

CaFD

Winter '97-98

Curriculum and Faculty Development Newsletter for Two-Year College Physics Teachers

*Part of a
workshop
project*

*Supported
by the*

*National
Science
Foundation*

*Joliet
Junior
College (IL)*

*Lee
College (TX)*

Editors Note: This newsletter is focused on the IPC 2 conference that was held last summer. It features some of the sharing and the results of the group participant projects in electricity and magnetism.

Introductory Physics Conference II (IPC 2): Looking at Electricity and Magnetism

Thomas L. O'Kuma
Lee College
Baytown, TX

Introduction

The second Introductory Physics Conference (IPC 2) was held June 17 - 21, 1997, at Lee College in Baytown, Texas. During the IPC 2, the participants heard about and discussed the implications of current projects and developments in the topic area of electricity and magnetism in teaching introductory physics. Additionally during this conference, the participants participated in several "hands-on" workshops and developed their own materials for teaching electricity and magnetism.

Introductory Physics Conference 2

The 26 two-year college faculty members who attended had an opportunity to listen to, ask questions of, and work with some of the innovators in the teaching of electricity and magnetism (E&M). Although the five-day conference had a fairly hectic schedule, the participants enjoyed the opportunity to "immerse" themselves in E&M. Prior to the conference, participants and leaders received a number of "pre-conference materials" (listed on page 8).

The conference began on Tuesday afternoon with a welcome by Curt and Tom followed by a round of introductions of the participants and workshop leaders. David Maloney shared some of his ideas on the "Research on Problem Solving" emphasizing some of the successes (and failures) of various approaches in teaching problem solving. Alan Van Heuvelen followed this intro-

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Introductory Physics Conference III (IPC 3): Waves

For the third year, we are offering an Introductory Physics Conference (IPC 3) that will be held June 16 - 20 at Joliet Junior College, Joliet, IL (near Chicago, IL). This conference, which is primarily for past TYC Workshop participants, will focus on waves — sound, light, and matter.

Joining us that week will be Dave Maloney and Alan Van Heuvelen. In addition, we expect to have Priscilla Laws from Dickinson College, Lillian McDermott from the University of Washington, Joe Redish from the University of Maryland and Dean Zollman from Kansas State University.

At this conference, we will look at what we should be teaching about waves, some of the misconceptions, and how we can assess how well are our students are doing in these areas. We are planning to provide time for participants to learn what others are doing as well as time for groups to construct some additional materials that will enhance student learning in waves. Since we expect that this will be our last IPC, we hope to have a strong number of participants. We encourage past IPC participants to attend since it will contain all new material.

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Designing a More Inclusive Curriculum for Introductory College Physics

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The evidence is now very compelling that virtually all physics education has traditionally been designed exclusively for “a few good men,” or to paraphrase one of our own group “for a very few, very good, white men.” It is now clear that we do society and ourselves a great disservice to continue such practices. All society is now so technological, it is imperative that some appreciation of physics must reside in a broad population of ordinary people. Such people not only need an understanding of the skills we teach in physics, but they are obviously the voters, parents and teachers who influence the attitudes of future possible scientists, policy makers, financial controllers and a whole world of others on whom we are dependent. To be properly appreciated by them, they must be appreciated by us.

The course description below is for an algebra/trig based course for non-majors. It is part of an on going effort to find ways to make an introduction to the study of physics accessible to all students, as recommended in the “Shaping the Future” report.¹ The program, which has been evolving for several years, was modified for 1996-1997 to include a grade contract, group/teaming structure and alternative problem solving strategies as described. Surveyed attitudes, retention, and increased enrollment for 1997-1998 indicate that the new design is well received by the students. Further, it has been fun and re-invigorating to accept the challenge.

As this is a “work in progress” readers are encouraged to offer critiques and suggestions. This course description is handed out to students on the first day of class.

Course Description - Introductory College Physics

The Course Design:

The philosophy of this course is that an introduction to physics is a core discipline for a college education, not a specialization for the elite few, especially in view of the rapid-

¹ “Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology” A Report on its Review of Undergraduate Education by the Advisory Committee to the National Science Foundation, Directorate for Education and Human Resources, May, 1996.

ly exploding impact of technology developments in routine daily endeavors.

Recognizing a broad range of interests, preparations, and future needs among physics students when the course is open to the entire population, this course is designed to allow each student to individually select a range of content and an individualized grading scheme.

Further, students may contract in advance for a guaranteed grade in the course, within each scheme. For example, a pre-med student may choose to emphasize problem solving in preparation for the MCAT while an English major or a future elementary teacher may be more interested in critical reading skills or creative explanations of observables.

For this course, broad “strands” involving different learning strategies are identified which rely heavily on certain characteristic skills and concepts that can be developed through the study of physics, including problem solving, critical reading, metacognitive skills, verbal description, multiple representations and working within a team. The pre-med major would probably contract for Strand I, where problem solving and traditional exams form the emphasis; the education major could chose Strand II, with emphasis on multiple representations; and the English major may choose Strand III, stressing verbal expression. Each would then decide on the level of commitment and contract for a grade of A, B or C within that strand. The contracted grade is guaranteed when the student has satisfied the terms of the contract. [Note: Failure to satisfy a grade contract will require a conference with the instructor to re-negotiate a grade.]

Activities:

I. Multiple approaches to problem solving:

- Traditional** worksheet and end-of-chapter problems from the text — reinforcing methods that strengthen algebraic formulation and solution.
- Describe and Defend (D&D)** problems - wherein an event or situation is posited for the student to describe and defend the applicable physics. A good response to such an item includes a

continued on the next page

Levels continued from previous page
 verbal description of the physics principles involved, a description of the behavior of the system in the immediate and foreseeable future, and a verbal defense of predictions citing appropriate physical law and logical arguments. D&D problems are often open ended with no specific question stated.

