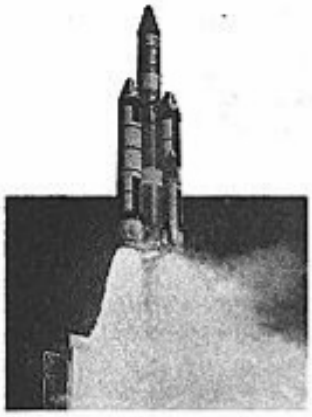
Centuri

Projects 5-7: X-16 Intro



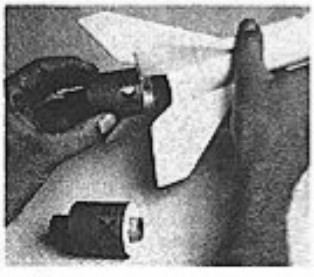
The Titan-111C is one of America's heavy payload lifters. It has launched large communication satellites and space observatories. In configuration #7, the X-16 is much like a Titan. A cluster is the operation of more than one rocket engine simultaneously within the same rocket. The X-16 can also fly with a single engine and carry an altitude measuring device.

DESIGN

The X-16 is much larger than the X-7. It is wider to accommodate the placement of two engines side-by-side and has a larger payload capsule providing more usable space. Parachutes will be easier to pack in the larger body.

Adding the additional engine to the rear of the X-16 moves the center of gravity farther back than on a typical single engine rocket. To help compensate, the fins were made a bit larger than normal. Putting the PX-16 payload unit on top helps move the CG back up the model. The extra engine also increases the model's weight so the fins were cut from thicker stock to resist landing damage.

The most unique item is the "plug 'n go" engine mount system. It allows the X-16 to quickly change from single engine power to clustered. The EX-161 (single engine mount) and EX-162 (cluster mount) snap into the X-16 with a metallic spring lock. A similar lock is used to hold in the engines, eliminating the need to friction fit them with tape.



PROJECTS

(refer to config. chart on page 2)

#5, BASIC: This is a simple, single engine flight that shows one way to determine a rocket's approximate altitude.

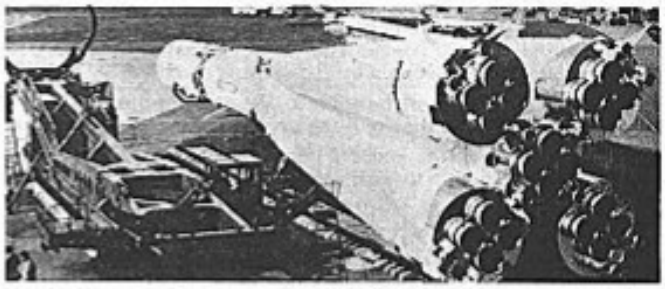
When the parachute ejects at the peak of flight, a ping-pong ball is also released. As it falls to the ground it accelerates (for less than a second) to a speed of 30 ft/sec. The ball is very light and offers so much air friction that at 30 ft/sec it reaches "terminal velocity" and descends at this constant rate. To measure the altitude it is necessary to observe how long it takes from parachute ejection to when the ball hits the ground. Multiply the number of seconds by 30 and that product is the altitude in feet, even in a breeze.

#6, PAYLOAD: The PX-16 payload unit is added to the X-16 and it is flown with the same engine type as in the basic flight, only a shorter delay is needed. Two chutes are needed to bring down the PX-16 and X-16 separately. If they were attached to each other, the PX-16 could snap back at ejection and damage the RX-161.

#7, CLUSTER: The EX-162 converts the X-16 to cluster power. Two flights with different power ranges will be flown. Clustering is very common when launching large payloads. The photo below shows a Saturn 1-B being assembled.



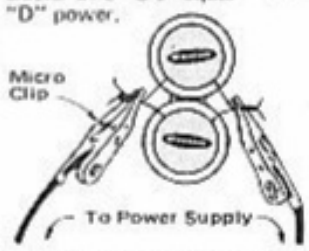
Cluster rockets can lift weight because the thrust of one engine is added to another (the total impulse of a cluster rocket is equal to the sum of the engines' individual total impulses). This increase in lift-off power is often needed to fly large payloads or scale rockets. With multistaging, one engine adds height and velocity to the other. Clustered, they both add their lift-off power simultaneously.



