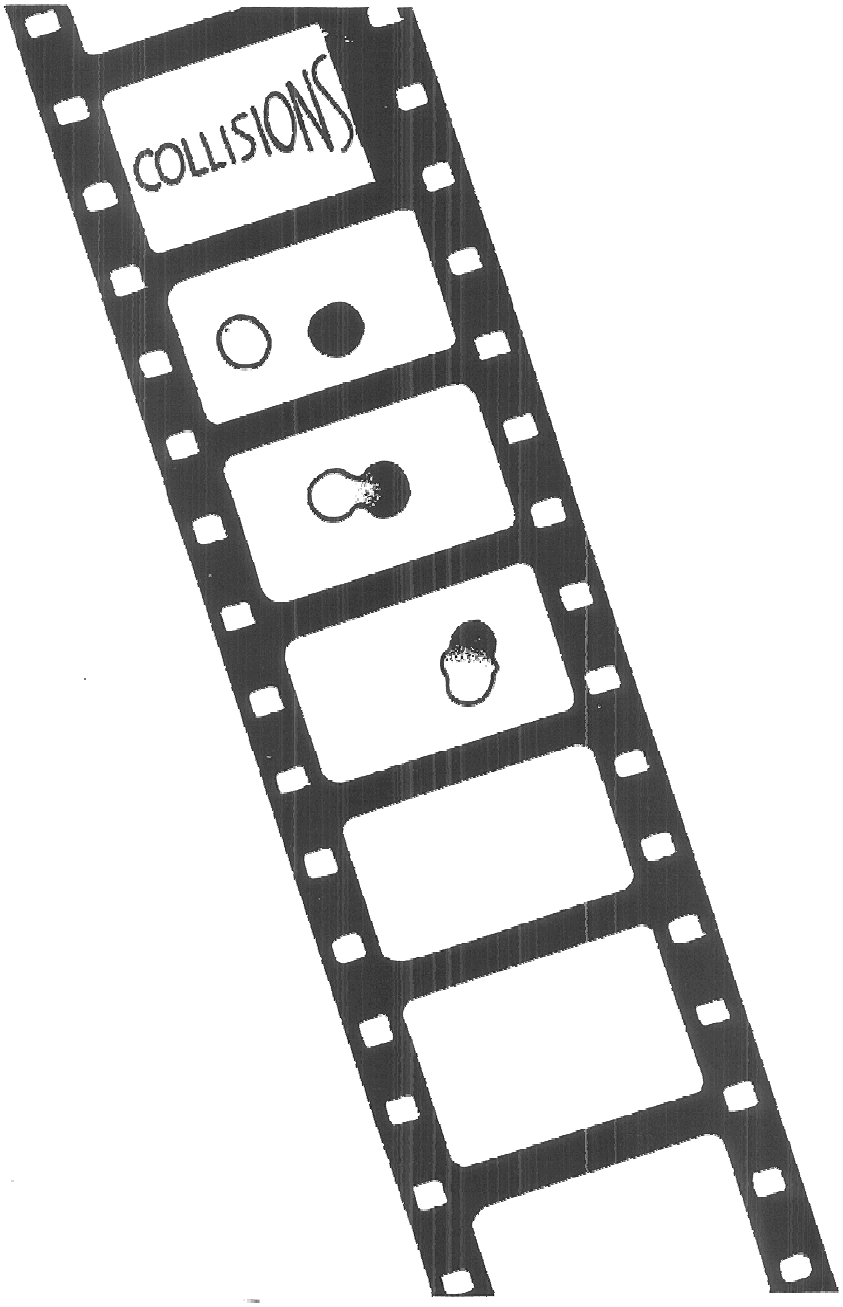
A Teachers Guide for the Videotape
Segment 8

Starts at 14:36:04
Run Time 01:58:26



NASA
National Aeronautics and Space Administration

FILM FOOTAGE FROM NASA SKYLAB MISSIONS

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I. Introduction

The weightless environment of the Skylab spacecraft provided many exciting examples of unusual phenomena. One of these was the behavior of water droplets formed by using springs and squeeze containers filled with water. The behavior of water when it is constrained primarily by its own surface tension had not been previously examined in detail since no laboratories on earth can duplicate weightlessness. Water droplets ranging from the size of a pea to the size of a grapefruit were formed, pushed, split, herded, and made to collide during the three manned missions.

