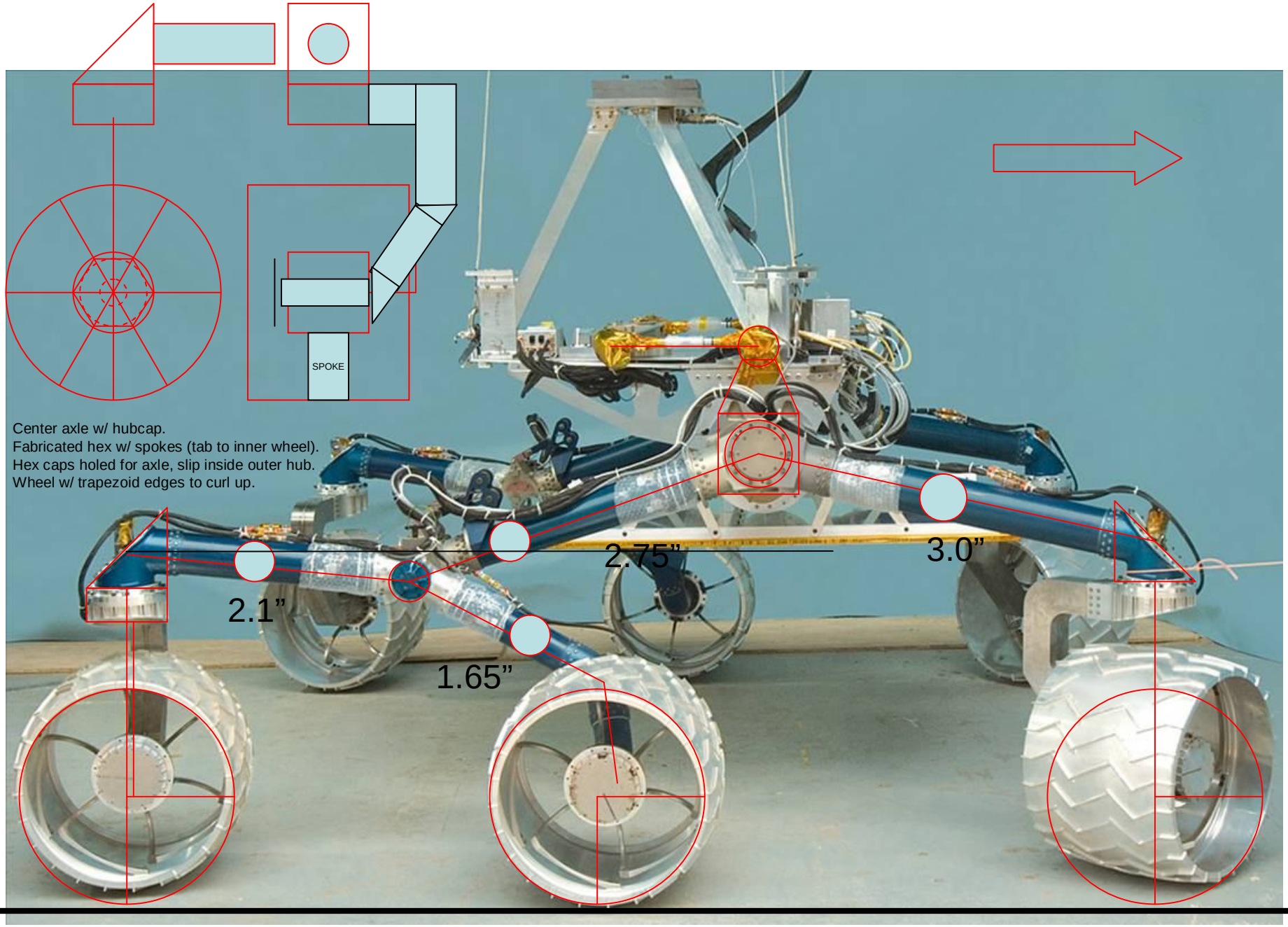






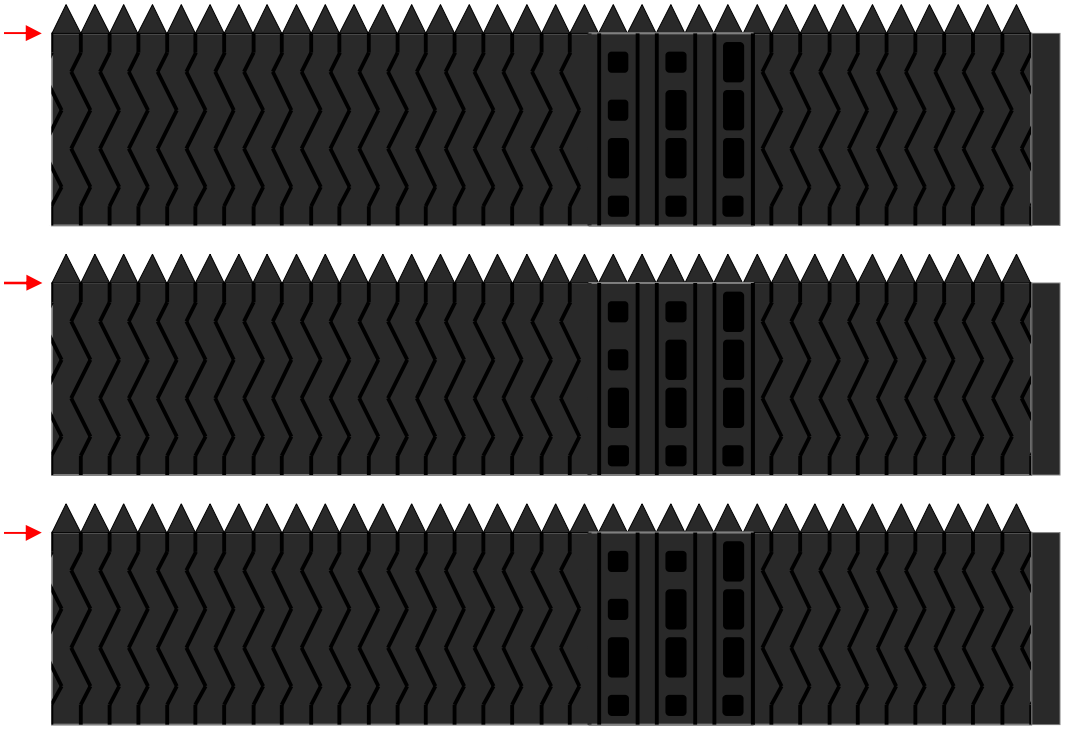
To form sleeve parts: roll sleeve over the outside of a completed axle taking care not to glue the two parts to each other.

Mars Science Laboratory – Suspension

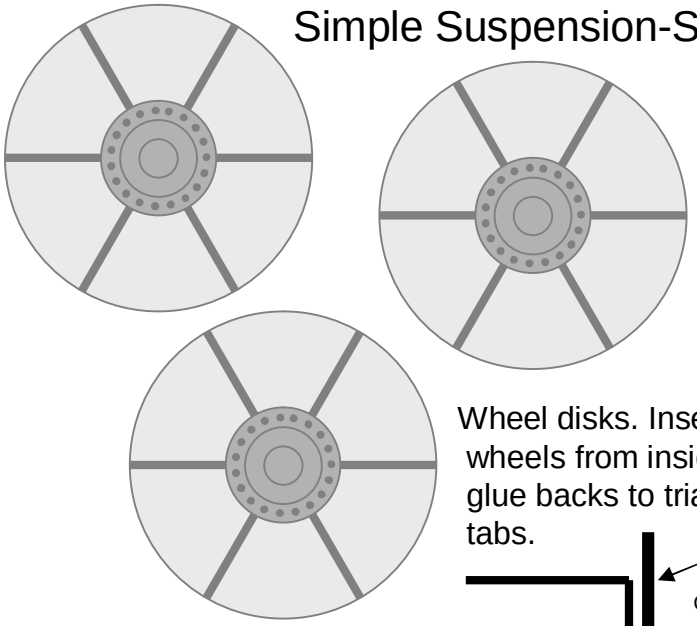


Mars Science Laboratory
Simple Suspension-Stb

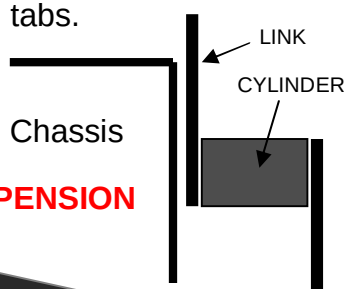
13



Color back of part (inside of wheel) black.

