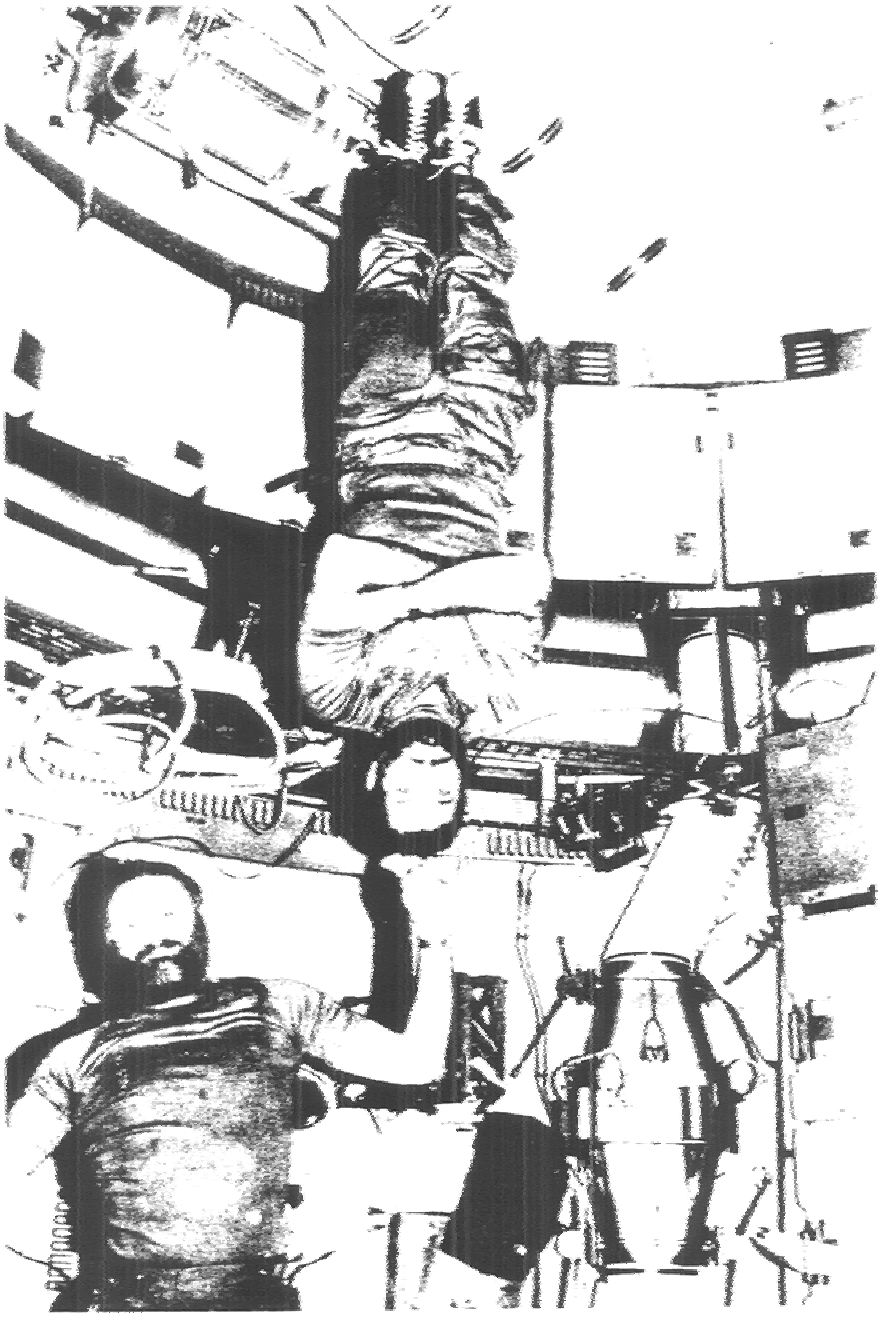
A Teachers Guide for the Videotape
Segment 1