This film provides the viewer the opportunity to judge the similarities and differences between waterdrop collisions and human body collisions. As the film begins several water drop collisions and human body collisions are shown in a normal time frame. The last half of the film shows human body collisions and water drop collisions in a reversed time frame. The spontaneous division of a weightless water drop violates accepted physical principles but by the use of film it is possible to observe.

II. Film Synopsis

The scene list below provides the viewer with a brief summary of the two major sections of this film.

Film Section A - Real time illustrations of collisions aboard Skylab.

Scene A-1. A large (approximately 4 cm in diameter) dark water drop, held in position by a piece of dental floss (seen on the screen as a light verticle line), collides with a smaller (approximately 1.5 cm in diameter) clear water drop.

Scene A-2. A red drop collides with a green drop of approximately the same size. (Both drops have a diameter of about 3 cm.) Note the variety of shapes and the intermixing of colors which are produced in the combined drop following the collision.

Scene A-3. A high speed small drop tears the larger target drop from its dental floss mooring.

Scene A-4. Two humans collide.

Scene A-5. Another human body collision occurs.

Scene A-6. A single human (at rest with respect to Skylab) collides with two other humans and rapid "three-body" rotation results.

Film Section A closes with the single frame "FINISH"

Film Section B begins with the single frame "FINIS"

Film Section B - Non-real (reversed) time illustrations of collisions aboard Skylab. This film section allows the viewer to view the scenes from Film Section A as they would appear if shown by a projector running backward.

Scene B-1. Three rapidly rotating human bodies separate. Two of the bodies carry away the rotational energy and most of the translational energy of the system. The third body is left suspended in Skylab with only slow translational motion toward the camera.

Scene B-2. Two rapidly rotating human bodies separate.

Scene B-3. Two rapidly rotating human bodies separate.

Scene B-4. A large water drop seems to eject a small drop spontaneously.

Scene B-5. A large red drop, after several oscillations, ejects a small green drop.

Scene B-6. A dark drop, after beginning to oscillate, divides itself into two different regions of color, and finally a green drop is ejected leaving a motionless red drop behind.

Film Section B closes with the final title "COLLISIONS"

Questions

1. Halliday and Resnick (Reference 1, page 157) makes the following statement concerning inelastic collisions: "When two bodies stick together after collision, the collision is said to be completely inelastic." Which of the collisions shown in Film Section A would you classify as completely inelastic?

2. Which of the collisions in Film Section A conserve momentum?

3. It can be shown (Reference 1, page 160) that if a collision is inelastic a fraction of the original translational kinetic energy of the colliding bodies will be transformed into some other forms of energy. How many of these alternate forms of energy can you identify in Film Section A?

4. The liquid drop separations shown in Film Section B violate the second law of thermodynamics. (See References 1 and 2.) Explain in some detai what this statement implies about Scene B-6.

5. Do any of the water drop scenes from Film Section B violate the first law of thermodynamics?

Exercises and Experiments

1. Attempt to duplicate the large water drops (2-4 cm) which were possible in Skylab. What seem to be the limitations to drop formation encountered on earth? Did similar limitations exist aboard Skylab? (One astronaut reported that he believed he could have made as large a water drop in Skylab as he wanted. It was a bit tedious to watch him create a water drop by using a syringe and enlarge it by injecting additional water inside the previously formed drop.)

2. It is possible, using the stop frame feature on most 8mm projectors, to trace the center of mass motion for many of the collisions and separations illustrated by this film. (Caution: Remember that several of the drops are secured by a dental floss mooring.) Project the film onto a large piece of newsprint taped to the wall and attempt to follow the motion of the center of mass for several of the scenes of this film.

3. Using the stop frame technique described above, a stopclock, and a ruler, show that linear momentum is conserved in the collision illustrated in Scene A-2. (Assume the masses to be equal.)

References

(1) Halliday and Resnick, Fundamentals of Physics (Revised Printing), John Wiley & Sons, 1970.

(2) Hewitt, Conceptual Physics...A New Introduction to Your Environment, 2nd Edition, Little, Brown and Co., Boston, 1974.