JOINT MATRICULATION BOARD

GENERAL CERTIFICATE OF EDUCATION

UNIVERSITIES OF MANCHESTER · LIVERPOOL · LEEDS · SHEFFIELD · BIRMINGHAM

37/5

UNIVERSITIES OF MANCHESTER LIVERPOOL LEEDS SHEFFIELD AND BIRMINGHAM

JOINT MATRICULATION BOARD

This is to certify that in 1958

ADAM OSBORNE

satisfied the Board's examiners in GENERAL STUDIES

Secretary to the Board

24839.8.58

UNIVERSITIES OF MANCHESTER LIVERPOOL LEEDS SHEFFIELD AND BIRMINGHAM

JOINT MATRICULATION BOARD

ADAM OSBORNE

BORN ON 6 MARCH 1939 WAS ENTERED IN JUNE 1958 BY

LEAMINGTON COLLEGE FOR BOYS

FOR THE EXAMINATION FOR THE GENERAL CERTIFICATE OF EDUCATION AND REACHED THE STANDARD SPECIFIED IN THE FOLLOWING SUBJECT(S)

1	MATHEMATICS ALTERNATIVE A	ADVANCED
2	PHYSICS SYLLABUS I	ADVANCED
3	CHEMISTRY	ADVANCED

THIS CERTIFICATE IS SIGNED ON BEHALF OF THE BOARD IN RESPECT OF THE ABOVE THREE SUBJECT(S)

Eastham

CHAIRMAN

Jan A Peak

SECRETARY TO THE BOARD

THE MINISTRY OF EDUCATION ACCEPT THE EXAMINATION OF THE JOINT MATRICULATION BOARD FOR THE GENERAL CERTIFICATE OF EDUCATION AS REACHING THE APPROVED STANDARD

TRWeaver

UNDER-SECRETARY

24833 8.58

UNIVERSITIES OF MANCHESTER LIVERPOOL LEEDS SHEFFIELD AND BIRMINGHAM

JOINT MATRICULATION BOARD

ADAM OSBORNE

WHO WAS BORN ON 6 MARCH 1939 WAS ENTERED IN JUNE 1955 BY

LEAMINGTON COLLEGE FOR BOYS

FOR THE EXAMINATION FOR THE GENERAL CERTIFICATE OF EDUCATION AND REACHED THE STANDARD SPECIFIED IN EACH OF THE FOLLOWING SEVEN SUBJECTS

1	ENGLISH LANGUAGE	ORDINARY
2	ENGLISH LITERATURE	ORDINARY
3	FRENCH	ORDINARY
4	MATHEMATICS SYLLABUS I	ORDINARY
5	PHYSICS SYLLABUS I	ORDINARY
6	CHEMISTRY	ORDINARY
7	BIOLOGY	ORDINARY

SIGNED ON BEHALF OF THE BOARD

CHAIRMAN

SECRETARY TO THE BOARD

THE MINISTRY OF EDUCATION ACCEPT THE EXAMINATION OF THE JOINT MATRICULATION BOARD FOR THE GENERAL CERTIFICATE OF EDUCATION AS REACHING THE APPROVED STANDARD

UNDER-SECRETARY

1B878 7-55

UNIVERSITIES OF MANCHESTER LIVERPOOL LEEDS SHEFFIELD AND BIRMINGHAM

JOINT MATRICULATION BOARD

ADAM OSBORNE

WHO WAS BORN ON 6 MARCH 1939 WAS ENTERED IN JUNE 1957 BY

LEAMINGTON COLLEGE FOR BOYS

FOR THE EXAMINATION FOR THE GENERAL CERTIFICATE OF EDUCATION AND REACHED THE STANDARD SPECIFIED IN EACH OF THE FOLLOWING FOUR SUBJECTS

1	GENERAL PAPER	ORDINARY
2	MATHEMATICS ALTERNATIVE A	ADVANCED
3	PHYSICS SYLLABUS I	ADVANCED
4	CHEMISTRY	

SIGNED ON BEHALF OF THE BOARD

L Eastham

CHAIRMAN

Ian A Louch

SECRETARY TO THE BOARD

THE MINISTRY OF EDUCATION ACCEPT THE EXAMINATION OF THE JOINT MATRICULATION BOARD FOR THE GENERAL CERTIFICATE OF EDUCATION AS REACHING THE APPROVED STANDARD

T Rhoeaver

UNDER-SECRETARY

ea/fb.5-57

THE UNIVERSITY OF BIRMINGHAM

TELEPHONE: SELLY OAK 1301

GMF/SB

BIRMINGHAM. 15.

THIS IS TO CERTIFY

that

ADAM OSBORNE

was a full-time registered student of this University, from October, 1958 to July, 1961. Details of his course and examination results are shown hereunder:

Session 1958-59	Examination Result	Grade
*Descript. Mech. Eng. 1B	Pass	Good
*Machine Drawing I	Pass	Very good
Mathematics IIM	Pass	Very good
Chemistry II	Pass	Very good
Elec. Eng. G/3.3/ G/3.7	Pass	Fair
Chemical Eng. 2.1	Pass	Good

Passed in the * two required subjects of the First B.Sc. (Chemical Engineering) Examination and passed the Second Examination, Division II, June, 1959.

Session 1959-60		
✓Workshop Processes	Pass	Good
Chem.Eng. 3.1,3.2A,3.2B	Pass	Fair
Chemical Eng. 3.3	Pass	Fair
Chemical Eng. 3.4	Pass	Fair
Chemical Eng. 3.6	Pass	Very Good
Chemical Eng. 3.7	Pass	Good
Civil Engineering 3.2	Pass	Very good

Completed the ✓ First Chemical Engineering Examination and passed the Third Examination Division II, June, 1960

Continued.....

Session 1960-61

Chemical Engineering 3.1
Chemical Engineering 3.2
Chemical Engineering 3.3
Chemical Engineering 3.4
Chemical Engineering 3.5
Chemical Engineering 3.9

Awarded Honours Class II, Division II.

The degree of B.Sc. with Honours Class II, Division II, School of Chemical Engineering, was conferred on him on the 15th July, 1961.

Note: The lowest passing mark is 40%. The highest grade is "Very good".

Assistant Registrar (Science)

5th December, 1963.

UNIVERSITY OF DELAWARE

NEWARK, DELAWARE

DEPARTMENT OF CHEMICAL ENGINEERING

March 5, 1964

Mr. Adam Osborne
9131 Lamont Avenue
Elmhurst, New York 11373

Dear Mr. Osborne:

With regard to your application for a Research Fellowship in this Department, we are pleased to offer you an appointment for twelve months with a monthly stipend of $244.00*. This stipend is tax-free. The appointment will be effective September 1 but you will not need to be on the campus here until September 14. Prior to the beginning of classes on September 21, new research fellows have the opportunity of choosing their research problem and conferring with their advisor on the background to the problem.

As a research fellow you would be excused from laboratory and out-of-state fees, but would be required to pay course fees amounting to $13.00 per credit hour, or $156.00 per semester during the regular sessions. Graduate students usually take six credits during the summer term, when graduate courses are also regularly available. Our research program is fully active during the summer.

Research fellows indicate their preference for a research assignment from a listing of contract research problems under study for various sponsors. The research assignment is also the student's thesis, and a research fellow has no duties other than performing a good job on his thesis. We make every effort to give our new research fellows their first choice in these assignments, although in some cases where more than one person chooses a given topic, it may be necessary to assign a second choice.

Research assignments available to new students in September, 1964 include investigations on kinetics of reacting gases in rocket nozzles with Dr. Pigford, study of distillation column dynamics with Dr. Gerster, research on non-Newtonian flow problems with Dr. Metzner, studies or process dynamics and of turbulent mixing with Dr. Lamb, studies of non-linear diffusion problems with Dr. Ferron, diffusion of oxides in metals with Dr. Birchenall, kinetics of radio-chemical reactions with Dr. Olson, and research on two-phase flow with Dr. Russell.

It is our hope to have a reply from you as soon as convenient, and in any case before April 15. We have a large group of fellowship applicants standing by as alternates to whom we can give no definite decision with regard to financial aid until we hear from those to whom definite offers have been made, so that an early reply is highly desirable.

If you have any questions regarding our offer to you, or concerning our graduate program, please do not hesitate to write us. We do hope you can accept our offer.

Very truly yours,

R. L. Pigford, Chairman
Dept. of Chemical Engineering

RLP:bv
cc: Graduate Office

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE

SCHOOL OF GRADUATE STUDIES

March 9, 1964

Mr. Adam Osborne
9131 Kamont Avenue
Elmhurst, New York

Dear Mr. Osborne:

This is to inform you that you have been admitted to the School of Graduate Studies to work toward the degree of Doctor of Philosophy in the Department of Chemical Engineering.

We look forward to our associations with you while you work toward an advanced degree at the University of Delaware.

Sincerely,

James C. Kakavas

James C. Kakavas
Dean

JCK:hhl

UNIVERSITY OF DELAWARE

NEWARK, DELAWARE

DEPARTMENT OF CHEMICAL ENGINEERING

April 6, 1964

Mr. A. Osborne
Apartment 3-B
355 Plainfield Avenue
Edison Township, New Jersey

Dear Mr. Osborne:

We are very pleased to learn that you have accepted our fellowship offer. It will be a pleasure to have you study with us. We shall be writing you later giving more details of our fellowship offer, although I imagine that Dr. Pigford has already gone over most of this information with you in the various conferences you have had.

Yours very truly,

J. A. Gerster, Professor
Dept. of Chemical Engineering

JAG:maw

UNIVERSITY OF DELAWARE
NOTICE OF FACULTY PERSONNEL ACTION

NCC

DATE May 27, 1964.

NAME Adam Osborne, Research Fellow
ADDRESS Apartment 3-B, 355 Plainfield Ave. Edison Township, N. J.

"NO CARBON REQUIRED"

NATURE OF ACTION AND CONDITIONS

Subject to approval of the Board of Trustees, your status on the University Staff will be as follows. This action is contingent upon your acceptance of the conditions of employment (for your proposed appointment) as promulgated by the University.

ACTION	EFFECTIVE DATE	SALARY	ENDING DATE	SALARY
☐ INITIAL APPOINTMENT —	FROM Sept. 1, 1964	$2200.00	TO May 31, 1965	
☐ REAPPOINTMENT —	FROM	TAX FREE	TO	
☐ STATUS (CHANGE IN) —	FROM		TO	
☐ SALARY (ADJUSTMENT) — $244.44/mo. TAX FREE	FROM		TO	
☐ RANK (CHANGE IN) —	FROM		TO	
☐ TERMINATION —	EFFECTIVE DATE		LAST DAY TO BE PAID	

BUDGET CODE TO BE ASSIGNED LATER BUDGET DESCRIPTION

PERIOD OF YEAR EMPLOYED ☐ ACADEMIC YEAR ☐ FISCAL YEAR

REASON FOR ACTION — SPECIAL CONDITIONS: (INCLUDE RESTRICTIONS, FURTHER EXPLANATION OF APPOINTMENT OR ACTION).

Mr. Osborne will be doing graduate work for a Master's degree

The salary indicated in this appointment is paid from restricted funds. The Board of Trustees reserves the right, in case of cessation of funds from this special source, to forthwith terminate all appointments paid from this fund.

ASSIGNMENT

DEPARTMENT Chemical Engineering SCHOOL Engineering

☐ REGULAR FACULTY ☐ UNIVERSITY EXTENSION ☐ RESEARCH

☐ ADMINISTRATIVE-PROFESSIONAL ☐ AGRICULTURE EXPERIMENT-EXTENSION ☐ SUMMER SCHOOL

APPROVALS

DEPARTMENT CHAIRMAN R. L. Shepard	DATE 5-27-64	DEAN—SCHOOL OF GRADUATE STUDIES James A. Kalajian	DATE 7-17-64
APPROPRIATE DIRECTOR Louis D. Collins	DATE 6-11-64	PROVOST—DIRECTOR OF RESEARCH JWS	DATE 7/23/64
DEAN OR ADMINISTRATIVE OFFICER E. W. Cuming	DATE 7-20-64	PRESIDENT John A. Perkins JAP	DATE 7/27/64

ACCEPTANCE

I accept ☐ decline ☐ the appointment. I certify that I have read and understand the conditions of employment as promulgated by the University. (Please sign both appointment forms returning the original within 10 days to the Accounting Office and retaining the carbon copy for your files.)

SIGNATURE DATE

RES

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ORIGINAL	(WHITE)	PRESIDENT'S OFFICE	5TH COPY	(WHITE)	ACCOUNTING
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4TH COPY	(BLUE)	ACCOUNTING	8TH COPY	(CANARY)	DIR. OF UNIV. EXT./AG. EXP. STA./ AG. EXT. SER./UNIV. RES./SUMMER SCH

UNIVERSITY OF DELAWARE
NOTICE OF FACULTY PERSONNEL ACTION

DATE 3-30-65

NAME Adam Osborne, Research Fellow

ADDRESS Dept. of Chemical Engineering

"NO CARBON REQUIRED"

NATURE OF ACTION AND CONDITIONS

Subject to approval of the Board of Trustees, your status on the University Staff will be as follows. This action is contingent upon your acceptance of the conditions of employment (for your proposed appointment) as promulgated by the University.

ACTION	EFFECTIVE DATE	SALARY	ENDING DATE	SALARY
☐ INITIAL APPOINTMENT —	FROM		TO	
☒ REAPPOINTMENT —	FROM June 1,1965	$733.32	TO Aug.31,1965	
☐ STATUS (CHANGE IN) —	FROM	TAX FREE	TO	
☐ SALARY (ADJUSTMENT) —	FROM		TO	
$244.44/month, TAX FREE				
☐ RANK (CHANGE IN) —	FROM		TO	
☐ TERMINATION —	EFFECTIVE DATE		LAST DAY TO BE PAID	

BUDGET CODE 2-97F-719 BUDGET DESCRIPTION UDRF Schultz

PERIOD OF YEAR EMPLOYED ☐ ACADEMIC YEAR ☐ FISCAL YEAR

REASON FOR ACTION – SPECIAL CONDITIONS: (INCLUDE RESTRICTIONS, FURTHER EXPLANATION OF APPOINTMENT OR ACTION).

Graduate work for Master's degree.

The salary indicated in this appointment is paid from restricted funds. The Board of Trustees reserves the right, in case of cessation of funds from this special source, to forthwith terminate all appointments paid from this fund.

