1. Program Title: Instructional Scientific Equipment Program

2. a. Name of Institution: SANTA BARBARA CITY COLLEGE

b. Location: City Santa Barbara State CA Zip Code 93109

c. Grant to: Santa Barbara Community College District

(Official name of institution or agency to which grant should be made if different from 2a. above.)

d. Name and Title of Chief Administrative Officer: Glenn G. Goeder, Superintendent/President

e. Institution’s opening fall enrollment as reported to the U.S. Office of Education for 1975: 9,080

3. a. Field of Science and Engineering Code: 1300000

b. Specific Discipline Name(s): PHYSICS

c. Field of Interest and Application Code(s): 0101000

4. a. Amount Requested from NSF ................................. $ 2,700

   (Round to nearest $100)

b. Amount to be provided from non-Federal sources ............................. $ 2,700

   (Round to nearest $100)

5. Are funds for the project specified herein being requested from another NSF Program or another Federal Agency? No

If yes, please indicate the agency, program, and date submitted:

   (Agency)    (Program)    (Date)

NOTE: The Foundation should be promptly notified of any request to another NSF Program or another Federal Agency for this project which is made before June 15 of the year of this request.

6. Matching Funds Statement by the Authorized Institutional Representative:

I am authorized to certify, and do certify, that before the expiration of a grant resulting from this proposal, SANTA BARBARA CITY COLLEGE will provide, from non-Federal sources, its share of funds which have not been obligated prior to the date this proposal is received by the National Science Foundation. The institutional funds designated herein will be used specifically for the purchase of instructional equipment listed in this proposal.

7. Project Director:

   a. Name: (Prof., Dr., Mr., Ms., etc.) Dr. Elwood J. Schapansky

   b. Social Security No.: 552-54-0031

   c. Department: Physics

   d. Phone: Office (805) 965-0581 (Ext 454)

   (Incl. Area Code) Home (805) 967-3264

   e. Mailing Address (Academic)

      SANTA BARBARA CITY COLLEGE

      721 CLIFF DRIVE

      SANTA BARBARA, CA 93109

   f. Signature: ............................... [Signature]

   g. Date: January 13, 1976

8. Authorized Institutional Representative

   a. Name: (Mr., Ms., Dr., etc.) Dr. Glenn G. Goeder

   b. Title: Superintendent/President

   c. Mailing Address:

      SANTA BARBARA CITY COLLEGE

      721 CLIFF DRIVE

      SANTA BARBARA, CA 93109

   d. Signature: [Signature]

   e. Date: January 13, 1976

* See comments regarding Social Security account number disclosure, page 4.
<table>
<thead>
<tr>
<th>Description</th>
<th>Model No.</th>
<th>Mfr.</th>
<th>Unit Price</th>
<th>Qty</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Counter Timer Assortment, consisting of: Amplifier Power Supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Counter Timer</td>
<td>APS-101</td>
<td>Thornton Associates, Inc.</td>
<td>$360.00</td>
<td>12</td>
<td>$4,320.00</td>
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<td>Loudspeaker</td>
<td>DEC-101</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Photocell (2)</td>
<td>PHC-100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geiger tube</td>
<td>GET-100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light source (2)</td>
<td>LIS-100</td>
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<td></td>
<td></td>
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<tr>
<td>2. Preset Counter Adapter</td>
<td>PCA-100</td>
<td>Thornton Associates, Inc.</td>
<td>49.00</td>
<td>12</td>
<td>588.00</td>
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<td>3. Geiger-Mueller Tube Mount</td>
<td>GTM-100</td>
<td>Thornton Associates, Inc.</td>
<td>5.00</td>
<td>12</td>
<td>60.00</td>
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Equipment subtotal
California Sales Tax (6%)
Shipping costs