- c. **Event Frame Representation (EFR)** which involves a series of sketches showing the system in progressive states as it changes, e.g., the student may draw a "cartoon strip" picturing the system behavior in successive frames.
- d. **Interdisciplinary Applications (IA)** which show connections between physics and other studies, couched in a rich context of events from history, works of literature, political impact and government policy, among others. The student may be asked to analyze physics or develop the context for other applications.

II. Investigations

- a. Experiments in the lab
- b. Internet and library searches
- c. Projects

III. Collaborative Learning

- a. **Group Problem Solving (GPS)** - Teams of three students will be presented with a situation problem. The team will submit a single report on the resolution to the situation incorporating at least three representations (i.e., D&D, algebraic, EFR, etc.)
- b. **Class discussion** - the success of which depends on the willingness of each student to relax the instinctive guard against having someone else know what we think. Many times, learning physics requires identifying what our misconceptions are.

IV. Personal Journal

An option for students who may choose to maintain a log of thoughts and observations about physical phenomena and ideas. Such a journal should be kept in a bound notebook with dated entries. The progress through the journal should clearly show how a developing consciousness of physical principles impacts the way we sense and interpret the world around us.

V. Exams

They will also be varied in style, incorporating all of the learning styles used in other facets of the course. In particular, there will be a group problem on every exam, valued at 20% of the exam.

Selecting A Strand:

The following table is a guideline for selecting a strand and deciding on an emphasis for your grade partition. The five main categories of activities for the course are listed in the first column and the **minimum** percentages of the grade composition for each category is listed for each strand. Each student should decide which learning style most suits them and then specify percentages for each category so that the total is 100%.

| <u>Strand</u> | <u>I</u> | <u>II</u> | <u>III</u> |
|-----------------------|----------|-----------|------------|
| Homework | 10 % | 10 % | 10 % |
| Investigations | 10 % | 20 % | 10 % |
| Group Problem Solving | 10 % | 10 % | 10 % |
| Journal | | | 10 % |
| Exams (all equal) | 50 % | 40 % | 30 % |

Grade Contract

Please complete the table below for one strand only. Refer to the information page for minimum percentage values within a given strand. Be sure that the total of your percentages adds up to 100%.

| <u>Strand</u> | <u>I</u> | <u>II</u> | <u>III</u> |
|-----------------------|----------|-----------|------------|
| Homework | | | |
| Investigations | | | |
| Group Problem Solving | | | |
| Journal | | | |
| Exams (all equal) | | | |

The following criteria are applied in determining grades:

For Honors Credit:

- a final grade of B or better
- at least one project level investigation and report
- evidence of creativity in group and written work
- participation in one extracurricular physics demonstration program

For an A:

- on time attendance with no more than one absence from class
- good quality written work on all assignments, submitted on time
- active participation in class discussion and group work
- a minimum of 85 % within the contracted strand
- a demonstrated enthusiasm for the material of the course

For a B:

- on time attendance with no more than two absences from any class meeting
- quality written work on all assignments
- active participation in class discussion/responsibility in groups

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Introductory College Physics: Twenty-First Century (ICP/21)*

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***Partially Funded By NSF, ATE Grant # DUE-9553665**

Introductory College Physics/Twenty First Century (ICP/21) is a new modular approach to the standard algebra/trigonometrybased physics course. It is aimed at both engineering and medical technical students. It will be at a level that will make it acceptable for transfer to any university.

Other leaders on this project are Marvin Nelson from Green River Community College in Auburn, Washington, and Pearly Cunningham from the Community College of Allegheny County in West Mifflin, Pennsylvania.

Pedagogy:

The curriculum incorporates the findings from educational research. ICP/21 places its emphasis on students understanding fewer basic concepts and having confidence in applying them, rather than on exposing students to many ideas which are neither understood or remembered.

Several features are found throughout each module.

- a. Students are actively engaged. The need for lectures has been greatly reduced. Most classroom time is devoted to laboratories, work sheet activities, and discussion among students.
- b. The curriculum will have two tracks. One will incorporate the advantages of using technologically advanced equipment in the laboratory and the classroom (MBL, CBL, multimedia, computer analysis of data), while a second track will allow instructors to teach the same concepts using traditional equipment.
- c. Quantitative problem solving is just as important as students understanding the concepts. Procedures and problem-solving strategies will be emphasized and not "the answers." Students will use multiple representations for most problems and be able to tie together the knowledge gained by analyzing a problem from a pictorial, graphical and mathematical perspective.

- d. Through the use of learning cycles, students will actively test their own conceptual understanding of our natural world. If their conceptual model does not work, they will be led to the construction of a more accepted scientific model that does.

Motivation:

In addition to the pedagogical approach used, there also is the problem of student motivation. College physics students, especially technical students, more and more often want to understand why they need to take physics.

- a. ICP/21 uses applications found in industry and medicine throughout the problem sets and examples. Students quickly understand that physics is an important underpinning in their field of study.
- b. Modeling is emphasized. The necessary simplifications and assumptions that are made by physicists in explaining the simple models and theories used in introductory college physics are clearly explained. These models give "approximate" answers to "real world" problems. Possible modification that could be made to give better answers are often introduced.

The Modules:

Ten modules are under development by a group of twelve different individuals from ten different institutions including eight two-year colleges. Some of these are in the second stage and others are in the first-draft stage.