ASSIGNMENT

DEPARTMENT Chemical Engineering SCHOOL Engineering

☐ REGULAR FACULTY ☐ UNIVERSITY EXTENSION ☐ RESEARCH

☐ ADMINISTRATIVE-PROFESSIONAL ☐ AGRICULTURE EXPERIMENT-EXTENSION ☐ SUMMER SCHOOL

APPROVALS

DEPARTMENT CHAIRMAN R. L. Pigford	DATE 3-30-65	DEAN–SCHOOL OF GRADUATE STUDIES C. E. Birchenall	DATE
APPROPRIATE DIRECTOR Lester D. Reeves	DATE 5-24-65	PROVOST–DIRECTOR OF RESEARCH JW	
DEAN OR ADMINISTRATIVE OFFICER E. W. Comings	DATE 5-4-65	PRESIDENT John A. Perkins JAP	D 4/7/65

ACCEPTANCE

I accept ☐ decline ☐ the appointment. I certify that I have read and understand the conditions of employment as promulgated by the University. (Please sign both appointment forms returning the original within 10 days to the Accounting Office and retaining the carbon copy for your files.)

Adam Osborne — SIGNATURE

June 22 1965 — DATE

RES

DISTRIBUTION

ORIGINAL	(WHITE)	– PRESIDENT'S OFFICE	5TH COPY	(WHITE)	– ACCOUNTING
2ND COPY	(CANARY)	– EMPLOYEE	6TH COPY	(PINK)	– DEAN OR ADMINISTRATIVE OFFICER
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UNIVERSITY OF DELAWARE
NOTICE OF FACULTY PERSONNEL ACTION

NCC

DATE MCLE B 6-11-65

NAME Adam Osborne, Research Fellow

ADDRESS Dept. of Chemical Engineering

"NO CARBON REQUIRED"

NATURE OF ACTION AND CONDITIONS

Subject to approval of the Board of Trustees, your status on the University Staff will be as follows. This action is contingent upon your acceptance of the conditions of employment (for your proposed appointment) as promulgated by the University.

ACTION	EFFECTIVE DATE	SALARY	ENDING DATE	SALARY
☐ INITIAL APPOINTMENT —	FROM		TO	
☒ REAPPOINTMENT —	FROM Sept.1,1965	$2700 TAX FREE	TO Aug.31,1966	
☐ STATUS (CHANGE IN) —	FROM		TO	
☐ SALARY (ADJUSTMENT) —	FROM		TO	
☐ RANK (CHANGE IN) —	FROM		TO	
☐ TERMINATION —	EFFECTIVE DATE		LAST DAY TO BE PAID	

BUDGET CODE 2-952-201 BUDGET DESCRIPTION Chemical Eng. Ind. Fellow.

PERIOD OF YEAR EMPLOYED ☐ ACADEMIC YEAR ☐ FISCAL YEAR

REASON FOR ACTION — SPECIAL CONDITIONS: (INCLUDE RESTRICTIONS, FURTHER EXPLANATION OF APPOINTMENT OR ACTION).

Mr. Osborne has been awarded the Sun Oil Company Fellowship for 1965-66.

The salary indicated in this appointment is paid from restricted funds. The Board of Trustees reserves the right, in case of cessation of funds from this special source, to forthwith terminate all appointments paid from this fund.

ASSIGNMENT

DEPARTMENT Chemical Engineering SCHOOL Engineering

☐ REGULAR FACULTY ☐ UNIVERSITY EXTENSION ☒ RESEARCH

☐ ADMINISTRATIVE-PROFESSIONAL ☐ AGRICULTURE EXPERIMENT-EXTENSION ☐ SUMMER SCHOOL

APPROVALS

DEPARTMENT CHAIRMAN [signature]	DATE 6-11-65	DEAN—SCHOOL OF GRADUATE STUDIES C.E. Birchenall	DATE 7-13-65
APPROPRIATE DIRECTOR	DATE	PROVOST—DIRECTOR OF RESEARCH JWS	DATE 7/16/65
DEAN OR ADMINISTRATIVE OFFICER E.O.N. Conway	DATE 7/15/65	PRESIDENT John U. Perkins JAP	DATE 7/16/65

ACCEPTANCE

I accept ☒ decline ☐ the appointment. I certify that I have read and understand the conditions of employment as promulgated by the University. (Please sign both appointment forms returning the original within 10 days to the Accounting Office and retaining the carbon copy for your files.)

Adam Osborne — SIGNATURE

sept 1 1965 — DATE

AJO 7-8-65

DISTRIBUTION

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UNIVERSITY OF DELAWARE
NEWARK, DELAWARE

DEPARTMENT OF CHEMICAL ENGINEERING

July 1, 1965

MEMORANDUM TO: Mr. Adam Osborne

FROM: R. L. Pigford /JHO

SUBJECT: Qualifying Examination

The chemical engineering faculty has voted for you to pass the recent Ph.D. Qualifying Examination in Physical Sciences and in Chemical Sciences. Your performance on the General examination was considered unsatisfactory, however, and you may take this examination again when it is given in the Fall.

RLP:mah

68-15,546

Certificate

Registration of a Claim to Copyright

in a published book manufactured in the United States of America

FORM A

CLASS	REGISTRATION NO.
A	A 59590
	DO NOT WRITE HERE

This Is To Certify that the statements set forth on this certificate have been made a part of the records of the Copyright Office. In witness whereof the seal of the Copyright Office is hereto affixed.

Abraham L. Kaminstein

Register of Copyrights
United States of America

NOT VALID WITHOUT COPYRIGHT OFFICE IMPRESSION SEAL

1. Copyright Claimant(s) and Address(es):

Name ADAM OSBORNE (NO MIDDLE NAME)

Address 282 MANUEL ST., NEWARK, DELAWARE

Name

Address

2. Title: THE SOLUTION OF UNSTEADY STATE MULTICOMPONENT DISTILLATION USING PARTIAL DIFFERENTIAL EQUATIONS.
(Title of book)

3. Authors:

Name AS ABOVE (Legal name followed by pseudonym if latter appears on copies) Citizenship UNITED KINGDOM (Name of country)

Domiciled in U.S.A. Yes ..X.. No ..... Address AS ABOVE

Name (Legal name followed by pseudonym if latter appears on copies) Citizenship (Name of country)

Domiciled in U.S.A. Yes ..... No ..... Address

Name (Legal name followed by pseudonym if latter appears on copies) Citizenship (Name of country)

Domiciled in U.S.A. Yes ..... No ..... Address

4. Date of Publication of This Edition:

FEBRUARY 28, 1969
(Month) (Day) (Year)

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6. Book in English Previously Manufactured and Published Abroad: If all or a substantial part of the text of this edition was previously manufactured and published abroad in the English language, complete the following spaces:

Date of first publication of foreign edition ..... (Year)

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If your answer is "Yes," give registration number .....

EXAMINER

Complete all applicable spaces on next page

APPLICATION FOR ADVANCED DEGREE

SCHOOL OF GRADUATE STUDIES
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE, 19711

INSTRUCTIONS – PRINT BOLDLY

1. PREPARE IN DUPLICATE
2. PRINT CLEARLY
3. CHECK APPROPRIATE BOXES
4. COMPLETE DOWN TO HEAVY LINE AND FORWARD YELLOW COPY TO THE RECORDS OFFICE IMMEDIATELY
5. COMPLETE ORGINAL COPY IN FULL, SECURE FACULTY APPROVALS AND SUBMIT TO GRADUATE SCHOOL OFFICE BEFORE MARCH 15TH
6. REPORT ANY CHANGES TO DATA SHOWN BELOW TO GRADUATE OFFICE PROMPTLY

A NEW APPLICATION IS REQUIRED IF YOU DO NOT RECEIVE DEGREE AT COMMENCEMENT FOR WHICH APPLYING.

TODAY'S DATE: 3-3-66

FULL NAME	(FIRST NAME)	(MIDDLE NAME)	(MAIDEN NAME)	(LAST NAME)
→	ADAM	~~A. B.~~	—	OSBORNE

ADDRESS (APRIL PRECEDING COMMENCEMENT)	STREET	CITY	STATE	POSTAL ZIP CODE
	282 MANUEL ST	NEWARK	DEL	19711

SEX: [X] 1 MALE [ ] 2 FEMALE

MARITAL STATUS: [ ] 1 SINGLE [X] 2 MARRIED [ ] 3 DIVORCED [ ] 4 SEPARATED [ ] 5 WIDOWED

PERMANENT RESIDENCE: [X] IN DELAWARE [ ] IN U.S. OTHER THAN DEL. [ ] IN FOREIGN COUNTRY

EXPECT TO COMPLETE DEGREE REQUIREMENT

MONTH	YEAR
[ ] SEP.	
[X] FEB.	196 6
[ ] JUN.	

DEGREE TO BE AWARDED JUNE: 196 6

DEGREE SOUGHT

- [ ] 80 MAS MASTER OF APPLIED SCIENCE
- [ ] 81 MA MASTER OF ARTS
- [ ] 82 MS MASTER OF SCIENCE
- [ ] 83 MBA MASTER OF BUSINESS ADMINISTRATION
- [ ] 84 MED MASTER OF EDUCATION
- [ ] 85 MCE MASTER OF CIVIL ENGINEERING
- [X] 86 MCHE MASTER OF CHEMICAL ENGINEERING
- [ ] 87 MEE MASTER OF ELECTRICAL ENGINEERING
- [ ] 88 MME MASTER OF MECHANICAL ENGINEERING
- [ ] 89 PHD DOCTOR OF PHILOSOPHY

PHD STUDENTS ONLY

DATE ADMITTED TO CANDIDACY:

HOMETOWN NEWSPAPER:

MAJOR FIELD (Circle One)

71	AGRIC ECONOMICS
72	AGRIC EDUCATION
73	AGRONOMY
02	AMERICAN STUDIES
74	ANIMAL & POULTRY SCIENCE
58	APPLIED SCIENCES
03	ART
48	BEHAVIORAL SCIENCES
05	BIOLOGICAL SCIENCES
06	BUSINESS ADMINISTRATION
50	CHEMICAL ENGINEERING
07	CHEMISTRY
51	CIVIL ENGINEERING
08	DRAMATIC ARTS & SPEECH
09	ECONOMICS
67	EDUC - ADMINISTRATION
60	EDUC - ELEMENTARY
68	EDUC - GUIDANCE
66	EDUC - NATURAL SCIENCE
63	EDUC - READING
64	EDUC - SECONDARY
65	EDUC - SOCIAL SCIENCE
52	ELECTRICAL ENGINEERING
10	ENGLISH
76	ENTOMOLOGY
11	FRENCH
13	HISTORY
93	HOME ECONOMICS EDUCATION
92	HOME ECONOMICS GENERAL
77	HORTICULTURE
47	INTERNATIONAL RELATIONS
15	MATHEMATICS
53	MECHANICAL ENGINEERING
57	METALLURGY
43	MODERN LANGUAGE
66	NATURAL SCIENCES
18	PHILOSOPHY
19	PHYSICS
78	PLANT PATHOLOGY
20	POLITICAL SCIENCE
26	PSYCHOLOGY
65	SOCIAL SCIENCE
27	SOCIOLOGY
28	SPANISH
44	STATISTICS
45	WINTERTHUR

TITLE OF THESIS OR DISSERTATION: The Mechanism of the Melting of Solids

ACADEMIC DEGREES PRESENTLY HELD (LIST CHRONOLOGICALLY)

DEGREE (ABBREVIATION)	INSTITUTION GRANTED BY (FULL TITLE)	STATE IN WHICH INSTITUTION LOCATED	DATE AWARDED
B. Sc.	U. of Birmingham (England)	1–	6-61
		2–	

COURSES OFFERED AS PART OF MY PROGRAM FOR THIS DEGREE (USE OTHER SIDE, IF NEEDED)

COURSE SYM. & NO.	CREDIT HOURS	GRADE *	COURSE SYM. & NO.	CREDIT HOURS	GRADE *	COURSE SYM. & NO.	CREDIT HOURS	* GRADE

* GRADUATE OFFICE WILL RECORD GRADES FOR COURSES INWHICH CURRENTLY ENROLLED

SIGNATURE OF APPLICANT: Adam Osborne

FACULTY APPROVALS	DATE APPROVED	SIGNATURE
ADVISER		
DEPT. CHAIRMAN		
GRADUATE DEAN		

G 015-EX

PRINT AND PRESS FIRMLY

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

DEPARTMENT OF CHEMICAL ENGINEERING

March 15, 1966

Memorandum to: Mr. Adam Osborne

From: J. A. Gerster, Chairman JAG

In regard to your application for continuation towards the Ph. D. degree, the chemical engineering faculty has agreed that they should support your application. To this end, we are approving a research fellowship, industrial fellowship, or government fellowship for you for 12 months beginning September, 1966.

Formal application for permission to study for the Ph. D. degree is granted only by the graduate office, but if your Master's degree is completed, and a favorable departmental recommendation is made, such permission is usually granted.

JAG:jr

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

DEPARTMENT OF CHEMICAL ENGINEERING

May 24, 1966

MEMORANDUM TO: Adam Osborne

FROM: J. A. Gerster

We are pleased to inform you that you have successfully passed the written examination for your minor subject of specialization, Applied Mathematics.

We are glad to see the steady progress toward completion of your Ph.D. degree by your satisfying this particular requirement.

JAG:bv
cc: Graduate Office

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

DEPARTMENT OF CHEMICAL ENGINEERING

June 15, 1966

MEMO TO: Adam Osborne

We are nominating you for the Shell Fellowship in Chemical Engineering for the coming year. We hope this meets with your approval.

Adam, this fellowship award represents the third year which we have supported you for graduate study. If at all possible, we would like you to spend every effort toward completion of your Ph.D. degree by the time that this fellowship award expires, which is August 31, 1967. We cannot guarantee financial aid beyond that time. There is a possibility that assistance for a few months could be obtained, but I would say that the likelihood of an industrial fellowship or governmental fellowship help for you for a fourth year is not very good.

Yours very truly,

J. A. Gerster, Chairman
Dept. of Chemical Engineering

JAG:pm

UNIVERSITY OF DELAWARE

NEWARK, DELAWARE

RECORDS OFFICE

MEMORANDUM TO: Degree Recipients

FROM: Robert Gebhardtsbauer
Registrar

Just a quick note to congratulate you on receiving your degree and to enclose for your personal files a complimentary copy of your academic record in your degree program. Graduates receiving the baccalaureate degree will find thereon their rank in class based on their University of Delaware cumulative index.

For your information and in accordance with the action of the Board of Trustees, each transcript requested <u>including the first</u> will cost $1.00, excluding the one attached.

May we extend our wishes for a successful career.

RG:jw

June 17, 1966

Memorandum to: Graduate Office

From: Dr. J. A. Gerster, Chairman

This is to certify that Mr. Adam Osborne has successfully completed the oral portion of his qualifying examination for the Ph.D. degree.

JAG:jr

June 23, 1966

To: Dr. J. Gerster
From: A. Osborne

Re: The Shell Industrial Fellowship.

In connection with the above fellowship, and with regard to your comments on the question of my taking U.S. Citizenship, it is my intention to make the U.S.A. my permanent home, and it is therefore also my intention and my wife's intention to take U.S. Citizenship.

