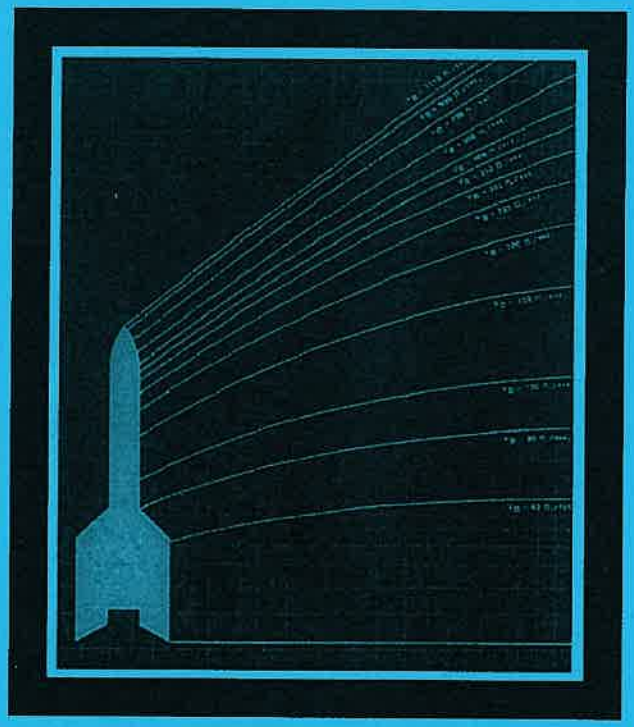
Colorado State University

Extension

MC1304A - Unit 4
Member's Manual



4-H Advanced Model Rocketry

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TABLE OF CONTENTS AND REQUIREMENTS

TO MEMBERS:

Welcome to unit 4 of model rocketry called Advanced Model Rocketry. This unit is written for the more serious model rocket hobbiest. In this unit you will expand your interest even more than in the previous two units.

REVIEW OF PREVIOUS UNIT

In unit 3, there were discussions on:

- multi-staging
- multi-staged ignition
- coupling
- booster recovery
- what engines to use
- cold power rocketry
- how electrical circuits and systems are applied to the launching of model rocketry
- electrical symbols
- mathematics
- principles of electrical circuits
- the rear engine rocket or booster-glider and the different phases
- glossary of terms
- record and requirements

REQUIREMENTS TO BE COMPLETED BEFORE STARTING UNIT 5

1. Complete all questions after each adventure, have signed by you and your leader.
2. Finish record completely, have signed by you and your leader.
3. Build and fly a skill level 4 rocket.
4. Exhibit your rocket and record book at county fair.

MODEL ROCKETRY CLUBS

49. GUIDE TO ORGANIZING A CLUB - The following areas of discussion will help set guidelines for starting a model rocketry club. (If you have questions that are not answered here, write to Estes Industries, Rocketeer Marketing Department, Attn: Dane M. Boles.)

50. WHY A CLUB - Opportunities are offered to clubs that are not offered to individuals, such as educational and recreational activities. Another advantage is you can pool your ideas and resources. The potential activities are unlimited such as contests, research, demonstrations and others.

51. ORGANIZING A CLUB - One way to start a club is to give a public demonstration. Then have an organizational meeting to determine name of club, purpose, duties, sponsor, membership, funding, committees, teams, club symbols and amendments.

52. WHAT FACILITIES AND EQUIPMENT - The launch site will depend on availability of land and the size of the site. You will need several items: launching equipment, pylons, flags, table and chairs, and calculating equipment. You will also need a workshop area. This can be almost any place your club meets.

53. CLUB FUN TIME OR ACTIVITIES - One of the first things you do is to organize your activity. Set up your range teams and committees and the launch site activities. Then plan the actual competition, workshop activities, special projects, club library, field trips and other activities.

54. WHY FUNDING IS IMPORTANT TO A CLUB - Funding is very important to a club to carry out its activities. There are many ways to do this. Drives (papers, cans, car washes, etc.), donations, club sales, range store and concessions are all good. The final thing is proper maintenance of funds.