Modules and authors currently in the second-draft stage:

Module 1: Motion

Sherry Savrda
Lake-Sumter Community College

Module 2: Forces

Alex Dickison
Seminole Community College

continued on the next page

Module 3: Torque

Leo Takahashi
Penn State University, Beaver Campus

Module 4: Electricity

Marvin Nelson
Green River Community College

Module 5: Magnetism

Rebecca Hartzler
Edmonds Community College

Modules and authors currently in the first-draft stage:

Module 6: Heat

Pearley Cunningham & Brad Sandrock
Community College of Allegheny County

Module 7: Optics

Charles Robertson
University of Washington

Module 8: Modern

Charles Lang
University of Nebraska

Module 9: Work/Energy

Brian Box
Northern Oklahoma College

Module 10: Waves/Sound

Roger Edmonds & John Terrell
Middlesex Community College

We plan to produce an alpha version of the CD-ROM next summer. Workshops will be held next fall for anyone who would like to field test and try all or part of the new curriculum in the classroom.

_____ *Evers continued from page 3*

- a minimum of 75 % within the contracted strand

For a C:

- no more than four absences from any class meeting
- all assignments submitted, complete active participation in activities
- a minimum of 60 % within the contracted strand

Name (printed)

Grade Contracted _____

Signature

Date _____

IPC 2 Group Projects

Group 1 : The Abstractness of the Concept of Magnetic Flux

Susie Evers (Panola College - TX), Nick Nicholson (Central Alabama CC - AL), and David Mills (College of the Redwoods - CA)

Group 2: Faraday's Law

Mary Beth Monroe (Southwest Texas JC - TX), Davene Evers (North Seattle CC - WA) and Mickey Odom (Albuquerque TVI - NM)

Group 3: Assessment for Electric Fields

Nancy Bryant (Jamestown CC - NY), Sally Heath (Santa Rosa JC - CA), Dennis Van Swol (Highland CC - KS) and Bill Gene Smith (South Florida CC - FL)

Group 4: Magnetic Field near a Long Current Carrying Wire & Ampere's Law

Chad Davies (Cloud County CC - KS), Butch Diesslin (Vermilion CC - MN), Marv Nelson (Green River CC - WA) and Gordon Shepherd (Guilford Tech CC - NC)

Group 5: Potential & Potential Difference

Alex Dickison (Seminole CC - FL), Cathy Ezrailson (Montgomery College - TX), Marie Plumb (Jamestown CC - NC) and David Ting (HCCS Southeast College - TX)

Group 6: Transfer of Charge in Conductors

Jim Gundlach (John A. Logan College - IL), Bruce Kaasa (Iowa Central CC - IA), Umesh Pandey (Albuquerque TVI - NM) and Myra West (Kent State Universit - OH)

Group 7: Electric Field and Potential

Robert Johnson (Del Mar College - TX), Beta Keramati (Holmes CC - MS), Clement Lam (North Harris College - TX) and Sherry Svarda (Lake-Sumter CC - FL)

Since 1991, the TYC Physics Workshop Project has provided 32 workshops or conferences at 15 different TYC campuses located in 11 states.

These workshops have served 673 participants (333 individuals) from 268 TYCs representing 44 states and two U.S. territories.

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Lee College (TX)

duction to problem solving with a session on "Building an E&M Learning System." He described the various techniques that have been championed in the last few years on how to successfully teach students E&M concepts and problem solving. His list of techniques included tutorials, ranking tasks, CASTLE physics, the Chabay and Sherwood approach, interactive qualitative demonstrations, MBL, ALPS, peer instruction, jeopardy problems, simulations and multimedia, context-rich problems and experiment problems. After supper, participants received instructions on their group projects. The rest of the evening was spent by each group discussing potential projects and starting the initial development of their ideas.

The first session on Wednesday morning was presented by Lillian McDermott and Paula Heron of the University of Washington's Physics Education Group (PEG). In addition to providing some wonderful articles, they presented the cyclic process that the PEG uses to conduct physics education research, implement the findings, assess the usefulness and modify this cycle. To illustrate *Physics by Inquiry*, the participants did "Light and Shadow" activities from the book. In the afternoon to illustrate *Tutorials in Introductory Physics*, the participants worked on the "A Model for Electric Circuits" section from the book. Having the opportunity to work with Lillian and Paula gave the participants a chance to see the processes involved and ask questions about the implementation of these methods in courses.

Later on Wednesday afternoon, Alan Van Heuvelen orchestrated an interactive session with the participants on "Using Multimedia and Interactive Simulations in Large and Small Classrooms." The participants had an opportunity to not only use the *ActiviPhysics I CD*, but also to work through a number of selected sections of the workbook. In the evening, several participants presented some of the interesting approaches that they are implementing at their colleges. The rest of the evening was spent with the groups continuing their development of their project. Some groups had to start new projects when their initial project did not develop as fully as they had hoped.

The Thursday morning session was presented by Alex Dickison of Seminole Community College. Alex gave a lively presentation on his Advanced Technology Education project on *Introductory College Physics: Twenty-First Century - ICP/21*. This presentation was followed by Marv Nelson of Green River Community College who conducted a workshop session with the participants on the "Concepts of Electricity," an exercise from

the ICP/21 curriculum. Marv showed the participants a way in which he uses the various materials when he teaches E&M. The afternoon workshop session was one in which the participants could try the *Interactive Journey Through Physics CD*. There was a lively discussion on how this CD could be used effectively in the classroom.

Later on Thursday afternoon, all the conference participants and leaders went to the NASA Space Center in Houston to view the exciting animated robotics exhibit, various IMAX shows and a tour of the Johnson Space Center.