Starts at 00:14:26
Run Time 01:57:27

THE GAMES ASTRONAUTS PLAY



NASA
National Aeronautics and Space Administration

FILM FOOTAGE FROM NASA SKYLAB MISSIONS

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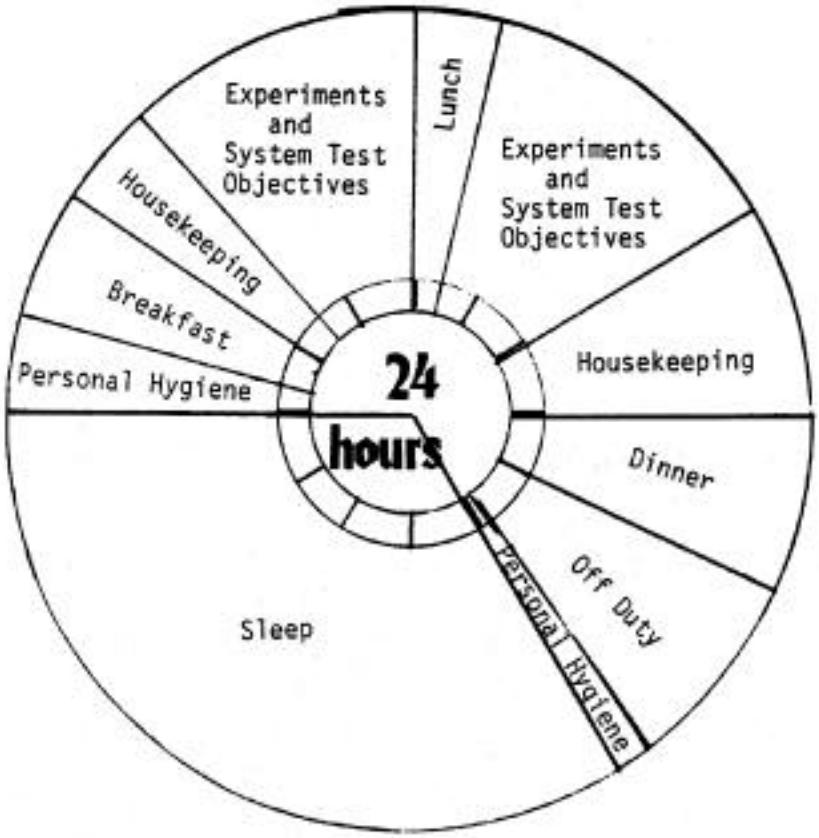
I. Introduction

During the Skylab program, three crews operated a unique orbiting laboratory for a period of 171 days breaking all existing space flight records. While inhabiting the station 386 KM (240 miles) above the earth's surface, the astronauts operated on a schedule consisting of an 8 hour sleep period followed by specifically assigned times for eating, working, and relaxing. The assigned activities for a typical 24 hour period are illustrated in the diagram shown below.



*Skylab M071 is the mineral balance experiment.

In addition to the short off-duty time allowed daily, the crews were given one day off each week. During these free times, the Skylab crews relaxed in their orbital home with recreational activities. Some of these activities were planned ahead of time. Others developed in response to the weightless environment. The astronauts staged several stunts which project a feel for their environment and celebrate the uniqueness of weightless life aboard their orbital home.

This film illustrates several of these recreational activities conducted by Skylab crews. Some scenes are fascinating and humorous. The physical principles governing motion and the behavior of energy and momentum are clearly illustrated. As you view these activities some scenes appear at first to be very much like similar activities on earth with subtle physical clues revealing the fact that the astronauts feel no gravity. Later scenes show unmistakable evidence of the remarkable characteristics of the weightless environment of Skylab.

II. Film Synopsis

The scene list below will provide the viewer with a brief summary of the four major sections of this film. Included with each section are questions and exercises designed to assist the viewer who wishes to relate his or her observations to the principles of physics.

A. Paper Air Planes - The scene opens with an astronaut folding common paper airplanes. The folded planes are thrown in the weightless environment to another astronaut located behind the camera position.

Questions and Exercises

1. Fold a paper airplane similar to the plane created aboard Skylab. Launch the plane several times and list its flight characteristics such as range, velocity, rotation and aerodynamic properties.

2. View the paper airplane sequence of this film several times, noting the characteristics of weightless flight. Compile a list of similar and unique characteristics, comparing the flight aboard Skylab to the airplane you launched on earth.