May I take this opportunity to thank you, Dr. Gerster, and the Shell Company, for making this fellowship available to me. I look forward to discussing my future plans with a representative of the Shell Company.

Adam Osborne

cc: Shell
F/Un.

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

COLLEGE OF GRADUATE STUDIES

July 7, 1966

Memorandum:

To: Mr. Adam Osborne

From: C. E. Birchenall, Dean, College of Graduate Studies

Your request for permission to continue your studies toward the Ph.D. degree has been recommended by the Department of Chemical Engineering Evaluating Committee.

I am pleased to advise you that your petition has been approved. I extend to you my best wishes for continued success in your education goal.

C. E. Birchenall

CEB:bpm
cc: Prof. Olson
Prof. Ferron
Prof. Russell
Prof. Lamb
Prof. Gerster
IBM

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

COLLEGE OF GRADUATE STUDIES

February 9, 1967

Memorandum:

To: Mr. Adam Osborne

From: C. E. Birchenall, Dean, College of Graduate Studies

Your request for permission to continue your studies toward the Ph.D. degree has been recommended by the Department of Chemical Engineering Evaluating Committee.

I am pleased to advise you that your petition has been approved. I extned to you my best wishes for continued success in your education goal.

CEB:bpm
cc: Dr. Lamb
Dr. Denn
Dr. Gerster
IBM

C. E. Birchenall

UNIVERSITY OF DELAWARE
RECORDS OFFICE

REPORT OF FOREIGN LANGUAGE EXAMINATION
COLLEGE OF GRADUATE STUDIES

NAME	Last: Osborne,	First: Adam	Middle Initial:	Major Department: Ch. Eng.r
ADDRESS				
LANGUAGE	☐ German	☐ French	☐ Other (Specify): Russian	Date: 4/1/67
MAJOR DEPARTMENT	☒ Passed	☐ Failed	Examiner: M M Denn	
MODERN	☒ Passed	☐ Failed	Examiner: [illegible]	
RESULT	☒ Passed	☐ Failed	College of Graduate Studies: C-E. Burchard	

1M 9/66 | 1 STUDENT | 2 DEPARTMENT | 3 RECORDS OFFICE | 4 GRAD. OFFICE | G-014-D

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE

SCHOOL OF GRADUATE STUDIES

July 7, 1967

TO WHOM IT MAY CONCERN:

Adam Osborne

has completed all of the requirements for the degree of

Ph.D. - Chemical Engineering - effective 7/7/67

The degree will be conferred at our next Commencement in June, **1968.**

Sincerely,

A. Elise Delano
Assistant to the Dean

AED:hhl

ADFORD INSTITUTE

OF TECHNOLOGY

BRADFORD 7

POST CARD

15 IX 66

=0,4=

GREAT BRITAIN

AB 595

Dr. A. Osborne

M. W. Kellogg Co.,

New Market,

New Jersey,

U. S. A.

Petr Boček

ČESKOSLOVENSKÁ AKADEMIE VĚD

Ústav instrumentální analytické chemie

BRNO, Leninova 82

Czechoslovakia

D^r

Adam Osborne

M. W. Kellog Co., New Market,

New Jersey,

USA

PAR AVION LETECKY

DOPORUČENĚ

R. 161

Dipl.-Ing. H. Hien

im Hause

VEB LEUNA-WERKE »Walter Ulbricht«

Abteilung Petrolchemie Bau 3564

422 LEUNA 3

DDR - GDR - ГДР

East Germany

IV-15-16 2657-5000-665 PLG 9/352/65

To

Dr. Adam Osborne

The M.W.Kellogg Company

New Market /New Jersey

U.S.A.

Dept. of Chem. Tech.,
BRADFORD INSTITUTE OF TECHNOLOGY,

BRADFORD 7, YORKSHIRE, ENGLAND. 12 — 9 — 1966

Sehr geehrter Herr!

Für die Übersendung eines Sonderdruckes Ihrer Arbeit,

Dear Sir,

I would greatly appreciate a reprint of your paper

Monsieur,

Je serais très heureux de recevoir un tiré à part de votre travail

The prediction of liquid mixture enthalpies from pure component properties,
A.I.Ch.E. 12, March, 377-84

ebenso wie für die Übersendung von Separaten früherer Arbeiten auf diesem Gebiet, wäre ich Ihnen sehr dankbar. Mit besten Dank im voraus und vorzuglicher Hochachtung.

together with reprints of your previous papers on the same subject. Thanking you in advance for your trouble. Yours sincerely,

et de vos autres publications traitant du même sujet. Je vous prie, Monsieur, de croire à mes sentiments les plus distingués.

R. F. Nijjhar.

BRNO, 14 September

We should greatly appreciate receiving a reprint of your paper

The prediction of Liquid Mixture Enthalpies from Pure comp. Properties.

which appeared in A.I.Ch.E. J. 12 (2), 377 (1966)

Sincerely yours

Petr Boček
Czechoslovak Academy of Science
Institute of Instrumental Analytical Chemistry
BRNO
Czechoslovakia

Leuna, den 16.9.1966

Sehr geehrter Herr
Dear Sir
Уважаемый коллега Dr. Osborne !

Für die Übersendung eines Sonderdruckes Ihrer Arbeit(en):
I learned from your publication(s):
Я узнал о вашей публикации:

" The Prediction of Liquid Mixture Enthalpies from pure Component Properties "

A.I.Ch.E.-Journal 12(1966)2; 377 - 384

wäre ich Ihnen sehr dankbar. In der Hoffnung, daß Sie meinem Wunsche entsprechen, verbleibe ich
and I am very interested in the matter. There-fore, I beg You to send me a / the pre-print(s) of the mentioned publication(s). Thanking You in advance of your kind reply and for your esteemed assistance, I remain, Dear Sir
Меня интересует эта тема и я был бы очень благодарен за пересылку оттиска цитированной статьи

mit vorzüglicher Hochachtung
sincerely yours
уважающий вас

Helfried Hein

AIR-MAIL

To Mr. Adam Osborne
M. W. Kellogg Company,
New Market,
New Jersey,
U.S.A.

Dr. Adam Osborne
Chemical Engineering Dept.
University of Delaware
Newark, Del.
U.S.A.

Air Mail

Library -
(Dr ~~A. Osborne~~)

M. W. Kellogg Co.
New Market, N. J.
U.S.A.

Imprimé

~~Jay → J. B. Osborne 4th fl~~

C. S. Kohli
Metallurgical Deptt.

INDIAN INSTITUTE OF TECHNOLOGY
I. I. T. Post Office
Kanpur (India)

Metallurgical Department

Dear Sir,

Would you kindly send me a reprint of the following paper, and also raprints of other publications of yours on the same subject.

Title : The prediction of liquid mixture enthalpies from pure component properties
Author (s) : Adam Osborne
Journal : A. I. Ch. E. Journal, P. 377, Vol. 12, No. 2, 1966

Yours sincerely,
C. S. Kohli

Dr. Aluf Orell

DEPARTMENT OF CHEMICAL ENGINEERING
ISRAEL INSTITUTE OF TECHNOLOGY
P. O. B. 4910, HAIFA, ISRAEL

Dear Dr. Osborne:

I would appreciate receiving 1 reprint(s) of your article "The prediction of liquid mixture enthalpies from pure components properties" which appeared in AIChE J. 12, 377 (1966).

Thank you for this courtesy.

Sincerely yours
Aluf Orell

DEPARTMENT OF PHYSICAL CHEMISTRY
TECHNICAL UNIVERSITY
Praha 6 - Dejvice, 1905, Czechoslovakia

Dear Sir,

I would greatly appreciate a reprint of your paper
The prediction of liquid mixture enthalpies from pure component properties
from
A. I. Ch. E. Journal 12(2), 377 (1966)
if you have copies for distribution.

Yours very truly, Frantisek Veselý

ST-15-510-66

THIS SIDE OF CARD IS FOR ADDRESS

Mr. Adam Osborne
Chem Eng Dept.
Univ. of Delaware
Newark. Delaware

Professor Osborne. A.
M.W. Kellogg College.
New-Market

U.S.A.

New. Jersey

DR. ADAM OSBORNE
M.W. KELLOGG COMPANY,
NEW MARKET,
NEW JERSEY,
U.S.A.

DEPARTMENT OF CHEMICAL ENGINEERING
UNIVERSITY OF HOUSTON
HOUSTON, TEXAS 77004

Dear Adam: 6/18 1966

Will you please send me 1 reprint — of the article

Prediction of Liquid Mixture Enthalpies ...

which appeared in J AIChE 12, 377 (1966)

Thank you for your courtesy.

Sales good!

H. WILLIAM PRENGLE, JR.

RECEIVED 20 JUN 1966 PM

Very truly yours,

J.-P. GROLIER
UNIVERSITÉ DE CLERMONT
FACULTÉ DES SCIENCES
—
LABORATOIRE DE CHIMIE-PHYSIQUE II
—
17 TER, RUE PAUL-GOLLOMP
63 - CLERMONT-FERRAND
FRANCE

Clermont, le 28 OCT. 1966

Nous serions très heureux de recevoir un tiré à part de votre article :
We would greatly appreciate a reprint of your paper :

The prediction of liquid mixtures enthalpies from pure component properties

qui a paru dans : A. I. Chem. E. J U.S.A. 1966
which appeared in : 12. n° 2 p. 377-84

Avec nos sincères remerciements.
Thank you for your courtesy.

Jean-Pierre Grolier

OSAKA CITY UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF APPLIED CHEMISTRY,
SUGIMOTO-CHO, SUMIYOSHIKU
OSAKA, JAPAN

Date Apr. 26, 1966

Dear Sir:

I would appreciate receiving a reprint of your article, The Prediction of Liquid Mixture Enthalpies from Pure Component Properties which appeared in Am. Inst. Chem. Eng. Journal, 12, 377 (1966)

Very truly yours,

T. Imoto

Prof. Tatsuya Imoto

QUICK DELIVER

Dr. Adam Osborne
Dept. Chem. Engg.
University of Delaware
Newark, Delaware
U.S.A.

AIR MAIL

To Prof. ADAM OSBORNE
Chem Cal Engg Dept.
University of Delaware
Newark.
Delaware.
U.S.A

S.M.K.A. GURUKUL
B.C. ROY HALL
INDIAN INSTITUTE
OF TECHNOLOGY.
KHARAGPHUR
INDIA.

Dr. Adam Osborne
Dept. of Chem. Eng.
Univ. of Delaware
Newark, Delaware
U.S.A.

DEPARTMENT OF CHEMICAL ENGINEERING
INDIAN INSTITUTE OF SCIENCE, BANGALORE-12, INDIA

Date June 1, 1966

Dear Sir,

We would be grateful for a copy of your article The Prediction of Liquid Mixture Enthalpies from Pure Component Properties published in AIChE J., 12, 377 (1966)

Yours faithfully,
D. S. Viswanath
D. S. VISWANATH

DEPARTMENT OF CHEMICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY
KHARAGPUR, (S. E. Rly.) INDIA.

Date 11.7.66

Dear Professor,

I would be grateful if you kindly send reprint of your valuable paper entitled The prediction of liq. mix Enthalpies from pure comp. properties published in A.I.Ch.E. Journal March '66

Yours very truly
Smt A Gurukul

DEPARTMENT OF CHEMICAL ENGINEERING
AND APPLIED CHEMISTRY
UNIVERSITY OF TORONTO
TORONTO 5, CANADA

DATE June 23 / 66

Dear Sir:

I should be most grateful for a reprint of your article, The Prediction of Liquid Mixture Enthalpies from Pure Component Properties

Yours sincerely,
Thomas Lien

Mr. Adam Osborne
M.W. Kellogg Co.
New Market
New Jersey

Dr. Adam Osborne,
M.W. Kellog Co.,
New Market,
New Jersey,
U.S.A.

Dr. James H. Weber, Chairman
Dept. of Chemical Engineering
University of Nebraska
Lincoln, Nebraska 68508

THIS SIDE OF CARD IS FOR ADDRESS

Mr. Adam Osborne
Dept. of Chemical Engineering
University of Delaware
Newark, Delaware

April 4/66

Dear sir:

I should appreciate receiving a reprint of your recent article entitled "The Prediction of Liquid Mixture Enthalpies from Pure Component Properties" which appeared in the A.I.Ch.E. Journal, 12, p. 377, 1966.

Yours truly

A.E. Mather
Graduate Student
Dept. of Chemical Engineering
University of Michigan
Ann Arbor, Michigan

INSTYTUT CHEMII FIZYCZNEJ PAN
Warszawa 42, POLAND
skr. 49

May 12th, 1966

Dear Sir,

I should greatly appreciate receiving the reprint(s) of your paper(s) entitled The prediction of liquid mixture enthalpies from pure component properties A.I.Ch.E. Journ., 1966 12 377

if you have any copies available for distribution.

Sincerely yours,
W. Brzostowski.

Dorgan p. 6. Zam. nr 924 n. 1000

THE UNIVERSITY OF NEBRASKA
DEPARTMENT OF CHEMICAL ENGINEERING
LINCOLN, NEBRASKA 68508

August 4, 1966

Dear Sir:

If available, I should appreciate receiving a reprint of your article "The Prediction of Liquid Mixture Enthalpies from Pure Component Properties" which appeared in A.I.Ch.E. Journal, Vol. 12, No. 2, p. 377, March 1966

Thank you.

Yours sincerely,
J.H.W.
James H. Weber
Professor and Chairman

M^r OSBORNE A

M.W. KELLOGG CO.

NEW MARKET

New Jersey

USA

POLLA
MAR 24
P.M.
1966

Dr Adam Osborne
University of Delaware
Newark
Delaware

Adam-Em?

THIS SIDE OF CARD IS FOR ADDRESS

Dr. Adam Osborne
Univ. of Delaware
Newark, Del

Adam-Em?

CENTRE DE RECHERCHES
DE MICROCALORIMÉTRIE
ET DE THERMOCHIMIE

26, RUE DU 141e R.I.A.
~~13~~ MARSEILLE (3e) France

r/ a. 9 pp BIBLIOTHÈQUE 52

Je vous serais reconnaissant de m'envoyer un
I would appreciate receiving a reprint of your

tiré à part de votre article Prediction sur les
article enthalpies...

publié dans AMER. INST. CHEM. ENGRS
published in 55TH NATION. MEETG 1965 Houston

Avec tous mes remerciements, veuillez agréer,
Monsieur, l'expression de mes sentiments les meilleurs.
and other papers on related subjects.

Sincerely yours

Marseille, 13-10-66
J. P. Bros

J. P. Bro

CHEMICAL ENGINEERING AND CHEMISTRY
Missouri School of Mines and Metallurgy
Rolla, Missouri

I should greatly appreciate a reprint of your article:
The Prediction of Liquid Mixture
Enthalpies from Pure Component
Properties
which appeared in A I ChE J
Vol. 12 Page 377 1966.