On Friday morning, the participants experienced an exciting presentation/workshop led by Ruth Chabay and Bruce Sherwood of Carnegie Mellon University. Ruth and Bruce presented their latest research results on student learning and retention of E&M concepts. The participants had an opportunity to work with the Electric and Magnetic Interactions curriculum with Bruce and Ruth providing help and one-on-one discussion. Additional discussion on E&M including implementation issues occurred early Friday afternoon. The later part of the afternoon was spent by the participants continuing their group projects working closely with David Maloney and the other workshop leaders. More group work was done after supper with many groups working even later trying to finish their presentations for the next day.

On Saturday morning, there were a number of last minute preparations before the group presentations that started around 9. The group presentations were exceptional. Parts of these presentations are found elsewhere in this *CaFD*. The morning sessions finished with some engaging discussions on where the community seems to be on the teaching of E&M. In the afternoon, the remaining participants went to the Houston Museum of Science and Technology. Among the many displays and things to do were laser light shows, IMAX shows, wonderful museum exhibits, an interactive science exhibit area, and a spectacular live butterfly garden.

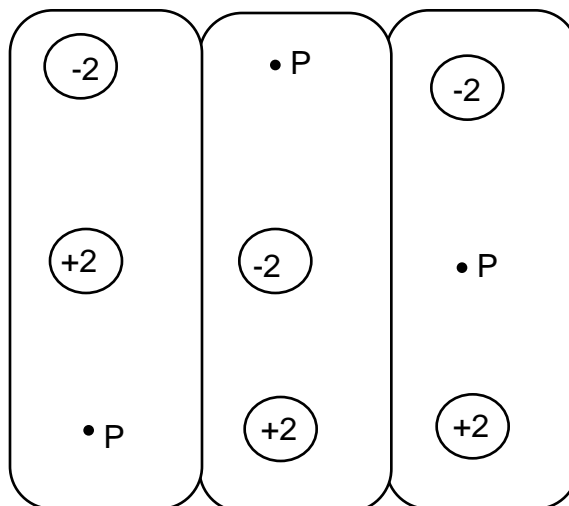
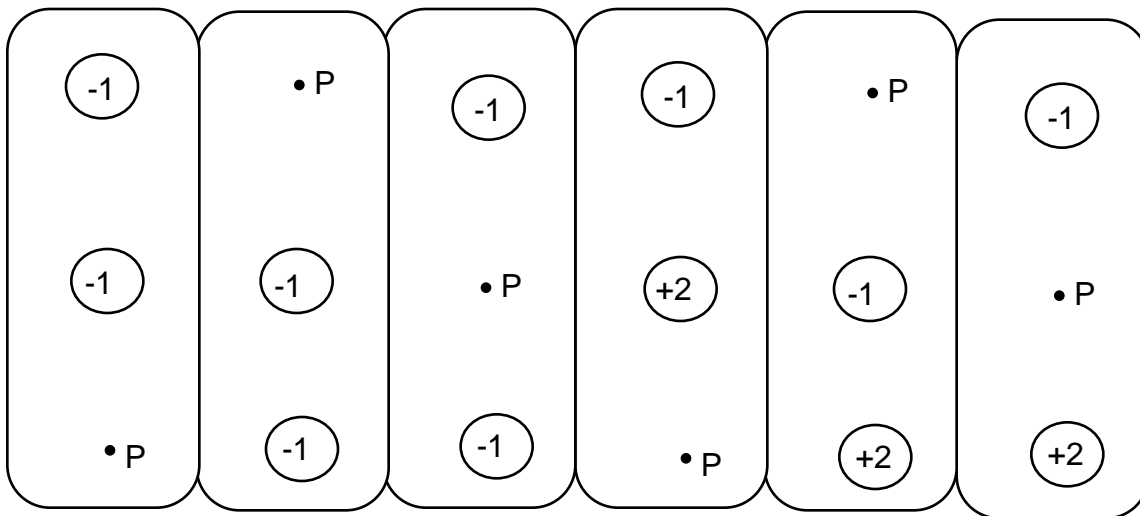
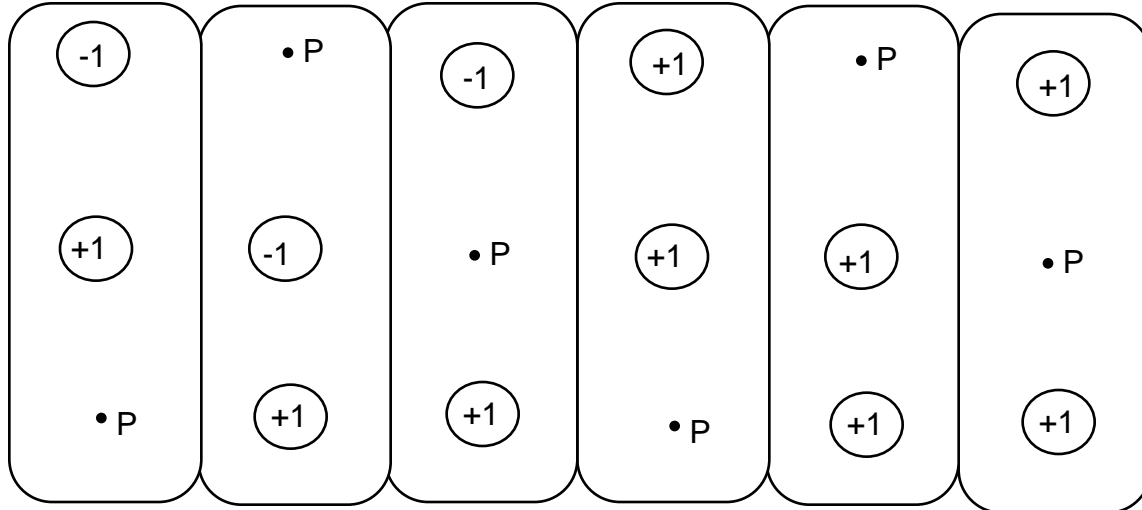
Summary