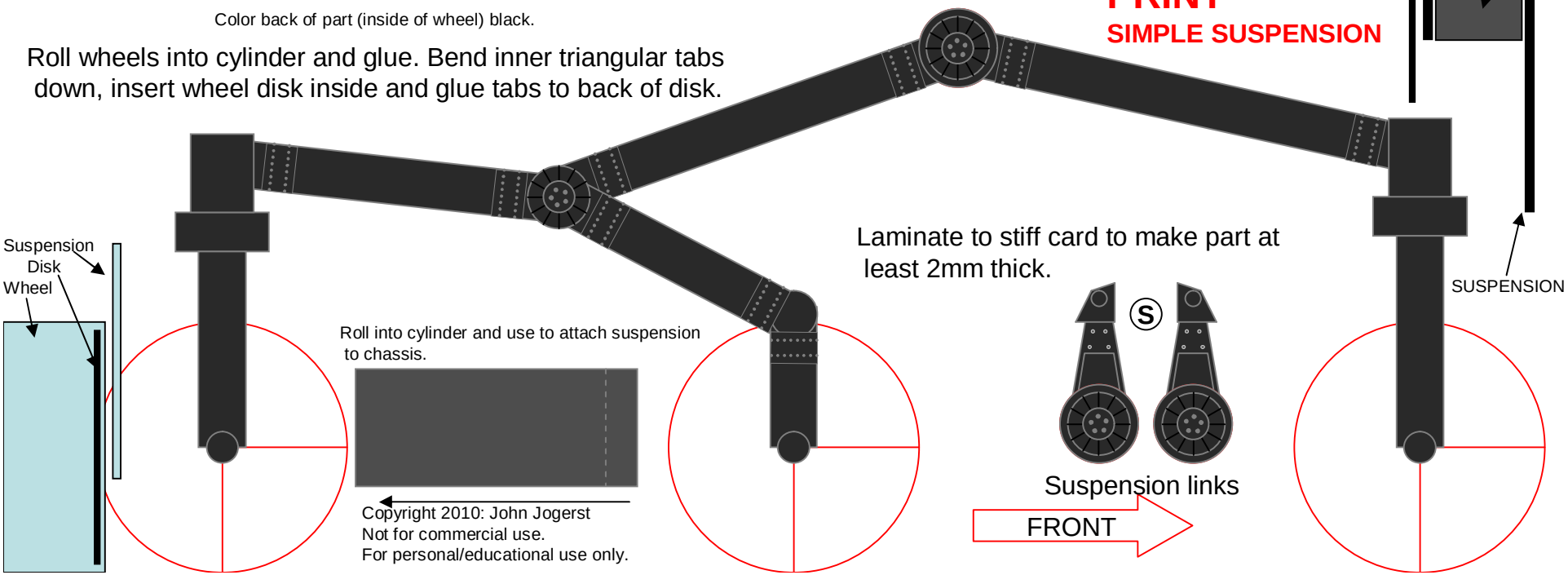


Wheel disks. Insert into wheels from inside and glue backs to triangular tabs.



PRINT
SIMPLE SUSPENSION

Roll wheels into cylinder and glue. Bend inner triangular tabs down, insert wheel disk inside and glue tabs to back of disk.

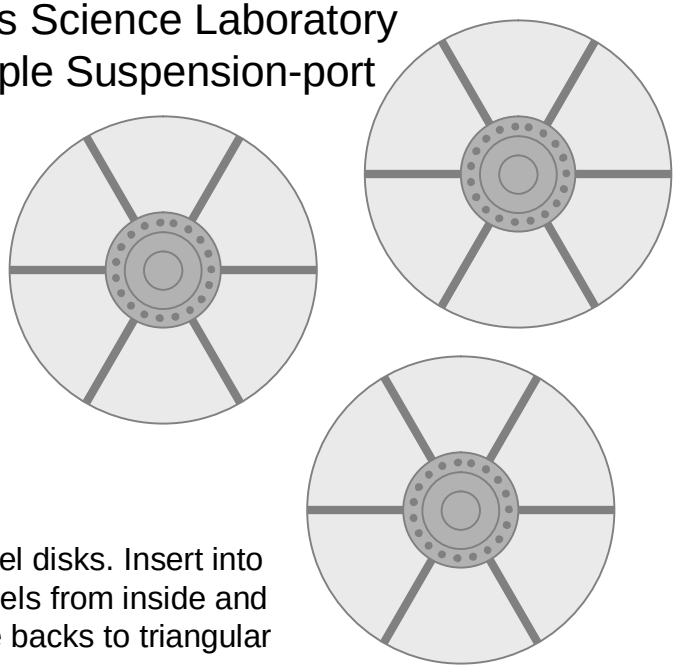


Laminate to stiff card to make part at least 2mm thick.

Suspension links

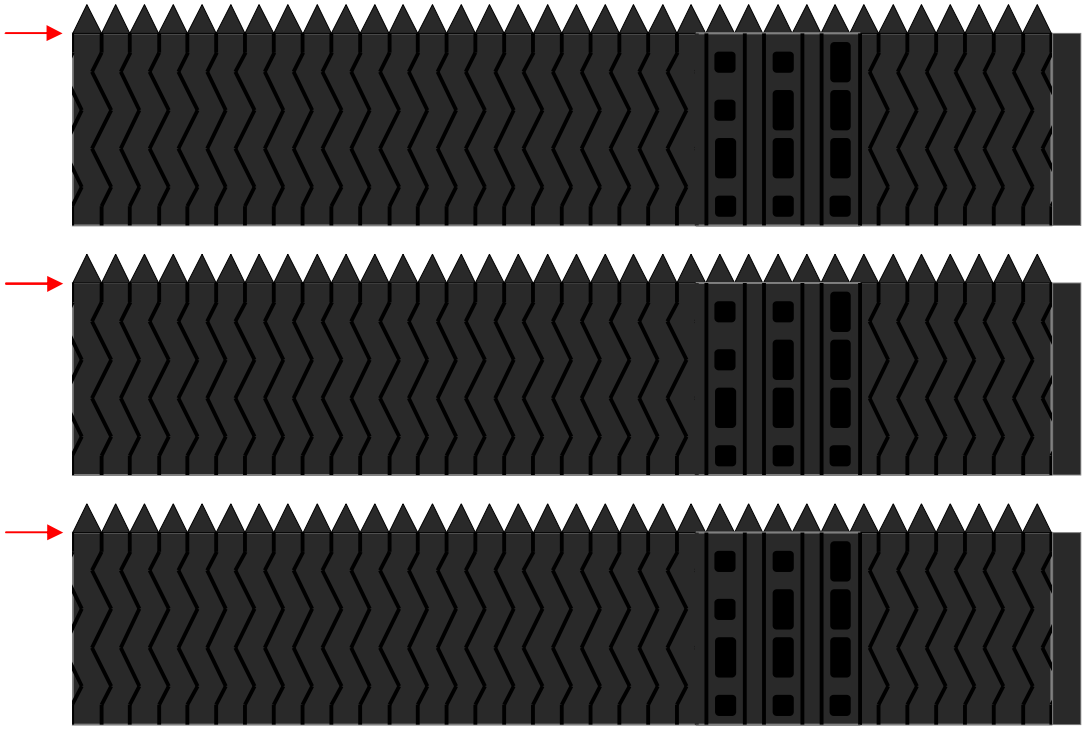
FRONT

Mars Science Laboratory
Simple Suspension-port



14

Wheel disks. Insert into wheels from inside and glue backs to triangular tabs.



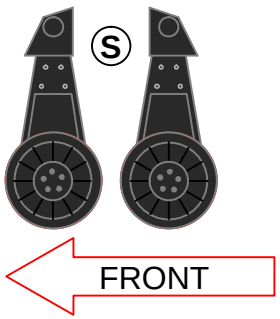
Color back of part (inside of wheel) black.

PRINT
SIMPLE SUSPENSION

Roll wheels into cylinder and glue. Bend inner triangular tabs down, insert wheel disk inside and glue tabs to back of disk.

Laminate to stiff card to make part at least 2mm thick.