55. PROGRAMS FOR ADVANCED MODEL ROCKET ACTIVITIES - Improvements of launch site, workshop improvements, planning of advanced range activities, advanced workshop activities and, finally, super field trips.

ADVENTURE XI - WHY, WHEN AND WHAT OF MOTION

56. WHY BODIES ORBIT IS THE FIRST LAW OF MOTION - The law states: A body at rest will remain at rest, and a body in motion will continue in motion with constant speed in a straight line as long as no unbalanced force acts on it. Humans have been fascinated with the stars for thousands of years and even named some of the stars. Then someone noticed that some of the stars did not stay in place. These wanderers were called planets. So far nine planets have been discovered with the use of telescopes. Scientists also have identified 31 moons to go with the planets. Thousands of asteroids and comets circle the sun. An object in space is influenced by another object's gravitational field, such as the earth and moon. If it were not for the earth's gravitational pull, the moon would either fall to earth or wander through space. The curvature of the earth's surface is about 16 feet per 5 miles. For an object to escape

the earth's gravitational pull and maintain a circular orbit, it must be traveling at a speed of 18,000 miles per hour. Objects can be launched into this orbit by artificial rockets. If any object goes slower than 18,000 miles per hour, it falls back to the earth; if it goes faster, it will wander through space endlessly. The farther an object is from the earth, the slower it needs to go to maintain an orbit because of less pull from the earth's gravity. The closer the object is to the earth, the faster it needs to go to maintain an orbit.

What forces act upon a ball when you throw it in the air? The first is gravity, which we have already discussed. The second force is the speed or velocity of the ball when it leaves your hand. Drag is the third factor (the lower the speed, the lower the drag; higher the speed, higher the drag) caused by wind and/or air. Mass and momentum also have a direct effect on it. Inertia can best be described as an object at rest, unless it is acted upon by some force. Kinetic inertia causes the object to keep moving in a straight line, unless acted upon by an outside or invisible force.

57. WHEN BODIES ARE STAGED IS THE SECOND LAW OF MOTION - The law states: If an unbalanced force acts on a body, the body will be accelerated; the magnitude of the acceleration is proportional to the magnitude of the unbalanced force, and the direction of the acceleration is in the direction of the unbalanced force. An unbalanced force is a force not matched by an opposing force. This part of the law will be described in a question-and-answer format.

Q. If you release a ball at arm's length, what happens?
A. The ball falls to the ground.

Q. What happens to an engine when it is ignited?
A. The unbalanced force acting on an object causes the object to accelerate. The unbalanced force accelerates an object in the direction in which the force is acting. If an object moves faster, it is called positive acceleration. If it slows down, it is called negative acceleration.

Q. What does mass have to do with acceleration?
A. A rocket with less mass will accelerate more than one with more mass. An engine with greater thrust will put a payload in orbit in a shorter time than one with less thrust.

58. WHAT BODIES PUSH AGAINST IS THE THIRD LAW OF MOTION - The law states: Whenever one body exerts a force on another, the second body exerts a force equal in magnitude and opposite in direction on the first body. When you hit a baseball, what causes it to go in the opposite direction from which it comes? This is caused by two factors: The first is the mass and speed of the ball, the second is the momentum of the bat to counteract the momentum of the ball. If both momentums are equal, nothing happens. Actually, a rocket is pushing against the chamber walls of the engine as it burns. As more fuel is burned, the less the thrust or push, unless it is properly channeled.

Please complete questions for Adventure XI found on page 14.

ADVENTURE XII - WHAT YOU ALWAYS WANTED TO KNOW ABOUT ROCKET ENGINES

59. ENGINE TYPES AND CLASSIFICATION - If an engine is not coded to indicate its use, do not buy or use it. Such an engine is extremely dangerous to use. Estes uses a color code to indicate recommended use of the engine: Green indicates use for single stage rockets; purple and blue are to be used in top stage and multi-stage rockets; and red is for booster and intermediate stages of multi-stage models. They also use a letter and number combination code to help identify the performance of the engine. Take an engine with a code of B6-4 and see what it means. B indicates total impulse or power produced by the engine; 6 shows engine's average thrust in newtons; 4 gives the delay in seconds between burnout and ejection charge.