The rocket above is a Russian Vostok—the main workhorse of the Russian space program. As you can see, they really believe in clustering! The four outside "cluster pods" drop off after their fuel is gone while the center continues to climb.

CLUSTERING AND TOTAL IMPULSE: The chart at the right shows some total impulse possibilities. Beyond the "C" range there is: D (10.01–20.00 nt/sec), E (20.01–40.00 nt/sec) and F (40.01–80. nt/sec). A cluster of 2 "C's" equal "D" power.

TYPE & TOT. IMP.	ENGINES IN CLUSTER		
	2	3	4
A 2.50	"B" 5.00	"C" 7.50	"C" 10.00
B 5.00	"C" 10.00	"D" 15.00	"D" 20.00
C 10.00	"D" 20.00	"E" 30.00	"E" 40.00



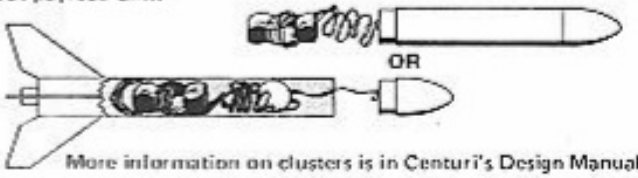
TWO ENGINE WIRING: Make and install the igniters in the normal manner. Twist together one wire from each engine about 5 turns. Clean the micro clips with sandpaper. Attach one clip to each twist. Gently tug the clips to make sure they have good electrical contact.

We have designed the X-16 to be very stable under all conditions, even if only one engine in the cluster ignites. We purposefully tested the X-16 with only one engine in a cluster of two firing with both "B" and "C" engines. Although the model did not crash, its altitude was too low and its direction was too horizontal to be considered safe. Do not attempt this experiment yourself!

CAUTION

1. Always use a 12 volt automobile battery to provide more power to the igniters. Simultaneous engine ignition is critical.
2. Do not hold down the launch button for more than 5 seconds . . . you may melt your launcher's wiring system.
3. Launch only in unpopulated areas . . . clusters are simply not as reliable as single-engine rockets.
4. Use extra chute wadding . . . you now have more than one ejection charge.
5. Do not mix engine types on the same flight. Use the same engine code.

INSTALLING THE BALL: Put in chute wadding and the X-16 chute. Place the ball on top of the X-16 chute. Next install the PX-16 chute and connector or X-16 nose cone if flown without payload unit.

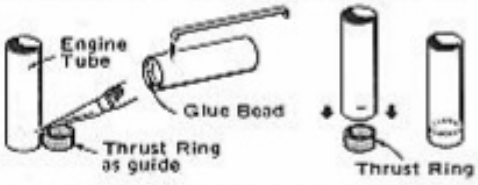


More information on clusters is in Centuri's Design Manual.

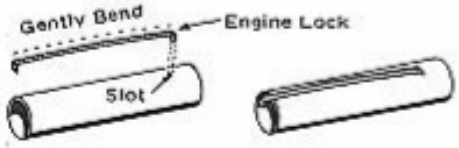
Projects 5-7:
X-16 Assembly

Several parts in this kit are in duplicate. You may use either one first. The various lengths of "shock cord" are cut from the long elastic material. Use white glue for all gluing steps, except when plastic cement is specified.

1. Cut a 9" long piece of shock cord. Tie one end thru the "spokes" in the plastic nose cone insert as shown in the exploded view. Now tie a loop in the free end.
2. Use plastic cement to glue the insert into the nose cone, carefully pushing it into position with a turning motion until it "seats."
3. Cut a 7" piece of shock cord and tie a loop in one end. Then tie the other end thru the "spokes" in the other plastic insert.
4. Attach four pressure sensitive tape discs to this insert as shown in note "A" on next page. Carefully remove the solid disc from the pre-cut card stock sheet and white glue it to the insert's edge as shown in note "A."
5. Wrap a ¼" wide strip of masking tape twice around the end with the disc. (See note "B".) The tape will provide a better fit and gluing surface in next step.
6. Test-fit this assembly into the payload tube. Apply a generous bead of glue around the inside edge of one end of the payload tube. Socket the base assembly into the payload tube. Roll tube along table surface to be sure the base assembly looks like it's in straight. Set assembly aside to dry in upright position, with insert down.
7. Use the fin guide on the next page to mark the 6 lines needed on the main body tube. Pencil the launch lug line with an "L": the engine lock line with an "E".
8. Carefully remove the pre-cut balsa fins from their sheet, using a modeling knife if necessary. Square them up, and glue in place. Allow this assembly to dry vertically, standing it upside down on the "top" end of the body tube.
9. Now go back to the payload section and draw a line (by using a groove and pencil as explained in "construction techniques") along its length. Glue a launch lug on the center of this line; about 2¾" from either end of the tube. Allow this assembly to dry.
10. Make an engine-lock slit in all three engine tubes included in this kit by poking holes with a modeling knife. Push engine locks into the tubes to finish the slits, then remove the locks. Run glue bead around inside of the slit end of each tube, and insert the thrust rings by pushing tubes down over them.