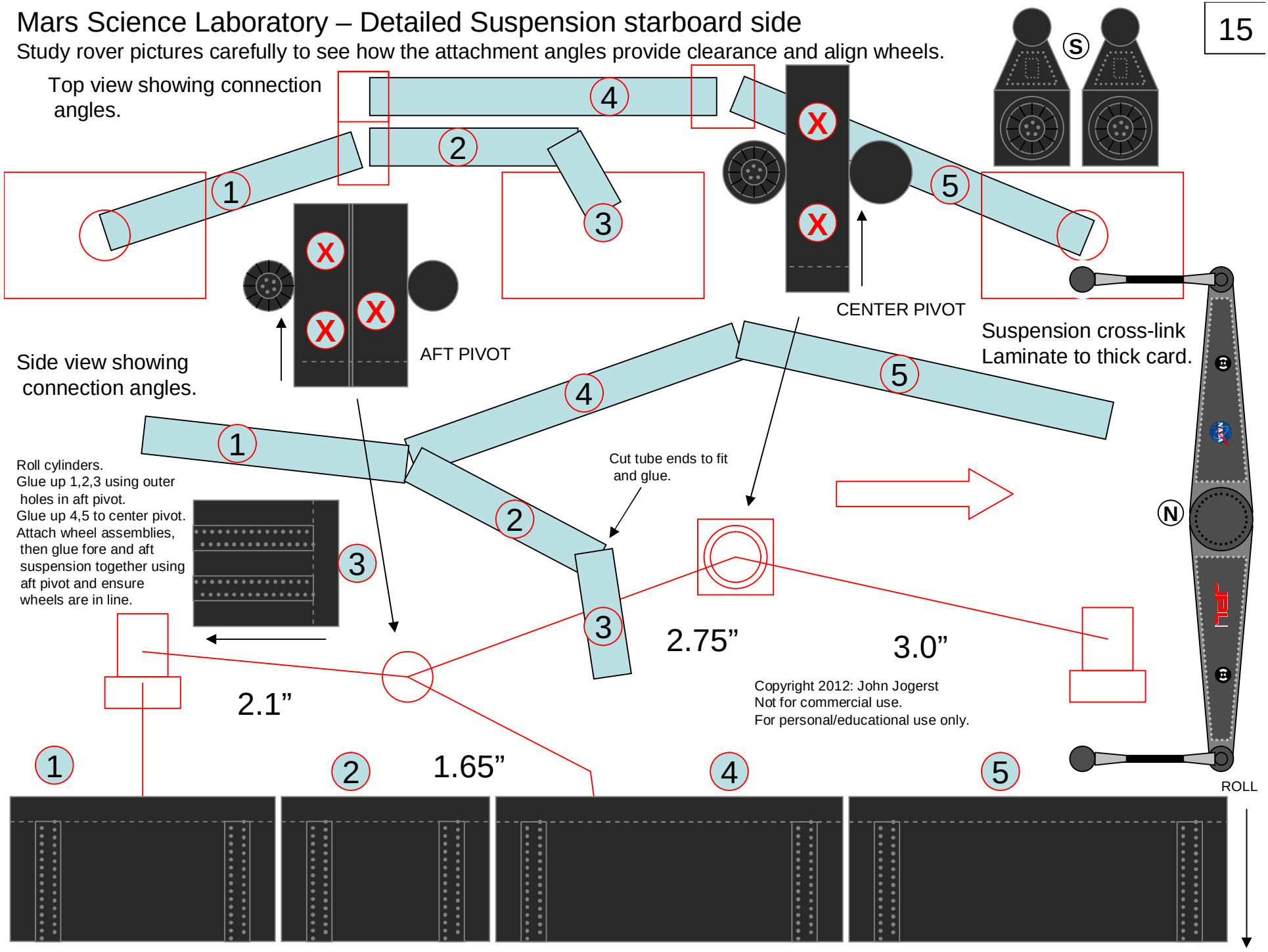
Suspension links



Roll into cylinder and use to attach suspension to chassis.

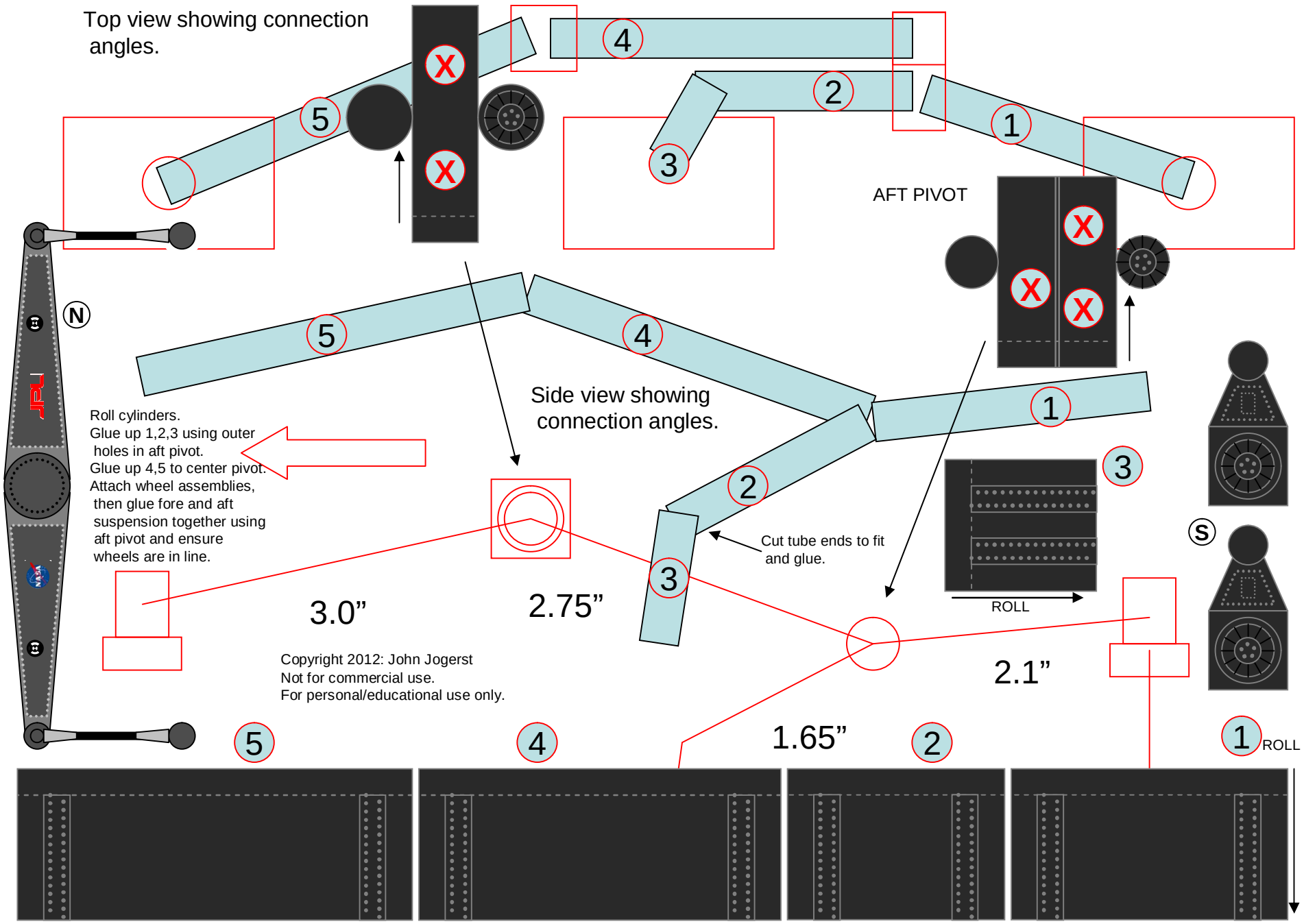
Mars Science Laboratory – Detailed Suspension starboard side

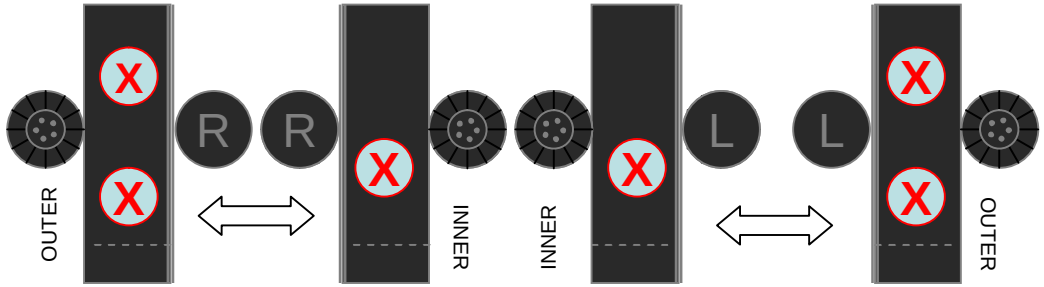
Study rover pictures carefully to see how the attachment angles provide clearance and align wheels.



16

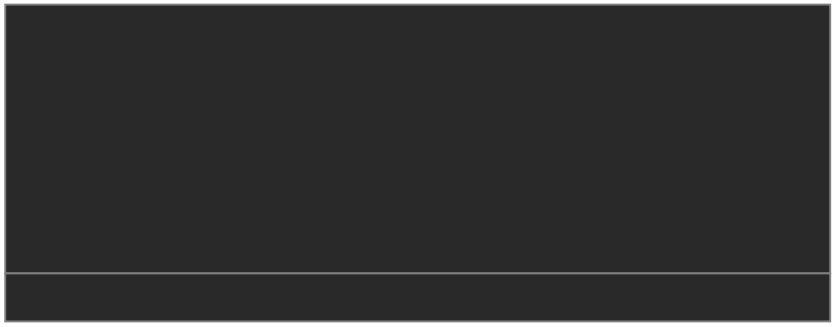
Mars Science Laboratory – Detailed Suspension portside





STBD AFT PIVOT

PORT AFT PIVOT



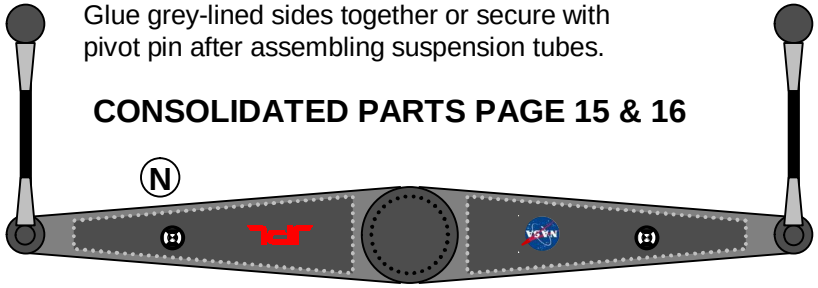
CROSS AXLE (through chassis and fit into center pivots slightly)

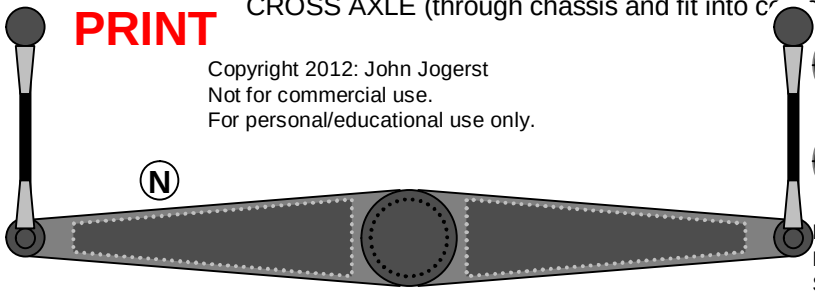
Glue grey-lined sides together or secure with pivot pin after assembling suspension tubes.