60. TOTAL IMPULSE CLASSIFICATION

CODE	POUND - SECONDS	NEWTON - SECONDS
1/4 A	0.00 - 0.14	0.00 - 0.625
1/2 A	0.14 - 0.28	0.625 - 1.25
A	0.28 - 0.56	1.25 - 2.50
B	0.56 - 1.12	2.50 - 5.00
C	1.12 - 2.24	5.00 -10.00
D	2.24 - 5.00	10.00 -20.00

1. In conjunction with total impulse, the following is given, per Estes selection charts.

2. Mini engines - single stage

MINI-ENGINE SELECTION CHART

Cat. No. & Engine Type	Total Impulse lb.-sec.[1]	Total Impulse n.-sec.[2]	Time Delay (± 15%)	Maximum Lift-off Weight	Maximum Thrust	Thrust	Initial Weight oz.	Initial Weight g.	Propellant Weight oz.	Propellant Weight g.
SINGLE STAGE ENGINES										
1/4A3-2T	0.14	0.625	2 sec.	1 oz.	23 oz.	0.18 sec.	0.173	4.9	0.031	0.88
1/2A3-2T	0.28	1.25	2 sec.	2 oz.	28 oz.	0.36 sec.	0.198	5.6	0.062	1.75
A3-2T	0.56	2.50	2 sec.	3 oz.	28 oz.	0.86 sec.	0.254	7.2	0.124	3.50
A3-4T	0.56	2.50	4 sec.	2 oz.	28 oz.	0.86 sec.	0.268	7.6	0.124	3.50
A10-3T	0.56	2.50	3 sec.	5 oz.	48 oz.	0.26 sec.	0.277	7.9	0.133	3.78
UPPER STAGE ENGINES*										
1/4A3-4T	0.14	0.625	4 sec.	0.75 oz.	23 oz.	0.18 sec.	0.187	5.3	0.031	0.88
1/2A3-4T	0.28	1.25	4 sec.	1.00 oz.	28 oz.	0.36 sec.	0.212	6.0	0.062	1.75
A3-6T	0.56	2.50	6 sec.	1.25 oz.	28 oz.	0.86 sec.	0.282	6.0	0.124	3.50
BOOSTER ENGINES										
1/2A3-0T	0.28	1.25	none	3.50 oz.	28 oz.	0.36 sec.	0.166	4.7	0.062	1.75
A3-0T	0.56	2.50	none	3.50 oz.	28 oz.	0.86 sec.	0.226	6.4	0.124	3.50
A10-0T	0.56	2.50	none	5 oz.	48 oz.	0.26 sec.	0.235	6.7	0.133	3.70

Each pack of 4 engines includes 4 igniters. Designed for specific launch and flight functions, rocket engines are expendable — not reusable.

Average thrust: 3 Newtons
*Or single stage engines if used in very light rockets.
Shipping Wt. for mini-engine is 2-1/2 oz. for a pack of 4.

3. This is just a partial list of Estes engines. Other engines can be found in their catalog.

61. ROCKET ENGINE DESIGN - Series I and mini-engines have a slight center bore at the tip of the nozzle end of the propellant, which serves two purposes. It provides for easy ignition and produces initial high thrust. The slight center bore provides a large burning area for faster consumption of fuel. After initial thrust, a transition is made to an end-burning grain, and thrust drops to a sustaining level. Wind tunnel tests show this dual action thrust is best for lightweight rockets at subsonic speeds. Slow-burning delay and tracking charge is ignited at burnout of propellant. This charge produces no thrust and permits the rocket to coast to peak altitude. As the delay charge burns out, it ignites the ejection charge and pressurizes the rocket body tube. Series II engines are basically the same except they have a full center burning grain which results in a larger burning area. This results in a higher thrust level with a shorter thrust duration.

62. ESTES ENGINE, COMPARATIVE TIME/THRUST CURVES - All times and thrusts are average and also show high peaks. These charts show all engines made by Estes, including the mini-engine to the powerful "D" engines. (See Figure 1 and 2.)