Very truly yours,
H C Hershey
Asst. Prof.

L-334

GULF RESEARCH & DEVELOPMENT COMPANY
P. O. DRAWER 2038 PITTSBURGH 30, PA.

Mar 24 1964

Dear Dr. Osborne

I would appreciate your sending me a reprint of your paper The Prediction of Liquid Mixture Enthalpies from Pure Component Properties
which was published in A.I.Ch.E.J. 12, 377 (1964)

Thank you very much,
Stuart T. Hadden

GULF

CARLA CUNIBERTI

UNIVERSITÀ DEGLI STUDI - GENOVA - ITALIA
ISTITUTO DI CHIMICA INDUSTRIALE
VIA PASTORE, N. 3

DIR. PROF. CORRADO ROSSI

Dr. A. Osborne

M.W. Kellogg Company,

New Market, N.J.

(U.S.A.)

31224 Morino

Gail Kramer

Dr. A. Osborne
The M. W. Kellogg Company
New Market, New Jersey

Genoa. 1/9/66

Dear Sir,

I would be pleased to receive a reprint of your article

The prediction of liquid mixture enthalpies from pure components properties.

appearing in A.I.Ch.E.J. 12(2) 377 (1966)

Thank you very much.

Carlo Cerutti

DEPARTMENT OF CHEMICAL ENGINEERING
AND APPLIED CHEMISTRY
UNIVERSITY OF TORONTO
TORONTO 5, CANADA

DATE Aug 29, 1965

Dear Sir:

I should be most grateful for a reprint of your article, The Prediction of Liquid Mixture Enthalpies From Pure Component Properties

Yours sincerely,

Henry Tan

Luftpost

Postkarte

BITTERFELD 44 28-9-66

Deutsche Post 010

CHEMIKALIEN METALLE u. PLASTE aus Bitterfeld

Dr. Joachim Liebig
im

VVB Elektrochemie und Plaste
Wissenschaftlich-Technisches Zentrum
Anorganisch-chemische Industrie
Sitz: VEB Elektrochemisches Kombinat Bitterfeld

Deutschland (DDR)

Pd G 09-66-4 EKB 87-500

Mr.
Adam Osborne
M W Kellogg Company
New Market
New Jersey
USA

Sehr geehrter Herr Kollege!
Dear Sir!
Monsieur!

Darf ich Sie höflichst um einen Sonderabdruck Ihrer Arbeit bitten:
I would be grateful if you could send me a reprint of your article entitled:
Je vous serais très obligé s'il vous était possible de m'adresser un exemplaire de votre publication:

A.J.Ch.E. Journal 12 2 (1966) 377-84
The Prediction of Liquid Mixture Enthalpies from Pure Component Properties

An Ihren späteren Arbeiten auf gleichem Arbeitsgebiet bin ich weiterhin interessiert.
I am always interested in your following articles of the same field.
Je suis intéressé toujours par vos travaux ultérieurs du même domaine.

Mit bestem Dank im voraus und vorzüglicher Hochachtung
Thanking you in advance Yours sincerely
Je vous remercie d'avance et vous prie d'agréer l'expression de mes sentiments très distingués

Joachim Liebig

Journal

iss

YALE UNIVERSITY, 225 PROSPECT STREET, NEW HAVEN 11, CONNECTICUT

January 14, 1966

am Osborne
anuel Street
, Delaware

Re: No. 7284 - "The Prediction of Liquid Mixture Enthalpies from Pure Component Properties"

Dear Mr. Osborne:

I enclose a copy of a very late review. If there are any points which you would like to change, there is still time. I do not insist on any changes at this late date.

Very truly yours,

Harding Bliss

HB:jo
Enclosure

A.I.Ch.E. Journal
EDITOR
Harding Bliss

YALE UNIVERSITY, 225 PROSPECT STREET, NEW HAVEN, CONNECTIC

September 13, 1965

Mr. Adam Osborne
282 Manuel Street
Newark, Delaware

Re: #7284 - "The Prediction of Li
Mixture Enthalpies from Pure
ponent Properties"

Dear Mr. Osborne:

I have been over the revision of subject paper and have f
it vastly improved. I believe that I would still like to get one
review on this revised paper, but I will in no case hold this up
than one month. During this period will you please be sure to i
the appearance of Figure 2 by using a lettering guide on the or
I will get in touch with you in a month.

Very truly yours,

Harding Bliss

HB:jo

282 Manuel Street
Newark,
Delaware

Nov. 10, 1965

Miss M.L.Byrd
Manuscript Editor
American Institute of Chemical Engineers
345 East 47th. Street
New York

Re: #7284

Dear Miss Byrd:

Below I list the answers to the questions you raised with regard to the paper numbered above.

1) On figure 2 I have inked in the required numbers on the ordinate scale.

2) Figure 9 may be removed from the paper. The removal necessitates no other alterations. This was an oversight on my part resulting from contraction in the revised paper.

3) In changing the form of equations to save space, the numerator and denominator of fractions must be bracketed. I have done this with pencil in equations 9 to 11

4) All the symbols P should be Cap.

5) Pg. 4 line 5. The numerals 6 - 12 are part of the title of the molecular model mentioned. They are not references.

6) Pg. 13. It is alrightto delete equation (1) from this page.

7) The swap of figures 7 and 8 is alright, as corrected by you.

8) Reference 17. Publisher: McGraw-Hill, New York, N.Y. 1963.

9) Reference 23. This refers to some data obtained in the laboratories of the U.S. Ind. Che. Co., by Messrs. Kohne, Anderson and Miller. Their data are to be published.

Very truly

Adam Osborne

THE PREDICTION OF LIQUID MIXTURE ENTHALPIES FROM PURE COMPONENT PROPERTIES

Adam Osborne

The M. W. Kellogg Company, New Market, New Jersey

Present address:

Department of Chemical Engineering

University of Delaware

Newark, Delaware

review, to be very sure of one's material and facts. At the end of paragraph 2, Griskey accuses me of faulting the experimental data of Sage and Lacey. (I deal with this point below.) Yet at the start of the very next paragraph, Griskey suggests that I have not considered Sage and Lacey's work at all! Perhaps Griskey feels I should also consider the other binary systems in Sage and Lacey's work. This would be mere repitition, and suffers from the fault of Griskey's whole review, namely considering the world to be made up of hydrocarbons only. Originally I had not made comparisons with any of the many hydrocarbon enthalpy correlations, (of which Griskey mentions a few), because these apply to a few components under limited conditions, whereas this paper presents a very broad application. At your behest I have now made such comparisons. Likewise I have now included the work of Holcomb and Brown on the ternery system propane - butane - pentane, which I had initially left out because this system has no heat of mixing, only pseudo liquid effects, and is therefore uninteresting.

Sage and Lacey derived their enthalpy data from experimental P - V - T data. If we justifyably assume that the B - W - R equation of state represents the vapor pressures of methane and butane within the limits of experimental error, then the B - W - R equation does by machine what Sage and Lacey did by hand. I am surprised that Griskey is unaware of this. I consider Dr. Ellington's first comment by reference to the differences between the data of Sage and Lacey and the B - W - R equation of state. These differences are excellent estimates of the minimum errors inherent in computations involving graphical differentiation.

I thank you forthe attention you have given my paper, and should you feel any further additions or changes are required, please let me know.

Very truly

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

Office of the Secretary

345 East 47 Street, New York, N. Y. 10017
212 PL 2-6800

November 8, 1965

Mr. Adam Osborne
282 Manuel Street
Newark, Delaware

Re: #7284

Dear Mr. Osborn:

In order to facilitate the editing of your paper and to keep printing costs to a minimum, we are enclosing your manuscript with queries written in the margins. Please answer the queries and return this copy to us as soon as possible.

Sincerely yours,

Mary Louise Byrd

Mary Louise Byrd
Manuscript Editor

Enclosure

MS 7284

The prediction of liquid mixture enthalpies from pure component properties, Osborne, Adam, **A.I.Ch.E. Journal, 12,** No. 1, p. 000 (January, 1966).

Key Words: A. Thermodynamic Properties-8, Calculating-8, Enthalpy-2, 9, Heat of Solution-1, 2, Heat of Mixing-1, 2, Mixtures-9, Liquids-9, Nonpolar-0, Binary-0, Ternary-0, Intermolecular Theory-10, Margules Equation-10, Comparing-8, Data-1, 9, Experimental-0, Calculated-0.

Abstract: A procedure is presented for calculating liquid mixture enthalpies by adding a liquid heat of mixing to the molal average of the pure liquid enthalpies. The heat of mixing for the mixture is calculated from the heats of mixing the binary systems at infinite dilution, which in turn are determined using a proposed molecular model for liquid mixing and a postulate of acceptance. Results are compared for four nonpolar binary systems, three with experimental data, and one with data calculated by other means.

The paper presents a procedure for calculating liquid mixture enthalpies, whereby a liquid heat of mixing is added to the molal average of the pure liquid enthalpies. The heat of mixing for the mixture is calculated from the heats of mixing of the binary systems at infinite dilution, which in turn are determined with a proposed molecular model for liquid mixing, and a postulate of acceptance. The two cases where the solute in the binary system is more volatile and less volatile than the solvent are treated separately. The case is also considered where a component of the liquid mixture is above its critical temperature; a pure liquid enthalpy is defined and justified for such pseudo liquids, and heats of mixing are then calculated as for actual liquids. Results are compared for four nonpolar binary systems, three with experimental data, and one with data calculated by other means. Data for a number of gases dissolved in water are also considered. The agreement in all cases is excellent.

The Prediction of Liquid Mixture Enthalpies from Pure Component Properties

ADAM OSBORNE
M. W. Kellogg Company, New Market, New Jersey

An increasing amount of work is being done on the problem of predicting the enthalpy of liquid mixtures, and the need for better liquid mixture enthalpy calculation procedures becomes more urgent, particularly in the light of the complete absence of data for most systems, and the relative complexity of obtaining experimental mixture enthalpy data. The cost to the petroleum industry alone of the lack of good liquid enthalpy data was discussed in a recent article by Findlay (*1*).

Adam Osborne is with the University of Delaware Newark, Delaware.

Methods of calculating liquid mixture enthalpies fall into three categories: intermolecular theory, correlatory equations, and equations of state. Prigogine's (*2*) work has formed the basis of the first category, but the state of art is such that intermolecular theory has met with little success in predicting liquid nonideality. In a recent paper, Pierotti (*3*) developed a theory which appears to calculate very well the excess thermodynamic properties of the inert gases, but it breaks down when handling molecules that cannot be considered as rigid spheres. Correlatory equations all require some binary enthalpy data with which to derive empirical constants, and thence the equations may be used to extend the data over a wider temperature range, or to predict ternary or multicomponent data. The most successful correlatory equations are the power series equations (*4* to *6*), which can be very accurate, providing sufficient data are available to obtain the necessary empirical constants. A number of graphical correlations have been presented over the years (*7* to *10*) to predict the enthalpies of mixtures of the lighter aliphatic hydrocarbons. These correlations, in general, give good engineering answers within the range of components and conditions for which they were derived. Moreover, they consider the effect of pressure on liquid enthalpy. Equations of state attempt to predict liquid enthalpies from the thermodynamic identity:

$$(H^\circ - H) = \int_0^P [T\,(\partial V/\partial T)_P - V_T]\,dP \qquad (1)$$

Any errors in the P-V-T relationship of an equation of state are greatly increased when predicting enthalpy data. Therefore, a very accurate fit to available P-V-T data must be made, and only the most complex equations would appear to have a chance of calculating good enthalpy data. The Benedict-Webb-Rubin equation of state is the only one that has been used with any extensive success in predicting liquid enthalpies (*11*). The simple Redlich-Kwong equation of state has been used extensively for calculating enthalpy, and for superheated vapors it serves the purpose admirably. However, due no doubt to the other successes of this remarkable equation of state, it is being used in industry to predict enthalpies of saturated vapors and liquids, and vapors below their saturation temperatures in mixtures. The dangers in using the Redlich-Kwong equation of state to calculate enthalpies near or below the critical temperature are obvious if virial coefficients are back-calculated and compared at these temperatures. Wilson (*12*) recently improved the Redlich-Kwong equation of state, and it will be interesting to see what success is achieved in calculating liquid enthalpies with this modified equation of state.

The work discussed herein may be loosely ascribed to the first category of intermolecular theory. Since the excess thermodynamic properties of a liquid mixture depend on the properties of the pure components only, it follows that it should be possible to calculate excess thermodynamic functions from pure component data only. By this calculation procedure, binary heats of solution at infinite dilution are calculated, differently for the two cases where the solute is the more volatile and the less volatile component. Heats of solution are calculated from infinite dilution values with a Margules type of equation, and total enthalpies are obtained by adding the excess enthalpy to the sum of the partial molal pure component enthalpies. For this purpose a pseudo liquid state is defined and justified, whereby "liquid" enthalpies above the critical temperature may be readily obtained.

THEORY

It is found empirically that where the less volatile component is the solute, an excellent value is calculated for the *enthalpy deviation from the ideal gas state* of the solute at infinite dilution, by reading the enthalpy deviation from the ideal gas state of the pure solute at the reduced temperature of the pure solvent.

$$(H^\circ - H^\infty)_{bTrb} = (H^\circ - H^o)_{bTra} \qquad (2)$$

The significance of Equation (2) may be examined in terms of intermolecular potential. We consider the Lennard-Jones 6-12 model for intermolecular potential, and the commonly used equations for intermolecular potentials in binary systems (*13*). As illustrated in Figure 1, ϵ, the potential well depth, commonly is greater for less volatile components over more volatile components. Furthermore, the well depth for a bimolecular pair is frequently estimated with Equation (3).

$$\epsilon ab = \sqrt{\epsilon a \epsilon b} \qquad (3)$$

Enthalpy deviations from the ideal gas state may be written in terms of the virial coefficients, which in turn may be represented by the equation adopted for intermolecular potential (*14*). It is approximately correct to imply from Equation (2) the relationship:

$$[\phi(r)]_{baTrb} = [\phi(r)]_{b\,Tra} \qquad (4)$$

Stated, the intermolecular potential $\phi(r)$ for the bimolecular pair $a - b$ at a reduced temperature Trb will have the same value as the intermolecular potential for the unimolecular less volatile pair $b - b$ at some reduced temperature Tr in excess of Trb. Equation (2) implies that this higher reduced temperature equals Tra. We may conclude that, though Equation (2) is unlikely to please a physical chemist, it does calculate heats of mixing at infinite dilution, of the right order of magnitude and sign, which at the present time is an achievement not to be underrated, when attempting to calculate multicomponent enthalpies without the aid of binary experimental data.