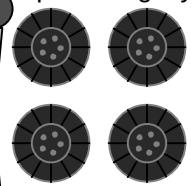
PRINT

CONSOLIDATED PARTS PAGE 15 & 16

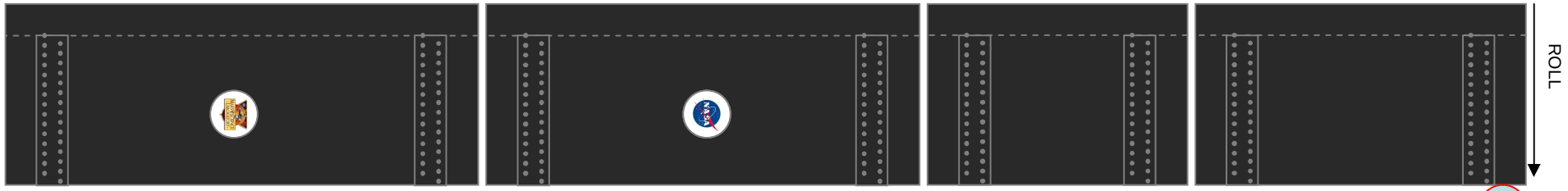
17



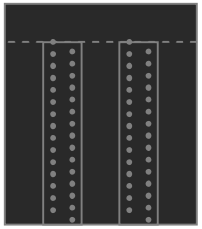




EXTRA PIVOT CAPS IF BUILDING FUNCTIONAL SUSPENSION



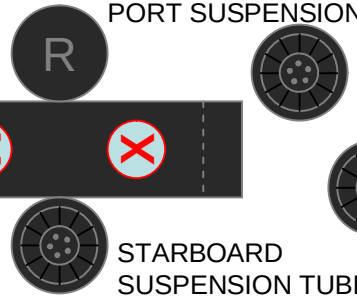
5



3

4

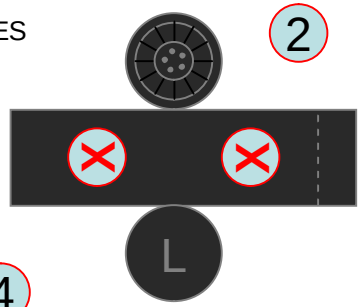
PORT SUSPENSION TUBES



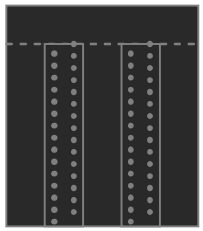
STB CENTER PIVOT

STARBOARD SUSPENSION TUBES

2



PORT CENTER PIVOT

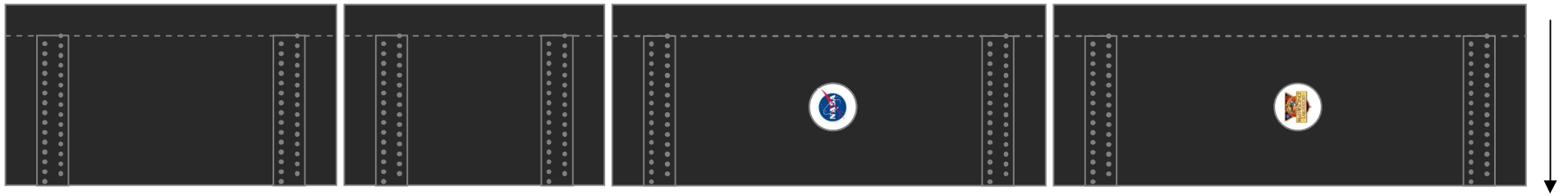


1

3

ROLL

1



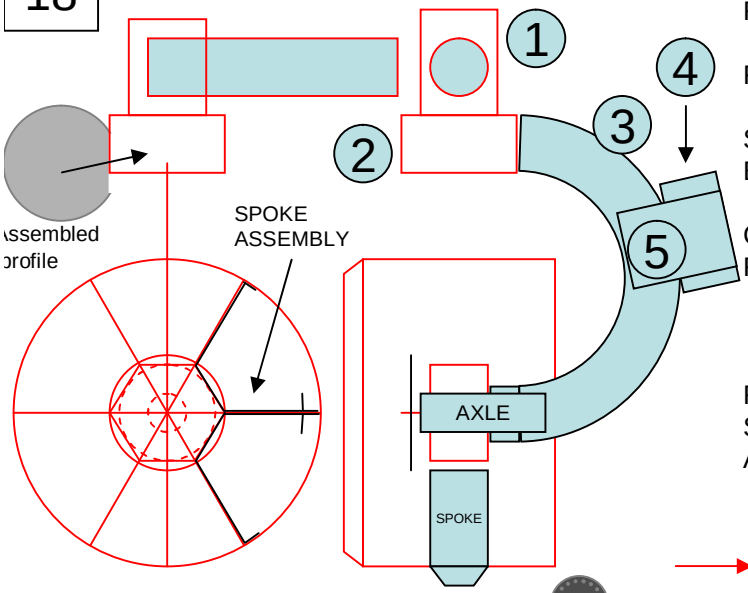
2

4

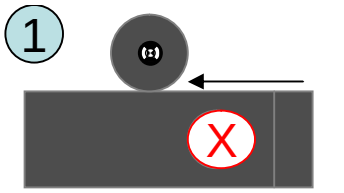
5

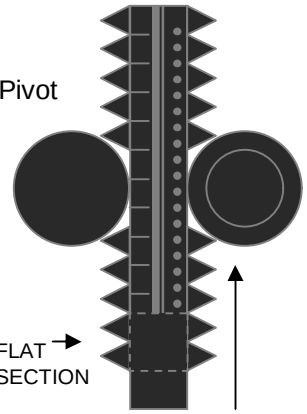
Mars Science Laboratory – Suspension 4 steering “corner” bogies

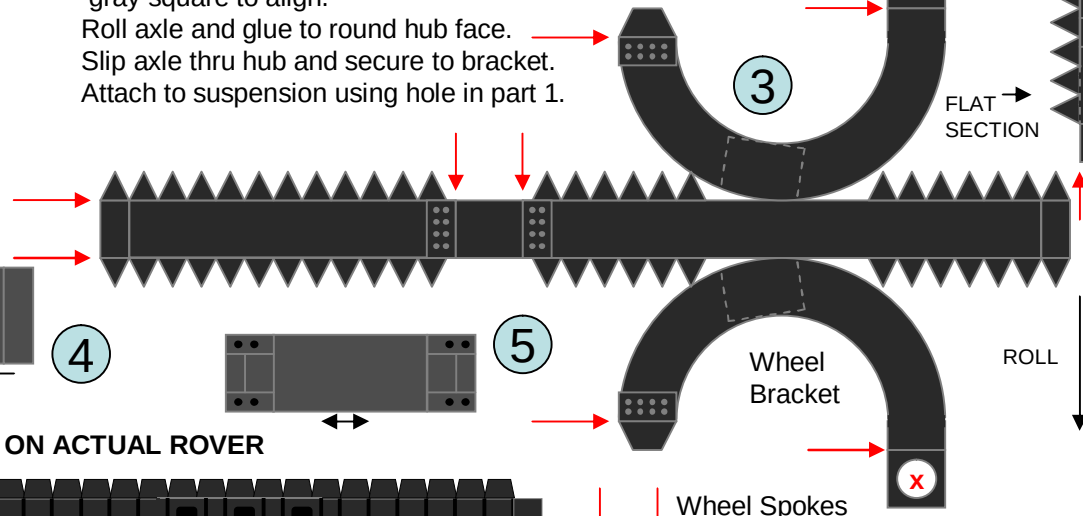
18



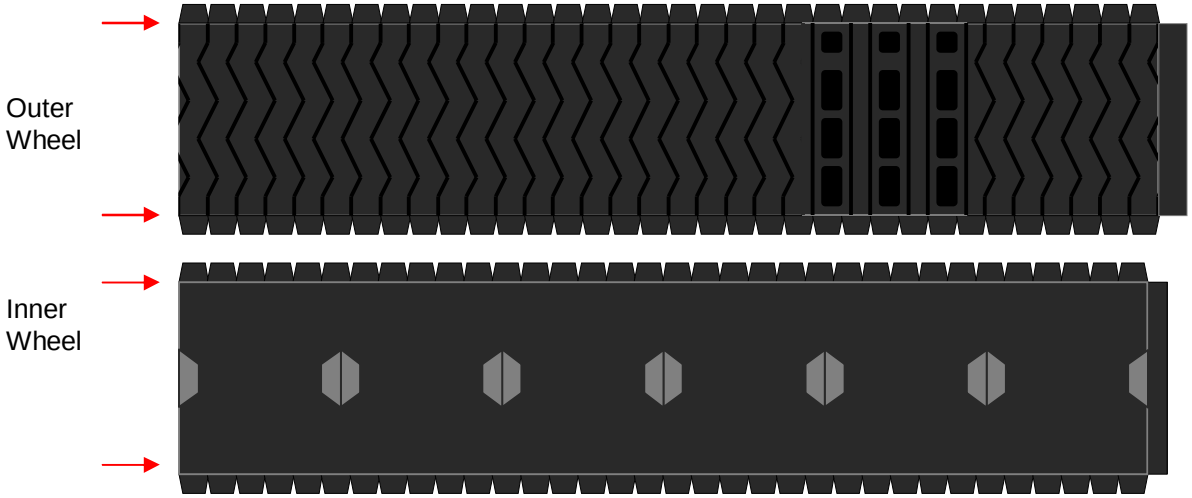
Roll outer wheel into a cylinder and glue.
Roll inner wheel to fit inside (trim if needed) and glue (no glue on edge tabs!).
Fold spokes and glue spoke faces to form a hexagonal hub. Fold tabs on assembly and hexagonal end caps down and glue to lock hub.
Slip hub inside wheel and secure using small tabs on spoke ends.
Bend edge tabs on wheel inward (glue between layers) to form wheel rim.
Curve, fold and glue part 3.
Roll and glue upper pivot parts 1 & 2, refer to suspension page to align suspension attachment hole (1) and bracket attachment flat section on part 2. Attach bracket to pivot cylinder using light gray square to align.
Roll axle and glue to round hub face.
Slip axle thru hub and secure to bracket.
Attach to suspension using hole in part 1.