Figure 1

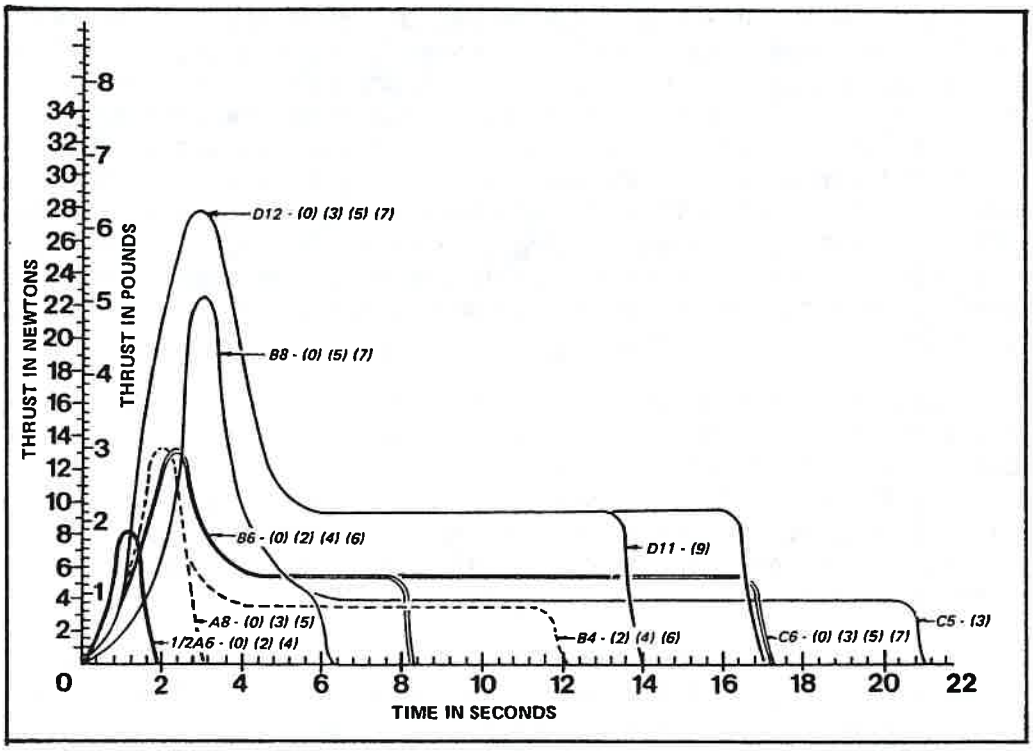
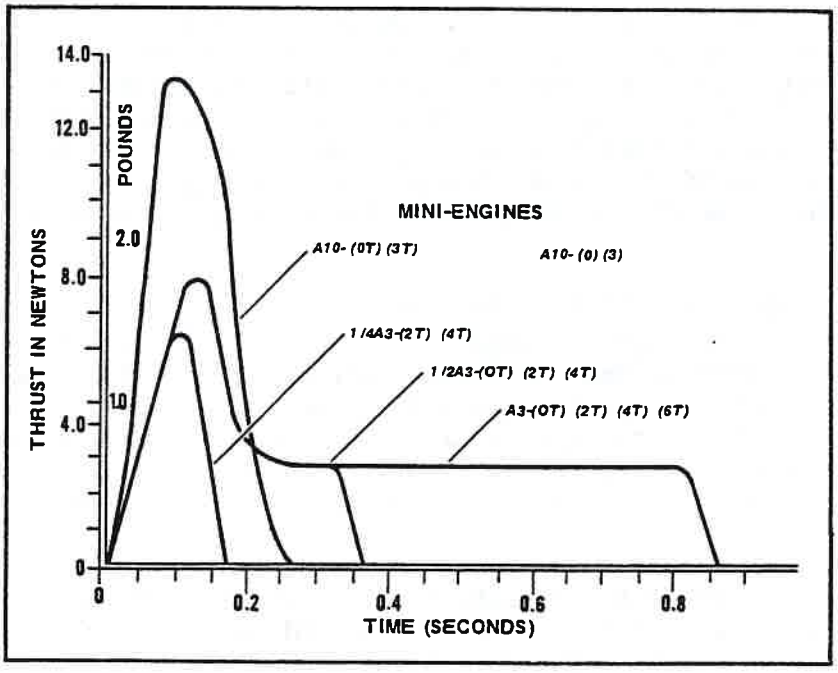


Figure 2



Please complete questions for Adventure XII found on page 15.