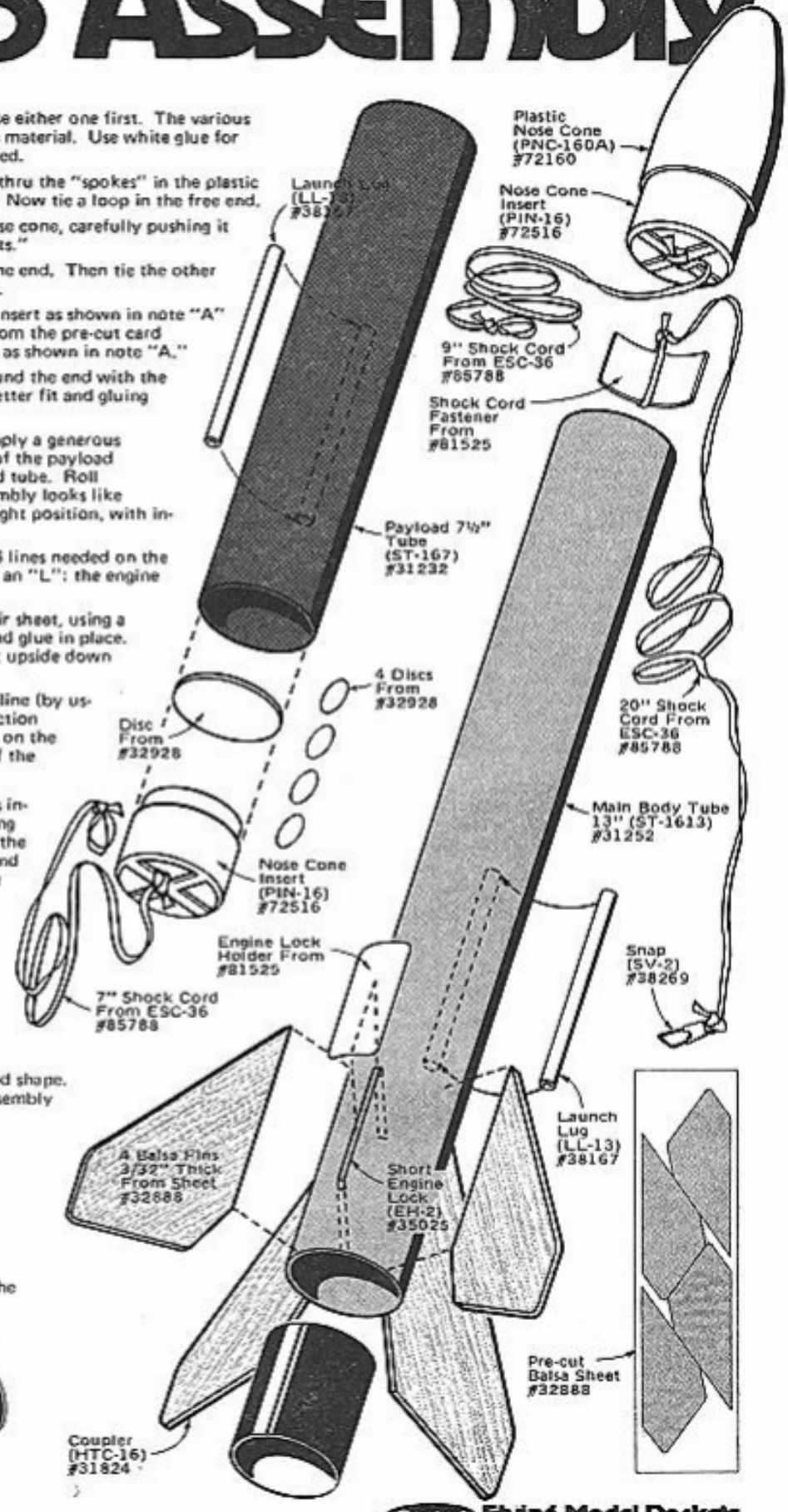


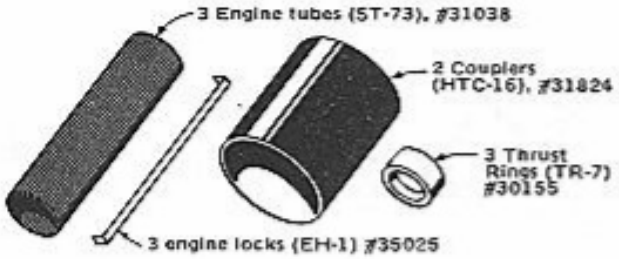
11. Bend the engine lock gently into a slightly curved shape. Insert one end of the lock into the slot. This assembly is a basic engine mount.



12. Carefully remove the two centering discs from the pre-cut card stock sheet and glue them to one coupler tube as shown below. Set aside to dry.





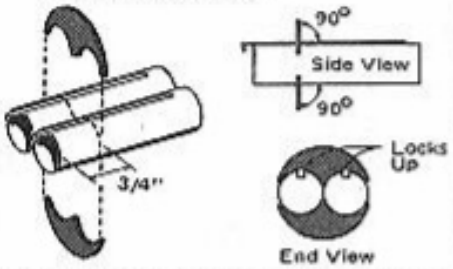


BEFORE YOU ASSEMBLE:

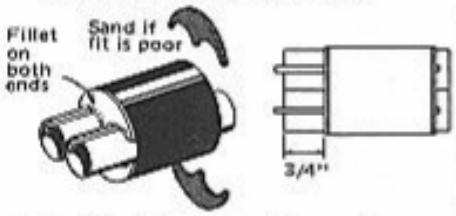
- You must have completed the X-7 assembly and flight projects.
- Be sure to follow the steps in numbered sequence.
- You will need these tools and materials to build the X-16:

*Modeling knife
*Ruler
*Pencil
*Scissors
*Sandpaper (fine & extra fine)
*Red spray enamel
*White spray enamel
*White glue
*Plastic cement
*Sealer
*Small brush
*Clean rags

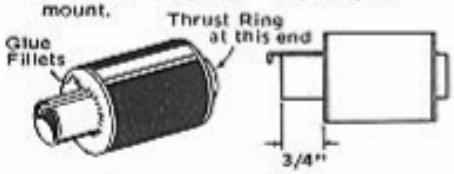
13 Glue two of the three basic engine mounts together; align tubes on flat surface with both engine locks up. Make a mark ¾" back from the rear. After carefully removing the four crescent shaped spacers from the pre-cut card stock sheet, glue two of them into position as shown. Carefully let this assembly dry for a few moments in your hand.



14 Slide the above assembly into the remaining coupler after first putting a bead of glue just on the inside edge of the coupler. Then glue the remaining two crescent spacers into position. Fillet, and allow this assembly to dry. This completes the "plug 'n go" cluster engine mount.



15 Carefully slide the remaining engine mount thru the coupler assembly made back in step 12. Position as shown below. Fillet it in place with glue. This completes the "plug 'n go" single engine mount.



16 Assemble the 20" parachute following the instructions printed on it. This is also a good time to fillet the fins, and to reinforce the coupler's glue joints on the engine mounts.

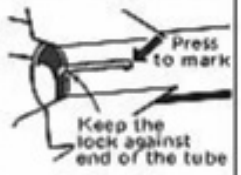
17 Glue the remaining launch lug into position on the main body line you drew earlier: 5" from the finned end.

18 See "Notes," item "C" before starting this step. Put a generous bead of glue around the inside of the bottom end of the main body tube. Smear glue around the outside of the remaining coupler and push it up and into the body tube by using the single engine mount as a tool. Push until the coupler is all the way in the body tube too. Then immediately remove the engine mount "tool" so that it does not become glued in place. The glued coupler is now a thrust ring.

19 Tie the little metal "snap" unit to one end of the remaining shock cord. Then carefully cut the shock cord fastener out of the printed bristol sheet. Fold the fastener in half, printed surface "inside." Apply glue to the fastener and hold it closed in a curved shape like that in the exploded view.