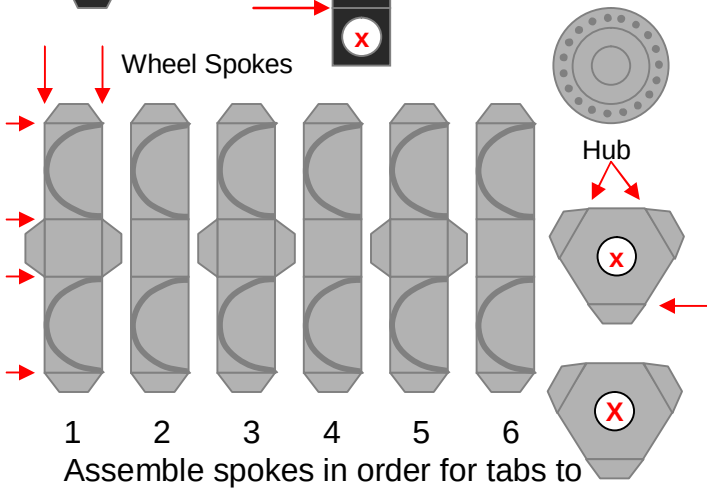






NOTE: PARTS 4 & 5 ONLY ON FORWARD BOGIES ON ACTUAL ROVER

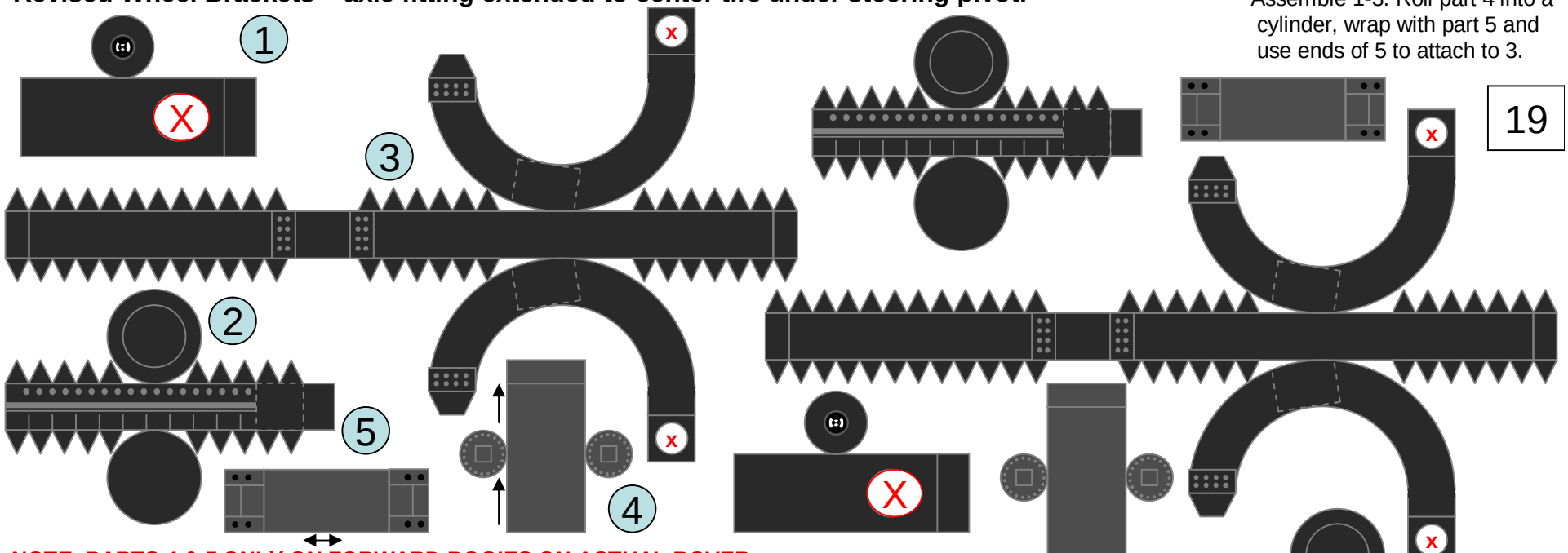




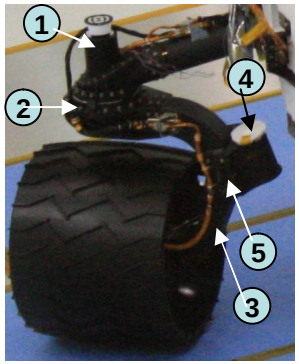
Assemble spokes in order for tabs to Interlock with hex end caps.

Revised Wheel Brackets – axle fitting extended to center tire under steering pivot.

Assemble 1-3. Roll part 4 into a cylinder, wrap with part 5 and use ends of 5 to attach to 3.



NOTE: PARTS 4 & 5 ONLY ON FORWARD BOGIES ON ACTUAL ROVER

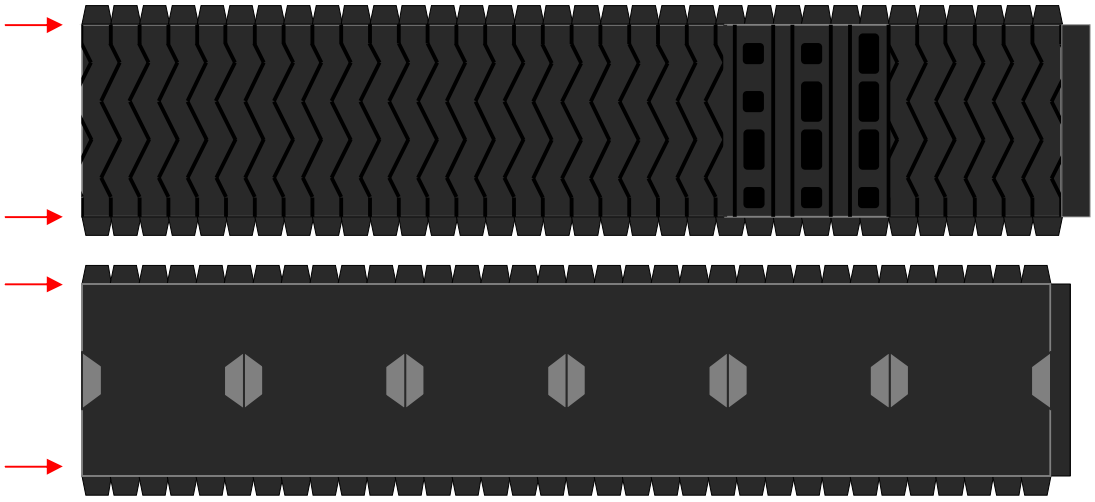


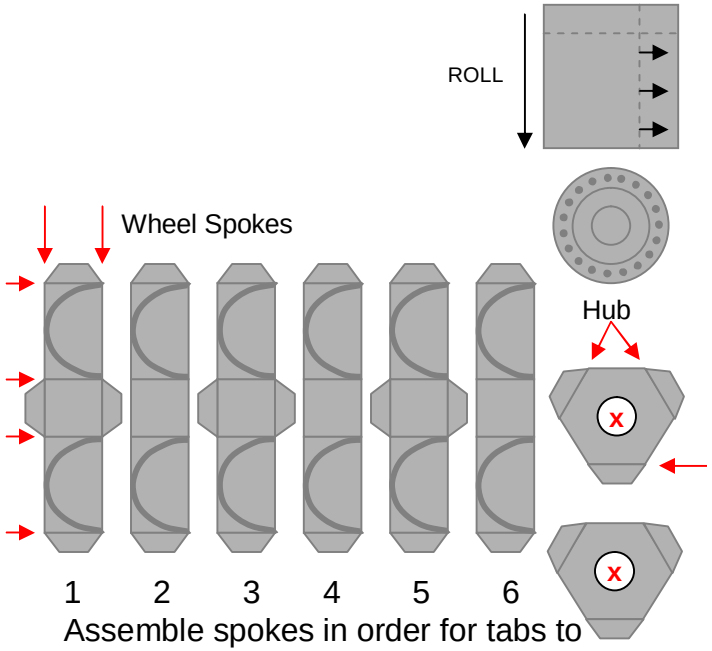
PRINT

INSIDE EDGE OF WHEEL

Outer Wheel

Inner Wheel



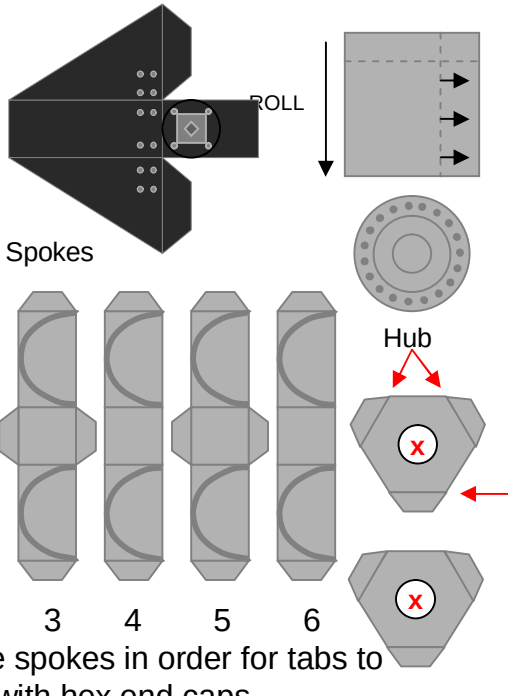


Assemble spokes in order for tabs to Interlock with hex end caps.