ADVENTURE XIII - ENGINE PERFORMANCE DURING FIRING

63. INTRODUCTION TO MODEL ROCKET ENGINE PERFORMANCE - A model rocket engine is designed to produce a precise amount of force for a determined length of time. This means each engine produces a certain total impulse, total impulse being equal to the average force produced multiplied by the time during which the force is generated. Units that are used to measure total impulse are mainly pound-seconds or newton-seconds. Numerous jobs can be achieved after thrust such as igniting another rocket engine (in staged rockets), activating the ejection charge to release the recovery system, activating or deactivating a circuit, taking a picture and releasing a glider. All commercially manufactured engines are thoroughly tested to meet standards set by the manufacturers plus national and international organizations.

64. THE ENGINE AND ITS PURPOSE - Take a C6-5 engine and use it as an example. The C tells that the total impulse must be between 1.12- and 2.24-pound seconds (5.00 and 10.00 newton-seconds); 6 indicates that the average thrust is 6 newtons (1.35 pounds); 5 tells that there is a 5- second delay before ejection charge is ignited. The retainer cap is to retain ejection charge until ignited. Ejection charge provides a fixed amount of gas to activate the recovery system.

Delay train is a slow-burning mixture producing smoke, which allows the rocket to reach its peak altitude before igniting the ejecton charge and gives a smoke trail for tracking. The propellant of an engine is a chemical composite that produces the reaction products by a self-sustaining combustion process. The nozzle (called the De Laval nozzle) converts the pressure (thermal) energy of reaction products into velocity (motion) energy of reaction products at the nozzle exit.

65. PROPELLANTS' TYPICAL CHARACTERISTICS - The most important characteristic of the propellant is its burning rate. Other characteristics are: specific impulse, density, exhaust velocity, specific heat ratio, temperature of combustion, pressure and temperature requirements for ignition, composition of reaction products, resistance to damage from handling or storage and possible toxicity. Specific impulse is defined as the total impulse if you fired an engine containing 1 pound of propellant. The other characteristics mentioned are too complex to discuss here.

66. DESIGN OF THE PROPELLANT GRAIN - The main guiding purpose of varying propellant grain design (grain geometry) is to give the burning area necessary time to produce desired chamber pressure. Grain design most commonly found in model rocket engines is a combination of core burning and end burning. Core burning is commonly known as progressive burning since it increases the burning area with time; end burning is normally called neutral burning since the area burning remains constant.

67. FUNCTION OF THE NOZZLE - Most model rocket engines use the De Laval nozzles, which consist of three sections: convergent section, a throat section and a divergent section. The convergent section works much the same way as water does when it speeds up as it goes through a narrow channel of a stream. (It forces reaction products to increase velocity as they pass through the throat section). The divergent section is a little more complicated to explain. At ground level a weather balloon

is slack and loose. As the balloon rises above the ground, the balloon begins to expand because the pressure inside remains the same while the air pressure outside is reduced. This is why the balloon expands. If the pressure in the balloon expands beyond the outside pressure, it will burst. The throat section works much the same way as the nozzle on a water hose. As the hole is made smaller, the water pressure becomes greater. The larger the hole, the less the pressure, although the amount of water coming out remains the same.

68. HOW THEY ARE TESTED - Every manufacturer uses very sophisticated equipment to test engines for thrust levels and impulse total. The goal is not only to meet the standards set by N.A.R., but to exceed these standards. Approximately three out of 100 engines are static tested to ensure that the standards are met. The equipment automatically performs various physical tests such as correct amount of propellant, delay, etc. All of these tests are essential to the manufacturers and model rocketeers.

Please complete questions for Adventure XIII found on page 16.