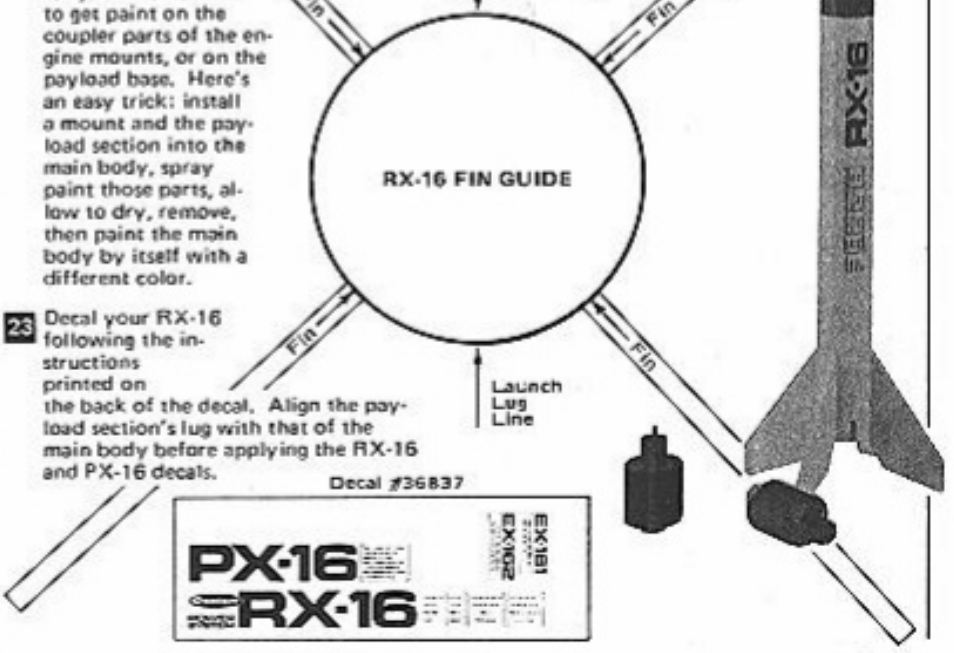
20 When the fastener is dry, tie the free end of the shock cord around the fastener and smear it with a generous amount of glue. Position it about 1" down on the inside wall of the main body. Hold in place and let this assembly dry.

21 Use the short engine lock to mark where to slit the main body tube on the line drawn earlier (side opposite launch lug). Slit the tube with a modeling knife, insert the engine lock. Carefully cut out the engine lock cover from the thin printed bristol sheet. Cover it with glue on the unprinted side and apply it over the engine lock with the screen pattern directly over the engine lock. Press down till dry and rub the cover to make it fit tightly over the lock. This completes the RX-16.



22 Sand fins and fill as with the X-7. Paint your rocket carefully. Remember not to get paint on the coupler parts of the engine mounts, or on the payload base. Here's an easy trick: install a mount and the payload section into the main body, spray paint those parts, allow to dry, remove, then paint the main body by itself with a different color.

23 Decal your RX-16 following the instructions printed on the back of the decal. Align the payload section's lug with that of the main body before applying the RX-16 and PX-16 decals.

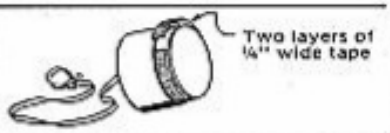


NOTES:

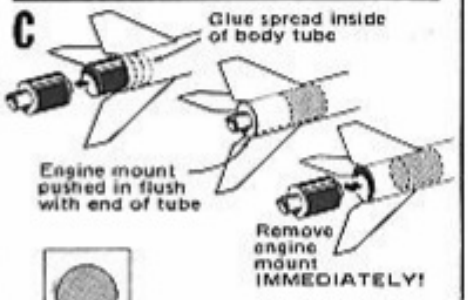
A.



B.