There were many aspects of IPC 2 that were enjoyable to the attendees — the chance to meet with colleagues and discuss teaching techniques; the opportunity to meet with, discuss, and question some of the innovators in E&M research and curriculum; the working experience with a variety of tools available for teaching E&M topics; and working with peers to develop new materials and techniques to enhance their teaching

Electric Fields Conceptual Exercise

Group 3: Nancy Bryant (Jamestown CC - NY), Sally Heath (Santa Rosa JC - CA), Bill Gene Smith (South Florida CC - FL) and Dennis Van Swol (Highland CC - KS)

For each of the following, indicate if the field at point P is zero, or by writing the word zero by point P or sketching a vector showing the direction. All charges are multiples of the same charge q . The distance between charges or a charge and point P are equal.



IPC 2 Participants ('97)

| | | | |
|------------------|-----------------------------------|----------------|----|
| Nancy Bryant | Jamestown Community College | Olean | NY |
| Chad Davies | Cloud County Community College | Concordia | KS |
| Alex Dickison | Seminole Community College | Sanford | FL |
| Blaine Diesslin | Vermilion Community College | Ely | MN |
| Norma Evers | Panola College | Carthage | TX |
| Davene Eyres | North Seattle Community College | Seattle | WA |
| Cathy Ezrailson | Montgomery College | Conroe | TX |
| Jim Gundlach | John A Logan | Carterville | IL |
| Sally Heath | Santa Rosa Junior College | Santa Rosa | CA |
| Robert Johnson | Del Mar College | Corpus Christi | TX |
| Bruce Kaasa | Iowa Central Community College | Fort Dodge | IA |
| Beta Keramati | Holmes Community College | Goodman | MS |
| Clement Lam | North Harris College | Houston | TX |
| David Mills | College of the Redwoods | Eureka | CA |
| Mary Beth Monroe | Southwest Texas Junior College | Uvalde | TX |
| Marvin Nelson | Green River Community College | Auburn | WA |
| K.W. Nicholson | Central Alabama Community College | Alexander City | AL |
| Boye Odom | Albuquerque TVI | Albuquerque | NM |
| Umesh Pandey | Albuquerque TVI | Albuquerque | NM |
| Marie Plumb | Jamestown Community College | Jamestown | NY |
| Sherry Savrda | Lake-Sumter Community College | Leesburg | FL |
| Gordon Shepherd | Guilford Tech Community College | Jamestown | NC |
| Bill-Gene Smith | South Florida Community College | Avon Park | FL |
| Cheng Ting | HCCS Southeast College | Houston | TX |
| Dennis Van Swol | Highland Community College | Highland | KS |
| Myra West | Kent State University | Kent | OH |

IPC 2 Invited Presenters ('97)

| | | | |
|-------------------|---|------------|----|
| Ruth Chabay | Carnegie Mellon University | Pittsburgh | PA |
| Alex Dickison | Seminole Community College | Sanford | FL |
| Curt Hieggelke | Joliet Junior College | Joliet | IL |
| Paula Heron | University of Washington | Seattle | WA |
| David Maloney | Indiana/Purdue University at Fort Wayne | Fort Wayne | IN |
| Lillian McDermott | University of Washington | Seattle | WA |
| Marv Nelson | Green River Community College | Auburn | WA |
| Tom O'Kuma | Lee College | Baytown | TX |
| Bruce Sherwood | Carnegie Mellon University | Pittsburgh | PA |
| Alan Van Heuvelen | The Ohio State University | Columbus | OH |

IPC 2 Pre-Conference Materials ('97)

1. Guruswamy, Somers, and Hussey "Students' understanding of the transfer of charge between conductors," *Physics Education*, 32(2), March 1997, pgs. 91-96.
2. McDermott "Millikan Lecture 1990: What we teach and what is learned - Closing the gap," *AJP*, 59(4), April 1991, pgs. 301-315.
3. McDermott "Guest Comment: How we teach and how students learn - A mismatch?," *AJP*, 61(4), April 1993, pgs. 295-298.
4. Materials from Alan Van Heuvelen on "Helping Students Learn Physics Better"
5. Steinberg and Wainwright "Using Models to Teach Electricity - The CASTLE Project," *TPT*, 31(6), September 1993, pgs. 353-357.
6. Mosca and DeJong "Implications of Using the CASTLE Model," *TPT*, 31(6), September 1993, pgs. 357-359.
7. Mitschele "Extending the CASTLE Project with Hand Generators," *TPT*, 31(9), December 1993, pgs. 556-557.
8. Sherwood and Chabay "Integrating Theory and Experiment in Lecture using Desktop Experiments," Proceedings of the International Conference on Undergraduate Physics Education (AIP #399).
9. Cohen, Eylon, and Ganiel "Potential difference and current in simple electric circuits: A study of students' concepts," *AJP*, 51(5), May 1983, pgs. 407-412.
10. Thacker, Kim, and Trefz "Comparing problem solving performance of physics students in inquiry-based and traditional introductory physics courses," *AJP*, 62(7), July 1994, pgs. 627-633.