ADVENTURE XIV - TO CHUTE OR NOT TO CHUTE

69. HOW BIG IS THAT PARACHUTE - TOO BIG OR TOO SMALL? - The main function of any recovery system is to return the rocket that was sent aloft safely to the ground. The parachute is the most popular form of recovery system. The other recovery systems were discussed in unit 2. The main purpose is to create more drag, which naturally slows down the model rocket. If the rocket "free falls," it will be damaged by the fall, as any object falling attains a velocity or acceleration of 32 feet per second. It means that an object will fall 32 feet per second faster at the end of each second than it was falling at the start of that second. The maximum speed an object can reach is called its terminal velocity. If you create too much drag, a good wind or breeze could cause an object to drift a great distance before it returns to the ground. Naturally, the higher the rocket is, the longer it will take to come down. If rockets go very high each time and you live in a very windy area, a large parachute can be a big problem. One way to reduce the drag on the chute is to "reef in" the shroud lines by shortening the shroud lines with masking tape or a piece of string. Another is by cutting a very small hole to start with and, experimenting by the time test, increase the hole accordingly, so the chute does not drift too far. When cutting a hole in the chute, be careful that the hole is always round and has no sharp corners because the shock of the opening could tear the chute to pieces. Another alternative to the hole is to use a smaller chute. Streamers can be used in very lightweight models in place of the chute.

70. RECOVERY SUPPLIES - The following are just for general knowledge as the preference will be left up to you.

    a. QUICK CHANGE SWIVELS - To make your recovery system interchangeable for any rocket, attach one to each system so you can pick the right recovery device for the right conditions. They also reduce tangling.

b. PARACHUTE KITS FOR EVERY PURPOSE - Each kit contains everything needed and proper size for the right rocket if you desire to use a chute.

c. SAFETY STREAMERS - These are the fastest ways to get your rocket back safely.

d. RECOVERY WADDING - This is necessary to absorb the shock of the sudden opening of the chute, also to prevent loss of recovery system.

e. SHOCK CORDS - These are used to absorb the shock of the sudden opening of the chute, also to prevent loss of recovery system.

f. TAPE DISCS - These attach shroud lines to chute.

g. DO-IT-YOURSELF PARACHUTE MATERIAL - This comes in 3-feet squares to make your own maxi-chutes or custom chutes. It is also aluminized.

h. SHROUD LINES - These are attached to the chute as previously mentioned.

Please complete questions for Adventure XIV found on page 17.

ADVENTURE XV - WHY PAYLOAD LAUNCHING IS A FINE ART

71. ART OF THE PAYLOAD LAUNCH - One of the reasons you launch rockets is for fun, but if it is strictly to watch the rocket go up and come down, you are in a minority. Most model rocketeers want to know why things happen and want to know how to make them happen. They also want to make the best rockets. Once you get involved with model rocketry, you will want to learn about such things as the center of gravity and the center of pressure, relationships between the fin, experiments and other areas of study. If you have unlimited imagination, the field is wide open to you.

Why is something put in a rocket before it is launched? There are several reasons why a professional may send up an instrument package. It may be to secure data on the atmosphere, to study stars or the earth, to explore other planets, send people to the moon or conduct experiments on the effects on humans when they are in space for a long time.

What can you launch? Here are a few simple launch items: insects such as flies, spiders, earthworms, beetles, grasshoppers, crickets; fish such as guppies or goldfish. Bear in mind, however, that biological payloads must be handled with care and be well-provided for so that the passenger is returned to earth undamaged. Crickets, flies, and grasshoppers stand an excellent chance of survival even if you do goof. Assorted items such as an egg (raw) may really test your skill. After you have launched a few payloads with the suggested items, you can go into a different field of aerial photography and telemetry. By using different engines, you can get different shots with Camroc (takes a single-exposure still picture), for example, high-, medium- and low-elevation shots. You can also map an area using the Camroc by locating the launch site in different areas each time (provided you have an area large enough to do so). Another part of aerial photography is the Cineroc (movie film -

Super 8mm, 10 feet in length). Such things as the velocity can be determined by studying each frame of the film. You can watch the breathtaking view as the rocket goes. The separation of the booster stage and spin rate can be determined. Rocketronics uses the telemetry transmitter, called the Transroc. The tiny transmitter has a range of up to 5 miles while in flight and hundreds of yards on the ground. There are sensors available and a microphone. Many things can be done with a payload.