C



Projects 5-7:
X-16 Flights

	BASIC	PAYLOAD	CLUSTER
PROJECT:			
CONFIGURATION	5 16" Chute Single Engine	6 16" & 20" Chute, Single Eng., Payload	7 16" & 20" Chute, Cluster, Payload
FLIGHT NUMBER	6	7	8, 9
SKILL LEVEL	2: Medium Altitude	3: Medium Altitude	4: High Altitude

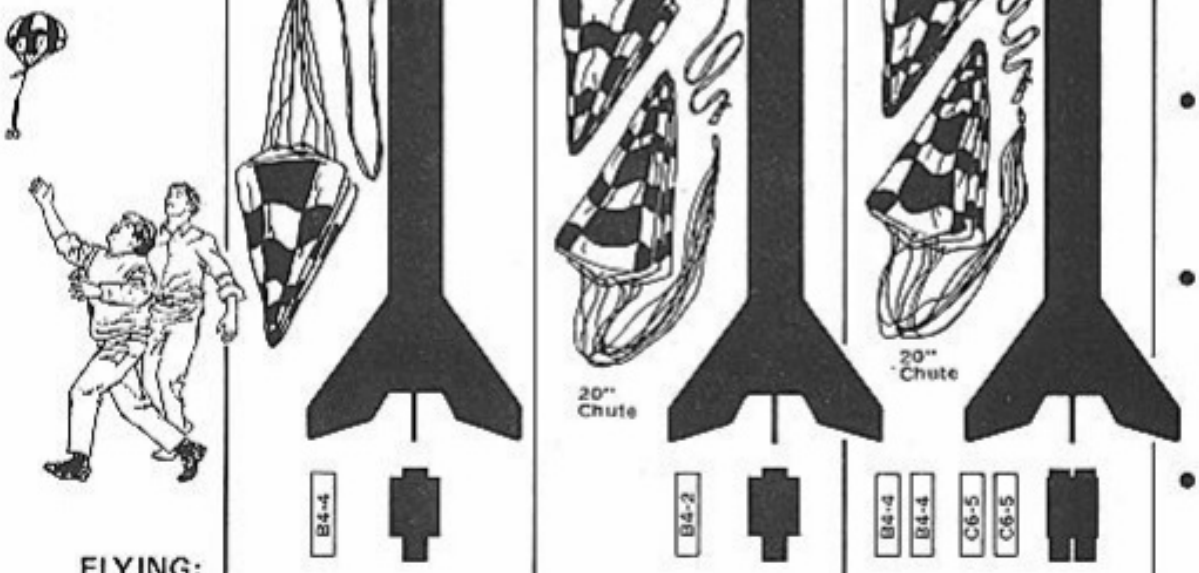
YOU NEED:

Remember that the final project (two cluster flights) require a 12 volt launch system.

- RX-16
- EX-161
- Ball
- 16" Chute
- Wadding
- B4-4
- Igniters

- RX-16
- EX-161
- Ball
- PX-16
- 16" & 20" Chutes
- Wadding
- B4-2
- Igniters

- RX-16
- EX-162
- Ball
- PX-16
- 16" & 20" Chutes
- Wadding
- B4-4 (2)
- C6-5 (2)
- Igniters



FLYING:

LAUNCH AREA	MEDIUM	MEDIUM	LARGE
FLIGHT TIPS	• Clean micro clips • Lock secure? • Mount secure?	• Nose cone secure? • Lugs aligned? • Ball between chutes.	• Clean micro clips • Extra wadding • Avoid "shorts"
MISSION SYMBOLS Apply onto RX-16 after each flight.	Century POWER SYSTEM X-16 BASIC FLIGHT MONTH DAY YEAR	Century POWER SYSTEM X-16 PAYLOAD FLIGHT MONTH DAY YEAR	Century POWER SYSTEM X-16 CLUSTER FLIGHT MONTH DAY YEAR
OTHER ENGINES you may later use with this version.	B6-4, C6-5	C6-3, C5-3	B6-4, B14-5

SOME TIPS ON PAYLOADS . . .

Configurations 6 & 7 may be flown without any payload, but here are some guidelines in case you do use a payload.

- Keep the payload weight modest; 1½ ounces for single engine . . . 2½ ounces for the cluster.
- Be aware that this additional weight will decrease altitude slightly.
- A payload moves the Center of Gravity forward, making the rocket overly stable. This means you should not use payloads during a breeze; doing so may cause too much "weathercocking."
- You can give a payload carrying rocket the extra needed boost at lift off by using a cluster of B14-5 instead of B4-4 or B6-4.
- Cushion your payload (even if it is just "dead weight") to avoid it shifting around and possibly damaging your rocket during flight.
- The payload section's nose cone must be on very securely to avoid it accidentally popping off at ejection. Use tape for a friction-fit if neccessary. The same goes for the joining of the payload section to the main rocket; avoid premature separation.