Equation (2) does not hold where the more volatile component is the solute in the less volatile solvent. For this second case, the solute appears to create for itself a liquid *cell* which the less volatile solute does not do. Moreover, the thermodynamic properties of the solvent at the site where the solute creates for itself a cell are not equal to the average thermodynamic properties of the solvent. We define here a liquid cell as a location for a solute molecule in a solvent, which is not randomly distributed with respect to energy levels. *Site* is defined as the location of the liquid cell in terms of the fluctuations of enthalpy, entropy, and momentum of the solvent molecules about their means. When it is assumed that the solvent thermodynamic properties have Maxwellian distributions about the mean values, the solute molecule chooses for itself, within the energy distribution of the solvent, the site most compatible with the energy state of the solute molecule. To understand the concept better, we discuss first the theory of thermodynamic distributions in a mass of a pure liquid. From the formula for quantum mechanical partition functions, it is possible to derive an expression for ensemble averages. It is also possible to express thermodynamic properties in terms of the partition function (*15*).

$$H = kT^2\left[\frac{\partial \ln Z_N}{\partial T}\right]_V + kTV\left[\frac{\partial \ln Z_N}{\partial V}\right]_T \qquad (5)$$

$$P' = kT\left[\frac{\partial \ln Z_N}{\partial V}\right]_T \qquad (6)$$

From Equations (5) and (6), using the relationship for canonical ensemble averages, we can derive expressions for the mean fluctuations of thermodynamic properties, as in Equations (7) and (8).

$$(\overline{H})^2 - H^2 = RTV^2\,(\partial P/\partial V)_T + RT^2\,C_P \qquad (7)$$

$$(\overline{P'})^2 - (P')^2 = RT\,(\partial P/\partial V)_T \qquad (8)$$

In consistent units, where H is B.t.u./lb.-mole, T is °R., CP is B.t.u./(lb.-mole)(°R.), P is lb./sq. in., and V is cu. ft./lb.-mole, Equations (7) and (8) become

$$(\overline{H})^2 - H^2 = 0.368\,TV^2\,(\partial P/\partial V)_T + 1987T^2C_P \qquad (7a)$$

$$(\overline{P'})^2 - (P')^2 = 10.73\,T\,(\partial P/\partial V)_T \qquad (8a)$$

It is found that Equations (7*a*) and (8*a*) will permit the accurate calculation of the energy level of a solute cell site, and that reduced temperature is the most successful measure of energy level. Thus, if the energy level of the solute molecule is characterized by the reduced temperature of the solute, the energy level of the solute cell site in the solvent must also be characterized by the solute reduced temperature. Then the solvent cell site vapor pressure equals the solvent vapor pressure at the reduced temperature of the solute. (Where the solute reduced temperature is greater than 1.0, the solvent vapor pressure is found according to the usual procedure, namely a plot of log P vs. $1/T$ is extrapolated through the critical temperature. Where a plot of log P vs. $1/T$ does not give a straight line, an accurate procedure is to express log P as a polynomial in terms of $1/T$. Three terms usually suffice. Such an equation is then employed to calculate pseudo vapor pressures above the critical point.) The vapor pressure of the solvent cell site is the *acceptance pressure* of the solvent, and the *acceptance enthalpy* of the solvent will be approximated by Equation (9).

$$(H_A - H^\circ)/(P'_A - P') = (\overline{H} - H)/(\overline{P} - P') \qquad (9)$$

We define *acceptance* properties as the properties acquired by solute molecule in its cell in the solvent. Unfortunately, there are no grounds for assuming that the ratio given in Equation (9) will be constant for all fluctuation levels; in fact the case is otherwise. When the acceptance level is not far removed from the mean enthalpy and vapor pressure of the solvent, it is more accurate to assume that the pressure and enthalpy fluctuations are equal to the saturation pressure and enthalpy variations with temperature, as in Equation (10).

$$(H_A - H^o)/(P'_A - P') = [(H)_{T_2} - (H)_{T_1}]/[(P)_{T_2} - (P)_{T_1}] \qquad (10)$$

where T_1 is the system temperature and T_2 is the temperature of the solvent at the reduced temperature of the solute. Equation (10) thus reduces to Equation (10*a*), which states that the acceptance enthalpy of the solvent equals the saturated liquid enthalpy of the solvent at the reduced temperature of the solute.

$$H_A = (H_{\text{solvent}})\,T_{r\ \text{solute}} \qquad (10a)$$

It is found that when the difference between the reduced temperatures of solute and solvent is 0.5 or less, H_A is best calculated by Equation (10*a*). When the difference is greater than 0.5, H_A is best calculated by Equation (9).

A knowledge of the acceptance enthalpy permits us to calculate the enthalpy of the solute at infinite dilution, since Lyderson et al. (*16*) have shown that the enthalpy deviation term $H^\circ - H/T_c$ may be plotted for saturated liquids as a universal function of reduced temperature and critical compressibility. Therefore, Lyderson's enthalpy deviation term must be the same for the solute molecule at infinite dilution and for the solvent cell site.

$$[(H^\circ - H^\infty)/T_c]_a = [(H^\circ - H_A)/T_c]_b \qquad (11)$$

Thus we may derive an expression for the enthalpy deviation from the ideal gas state of the more volatile solute at infinite dilution.

$$(H^\circ - H^\infty)_a = (T_{ca}/T_{cb})\,(H^\circ - H_A)_b \qquad (12)$$

Having calculated solute liquid enthalpy at infinite dilution, we may determine heats of solution at infinite dilution, and by use of a Margules type of equation, heats of solution at other concentrations may be calculated. The heat of solution at infinite dilution is $(H^\circ - H^\infty)_i$ or L_i, where i represents any component. H°_i, the pure liquid enthalpy, is determined from pure component data. Frequently, H°_i has to be determined for the pseudo liquid, as described in this paper. L_i is then determined as follows:

$$L_i = (H^\bullet - H^\infty)_i - (H^\bullet - H^\circ)_i \qquad (13)$$

and, similarly, for the second component j of a binary system

$$L_j = (H^\bullet - H^\infty)_j - (H^\bullet - H^\circ)_j \qquad (13a)$$

The three-suffix Margules equation for activity coefficient variation with composition is (*17*):

$$\ln\gamma_i = x_j^2 \left[A_{ij} + 2x_i \left(A_{ji} - A_{ij}\right)\right] \qquad (14)$$

Differentiating with respect to $1/T$, we obtain Equation (15).

$$\frac{\partial \ln \gamma_i}{\partial\left(\frac{1}{T}\right)} = x_j^2 \left[\frac{\partial A_{ij}}{\partial\left(\frac{1}{T}\right)} + 2x_i \left(\frac{\partial A_{ji}}{\partial\left(\frac{1}{T}\right)} - \frac{\partial A_{ij}}{\partial\left(\frac{1}{T}\right)}\right)\right] \qquad (15)$$

But we know that the following are true:

$$\partial \ln \gamma_i / \partial(1/T) = (H^\circ - \overline{H})_i / R \qquad (16)$$

$$\partial A_{ij} / \partial(1/T) = L_i / R \qquad (17)$$

$$\partial A_{ji} / \partial(1/T) = L_j / R \qquad (17a)$$

So, by substituting Equations (17) and (17*a*) into Equation (16) and by eliminating R, we obtain for component i

$$(H^\circ - H^L)_i = x_j^2 \left[L_i + 2x_i \left(L_j - L_i\right)\right] \qquad (18)$$

and for component j

$$(H^\circ - H^L)_j = x_i^2 \left[L_j + 2x_j \left(L_i - L_j\right)\right] \qquad (18a)$$

The total heat of mixing is given by Equation (19)

$$H^E = x_i \left(H^\circ - H^L\right)_i + x_j \left(H^\circ - H^L\right)_j \qquad (19)$$

and by substituting Equations (18) and (18*a*) into Equation (19), we obtain Equation (20):

$$H^E = x_i\, x_j \left(x_i\, L_i + x_j\, L_j\right) \qquad (20)$$

In an identical manner, the four-suffix Margules equation (*17*) may be differentiated to yield an enthalpy equation. Schnaible, Van Ness, and Smith (*18*) derived such an equation in which they gave the Margules D constant the value in Equation (21).

$$\partial D / \partial(1/T) = (L_i - L_j) \qquad (21)$$

Thus they derived the following total heat of mixing equation:

$$H^E = x_i\, x_j \left[x_i\, L_i + x_j\, L_j - x_i\, x_j \left(L_i - L_j\right)\right] \qquad (22)$$

The Margules equation is the only binary correlatory equation that may be converted into an enthalpy equation based on heats of solution at infinite dilution. The Van Laar equation cannot be differentiated to yield any simple solution for enthalpy, while the many polynomial expressions are purely empirical equations of limited value.

For multicomponent systems, heats of mixing may be calculated from a knowledge of binary heats of solution at infinite dilution by utilizing the enthalpy form of the Wohl equation (*19*). The Wohl equation yields an enthalpy of mixing equation in which the activity coefficient term is replaced by an enthalpy of mixing term and the Margules constants are replaced by respective enthalpy constants. This equation may be derived in the same manner as the preceding heat of mixing equation.

The total heat of a solution is obtained by adding the heats of mixing to the sum of the partial enthalpies of the pure liquids as in Equation (23).

$$H^M = \Sigma\, x_i\ H^\circ_i + H^E \qquad (23)$$

THE PSEUDO LIQUID

When calculating acceptance enthalpies and pure liquid enthalpies, it may be necessary to handle liquids at temperatures above their critical. A pseudo liquid state is therefore defined, starting from the equation for enthalpy deviation from the ideal gas state, as given by Equation (1). It will be observed from the generalized enthalpy deviation charts of Lyderson et al. (*16*) that the term $(H^\bullet - H)/T_c$, then plotted against reduced pressure, gives a broad maximum for any reduced temperature. Since, in the pseudo liquid state, both V_T and $(\partial V/\partial T)_P$ will be small, the term $[T\,(\partial V/\partial T)_P - V_T]$ may be approximated to zero, and $(H^\bullet - H^\circ_s)/T_c$ for the pseudo state is therefore taken as the maximum value of the term at the given reduced temperature, or the liquid enthalpy at the Joule-Thomson inversion pressure. The pseudo liquid enthalpy deviations are plotted in Figure 2 as a function of reduced temperature and critical compressibility. The pseudo liquid enthalpy starts to diverge from pure liquid enthalpy at a reduced temperature of 0.82. In the reduced temperature range from 0.82 to 1.0, there exist two liquid enthalpies: H°, the pure liquid enthalpy, and H°_s, the pseudo liquid enthalpy; H° is used for the pure solvent enthalpy, and H°_s is used for the solute enthalpy and in calculating the solvent acceptance enthalpy.

For components whose properties do not fit the generalized charts, the maximum enthalpy deviation from ideality $(H^\bullet - H^\circ_s)$ may be found by plotting $(H^\bullet - H)$ for the component at a given temperature and the range of pressures available against the values of $(H^\bullet - H)$ determined from generalized charts at the same temperature and pressures, according to the method of Othmer (*20*). The line usually is easily extended, and a corresponding maximum enthalpy deviation is read off this plot, using the maximum enthalpy deviation obtained from the generalized charts. As previously stated, vapor pressures above the critical temperature have been obtained by extending the usual plot of log of vapor pressure against reciprocal of absolute temperature. It can be argued that, according to the definition of the pseudo liquid state postulated above, the pseudo liquid vapor pressure should be the Joule-Thomson inversion pressure. However, very little accurate information is available for the Joule-Thomson inversion pressure of most components, and where such data are available, the enthalpies calculated are substantially the same as those using extended vapor pressure plots, since a similar correction is applied to both solute and solvent.

POLAR SYSTEMS

A full treatment of polar systems is left to a future paper, but Himmelblau's data (*21*) for the enthalpies of a number of gases dissolved in water are considered out of interest in the framework of nonpolar theory. It would be expected that a solute molecule would be held more firmly by a polar solvent, thus precluding the buoyancy effect, or acceptance of water toward a more volatile solute. This is found empirically to be the case. As temperature decreases, the effect of the polar forces becomes more noticeable, and two different mechanisms are found to exist, one at 80°C. and another at 25°C. In Table 1 calculated values of the enthalpy departure from the ideal gas state are compared with Himmelblau's data for the gases considered. At 80°C. there is found to be no heat of mixing for the gases, and the liquid enthalpy at infinite dilution is equal to the pseudo liquid enthalpy as defined in this paper, and may be read from Figure 2.

At 25°C., the gases behave as for nonpolar systems, but without the acceptance effect. In other words, the cell occupied by the solute gas has the average values of the solvent, and Equation (12) becomes Equation (12*a*).

$$(H^\bullet - H^\infty)_a = T_{ca}/T_{cb}\,(H^\bullet - H^\circ)_b \qquad (12a)$$

RESULTS

Heats of solution and mixture enthalpies have been calculated for four nonpolar binary systems for which experimental data are available (*22* to *24*) and for one ternery system (*25*). Himmelblau's data (*14*) for gases dissolved in water are also considered (see preceding section). For the system methane-nitrogen, enthalpy data derived from P-V-T data (*26*) are compared with the experimental data (*23*). Calculated heats of mixing are sufficiently accurate to enable liquid mixture enthalpies to be determined to within about 3 B.t.u./lb. accuracy,

In Figures 3 and 4 calculated data for the systems oxygen-argon and nitrogen-argon are compared with the experimental data of Pool et al. (*22*). It will be seen that the heats of mixing for these systems are very small and that they are reproduced very well by the two Margules equations, (20) and (22). For these systems the authors suggest the correlatory equation:

$$H^E = x_i\, x_j \left[L_i + L_j \left(x_i - x_j\right)\right] \qquad (24)$$

This equation is compared with Equations (20) and (22). Errors of less than 1% in pure component enthalpy, vapor pressure, or critical constant data could reproduce the data of Pool et al. exactly, or move the calculated line further from the experimental data, and it is doubted whether pure component enthalpy data are correct to within 1%, particularly for argon. It is therefore suggested that the calculated data are as close to the experimental data as is feasible by this method without very accurate pure component data. Figures 5 and 6 compare calculated enthalpy data for the system methane-nitrogen in which nitrogen is present above its critical temperature. In Figure 5 the calculated data are compared with the experimental data of the U.S. Industrial Chemicals Company (*23*) for the difference between gas enthalpy at 25°C. and saturation pressure, and saturated liquid enthalpy. The calculated data include heats of mixing, as well as pseudo liquid enthalpies for nitrogen and pure component enthalpy data for methane. Derived data of the Institute of Gas Technology (*18*) for the nitrogen-methane system are compared in Figure 6. It will be seen that the agreement is good for the 10% nitrogen system, but poor for the 30% nitrogen system. However, the latter system is close to the mixture critical temperature where P-V-T data are hard to obtain accurately, and as discussed below in connection with the data of Sage and Lacey, difficult to differentiate graphically. The 30% nitrogen data of the Institute of Gas Technology are suspect on the grounds that they show a crossover with the ideal mixing enthalpy. This is not shown at 10%, or by the experimental data of National Distillers at 46.65% nitrogen.