72. PAYLOAD PARTS OR SUPPLIES - The following supplies are available so that you can replace parts or design and build your payload rocket. This is a partial parts list.

1. NOSE BLOCKS

CAT. NO.	OUTSIDE DIAMETER	LENGTH	FITS BODY TUBE
NB - 20	0.710 inches	0.75 inches	BT - 20
NB - 30	0.725 "	0.75 "	BT - 30
NB - 50	0.950 "	1.00 "	BT - 50
NB - 55	1.283 "	1.25 "	BT - 55
NB - 60	1.593 "	1.50 "	BT - 60

2. PAYLOAD SECTION

CAT. NO.	BODY MAT'L.	INSIDE LENGTH	OVERALL LENGTH
PS - 20A	Clear plastic	2.00 inches	4.00 inches
PS - 20C	Clear plastic	3.00 "	7.00 "
PS - 30B	Regular tube	2.00 "	3.75 "
PS - 50A	Clear plastic	3.00 "	6.50 "
PS - 50C	Clear plastic	4.00 "	10.50 "
PS - 50E	Clear plastic	4.00 "	10.50 "
PS - 55B	Regular tube	3.00 "	7.63 "
PS - 60A	Clear plastic	4.00 "	9.50 "
PS - 60C	Clear plastic	4.00 "	9.50 "

3. CLEAR PLASTIC TUBES

CAT. NO.	LENGTH	OUTSIDE DIAMETER
PST - 20	8.00 inches	0.736 inches
PST - 20J	2.75 "	0.736 "
PST - 50S	4.00 "	0.976 "
PST - 60R	5.00 "	1.657 "
PST - 65R	5.00 "	1.796 "

4. MYLAR PLASTIC TUBE FOR FEATHER WEIGHT MODELS

CAT. NO.	LENGTH	OUTSIDE DIAMETER
BT - 10	9 inches	0.720 inches

Please complete questions for Adventure XV found on page 18.

73. GLOSSARY OF TERMS

A. AIRFOIL - A cross-section of a body designed to provide a lifting force to its surface when there is relative movement between it and the surrounding air.

B. AMATEUR ROCKETRY - Rocketry activities supervised by professionals and carried out by knowledgeable amateurs.

C. AMPERE (amp) - A unit used to measure the strength of an electrical current; ampere is equal to the current produced by one volt applied across the resistance of one ohm.

D. APOGEE - When a satellite or rocket is at its farthest point from earth while in orbit or flight.

E. ARMED - A term to tell when the ignition system is activated to check continuity so countdown can begin.

F. AVERAGE THRUST - The total impulse of a rocket engine divided by the duration of its thrust.

G. BALSA WOOD - A light, strong wood grown in Ecuador and used in model airplanes, also model rockets and model boats.

H. BASEMENT BOMBER - Person with little or no experience who tries to mix his or her own fuel and build rockets out of metal.

I. BLAST DEFLECTOR - A metal plate that protects launcher base and ground from engine's thrust or exhaust.

J. BODY TUBE - Main frame for the rocket, which is a light cardboard cylinder.

K. BURNOUT - When a rocket ceases to produce thrust, or when all propellant has been burned.

L. CENTERBORE - Round cavity in the propellant grain for ignition and controlled burn.

M. CENTER (core) BURNING - Engine with a deep centerbore providing a large burning area, results in a higher thrust level.

N. CENTER OF GRAVITY - A point on a rocket when its weight is evenly balanced.

O. CIRCUIT - A source of electric energy and its complete path of electrical current and its return.

P. COAST PERIOD - Phase between burnout and activation ejection charge, when it emits a smoke trail.

Q. COUNTDOWN - A verbal method of counting down to launch a rocket used both by model and professional rocketeers.

R. CURRENT - The movement or rate of electrical flow measured in amperes.

S. DELAY ELEMENT - A slow-burning chemical used in an engine to provide a time delay and smoke trail between burnout and activation of the recovery system.

