THE MODERN CHEMIST

*produced by*

Sutherland
EDUCATIONAL FILMS, INC.

201 North Occidental Boulevard, Los Angeles 26, California

THE MODERN CHEMIST was produced under the supervision of an Editorial Committee of the American Chemical Society:

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BIBLIOGRAPHY:

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"First Man-made Diamonds," *Science Digest,* 37:93, May 1955.

TEACHERS STUDY GUIDE

# Sutherland
EDUCATIONAL FILMS, INC.

*presents*

# THE MODERN CHEMIST
## (DIAMOND SYNTHESIS)

16mm Sound Film

GRADE: Junior High School
High School (non-technical)

SUBJECTS: Vocational Guidance
General Science

RUNNING TIME: 13 Minutes

PHOTOGRAPHY: Color

TECHNICAL ADVISOR: Willard F. Libby, *Professor of Chemistry, University of California at Los Angeles*

FEATURED IS Dr. H. Tracy Hall, *Director of Research at Brigham Young University, Provo, Utah*

*Grade Level*

Junior high school, high school (non-technical)

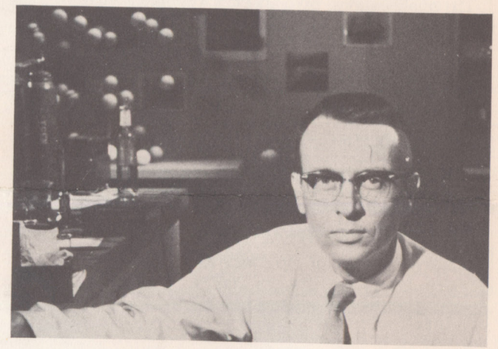
*Use*

1. To be used in a *Vocational Guidance* program as a composite character sketch of the research chemist, his problems, his methods, and his rewards.

2. To be used as a *General Science* film to show the tools, technique, and theory used in synthetic diamond research.

*Suggested use in following units:*

(a) Mineralogy
(b) Crystallography
(c) Carbon Chemistry
(d) Scientific Method



## CONTENT OF FILM

This film is a dramatic presentation of the discovery of the method for the manufacture of synthetic diamonds. Dr. H. Tracy Hall personally re-enacts in his laboratory certain experiments leading to the discovery of a man-made diamond as perfect as a natural gem.

*Vocational Guidance Content*

1. This film outlines personal qualifications of the research scientist.

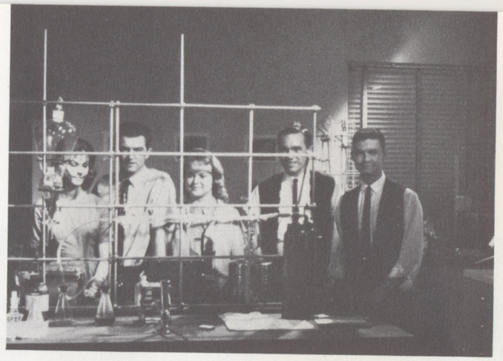
(a) Curious, inquiring mind.
(b) Patience and persistence.
(c) Imagination.
(d) Academic training.
(e) Careful observation.

2. The film gives historical perspective to the experimental method of science. It points out how the discovery of the process for the production of synthetic diamonds was achieved by theorizing, experimenting, failing, then re-theorizing on the basis of past failure and then experimenting again.

3. It presents the rewards of the successful scientist.

(a) The romance of scientific exploration.
(b) Self-satisfaction.
(c) Professional recognition.
(d) Contribution to mankind.

4. This film pictures the promise of the future for aspiring young chemists by describing important fields holding exciting opportunity for research.



## BEFORE SHOWING
*as a vocational guidance film*

To alert the students to the vocational guidance implications of this film, have them list their concept of the following:

1. The qualifications, psychological and intellectual, of a research scientist.

2. The problem solving method of the research scientist.

3. The rewards of the research scientist.

## AFTER SHOWING
*as a vocational guidance film*

Have students re-evaluate their lists and discuss and compare:

1. Qualifications that are brought out in the film:
   (a) High intelligence.
   (b) Curiosity.
   (c) Academic preparation. Point out that a master's degree in chemistry involves a four year bachelor's program and at least one to two years of graduate work. A Ph.D. involves three to four years of graduate work.
   (d) Patience.
   (e) Imagination.
   (f) Keen powers of observation.

2. The scientific method as brought out in the film:
   (a) Is one of observing.
   (b) Is generalizing or theorizing on the basis of observation.
   (c) Testing theory with an experiment.
   (d) On failure, creating a new theory.
   (e) Testing again.

This should lead students to a better grasp of the last three qualifications listed in #1.

3. Discussion of the rewards of chemical science should stress:
   (a) The romance of discovering the unknown. Listed frontiers are medicine, dyes, synthetic foods, fuels, plastics, and metals. Encourage students to list others.
   (b) Service to mankind.
      (1) Longer, healthier life due to medicine.
      (2) Greater abundance of material goods.
   (c) Monetary reward.
      (1) Explain that reward comes with level of achievement. A young research chemist with a Ph.D. starts out at from $600 to $800 a month. The acquisition of successful patents, the authorship of wide selling textbooks, or the achievement of executive position may bring true wealth.
   (d) Self-satisfaction and professional recognition are the crowning rewards for the individual who is active in research.

4. Since the research chemist is comparatively rare, discuss the very important role for supportive personnel—instrument makers, technicians, etc.

### *General Science Content*

1. The film explains the problems encountered in compressing graphite into diamond and the theory which leads to the first practical process for making large quantities of industrial diamonds.

2. This film presents an ultra-high pressure machine in actual use, describes its operation, and shows its finished product—synthetic diamonds.

3. The film gives historical development and current application of the scientific method.

## BEFORE SHOWING
*as a general science film*

Have students read section on crystal growing in text. Alert students to note in film:

1. Physical conditions under which diamonds were formed.
   (a) Temperature 1500°C., approx.
   (b) Pressure 1,000,000 lbs/sq. in.
   (c) Other conditions (solvent)

2. Differences in structure of graphite and diamond.

3. Structure of machine.

4. Steps in the scientific method.

## AFTER SHOWING
*as a general science film*

1. Give students a brief history of the discovery of the synthetic process. Note that while for dramatic reasons, the contribution of one man is stressed, that many were involved in the final discovery.

2. Lead into a discussion of the equipment by asking how the press might have been operated, how heat was generated.

3. Discuss allotropy (different molecular arrangements of the same element with different physical properties). Point out that even oxygen comes in different molecular groupings—$O_2$, common oxygen, $O_3$, ozone.
   (a) Compare crystal structure of graphite and diamond.
   (b) Ask class what must be done to convert graphite into diamond. Point up role of heat, solvent, pressure.

4. Compare the synthetic diamond process with other techniques of producing artificial crystal and gem growth.
   (a) Growing $CuSO_4$ crystals (copper sulfate) from a supersaturated solution.
   (b) Growing sapphire from a melt. Artificial sapphires of gem quality are grown by fusing (melting) $Al_2O_3$ (alumina or aluminum oxide) at a temperature of 2300°C. and solidifying into a crystal. See *Rocks and Minerals*, Herbert S. Zim and Paul R. Shaffer, Golden Press, New York, 1957, page 92.
   (c) Growing diamond from graphite.

5. Discuss scientific method outlined under Vocational Guidance. Use above.