In Figure 7 total enthalpies are presented for the liquid methane-butane system. The enthalpies calculated are compared with the data of Sage and Lacey (*24*), which were derived from P-V-T measurements, and with data calculated by the Benedict-Webb-Rubin equation of state (*27*). The agreement with the latter is seen to be excellent. The correlation of Canjar and Peterka (*10*) was found to be the best of the correlations investigated (*7* to *10*) and their results are included in Figure 8 by way of comparison. The order of magnitude of error inherent in graphical differentiation may be seen in Figure 8 by comparing Sage and Lacey's data for the methane-butane system with the data computed by machine using the Benedict-Webb-Rubin equation of state. Sage and Lacey derived their data by graphical differentiation of experimental P-V-T data. The computer does substantially the same calculation, but eliminates the human factor. Therefore, making the two assumptions that Sage and Lacey did work as accurate as humanly possible, and that the Benedict-Webb-Rubin equation of state represents P-V-T data for the system within the tolerance of experimental error, the difference between the two sets of data represents the order of magnitude of error inherent in graphical differentiation.

It must be clearly understood that the above does not imply that experimental data are wrong. The experimental P-V-T data are assumed to be absolutely correct. It is suggested that graphical differentiation of P-V-T data to obtain very accurate enthalpy data is impossible, and that machine-computed values will be more accurate. Accordingly, the agreement between the values calculated by the method of this paper for the methane-butane system, and the values computed with the Benedict-Webb-Rubin equation of state, is held to be a test of the usefulness of the method.

In Table 2 the experimental data of Nelson and Holcomb (*25*) for the ternary system propane–butane–pentane are compared with the values calculated by this paper, along with the values given by the correlation of Holcomb and Brown (*7*), which for this system was found to be the best correlation. Only data for the saturated liquid were compared. It will be seen that the two methods give equally good results, however, whereas the correlation of Holcomb and Brown considers the effect of pressure on liquid enthalpy, this paper does not.

CALCULATION PROCEDURE

For nonpolar binary systems, the following steps are employed in calculating total enthalpy:

1. Calculate enthalpy departure from the ideal gas state at infinite dilution for component *a* in component *b* and for component *b* in component *a*. Where the less volatile component is the solute, the enthalpy departure is given by Equation (2).

$$(H^\circ - H^\infty)_{bTrb} = (H^\circ - H^\circ)_{bTra} \qquad (2)$$

For the more volatile component as the solute, the enthalpy departure from the ideal gas state at infinite dilution is given by

$$(H^\circ - H^\infty)_a = T_{ca}/T_{cb}\,(H^\circ - H_A)_b \qquad (12)$$

The acceptance enthalpy H_A is calculated by Equation (9) if the solute reduced temperature is more than 0.5 greater than the solvent-reduced temperature, and by Equation (10*a*) if the solute-reduced temperature is less than 0.5 greater than the solvent-reduced temperature.

2. Calculate the heat of solution at infinite dilution according to Equation (13).

$$L = (H^\circ - H^\infty) = (H^\circ - H^\infty) - (H^\circ - H^\circ) \qquad (13)$$

3. Calculate the heat of mixing with Equation (20).

$$H^E = x_i x_j\,(x_i L_j + x_i L_j) \qquad (20)$$

If individual partial heats of mixing are required, these may be calculated with Equation (18).

$$(H^\circ - H_L)_i = x_j^2\,[L_i + 2x_i\,(L_j - L_i)] \qquad (18)$$

4. Equation (23) is used to predict the total molal enthalpy of the mixture

$$H^M = \Sigma x_i H^\circ_i + H^E \qquad (23)$$

CONCLUSION

A general method has been presented which allows the calculation of total enthalpies of liquid nonpolar mixtures with good engineering accuracy. An attempt is being made to gain a clearer understanding of the relationship between vapor pressure and enthalpy fluctuations, in order to improve on the "rules of thumb" set forth in this paper for calculating enthalpies. The application of this work to polar systems and to other liquid excess thermodynamic functions also promises rewarding results.

The correlations of Holcomb and Brown (*7*) and Canjar and Peterka (*10*) are probably as accurate as the method of this paper, and certainly are simpler to use. However, they are limited to a narrow range of components and conditions.

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Fig. 1. The intermolecular potentials of a less volatile solute at infinite dilution in a more volatile solvent and for the pure solute at the reduced temperature of the solvent.

Fig. 2. Pseudo liquid enthalpy deviation from the ideal gas state.
Fig. 3. Heat of mixing for the oxygen-argon system.
Fig. 4. Heat of mixing for nitrogen-argon system.

Fig. 5. Gas enthalpy at 25°C. and dew point pressure minus liquid enthalpy for nitrogen-methane system.

Fig. 6. Ideal gas enthalpy minus liquid enthalpy for methane-nitrogen mixtures.

Fig. 7. Total enthalpy of methane-butane mixture.

Fig. 8. Heat of solution at infinite dilution for the nitrogen-methane system.

TABLE 1. ENTHALPY DEVIATION FROM IDEAL GAS
$(H^\circ - H)$ CALS./MOLE

Gas	Calculated 25°C.	Himmelblau 25°C.	Calculated 80°C.	Himmelblau 80°C.
O_2	2,706	2,900	293	576
N_2	2,200	2,500	125	146
H_2	721	960		
HC	230	400		
XE	5,082	4,500	1,940	1,440
CH_4	3,343	3,200	552	626
Ne	780	1,080		
A	2,650	3,100		
Kr	3,686	3,440		

TABLE 2. SATURATED LIQUID MIXTURE ENTHALPIES FOR PROPANE-BUTANE-PENTANE MIXTURES
Datum level: Pure liquid at 80°F. = 0 B.t.u./lb.

Mixture component		A mole %			B mole %			C mole %		
C_3H_8		20.1			20.1			19.8		
n-C_4H_{10}		39.9			29.8			10.6		
n-C_5H_{12}		40.0			50.1			69.6		
Temperature, °F.	Exp.	*A* *H* & *B*	Osborne	Exp.	*B* *H* & *B*	Osborne	Exp.	*C* *H* & *B*	Osborne	
240	101	102	103	120	114	115	134	131	129	
260										
280	135	133	129	134	132	130	146	145	141	
300	146	149	146	147	147	145	161	160	160	
320	165	163	164	165	162	162	185	198	179	
340										

Abstract

The paper presents a procedure for calculating liquid mixture enthalpies, whereby a liquid heat of mixing is added to the molal average of the pure liquid enthalpies. The heat of mixing for the mixture is calculated from the heats of mixing of the binary systems at infinite dilution, which in turn are determined using a proposed molecular model for liquid mixing, and a postulate of acceptance. The two cases where the solute in the binary system is more volatile and less volatile than the solvent are treated separately. The case is also considered where a component of the liquid mixture is above its critical temperature; a pure liquid enthalpy is defined and justified for such "pseudo" liquids, and heats of mixing are then calculated as for actual liquids. Results are compared for four nonpolar binary systems, three with experimental data, and one with data calculated by other means. Data for a number of gases dissolved in water are also considered. The agreement in all cases is excellent.

THE PREDICTION OF LIQUID MIXTURE ENTHALPIES FROM PURE COMPONENT PROPERTIES

Introduction

An increasing amount of work is being done on the problem of predicting the enthalpy of liquid mixtures, and the need for better liquid mixture enthalpy calculation procedures becomes more urgent, particularly in the light of the complete absence of data for most systems, and the relative complexity of obtaining experimental mixture enthalpy data. The cost to the petroleum industry alone of the lack of good liquid enthalpy data was discussed in a recent article by Findlay (1).

Methods of calculating liquid mixture enthalpies fall into three categories: intermolecular theory, correlatory equations, and equations of state. Prigogine's (2) work has formed the basis of the first category, but the state of art is such that intermolecular theory has met with little success in predicting liquid nonideality. In a recent paper Pierotti (3) has developed a theory which appears to calculate very well the excess thermodynamic properties of the inert gases, but it breaks down when handling molecules that cannot be considered as rigid spheres. Correlatory equations all require some binary enthalpy data with which to derive empirical constants, and thence the equations may be used to extend the data over a wider temperature range, or to predict ternary or multicomponent data. The most successful correlatory equations

are the power series equations, (4, 5, 6) which can be very accurate, providing sufficient data are available to obtain the necessary empirical constants. A number of graphical correlations have been presented over the years (7, 8, 9, 10) to predict the enthalpies of mixtures of the lighter aliphatic hydrocarbons. These correlations in general give good engineering answers within the range of components and conditions for which they were derived. Moreover, they consider the effect of pressure on liquid enthalpy. Equations of state attempt to predict liquid enthalpies from the thermodynamic identity:

$$(H^* - H) = \int_0^P \left[T \left(\frac{\partial V}{\partial T}\right)_P - V_T \right] dP \qquad (1)$$

Any errors in the P-V-T relationship of an equation of state are greatly increased when predicting enthalpy data. Therefore a very accurate fit to available P-V-T data must be made, and only the most complex equations would appear to have a chance of calculating good enthalpy data. The Benedict-Webb-Rubin equation of state is the only one that has been used with any extensive success in predicting liquid enthalpies (11). The simple Redlich-Kwong equation of state has been used extensively for calculating enthalpy, and for superheated vapors it serves the purpose admirably, but due no doubt to the other successes of this remarkable equation of state, it is being used in industry to predict enthalpies of saturated vapors and liquids, and vapors below their saturation temperatures in mixtures. The dangers in using the Redlich-Kwong equation

of state to calculate enthalpies near or below the critical temperature are obvious if virial coefficients are back-calculated and compared at these temperatures. Wilson (12) has recently improved the Redlich-Kwong equation of state, and it will be interesting to see what success is achieved in calculating liquid enthalpies with this modified equation of state.

The work discussed herein may be loosely ascribed to the first category of intermolecular theory. Since the excess thermodynamic properties of a liquid mixture depend on the properties of the pure components only, it follows that it should be possible to calculate excess thermodynamic functions from pure component data only. By this calculation procedure binary heats of solution at infinite dilution are calculated, differently for the two cases where the solute is the more volatile and the less volatile component. Heats of solution are calculated from infinite dilution values using a Margules-type equation, and total enthalpies are obtained by adding the excess enthalpy to the sum of the partial molal pure component enthalpies. For this purpose a pseudo liquid state is defined and justified, whereby "liquid" enthalpies above the critical temperature may be readily obtained.

Theory

It is found empirically that where the less volatile component is the solute, an excellent value is calculated for the enthalpy deviation from the ideal gas state of the solute at infinite dilution, by reading the enthalpy deviation from the ideal

gas state of the pure solute at the reduced temperature of the pure solvent.

$$(H^* - H^{\infty})_{bT_{rb}} = (H^* - H^{\circ})_{bT_{ra}} \qquad (2)$$

The significance of equation 2 may be examined in terms of intermolecular potential. We consider the Lennard-Jones 6-12 model for intermolecular potential, and the commonly used equations for intermolecular potentials in binary systems (13). As illustrated in figure 1, ϵ, the potential well depth, commonly is greater for less volatile components over more volatile components. Furthermore, the well depth for a bimolecular pair is frequently estimated using equation (3).

$$\epsilon_{ab} = \sqrt{\epsilon_a \epsilon_b} \qquad (3)$$

Enthalpy deviations from the ideal gas state may be written in terms of the virial coefficients, which in turn may be represented by the equation adopted for intermolecular potential (14). It is approximately correct to imply from equation 2 the relationship.

$$\left[\phi(r)\right]_{baT_{rb}} = \left[\phi(r)\right]_{b\,T_{ra}} \qquad (4)$$

Stated, the intermolecular potential $\phi(r)$ for the bimolecular pair a - b at a reduced temperature T_{rb} will have the same value as the intermolecular potential for the unimolecular less volatile

pair b - b at some reduced temperature Tr in excess of Trb. Equation 2 implies that this higher reduced temperature equals Tra. We may conclude that though equation (2) is unlikely to please a physical chemist, it does calculate heats of mixing at infinite dilution, of the right order of magnitude and sign, which at the present time is an achievement not to be underrated, when attempting to calculate multicomponent enthalpies without the aid of binary experimental data.

Equation 2 does not hold where the more volatile component is the solute in the less volatile solvent. For this second case, the solute appears to create for itself a liquid "cell", which the less volatile solute does not do. Moreover, the thermodynamic properties of the solvent at the "site" where the solute creates for itself a "cell" are not equal to the average thermodynamic properties of the solvent. We define here a liquid "cell" as a location for a solute molecule in a solvent, which is not randomly distributed with respect to energy levels. The "site" is defined as the location of the liquid cell in terms of the fluctuations of enthalpy, entropy, and momentum of the solvent molecules about their means. Assuming that the solvent thermodynamic properties have Maxwellian distributions about the mean values, the solute molecule chooses for itself, within the energy distribution of the solvent, the "site" most compatible with the energy state of the solute molecule. In order to understand the concept better we discuss first the theory of thermodynamic distributions in a mass of a pure liquid. From the formula for quantum mechanical partition

functions it is possible to derive an expression for ensemble averages. It is also possible to express thermodynamic properties in terms of the partition function (15):

$$H = kT^2 \left[\frac{\partial \ln Z_N}{\partial T} \right]_V + kTV \left[\frac{\partial \ln Z_N}{\partial V} \right]_T \tag{5}$$

$$P' = kT \left[\frac{\partial \ln Z_N}{\partial V} \right]_T \tag{6}$$

From Equations 5 and 6, using the relationship for canonical ensemble averages, we can derive expressions for the mean fluctuations of thermodynamic properties, as in Equations 7 and 8.

$$(\overline{H})^2 - H^2 = RTV^2 \left(\frac{\partial P}{\partial V} \right)_T + RT^2 C_P \tag{7}$$

$$(\overline{P'})^2 - (P')^2 = RT \left(\frac{\partial P}{\partial V} \right)_T \tag{8}$$

In consistent units, where H is Btu/lb.-mole, T is °R, CP is Btu/lb.-mole °R, P is lb./sq. in., and V is cu. ft./lb.-mole, Equations 7 and 8 become:

$$(\overline{H})^2 - H^2 = 0.368 \; TV^2 \left(\frac{\partial P}{\partial V} \right)_T + 1987T^2 C_p \tag{7a}$$

$$(\overline{P}')^2 - (P')^2 = 10.73\ T \left(\frac{\partial P}{\partial V} \right)_T \qquad (8a)$$

It is found that Equations 7a and 8a will permit the accurate calculation of the energy level of a solute cell site, and that reduced temperature is the most successful measure of energy level. Thus if the energy level of the solute molecule is characterized by the reduced temperature of the solute, the energy level of the solute cell site in the solvent must also be characterized by the solute reduced temperature. Then the solvent cell site vapor pressure equals the solvent vapor pressure at the reduced temperature of the solute. (Where the solute reduced temperature is greater than 1.0, the solvent vapor pressure is found according to the usual procedure, namely, a plot of log P vs. 1/T is extrapolated through the critical temperature. Where a plot of log P vs. 1/T does not give a straight line, an accurate procedure is to express log P as a polynomial in terms of 1/T. Three terms usually suffice. Such an equation is then employed to calculate pseudo vapor pressures above the critical point.) The vapor pressure of the solvent cell site is termed the "acceptance pressure" of the solvent, and the "acceptance enthalpy" of the solvent will be approximated by Equation 9.

$$\frac{H_A - H^\circ}{P'_A - P'} = \frac{\overline{H} - H}{\overline{P}' - P'} \qquad (9)$$

We define "acceptance" properties as the properties acquired by

solute molecule in its "cell" in the solvent. Unfortunately there are no grounds for assuming that the ratio given in Equation 9 will be constant for all fluctuation levels, and in fact the case is otherwise. When the acceptance level is not far removed from the mean enthalpy and vapor pressure of the solvent, it is more accurate to assume that the pressure and enthalpy fluctuations are equal to the saturation pressure and enthalpy variations with temperature, as in Equation 10,

$$\frac{H_A - H^\circ}{P'_A - P'} = \frac{(H)_{T_2} - (H)_{T_1}}{(P)_{T_2} - (P)_{T_1}} \qquad (10)$$

where T_1 is the system temperature, and T_2 is the temperature of the solvent at the reduced temperature of the solute. Equation 10 thus reduces to Equation 10a, which states that the acceptance enthalpy of the solvent equals the saturated liquid enthalpy of the solvent at the reduced temperature of the solute.

$$H_A = \left(H_{\text{solvent}}\right)_{T_{r\ \text{solute}}} \qquad (10a)$$

It is found that when the difference between the reduced temperatures of solute and solvent is 0.5 or less, H_A is best calculated using Equation 10a. When the difference is greater than 0.5, H_A is best calculated using Equation 9.