TOTAL
From NSF Grant Funds
From District Matching Funds

$5,351.00
$2,675.50
$2,675.50
NARRATIVE

1. The Present Course

Santa Barbara City College offers a full range of lower division Physics and Physical Science courses which are transferable to most four-year colleges and universities. In addition to meeting the needs of Physics majors, Physics is offered to meet the needs of students in Engineering, Chemistry, Earth Science, and Life Science, as well as special courses for vocational majors in Marine Technology and Radiologic Technology. One course is offered in acoustics for Music majors, and many students choose Physics courses as a means of meeting their natural science requirement for graduation. Courses offered are as follows:

Physics 1/3. A one-semester introductory course in general physics suitable for the liberal arts major having an optional laboratory.

Physics 5/6. A two-semester sequence in general physics including laboratory for the Science major covering particle and rigid body mechanics, properties of matter, heat, waves, sound, electrostatics, magnetism, electrical circuits, physical optics, relativity, and atomic and nuclear physics.

Physics 11/12. A two-semester sequence in general physics including laboratory, stressing applied physics, mainly for the vocation/technical student.

Physics 13/15. A one-semester course in acoustics for Music majors and others with optional laboratory.

Physics 19. A one-semester course for Radiologic Technology students, including laboratory.

Physics 21. A one-semester course in Mechanics including laboratory, for Physics, Chemistry and Engineering majors.

Physics 22. A one-semester course following Physics 21, covering electricity and magnetism.

Physics 23. A one-semester course in Thermodynamics, Light and Modern Physics, following Physics 21, 22.
Over the last four years total enrollments in Physics and Physical Science courses has held steady at about 2,000 weekly student contact hours. The number of students majoring in these fields has increased at an average annual rate of over 20 percent over the last few years. (See Table.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total College Fall Enrollment</th>
<th>Physics, Physical Science and Engineering -- Weekly Student Contact Hours</th>
<th>Physics, Physical Science, Engineering Majors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>6,484</td>
<td>N. A.</td>
<td>102</td>
</tr>
<tr>
<td>1973</td>
<td>7,691</td>
<td>2,002</td>
<td>115</td>
</tr>
<tr>
<td>1974</td>
<td>8,385</td>
<td>2,103</td>
<td>142</td>
</tr>
<tr>
<td>1975</td>
<td>9,080</td>
<td>1,901</td>
<td>179</td>
</tr>
</tbody>
</table>

This would indicate that about 300-350 students are enrolled in Physics courses at any given time. Since about two-thirds of these students will use the equipment requested herein, it is estimated that at least 200 students per semester, or 2,000 students over the next five years will benefit from the proposed project.

2. Deficiencies in the Present Course

In 1963, a new Physical Science building was completed. Laboratories in this building were designed to accommodate 24 students, and the educational philosophy was adopted to provide sufficient equipment so that students could work in groups of two. This was felt to be necessary to assure "hands on" experience for all students.

This ideal has never been realized, because of financial limitations. At the present time, for most of the 50 different experiments performed in the areas of mechanics, electricity, magnetism, and modern physics, students must work in groups of four or more. For at least half the students, their laboratory experience is often equivalent to a poor demonstration.
It appears that the hope of acquiring the desired 12 laboratory setups in the foreseeable future is nil. The staff has therefore been examining various alternative methods of providing a high-quality laboratory experience for all students at a reasonable cost in terms of both equipment and staff time.

One approach that has been used to alleviate the problem is to divide the lab into two groups which do different experiments during a given week. This approach has the disadvantage that lectures and laboratory experiments are not synchronized, and logical sequences of experiments are sometimes sacrificed. It is not considered to be a satisfactory solution.

Another approach is to reduce the number of students per laboratory section. This is too costly in terms of staff time and is unacceptable.

Space and personnel limitations also prevent use of an individualized self-paced laboratory arrangement where students drop in at any time to perform assigned experiments.