T. EJECTION CHARGE - Used in single and upper stage engines to deploy recovery device.

U. END BURNING - Engine with a slight centerbore producing a high initial thrust dropping off to a sustained level.

V. ENGINE BLOCK (mount) - A hollow ring used to prevent engine from going forward during acceleration.

W. ENGINE CLASSIFICATION - A code stamped on an engine, giving data on engine's performance capabilities.

X. FILLET - A layer of glue or reinforced material used to reduce fin-body interference drag.

Y. FIN - Used to guide and stabilize the model rocket during its flight (usually three or more fins are used).

Z. FINISHING - The fine art of producing a quality surface that not only looks nice but has functional applications.

AA. GRAIN, BALSA - The direction grain or fibers run on any type of wood.

BB. IGNITER - An electrical device used to initiate combustion process in rocket engine.

CC. IGNITION - The instant the rocket's propellant starts to burn.

DD. LAUNCH LUG - A round, hollow tube that slips over the launch rod and helps guide the rocket during its first few feet.

EE. LEADING EDGE - The front surface of a fin or wing, which is subjected to the most amount of air.

FF. NEWTON-SECOND - The metric measurement for a rocket's total impulse.

GG. OHM'S LAW - States the practical unit of electric resistance. (One ohm equals the resistance of a circuit in which a potential difference of one volt produces a current of one ampere.)

HH. PAYLOAD SECTION - Section of a rocket that carries instruments, biological specimens, etc.

II. PEAK THRUST - The greatest thrust developed by a rocket engine during its firing.

JJ. POUND-SECOND - Measurement of the total impulse produced by a rocket engine.

KK. RESISTANCE, ELECTRICAL - The opposition created by a body or substance to the passage of a steady electric current through it.

LL. ROOT EDGE - The point at which a fin or wing is attached to the body tube.

MM. SPECIFIC IMPULSE - The measure of energy content per pound of propellant.

NN. TIME-THRUST CURVE - An expression of the relation between thrust produced by a rocket engine and time.

OO. TIP - The outermost end of a fin.

PP. TOTAL IMPULSE - Total amount of thrust developed by a rocket engine.

QQ. TOUCHDOWN - The moment the rocket touches the ground after recovery descent.

RR. TRAILING EDGE - The rear edge of a fin and wing surface.

SS. VOLT - A unit of electromotive force; the electrical potential required to make a current of one ampere flow through a resistance of one ohm.

QUESTIONS TO ADVENTURE XI

1. Are all satellites made by humans?

_____

2. Is momentum the only major force acting on a satellite?

_____

3. Mass times velocity equals what?

_____

4. For every action, is there an equal and opposite reaction?

_____

5. Does a satellite have inertia?

_____

_____ _____

4-H member signature 4-H leader signature

_____

Date of completion

QUESTIONS TO ADVENTURE XII

1. What does the color code indicate?

_____

2. What does B6-4 on an engine tell you?

B = _____

6 = _____

4 = _____

3. List two engines and their pound-seconds and newton-seconds (prefer ones listed in this adventure).

_____

4. Which has a higher thrust level - Series 1 or 2 engines?

_____

5. Refer to Question 4; now tell why it has a higher thrust.

_____

_____

_____

_____

_____ _____

4-H member signature 4-H leader signature

_____

Date of completion

QUESTIONS TO ADVENTURE XIII

1. What are units called that measure total impulse?

_____

2. What does C6-5 on an engine tell you in this adventure?

_____

_____

_____

3. What is the purpose of the retainer cap?

_____

_____

4. What is the most important characteristic of an engine propellant?

_____

_____

_____
4-H member signature

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4-H leader signature

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Date of completion

QUESTIONS TO ADVENTURE XIV

1. What is the main function of any recovery system?

_____

2. The maximum speed any object can fall is called what?

_____

3. How many feet per second per second does an object fall?

_____

4. What is one way of speeding descent of a rocket?

_____

5. Name two recovery parts.

_____

_____ _____

4-H mMember signature 4-H leader signature

_____

Date of completion

QUESTIONS TO ADVENTURE XV

1. Why may a professional send up a payload? (Name two reasons.)

_____

_____

2. Name two reasons why you would send up a payload.

_____

_____

3. There are two types of cameras used in aerial photography: name them.

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4. What is a Transroc?

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4-H member signature 4-H leader signature

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Date of completion