A knowledge of the acceptance enthalpy permits us to cal-

culate the enthalpy of the solute at infinite dilution, since Lyderson et al. (16) have shown that the enthalpy deviation term $\frac{H^* - H}{T_c}$ may be plotted for saturated liquids as a universal function of reduced temperature and critical compressibility. Therefore, Lyderson's enthalpy deviation term must be the same for the solute molecule at infinite dilution and for the solvent cell site:

$$\left[\frac{H^* - H^{\infty}}{T_c}\right]_a = \left[\frac{H^* - H_A}{T_c}\right]_b \qquad (11)$$

Thus we may derive an expression for the enthalpy deviation from the ideal gas state of the more volatile solute at infinite dilution:

$$(H^* - H^{\infty})_a = \frac{T_{ca}}{T_{cb}} (H^* - H_A)_b \qquad (12)$$

Having calculated solute liquid enthalpy at infinite dilution, we may determine heats of solution at infinite dilution, and by use of a Margules-type equation, heats of solution at other concentrations may be calculated. The heat of solution at infinite dilution is $(H^\circ - H^{\infty})_i$ or L_i, where i represents any component. H°_i, the pure liquid enthalpy, is determined from pure component data. Frequently H°_i has to be determined for the pseudo liquid, as described in this paper. L_i is then determined as follows:

$$L_i = (H^* - H^{\infty})_i - (H^* - H^{\circ})_i \qquad (13)$$

and similarly for the second component, j, of a binary system,

$$L_j = (H^* - H^{\infty})_j - (H^* - H^{\circ})_j \qquad (13a)$$

The three-suffix Margules equation for activity coefficient variation with composition is (17):

$$\ln \gamma_i = x_j^2 \left[A_{ij} + 2x_i (A_{ji} - A_{ij}) \right] \qquad (14)$$

Differentiating with respect to $\frac{1}{T}$, we obtain Equation 15.

$$\frac{\partial \ln \gamma_i}{\partial (\frac{1}{T})} = x_j^2 \left[\frac{\partial A_{ij}}{\partial (\frac{1}{T})} + 2x_i \left(\frac{\partial A_{ji}}{\partial (\frac{1}{T})} - \frac{\partial A_{ij}}{\partial (\frac{1}{T})} \right) \right] \qquad (15)$$

But we know that the following are true:

$$\frac{\partial \ln \gamma_i}{\partial (\frac{1}{T})} = \frac{(H^\circ - \overline{H})_i}{R} \qquad (16)$$

$$\frac{\partial A_{ij}}{\partial (\frac{1}{T})} = \frac{L_i}{R} \qquad (17)$$

$$\frac{\partial A_{ji}}{\partial (\frac{1}{T})} = \frac{L_j}{R} \qquad (17a)$$

So, substituting Equations 17 and 17a into Equation 16 and eliminating R, we obtain, for component i

$$(H^\circ - H^L)_i = x_j^2 \left[L_i + 2x_i (L_j - L_i) \right] \qquad (18)$$

and for component j

$$(H^\circ - H^L)_j = x_i^2 \left[L_j + 2x_j (L_i - L_j) \right] \qquad (18a)$$

The total heat of mixing is given by Equation 19:

$$H^E = x_i (H^\circ - H^L)_i + x_j (H^\circ - H^L)_j \qquad (19)$$

and substituting Equations 18 and 18a into Equation 19, we obtain Equation 20:

$$H^E = x_i x_j (x_i L_i + X_j L_j) \qquad (20)$$

In an identical manner the four-suffix Margules equation (17) may be differentiated to yield an enthalpy equation. Schnaible, Van Ness and Smith (18) derived such an equation in which they gave the Margules D constant the value in Equation 21:

$$\frac{\partial D}{\partial (\frac{1}{T})} = (L_i - L_j) \qquad (21)$$

They thus derived the following total heat of mixing equation:

$$H^E = x_i x_j \left[x_i L_i + x_j L_j - x_i x_j (L_i - L_j) \right] \quad (22)$$

The Margules equation is the only binary correlatory equation that may be converted into an enthalpy equation based on heats of solution at infinite dilution. The Van Laar equation cannot be differentiated to yield any simple solution for enthalpy, while the many polynomial expressions are purely empirical equations of limited value.

For multicomponent systems, heats of mixing may be calculated from a knowledge of binary heats of solution at infinite dilution by utilizing the enthalpy form of the Wohl equation (19). The Wohl equation yields an enthalpy of mixing equation in which the activity coefficient term is replaced by an enthalpy of mixing term and the Margules constants are replaced by respective enthalpy constants. This equation may be derived in the same manner as the preceding heat of mixing equation.

The total heat of a solution is obtained by adding the heats of mixing to the sum of the partial enthalpies of the pure liquids as in Equation 23:

$$H^M = \left[\sum x_i \; H^\circ_i + H^E \right] \quad (23)$$

The Pseudo Liquid

When calculating acceptance enthalpies, and pure liquid

enthalpies, it may be necessary to handle "liquids" at temperatures above their critical. A pseudo liquid state is therefore defined, starting from the equation for enthalpy deviation from the ideal gas state, as given by Equation 1:

$$(H^* - H) = \int_0^P \left[T \left(\frac{\partial V}{\partial T}\right)_p - V_T \right] dP \qquad (1)$$

It will be observed from the generalized enthalpy deviation charts of Lyderson et al. (16) that the term $\frac{H^* - H}{T_c}$, then plotted against reduced pressure, gives a broad maximum for any reduced temperature. Since, in the pseudo liquid state, both V_T and $\left(\frac{\partial V}{\partial T}\right)_p$ will be small, the term $\left[T \left(\frac{\partial V}{\partial T}\right)_p - V_T \right]$ may be approximated to zero, and $\frac{H^* - H^\circ s}{T_c}$ for the pseudo state is therefore taken as the maximum value of the term at the given reduced temperature, or the liquid enthalpy at the Joule-Thomson inversion pressure. The pseudo liquid enthalpy deviations are plotted on Figure 2 as a function of reduced temperature and critical compressibility. The pseudo liquid enthalpy starts to diverge from pure liquid enthalpy at a reduced temperature of 0.82. In the reduced temperature range from 0.82 to 1.0, there exist two liquid enthalpies, H°, the pure liquid enthalpy, and H°s, the pseudo liquid enthalpy; the pure liquid enthalpy, H°, is used for the pure solvent enthalpy, and H°s, the pseudo liquid enthalpy, is used for the solute enthalpy, and in calculating the solvent acceptance enthalpy.

For components whose properties do not fit the generalized charts, the maximum enthalpy deviation from ideality ($H^* - H°s$) may be found by plotting ($H^* - H$) for the component at a given temperature and the range of pressures available against the values of ($H^* - H$) determined from generalized charts at the same temperature and pressures, according to the method of Othmer (20). The line is usually easily extended, and a corresponding maximum enthalpy deviation is read off this plot, using the maximum enthalpy deviation obtained from the generalized charts. As previously stated, vapor pressures above the critical temperature have been obtained by extending the usual plot of log of vapor pressure against reciprocal of absolute temperature. It can be argued that according to the definition of the pseudo liquid state postulated above, the pseudo liquid vapor pressure should be the Joule-Thomson inversion pressure. However, very little accurate information is available for the Joule-Thomson inversion pressure of most components, and where such data are available the enthalpies calculated are substantially the same as those using extended vapor pressure plots, since a similar correction is applied to both solute and solvent.

Polar Systems

A full treatment of polar systems is left to a future paper, but Himmelblau's data (21) for the enthalpies of a number of gases dissolved in water are considered out of interest, in the framework of nonpolar theory. It would be expected that a solute molecule would be "held" more firmly by a polar solvent, thus pre-

cluding the "buoyancy" effect, or "acceptance" of water towards a more volatile solute. This is found empirically to be the case. As temperature decreases, the effect of the polar forces becomes more noticeable, and two different mechanisms are found to exist, one at 80°C. and another at 25°C. On Table 1 calculated values of the enthalpy departure from the ideal gas state are compared with Himmelblau's data for the gases considered. At 80°C there is found to be no heat of mixing for the gases, and the liquid enthalpy at infinite dilution is equal to the pseudo liquid enthalpy as defined in this paper, and may be read from Figure 2.

At 25°C. the gases behave as for nonpolar systems, but without the "acceptance" effect. In other words, the cell occupied by the solute gas has the average values of the solvent, and Equation 12 becomes Equation 12a:

$$(H^* - H^{\infty})_a = \frac{T_{ca}}{T_{cb}} (H^* - H^{\circ})_b \qquad (12a)$$

Results

Heats of solution and mixture enthalpies have been calculated for four nonpolar binary systems for which experimental data are available (22, 23, 24) and for one ternery system (25). Himmelblau's data (14) for gases dissolved in water are also considered. (See preceding section.) For the system methane-nitrogen, enthalpy data derived from P-V-T data (26) are compared along with the experimental data (23). Calculated heats of mixing are

sufficiently accurate to enable liquid mixture enthalpies to be determined to within about 3 Btu/lb. accuracy.

On Figure 3 and 4 calculated data for the systems oxygen-argon and nitrogen-argon are compared with the experimental data of Pool et al. (22). It will be seen that the heats of mixing for these systems are very small and that they are reproduced very well by the two Margules equations (20 and 22). For these systems the authors suggest the correlatory equation:

$$H^{E} = x_i x_j \left[L_i + L_j (x_i - x_j) \right] \qquad (24)$$

This equation is compared along with equations 20 and 22. Errors of less than 1% in pure component enthalpy, vapor pressure, or critical constant data could reproduce the data of Pool et al. exactly, or move the calculated line further from the experimental data, and it is doubted whether pure component enthalpy data are correct to within 1%, particularly for argon. It is therefore suggested that the calculated data are as close to the experimental data as is feasible by this method without very accurate pure component data. Figures 5 and 6 compare calculated enthalpy data for the system methane-nitrogen in which nitrogen is present above its critical temperature. In Figure 5 the calculated data are compared with the experimental data of the U.S. Industrial Chemicals Company (23) for the difference between gas enthalpy at 25°C and saturation pressure, and saturated liquid enthalpy. The calculated data include heats of mixing, as well as pseudo

liquid enthalpies for nitrogen, and pure component enthalpy data for methane. Derived data of the Institute of Gas Technology (18) for the nitrogen-methane system are compared in Figure 6. It will be seen that the agreement is good for the 10% nitrogen system, but poor for the 30% nitrogen system. However, the latter system is close to the mixture critical temperature where P-V-T data are hard to obtain accurately, and as discussed below in connection with the data of Sage and Lacey, difficult to differentiate graphically. The 30% nitrogen data of I. G. T. are suspect on the grounds that they show a crossover with the ideal mixing enthalpy. This is not shown at 10%, or by the experimental data of National Distillers at 46.65% nitrogen.

On Figure 8 total enthalpies are presented for the liquid methane-butane system. The enthalpies calculated are compared with the data of Sage and Lacey (24) which were derived from P-V-T measurements, and with data calculated by the Benedict-Webb-Rubin equation of state (27). The agreement with the latter is seen to be excellent. The Correlation of Canjar and Peterka (10) was found to be the best of the correlations investigated, (7, 8, 9, 10) and their results are included on figure 7 by way of comparison. The order of magnitude of error inherent in graphical differentiation may be seen on figure 7 by comparing Sage and Lacey's data for the methane-butane system with the data computed by machine using the Benedict-Webb-Rubin equation of state. Sage and Lacey derived their data by graphical differentiation of experimental P-V-T data. The computer does substantially the

same calculation, but eliminates the human factor. Therefore, making the two assumptions,(a) that Sage and Lacey did work as accurate as humanly possible, and (b) that the B-W-R equation of state represents P-V-T data for the system within the tolerance of experimental error, the difference between the two sets of data represent the order of magnitude of error inherent in graphical differentiation.

It must be clearly understood that the above does not imply that experimental data are wrong. The experimental P-V-T data are assumed to be absolutely correct. It is suggested that graphical differentiation of P-V-T data to obtain very accurate enthalpy data is impossible, and that machine computed values will be more accurate. Accordingly the agreement between the values calculated by the method of this paper for the methane-butane system, and the values computed using the B-W-R equation of state, is held to be a test of the usefulness of the method.

On table 2 the experimental data of Nelson and Holcomb (25) for the ternary system propane, butane, pentane are compared with the values calculated by this paper, along with the values given by the correlation of Holcomb and Brown (7), which for this system was found to be the best correlation. Only data for the saturated liquid were compared. It will be seen that the two methods give about equally good results, but whereas the correlation of Holcomb and Brown considers the effect of pressure on liquid enthalpy, this paper does not.