Transfer of Charge in Conductors

Group 6: Jim Gundlach (John A. Logan College - IL), Bruce Kaasa (Iowa Central CC - IA), Umesh Pandey (Albuquerque TVI - NM), and Myra West (Kent State Univ. - OH)

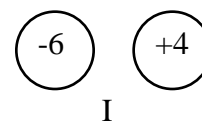
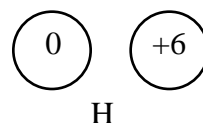
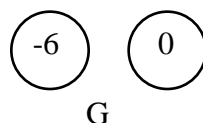
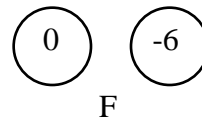
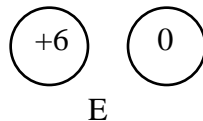
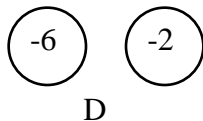
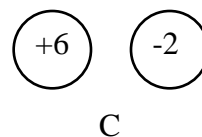
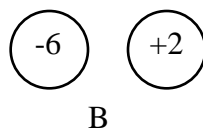
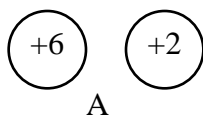
Previous studies by Chitra Guruswamy, Mark Somers and R.G. Hussey (see Reference 1 of Pre-Conference materials on page 8) found that when students were presented with problems involving transfer of charge between identical metal spheres or aluminum wrapped styrofoam packing "peanuts," most students could not correctly predict the final charges on the conductors.

To understand why students had difficulty making such predictions, students were asked to explain the reasoning underlying their predictions. Two of the most common misconceptions were:

1. Since "like charges repel," no charge will transfer between like charges; and
2. Charge is transferred between unlike charges until the charge on the object with the lesser charge is reduced to zero. Once the one object is neutral, no further charge transfer occurs.

Ranking Task

In each of the following situations two conducting spheres with the same size are shown with a given number of units of charge. The two spheres are placed in contact with each other. After several moments the spheres are separated.



Rank the situations as to the quantity of charge on the first (left) sphere from the highest positive charge to the least negative charge after they have been separated.

Highest (Positive Charge) 1__ 2__ 3__ 4__ 5__ 6__ 7__ 8__ 9__ Lowest (Negative Charge)

Or, all have the same charge on the first (left) sphere after contact _____

Please carefully explain your reasoning-

How sure are you of your reasoning? (Circle one of the following.)

Basically guessed Sure Very Sure
1 2 3 4 5 6 7 8 9 10

'97 TYC Physics Workshop Participant Colleges

| | | |
|---|------------------|----|
| Central Alabama Community College | Alexander City | AL |
| Reid State Technical College | Evergreen | AL |
| Wallace State Community College | Hanceville | AL |
| Arizona Western College | Yuma | AZ |
| Mesa Community College | Mesa | AZ |
| Cerritos Community College | Norwalk | CA |
| Chaffey Community College | Alta Loma | CA |
| College of the Redwoods | Eureka | CA |
| Cypress College | Cypress | CA |
| Fullerton College | Fullton | CA |
| Hartnell Community College | Salinas | CA |
| Orange Coast College | Costa Mesa | CA |
| Rancho Santiago College | Santa Ana | CA |
| Santa Rosa Junior College | Santa Rosa | CA |
| Pikes Peak Community College | Colorado Springs | CO |
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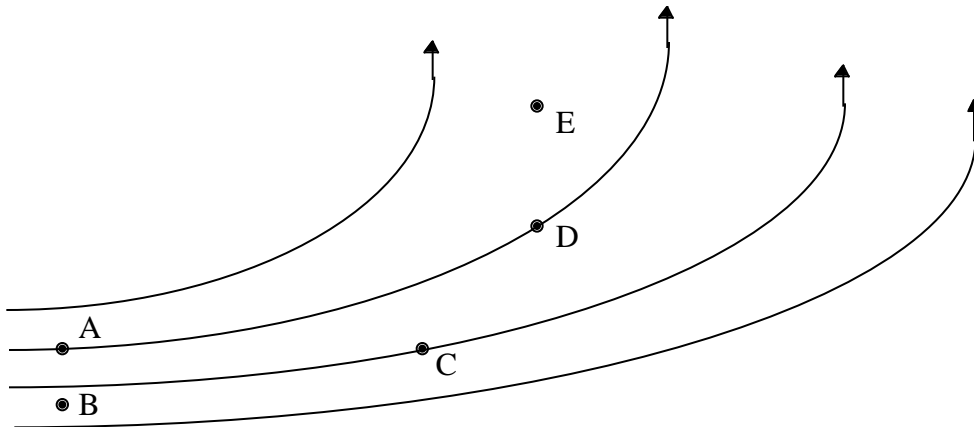
Lee College (TX)

Electric Fields and Potentials

Group 7: Robert Johnson (Del Mar College - TX), Beta Keramati (Holmes CC - MS), Clement Lam (North Harris College - TX), and Sherry Svarda (Lake-Sumter CC - FL)

Ranking Task

A non-uniform electric field is being represented below. Rank the electric potential of the marked points from greatest to least.



Greatest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ Least

Or, all of the potentials are the same _____

Please carefully explain your reasoning-

How sure are you of your reasoning? (Circle one of the following.)

Basically guessed Sure Very Sure
 1 2 3 4 5 6 7 8 9 10

The Abstractness of the Concept of Magnetic Flux

Group 1 : Susie Evers (Panola College - TX), Nick Nicholson (Central Alabama CC - AL) and David Mills (College of the Redwoods - CA)

The conceptual difficulties rooted in “flux” are a consequence of :

- A. its abstract and non-intuitive nature,
- B. the fact that it is used in two definitions and the definitions themselves are in terms of physical quantities and a mathematical operation that are, in turn, conceptually challenging, and
- C. its use in the description of both static and time-dependent phenomenon.