3. Using a stopclock, time the flight of the airplanes on Skylab from the thrower's hand to the camera position, a distance of 4.5 meters. Transform this film time to real time by multiplying your clock time by 1.25. Now calculate the average time for each of the thrown airplanes by taking several trials for each throw. The data table below will assist you in taking data and in computing the average velocity of the plane.

Throw	Trial	Film Time (sec)	Actual Time * (sec)	Ave. Time (sec)	Ave. Velocity (meters/sec)
1	1				
	2				
	3				
2	1				
	2				
	3				
3	1				
	2				
	3				

*Actual Time = 1.25 x video playing time

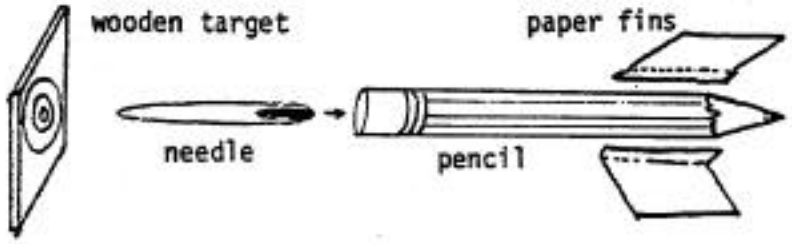
4. What physical variables could cause a significant difference in the average velocities calculated in exercise 3?

5. What physical factors determine the range of a paper airplane thrown near the surface of the earth? What physical factors determine the range of the paper airplanes thrown on board Skylab?

B. Dart Throwing - Dart throwing is a common recreational activity. The opening scene of this section of the film illustrates the sticking action of the special Velcro-tipped darts and board provided for the Skylab crew. The action which follows shows the darts being thrown from a distance of 4.0 meters. Subsequent scenes show several throwing attempts and the corresponding outcomes.

Questions and Exercises

1. Set up an actual dart board in a location where the darts may be thrown a distance of about 4 meters. If a dart set is not available, you may construct your own for this purpose with a pencil, a needle, and a piece of wood as illustrated below.



Have a friend throw the dart several times so that it strikes the dart board while you stand behind and to the side of the action. Observe the action of the thrower, the flight of the projectile and the final position of the dart. Throw the dart yourself several times and think about how the dart must be thrown so that it successfully strikes the target.

2. View the DARTS sequence of the film several times. Make a list of similar and unique characteristics, comparing the dart flight aboard Skylab to the dart flight you observed on earth. Make special note of the throwing of the dart, its path to the board and the action of the darts which do not stick to the board. Make special note of the additional fin area which has been added to several darts. Why is this extra area needed? (Hint; the cabin pressure aboard Skylab was 34.5×10^3 Newtons/m^2, or 5 lbs/$in.^2$).

3. Watch the DARTS sequence again, making note of the 3rd throw in which the dart failed to stick to the target. Using a stopclock, measure the time of flight from the thrower's hand to the target (4 meters) and the time from the target until it was caught by the thrower (4 meters). Correct this Film Time to true time by multiplying by the velocity of the dart toward the board, and its velocity away from the board. The data table provided below will aid you in recording data and in calculation.

Dart Direction	Trial	Film Time (sec)	Actual Time* (sec)	Velocity (meters/sec)
Toward Board	1			
	2			
Away from Board	1			
	2			

*Actual Time =

4. If the mass of the thrown dart is 30 grams, calculate the impulse transferred to the board for the collision specified for examination in exercise three.

5. Using the data given above, calculate the coefficient of restitution for the dart that bounces off the target.

C. Weightlifting and Balancing Act - In these last two film actions it appears that the astronauts are attempting to give their viewers on earth some feeling for their impressions of weightlessness. To do this they carefully staged two common stunts which some of us may have seen performed on earth.

You will notice that at the beginning of each sequence the astronauts are careful to make the activity appear as if it is taking place on earth and things are quite normal. Just about the time you might be wondering about what is happening, the dramatic contrast of weightlessness suddenly and unmistakably becomes obvious.

Questions and Exercises

After you have viewed these two film sections, try to recall the first clue in which each revealed to you that the astronauts were weightless. Look at the film again and see if you can find a clue before the one you noted above. Repeat this several times.

References:

Physics Content

1. Halliday and Resnick, Physics Parts I and II, John Wiley & Sons, Inc. (1967).

2. Hewitt, Conceptual Physics, Little Brown and Co., (1971).