3. The Improvement Plan

Recently, as a result of technological advances, an inexpensive modular electronics system has become available for the teaching of Physics. The system, produced by Thornton Associates, Inc., is highly versatile, and it is the feeling of the Physics faculty that a full complement of this system (twelve sets) would significantly improve the instructional program. It would permit highly professional and modern duplication of all of the experiments which require precise and accurate timing, and would allow the performance of many completely new experiments, heretofore beyond our technical capabilities.

Another advantage is inherent in the fact that the equipment is electronic in nature. There is a significant trend in the sciences toward the
use of such instrumentation. Many colleges and universities now offer an advanced degree in instrumentation. Thus, the proposed equipment would provide a stimulating introduction to many students, not only in Physics, but in other scientific majors and vocational fields.

The Thornton Counter-Timer Assortment consists of a 5-decade counter-timer, an amplifier/power supply, a geiger tube, a loud speaker, two light-gate photocells, and two light sources. This request also includes a pre-set counter adapter and a geiger tube mount. Additional equipment can be purchased at a later time for expanding the repertoire of experiments. With the basic assortment, we will be able to perform at least seven stimulating experiments not now possible in our laboratory courses.

1) Determination of acceleration of gravity by direct timing.
2) Frequency analysis in audio-spectrum.
3) Calibration of stroboscopic light sources (used with existing air table and air track).
4) Determination of angular velocity by light pulse counting.
5) Determination of frequency of water waves in a ripple tank.
6) Determination of the speed of sound in air.
7) Statistical analysis of reaction times.

We will also be able to improve several of our current experiments, for example,

1) Velocity and momentum experiments on the air track and air table.
2) Radiation counting.
3) Period determination of simple harmonic systems.

These experiments are primarily related to the study of mechanics. This is an area where stimulating experiments are hard to find. The proposed system would correct that problem. It would be used in all of
the mechanics courses, and would greatly enhance our applied physics offerings. The ability to use the equipment for frequency counting and spectral analysis would make it extremely useful in our Physics of Music Laboratory.

4. The Equipment Request

The equipment requested consists of the basic assortment known as the Thornton Counter-Timer Assortment. As noted above, this assortment permits the performance of a wide variety of basic physics experiments with a single, relatively inexpensive, durable, and easy-to-use system.

The system includes the following modules:

**Five decade counter-timer** - Capable of counting at rates up to 5 MHz. Contains an internal 1 KHz generator for millisecond timing, and provides 450 volt output for Geiger tube.

**Amplifier/Power Supply** - Stable high-gain amplifier and regulated power supply. Amplifier has variable gain of 0 to 100 with 500 KHz bandwidth and output of 300 mw DC or 150 mw AC. Power supply provides regulated (to .03%) 12-volt and -6-volt and unregulated +18 volts DC, and 25 volts and 150 volts AC. Amplifier can also be used as oscillator.

**Geiger tube** - End window geiger tube responsive to beta and gamma radiation.

**Loudspeaker** - 40 ohm, 150 mw speaker, usable as microphone, is matched to the amplifier/power supply.

**Photocell and Lightsource** - Used in combination to produce event pulses or gates for timing experiments.

Two additional items are requested with each basic assortment:
Pre-set counter adapter - Provides selectable gate intervals of 1 second, 10 seconds, 100 seconds, or 250 seconds. Used with the 5-decade counter timer and photocell for stroboscope calibration, angular velocity measurements, or water wave frequency measurements, for example.

Geiger tube mount - Enables tube to be positioned accurately with respect to a source.