Aft wheel bogie – note stowage bracket.

PRINT 2 copies of this page.

Optional Detailing-latch for aft wheels. Fold into triangular shape and glue over aft bogies to square off aft stowage bracket area.

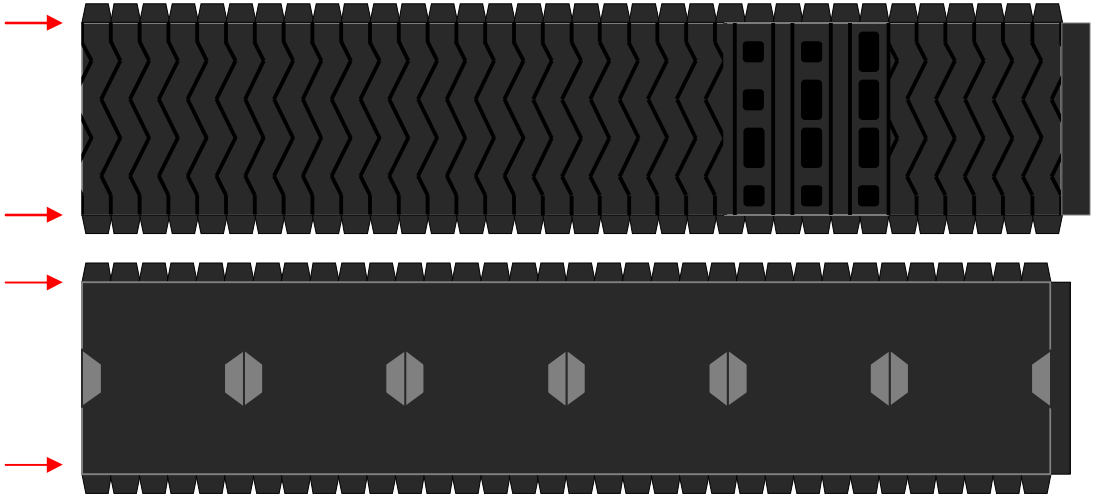


Assemble spokes in order for tabs to Interlock with hex end caps.