Instructional Materials and Activities — Outline Of Possible Resources

- A. Introduction: Demonstration of the deflection of a galvanometer when a
 - 1. magnet is inserted into a coil
 - 2. coil is rotated in magnetic field
 - 3. straight wire segment of a circuit crosses a magnetic field
- B. Lecture
 - 1. Examples (generic chalk) of voltage induced in a conductor moving in a magnetic field.
 - a. Blv for linear conductor moving perpendicular to a magnetic field
 - b. $BA \sin t$ for a conducting loop rotating in a magnetic field
 - c. rail and bar “generator”: Using the relation of work per unit charge to potential difference to develop a motivation for the definition of flux.
 - 2. Model demonstrations: cardboard box magnets, string field lines, coathanger loops, using students in groups as models of flux.
(Using the students is envisioned as an activity counting the number standing in a given area \times area = flux; number sitting down (or standing up)/ sec = change in flux /sec; and use heads as direction of the magnetic field.)
 - 3. Definitions (flux, area normal, induced emf, induced current, units, etc.)
[NOTE: idea first, name afterward]
- C. Activities (order needs work!)
 - 1. Sherwood software on E field flux (*EM Fields*) - review comparison for static case
 - 2. Ranking tasks (e.g., from collection edited by O’Kuma et.al., pages 270, 276, 277)
 - 3. Text problems
 - 4. *Workshop Physics, Unit 27*
 - 5. *Interactive Journey Through Physics CD:*
E & M Moving Charges Induced EMF Simulations 1 & 2
 - 6. Group problem solving — Define & Defend problem
 - 7. DeskTop experiments (solenoid, magnets, galvanometers)
 - 8. ALPS
 - a. Magnetism: Chapter IX, Section C, Pages 1 - 22.
 - b. Electrostatics: Chapter VIII, Section C, Pages 21-24.
 - 9. Chabay and Sherwood - Chapter 10 (Electric Flux for Comparison)
- D. Laboratory Investigations
 - 1. Chabay and Sherwood; Magnetic Induction - Chapter 13
 - 2. Induced Emf: MBL voltage and current probes, magnetic field probes

Faraday's Law

Group 2: Davene Evers (North Seattle CC - WA), Mary Beth Monroe (Southwest Texas JC - TX) and Mickey Odom (Albuquerque TVI - NM)

Likely Student Difficulties

Difficulties Related to Diagrammatic Information

Diagram Details-

Students have difficulty interpreting diagrams for a variety of reasons. Most diagrams convey many pieces of information. The student may not always have the skill to distinguish between this necessary information and that which is extraneous.

3-D Information-

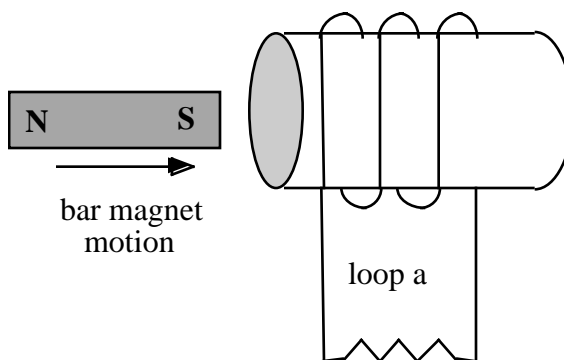
2-D diagrams conveying 3-D information can add an extra degree of difficulty for the student. In this case the student is expected to visualize from the 2-D diagram to a mental image of a 3-D situation. That translation can be faulty and is not easily checked. The student's visualization may be different from what was intended by the instructor.

For example, consider this diagram to the right:

Students might be asked to find the induced current direction in the coil.

One difficulty with the problem is often due to the student viewing the apparent loop at the bottom of the drawing (see "loop a"). It is ideally supposed that the problem solver will ignore the effects of this loop in the solution.

It is also necessary to view the tube from the perspective of its end, not from the side view given in the diagram. This is an example of the 3-D nature of the difficulty.



Difficulties Related to Dependence on the Rate of Change

Students often will describe the direction of the field as the direction of the change in the field strength.

Likewise, students will fail to describe the change in flux as contributing to the induced emf. The student fails to focus on the concept of "change".

Then, to add to the difficulty, this topic requires the student to consider not only the "change" but the "opposing" nature of the induced effect.

Difficulties Related to Problem Solving

Angle dependence of the Flux-

The flux is defined in terms of the angle between the field line and the normal to the surface of the loop. This may not be the angle given in the diagram. This difficulty is compounded by the 2-D representation of a 3-D phenomenon.

There is also a need to clarify the distinction between the magnetic field of the bar magnet and the magnetic field produced by the induced current.

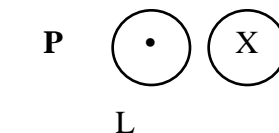
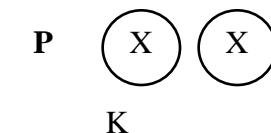
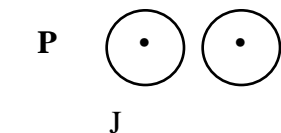
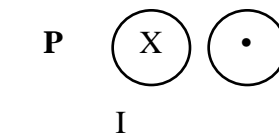
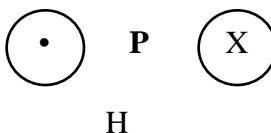
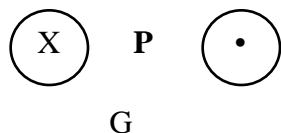
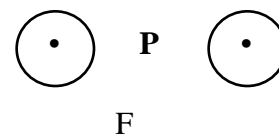
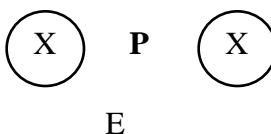
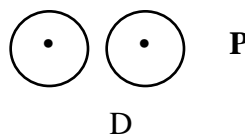
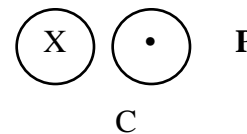
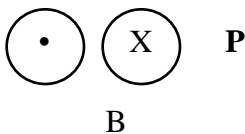
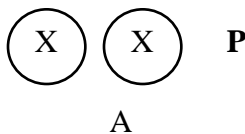
In addition, there is a need to clarify that the \mathbf{B} diagrams are using two arrows separated only by time. Motion diagrams use two points separated by both distance and time.