5. Equipment on Hand

The equipment now on hand has been surveyed with regard to many of the experiments to be performed, and much of it will be used in conjunction with the Thornton system. Existing equipment will be used as follows:

a. Simple pendulum
   1) Pendulum bobs
   2) Support rod and pendulum clamp
   3) 2-meter sticks
   4) Vernier calipers
   No. on hand
   9
   12
   12
   12

b. Uniformly accelerated motion—the Atwood machine
   1) Atwood machine
   2) Slotted weights
   3) 2-meter sticks
   No. on hand
   4
   12
   12

c. Uniform circular motion
   1) Centripetal force apparatus
   2) Variable speed motor
   3) Support stands
   4) Weight hangers and weights
   5) Vernier calipers
   No. on hand
   6
   6
   --
   6
   12

d. Torsion pendulum
   1) Torsion pendulum with disc and ring
   2) Vernier calipers
   3) Equal arm balance
   4) Standard weights
   No. on hand
   4
   12
   8
   8

e. Rotational motion
   1) Moment of inertia apparatus
   2) Hook weights
   3) Meter stick
   4) Vernier calipers
   5) Large calipers
   No. on hand
   6
   8
   12
   12
   2
f. Simple harmonic motion
   1) Springs 12
   2) Table clamps with rod and clamp 12
   3) Hook weights 8
   4) 2-meter sticks 12
   5) Equal arm balance 18
   6) Standard weights 8

g. Joule's Law - Mechanical equivalent of heat
   1) Immersion heater 10
   2) Calorimeter 12
   3) Thermometer 24
   4) DC Voltmeter (0-1500 v) 6
   5) DC Ammeter (0-3a) 6
   6) Equal arm balance 18
   7) Standard weights 8
   8) Tubular rheostats --

h. Acceleration of gravity
   1) Cenco-Behr free-fall apparatus 2
   2) Meter sticks 12

i. Compound pendulum
   1) Experimental pendulum 4
   2) Large weights 30

j. Newton's Second Law
   1) Precision car and track 5
   2) Slotted weights 12
   3) Meter sticks 12

k. Speed of sound measurement
   1) Tektronix 5103 Oscilloscope 6
   2) Signal generators 7

l. Audio frequency measurement
   1) Microphones and stands 2

m. Frequency of waves in ripple tanks
   1) Ripple tanks 6
   2) Variable speed wave generators 6

6. Faculty Expertise

The five Physics and Physical Science faculty members who will be using the equipment proposed herein, have a combined experience of 66 years of teaching and 33 years in industrial research and engineering. All have a minimum of a Master's degree, and two have earned their PhD. Brief resumés follow.
1. Elwood J. Schapansky, Associate Professor, Physics, and Project Director

Education - BS, 1961, Fresno State University
MS, 1963, University of California, Santa Barbara
PhD, 1971, Colorado State University

Experience - Teaching: 2 years at UCSB and 10 years at SBCC
Other: 2 years in electronics and aerospace


2. Frederic W. Schuler, Associate Professor, Physical Science and Engineering

Education - BS, 1944, University of Wisconsin, Chemistry
PhD, 1949, University of Wisconsin, Physical Chemistry

Experience - Teaching: 8½ years at junior college level,
19 years research in various government, university, and industrial laboratories

Publications - Two books on craft glassmaking, numerous articles in fields of glass and magnetic thin films

3. William E. Miller, Professor, Physical Science and Engineering

Education - BS, 1948, University of Missouri
- MEd, 1952, University of Missouri
Additional graduate work at University of Missouri and Stanford University

Experience - Teaching: 18 years at junior college level
and 8 years at high school level

Publications - Physics Laboratory manual

4. Isidor Elias, Associate Professor, Physics

Education - BA, 1949, UCLA, Physics
MA, 1955, UCLA
Additional graduate work at UCLA and University of Wyoming

Experience - Teaching: 4 years in UCLA extension,
12 years at junior college level
Other: 11 years with various aerospace companies doing research in acoustics, vibration, propulsion, and aerodynamics

5. Gregory W. Cain, Lecturer in Physical Science and Engineering

Education - BS, University of California, Santa Barbara
MAT, UCLA

Experience - Teaching: 2½ years at junior college level
in Physics and Astronomy
1½ years at Brooks Institute of
Photography

Publications - Two articles in The Physics Teacher related
to search for extraterrestrial life and
intelligence