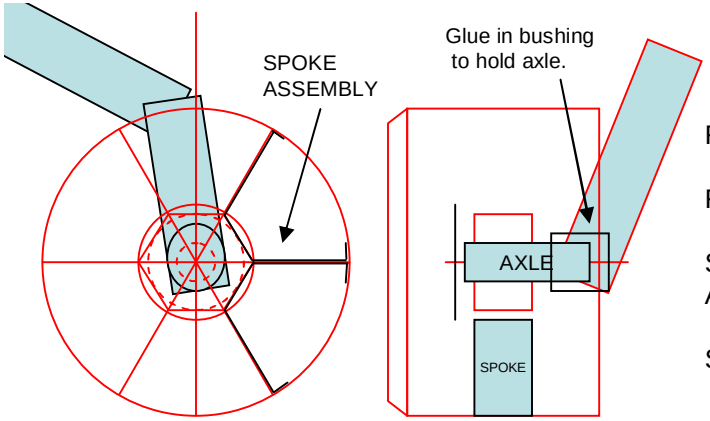
INSIDE EDGE OF WHEEL

Outer Wheel

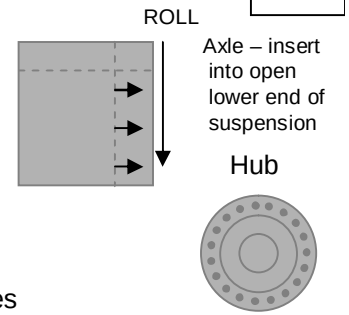
Inner Wheel

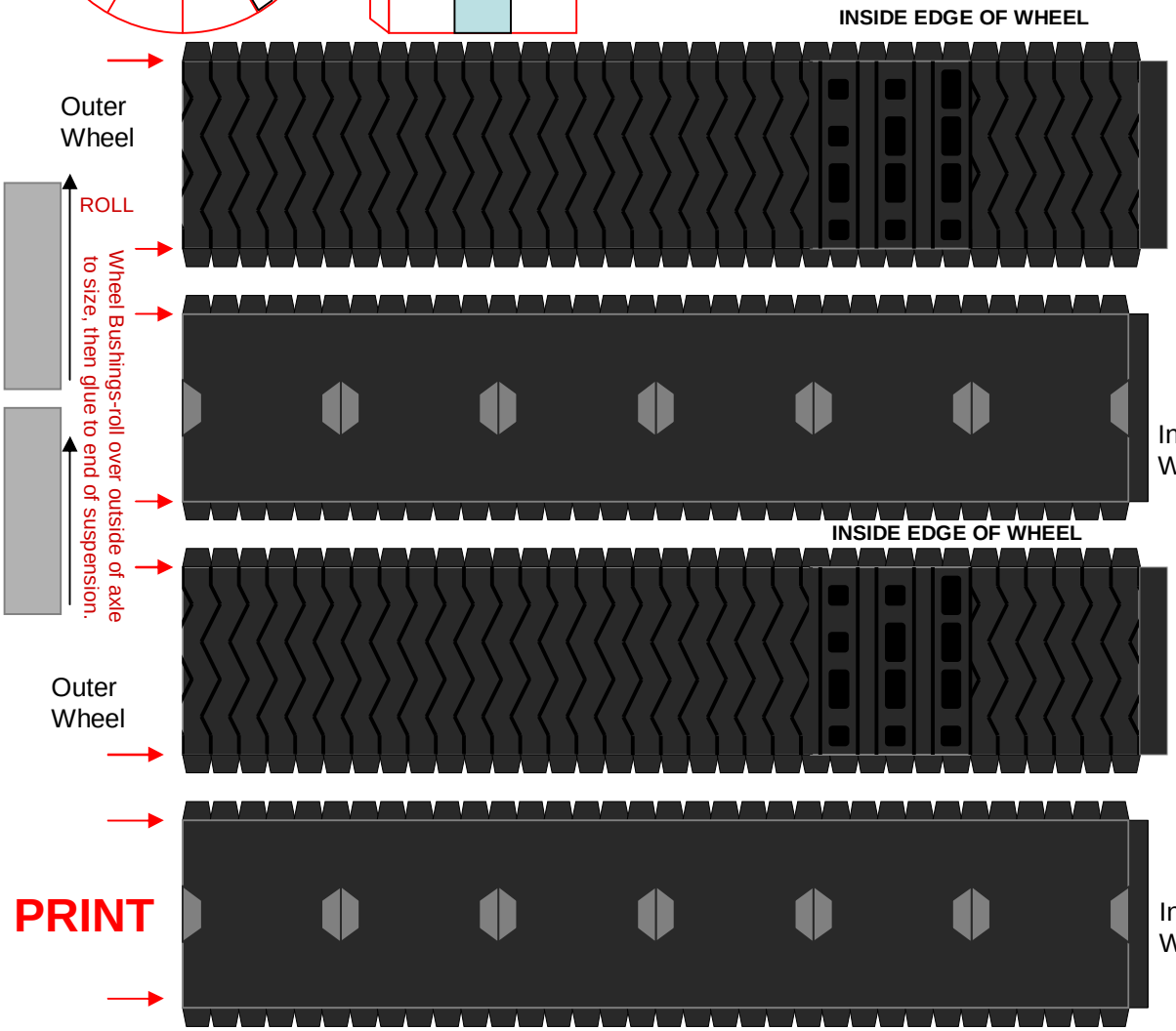


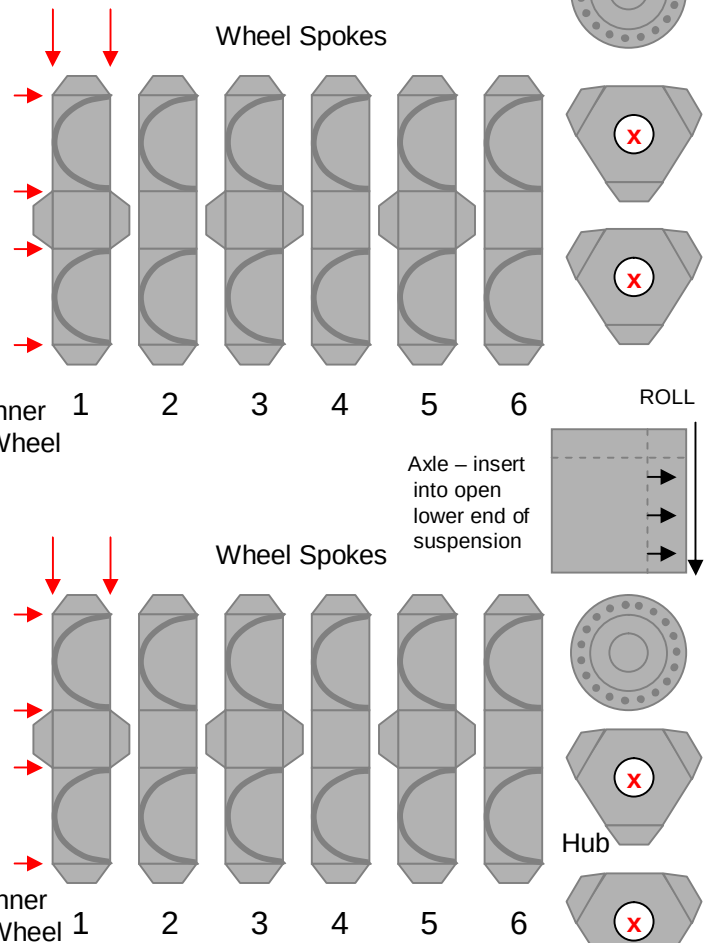
Mars Science Laboratory – Suspension 2 fixed center wheels



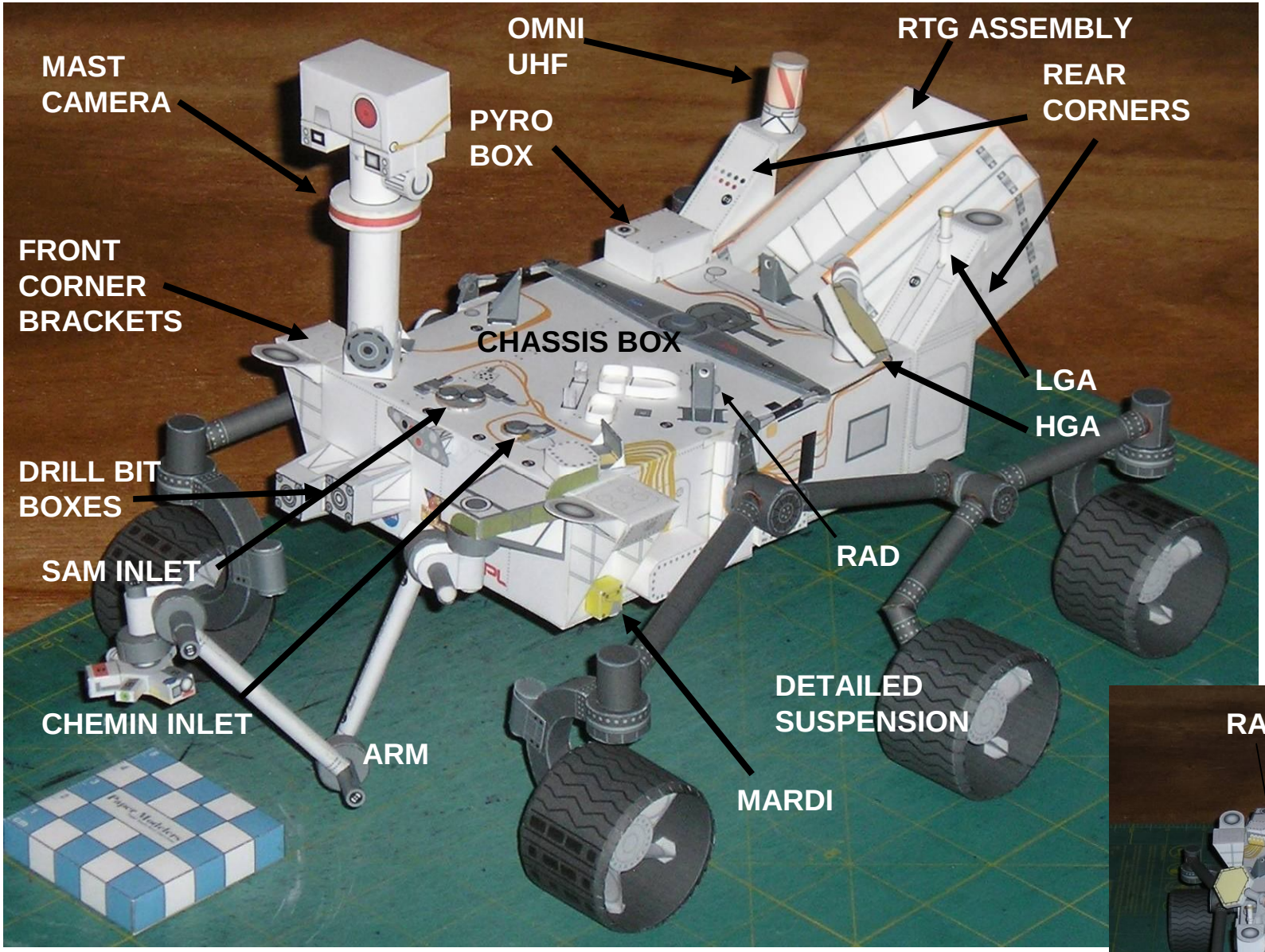
Roll outer wheel into a cylinder and glue. Roll inner wheel to fit inside (trim if needed) and glue. Bend edge tabs on wheel inward to form rim.
Fold spokes and glue spoke faces to form a hexagonal hub. Attach hexagonal end caps using interlocking tabs.
Slip hub inside wheel and secure using small tabs on spoke ends.
Attach one corner bogie to the aft suspension section, trim suspension part 3 and insert axle, making sure it lines up with the corner bogie axle.
Slip wheel assembly onto axle and secure with round hub face.