Magnetic Field near a Long Current Carrying Wire & Ampere's Law

Group 4: Chad Davies (Cloud County CC - KS), Butch Diesslin (Vermilion CC - MN), Marv Nelson (Green River CC - WA) and Gordon Shepherd (Guilford Tech CC - NC)

Ampere's Law Ranking Task

Shown below are several situations with two wires with currents of 2 A flowing out of (•) or into (X) the page. Rank the magnetic field at point P from greatest to least. Count a downward pointing field as negative and upward as positive. You may assume that each position is equidistant separated from the other points of interest and that each situation is independent of all others.



Highest

Lowest

1__ 2__ 3__ 4__ 5__ 6__ 7__ 8__ 9__ 10__ 11__ 12__

Circle any ties

Or, the magnetic field is zero in all cases _____.

Please carefully explain your reasoning-

How sure are you of your reasoning? (Circle one of the following.)

Basically guessed Sure Very Sure
1 2 3 4 5 6 7 8 9 10

Potential & Potential Difference

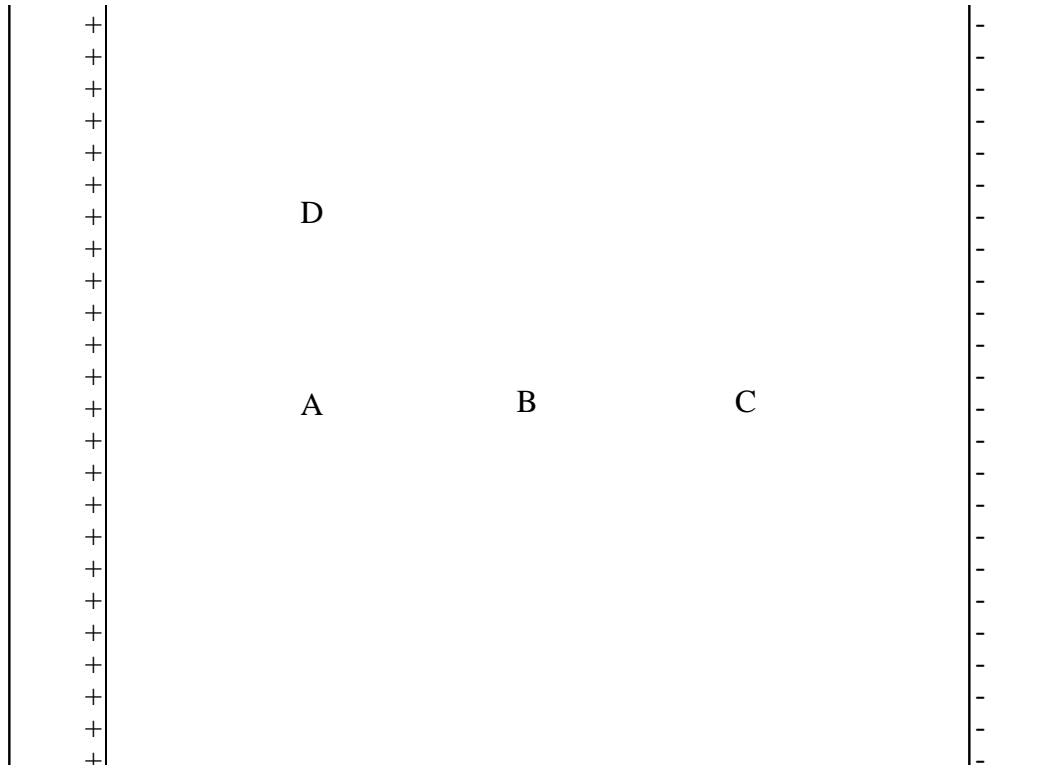
Group 5: Alex Dickison (Seminole CC - FL), Cathy Ezrailson (Montgomery College - TX),
Marie Plumb (Jamestown CC - NC) and David Ting (HCCS Southeast College - TX)

Possible Erroneous Conceptions

There is no connection between voltage and electric potential.
Equal potential means uniform field.

Uniform Electric Field- Potential Difference Ranking Task

We have two parallel plates that have been charged and create a uniform electric field of 30 N/C between the plates. Rank the magnitude of the electrical potential differences of all the possible-difference combinations between the four points: A at (2,0) m; B at (5, 0)m; C at (8,0) m; and D at (2, 3) m within this region.



List of potential difference combinations that are to be ranked—

I: A-B; II: A-C; III: B-C; IV: D-A; V: D-B VI: D-C;

Highest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ Lowest

Circle any ties

Or, all have the points have the same potential difference _____.

Please carefully explain your reasoning.

How sure are you of your reasoning? (Circle one of the following.)

Basically guessed Sure Very Sure
1 2 3 4 5 6 7 8 9 10

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CaFD is a component of the networking, follow-up, and dissemination process of a National Science Foundation supported Faculty Enhancement project (DUE 9554683). The opinions, statements, findings, recommendations, or conclusions expressed in this newsletter are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, Joliet Junior College or Lee College. Readers are encouraged to submit responses to articles. They should be sent to Curtis Hieggelke, Natural Science Department, 1215 Houbolt Road, Joliet Junior College, Joliet, IL 60431, or e-mailed to curth@jjc.cc.il.us

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