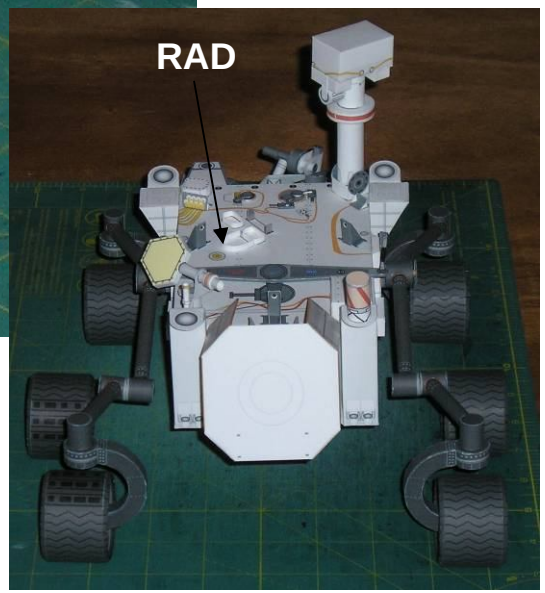


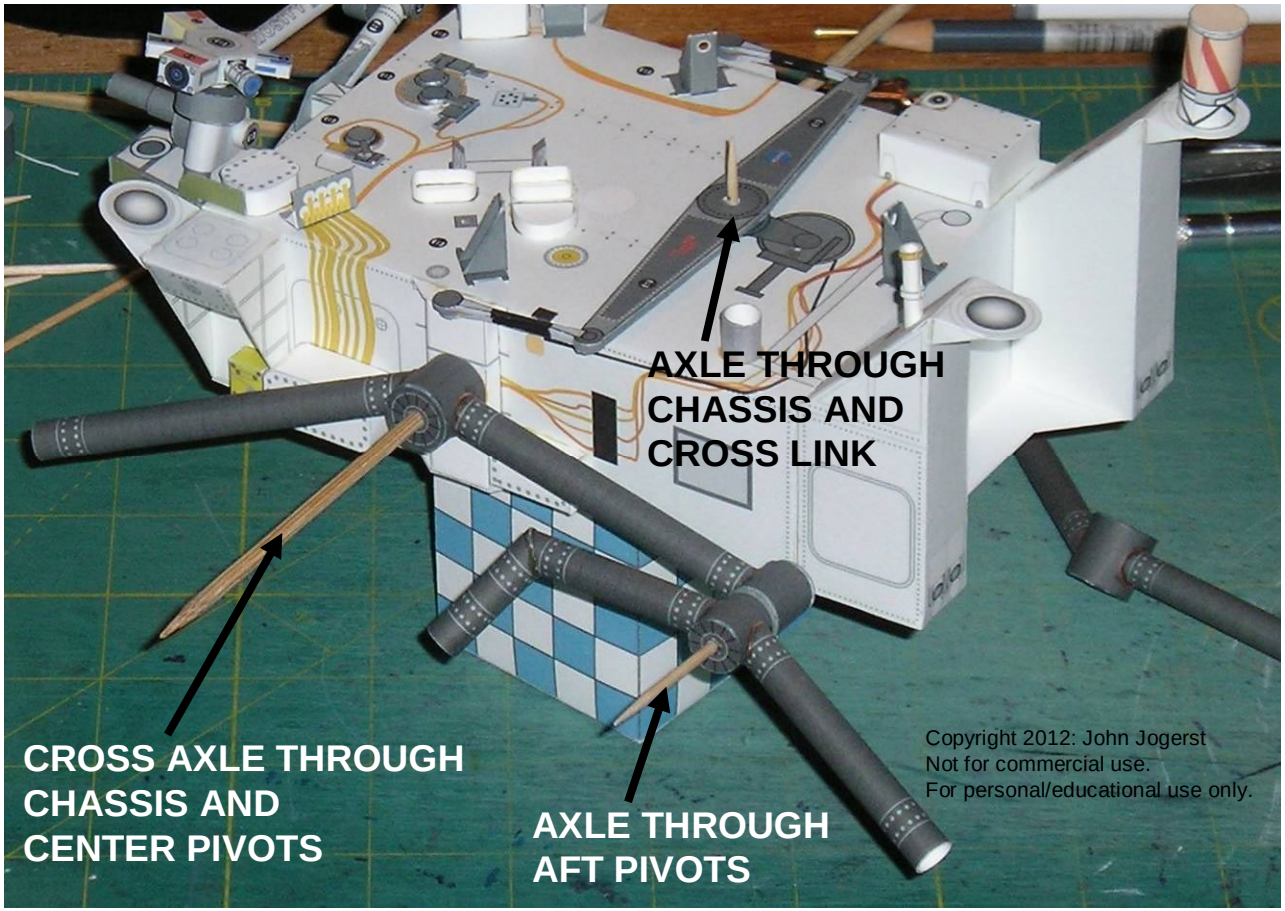


Assemble spokes in order for tabs to Interlock with hex end caps.

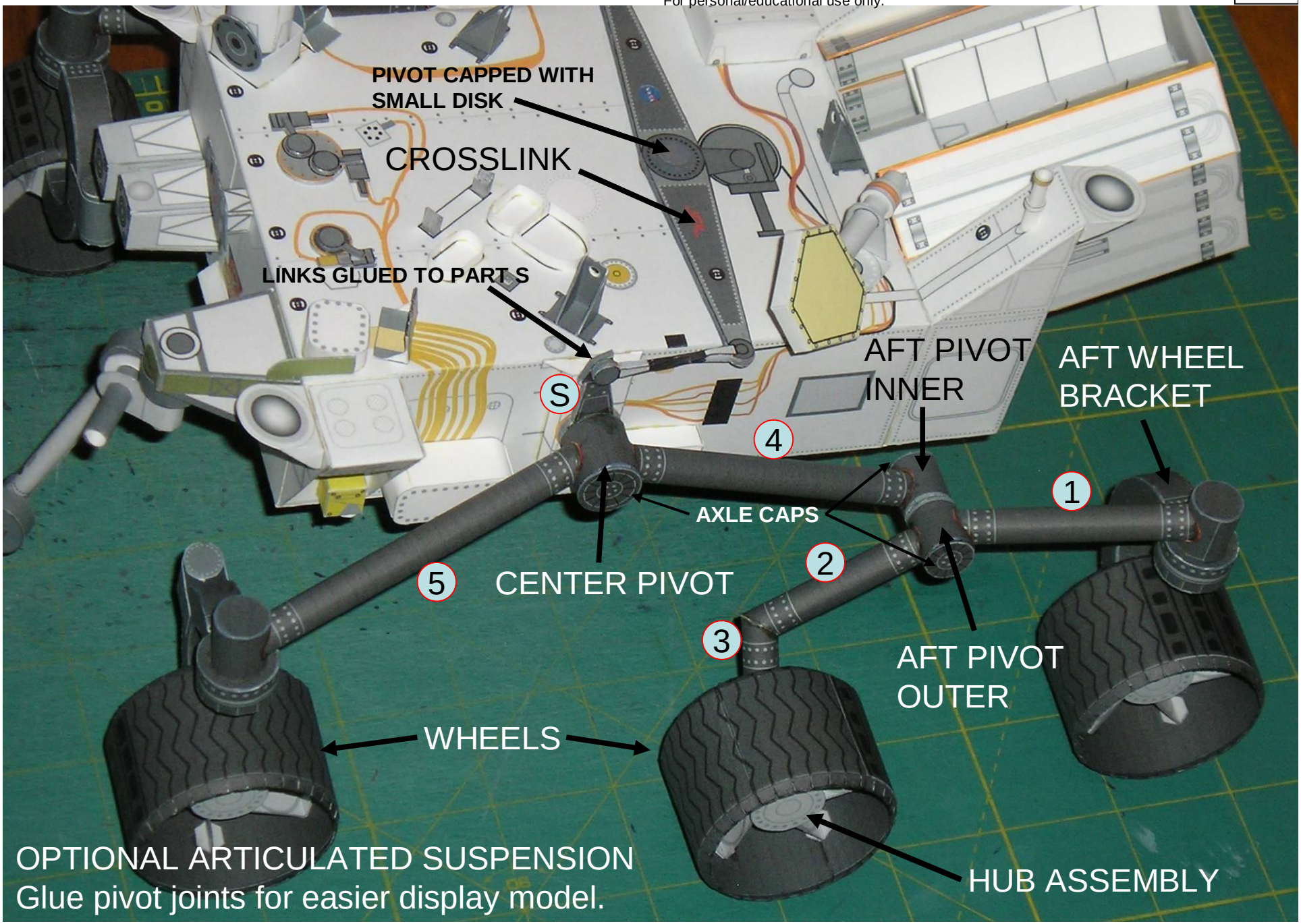


PROTOTYPE MODEL

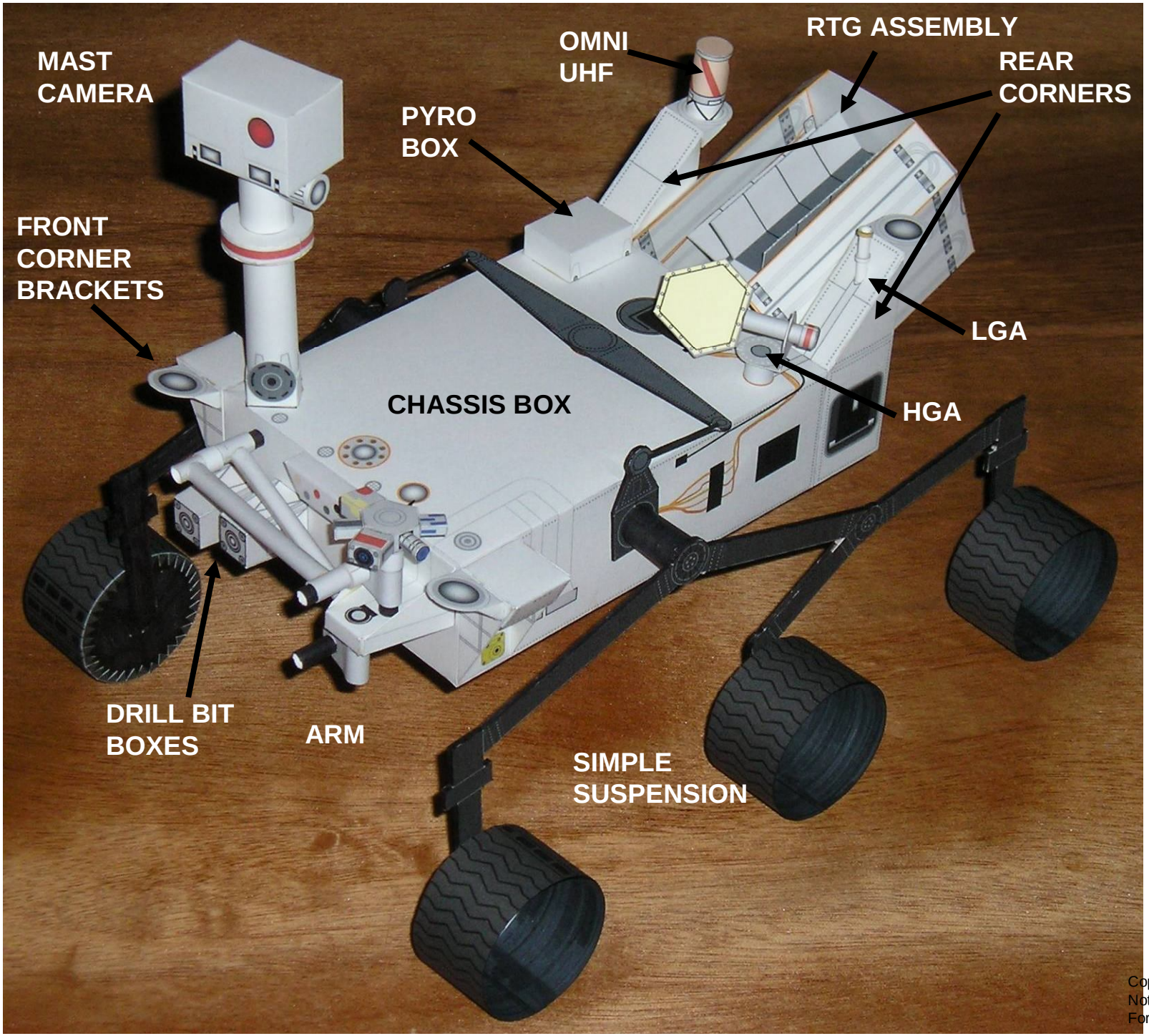




OPTIONAL ARTICULATED SUSPENSION
Glue pivot joints for easier display model.



OPTIONAL ARTICULATED SUSPENSION
Glue pivot joints for easier display model.



EARLY PROTOTYPE MODEL (simple suspension)