Calculation Procedure

For nonpolar binary systems, the following steps are employed in calculating total enthalpy:

1. Calculate enthalpy departure from the ideal gas state at infinite dilution for component (a) in component (b) and for component (b) in component (a). Where the less volatile component is the solute, the enthalpy departure is given by Equation 2.

$$(H^* - H^{\infty})_{bT_{rb}} = (H^* - H^\circ)_{bT_{ra}} \qquad (2)$$

For the more volatile component as the solute, the enthalpy departure from the ideal gas state at infinite dilution is given by:

$$(H^* - H^{\infty})_a = \left(\frac{T_{ca}}{T_{cb}}\right) (H^* - H_A)_b \qquad (12)$$

The acceptance enthalpy, H_A, is calculated using Equation 9 if the solute reduced temperature is more than 0.5 greater than the solvent reduced temperature, and using Equation 10a if the solute reduced temperature is less than 0.5 greater than the solvent reduced temperature.

2. Calculate the heat of solution at infinite dilution according to Equation 13.

$$L = (H^\circ - H^{\infty}) = (H^* - H^{\infty}) - (H^* - H^\circ) \qquad (13)$$

3. Calculate the heat of mixing using Equation 20.

$$H^E = x_i x_j (x_i L_j + x_i L_j) \tag{20}$$

If individual partial heats of mixing are required, these may be calculated using Equation 18.

$$(H^\circ - H_L)_i = x_j^2 \left[L_i + 2x_i (L_j - L_i) \right] \tag{18}$$

4. Equation 23 is used to predict the total molal enthalpy of the mixture:

$$H^M = \sum x_i H_i^\circ + H^E \tag{23}$$

Conclusion

A general method has been presented which allows the calculation of total enthalpies of liquid nonpolar mixtures with good engineering accuracy. An attempt is being made to gain a clearer understanding of the relationship between vapor pressure and enthalpy fluctuations, in order to improve on the "rules of thumb" set forth in this paper for calculating acceptance enthalpies. The application of this work to polar systems and to other liquid excess thermodynamic functions also promises rewarding results.

The correlations of Holcomb and Brown (7), and Canjar and Peterka (10) are probably as accurate as the method of this paper,

and certainly are a good deal simpler to use. However, they are limited to a narrow range of components and conditions.

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TABLE 1

ENTHALPY DEVIATION FROM IDEAL GAS (H* - H) Cals/Mole

Gas	Calculated 25°C	Himmelblau 25°C	Calculated 80°C	Himmelblau 80°C
O_2	2706	2900	293	576
N_2	2200	2500	125	146
H_2	721	960		
HC	230	400		
XE	5082	4500	1940	1440
CH_4	3343	3200	552	626
Ne	780	1080		
A	2650	3100		
Kr	3686	3440		

TABLE 2

SATURATED LIQUID MIXTURE ENTHALPIES FOR PROPANE-BUTANE-PENTANE MIXTURES

Datum Level: Pure Liquid at 80° F = 0 BTU/lb.

Mixture Component	A Mole %	B Mole %	C Mole %
$C_3 H_8$	20.1	20.1	19.8
$n\text{-}C_4 H_{10}$	39.9	29.8	10.6
$n\text{-}C_5 H_{12}$	40.0	50.1	69.6

Temperature °F	A			B			C		
	Exp.	H & B	Osborne	Exp.	H & B	Osborne	Exp.	H & B	Osborne
240	101	102	103						
260				120	114	115			
280	135	133	129	134	132	130	134	131	129
300	146	149	146	147	147	145	146	145	141
320	165	163	164	165	162	162	161	160	160
340							185	198	179

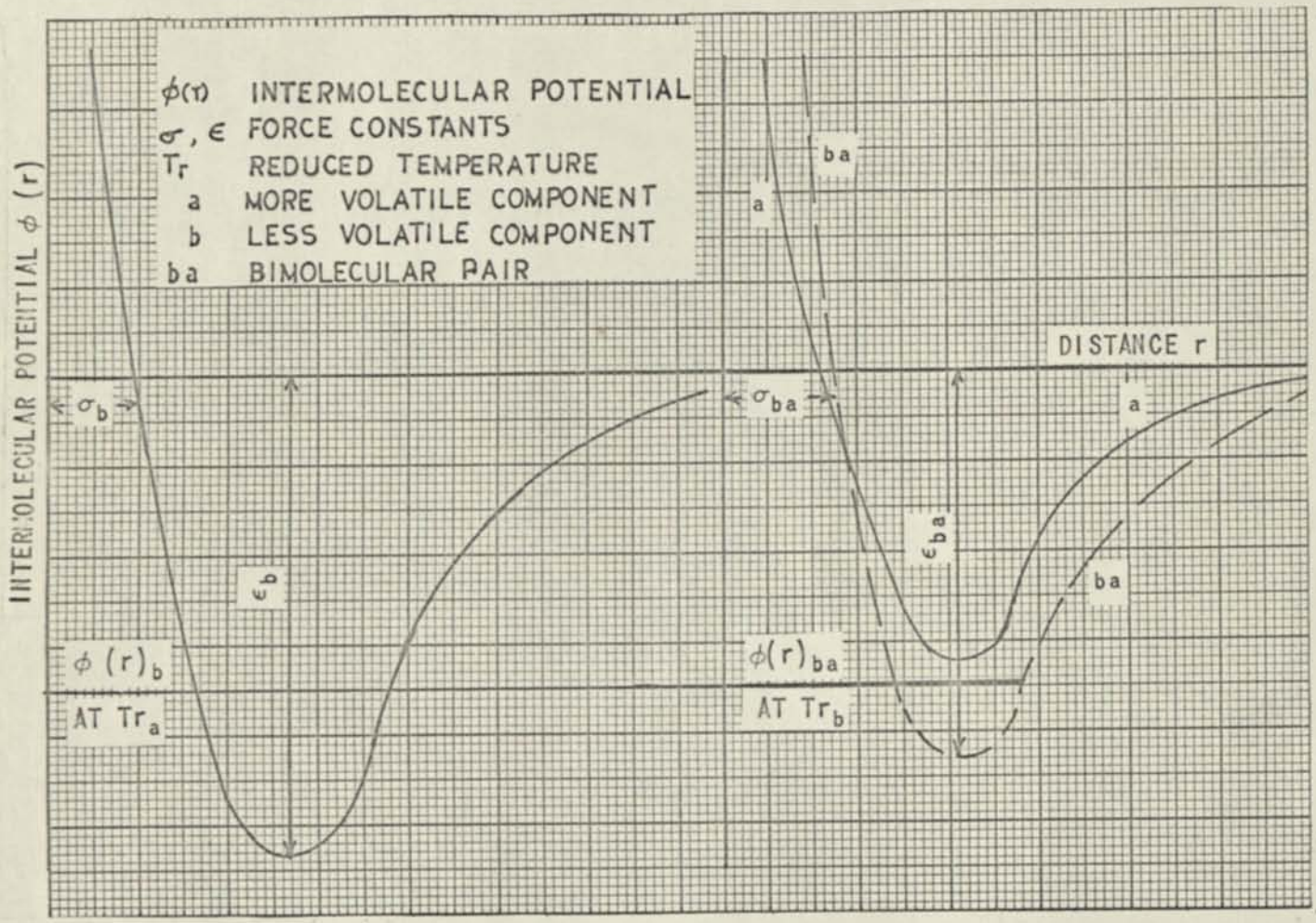
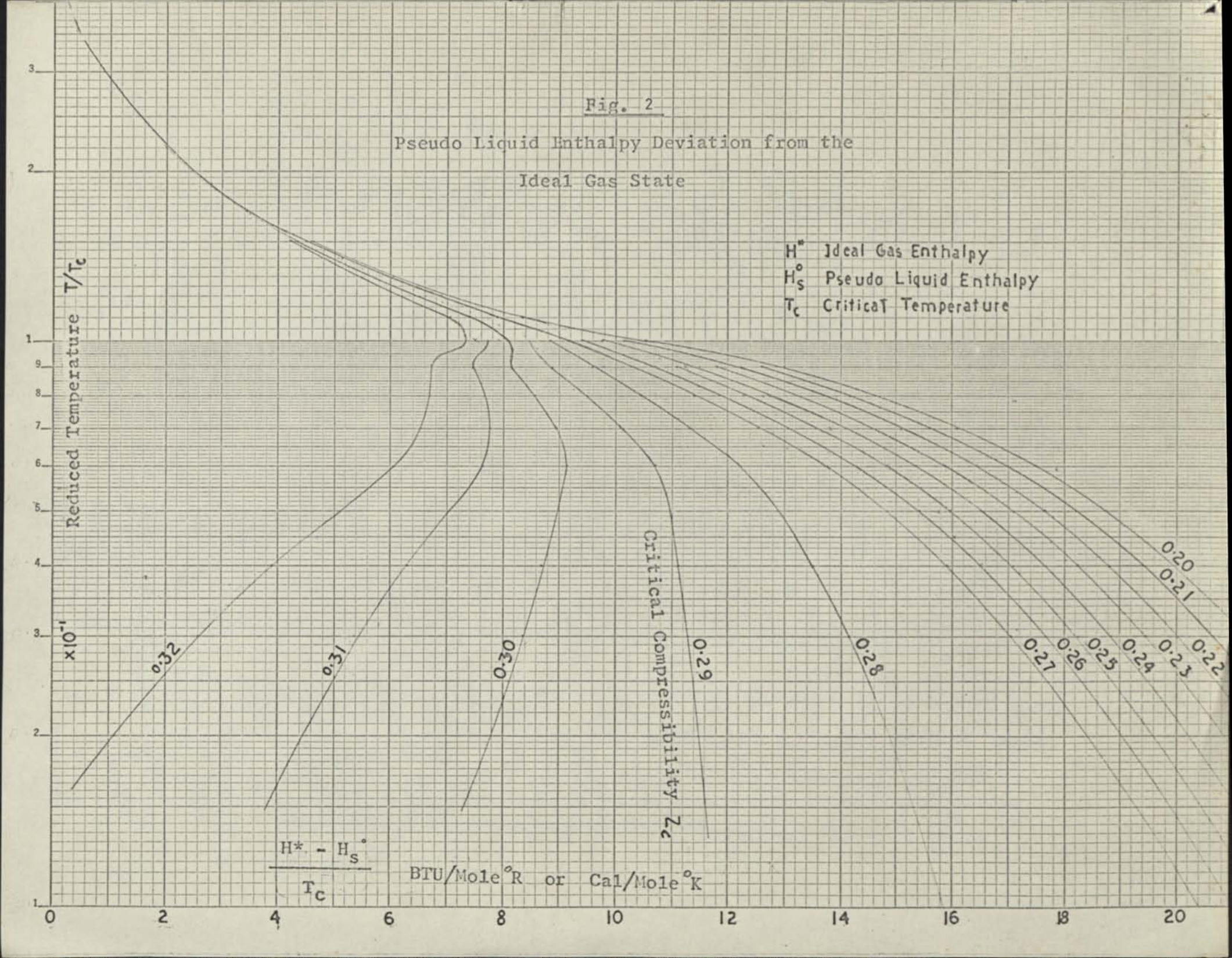
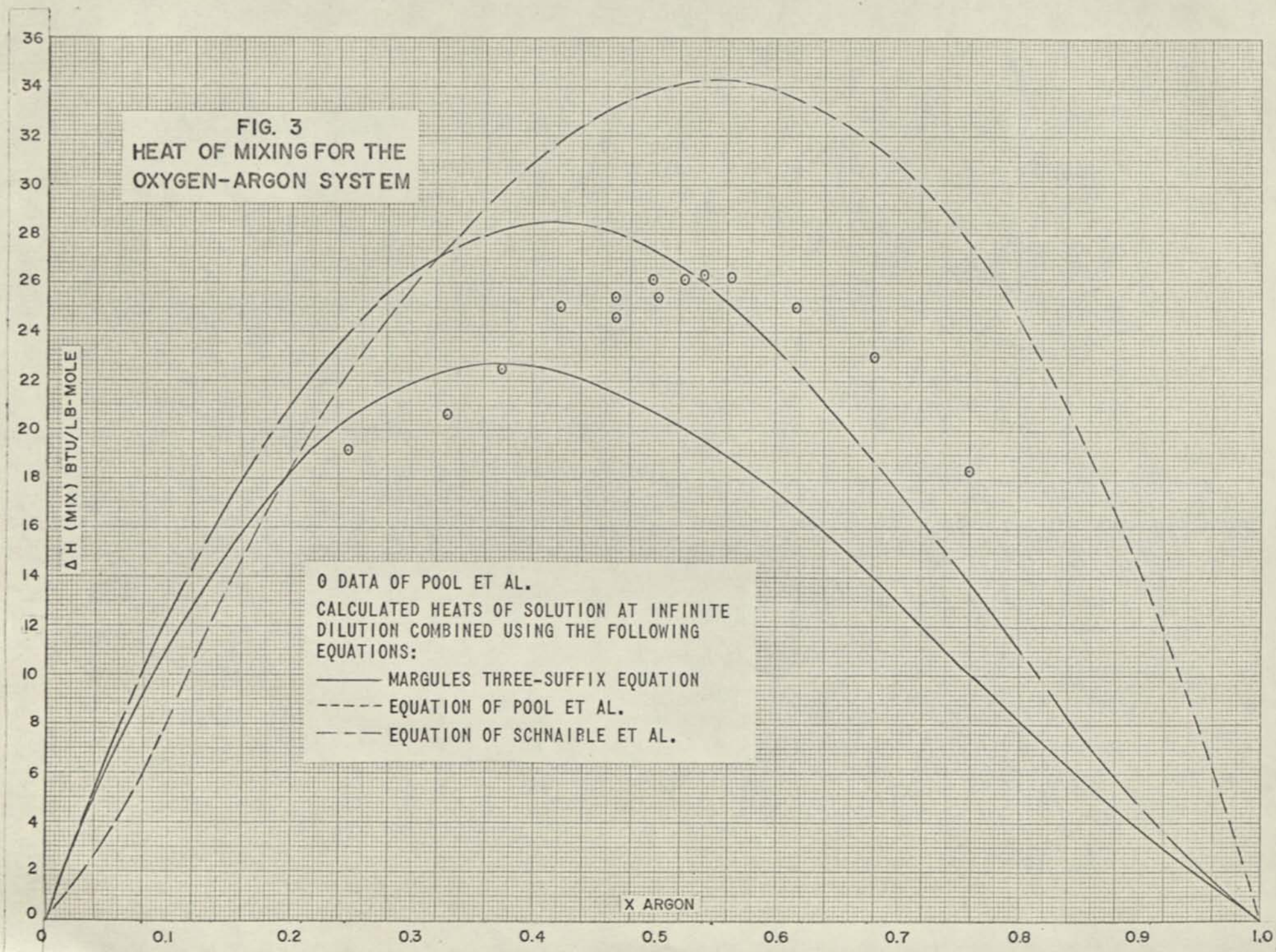


Figure 1: The intermolecular potentials of a less volatile solute at infinite dilution in a more volatile solvent, and for the pure solute at the reduced temperature of the solvent.

Fig. 2

Pseudo Liquid Enthalpy Deviation from the Ideal Gas State





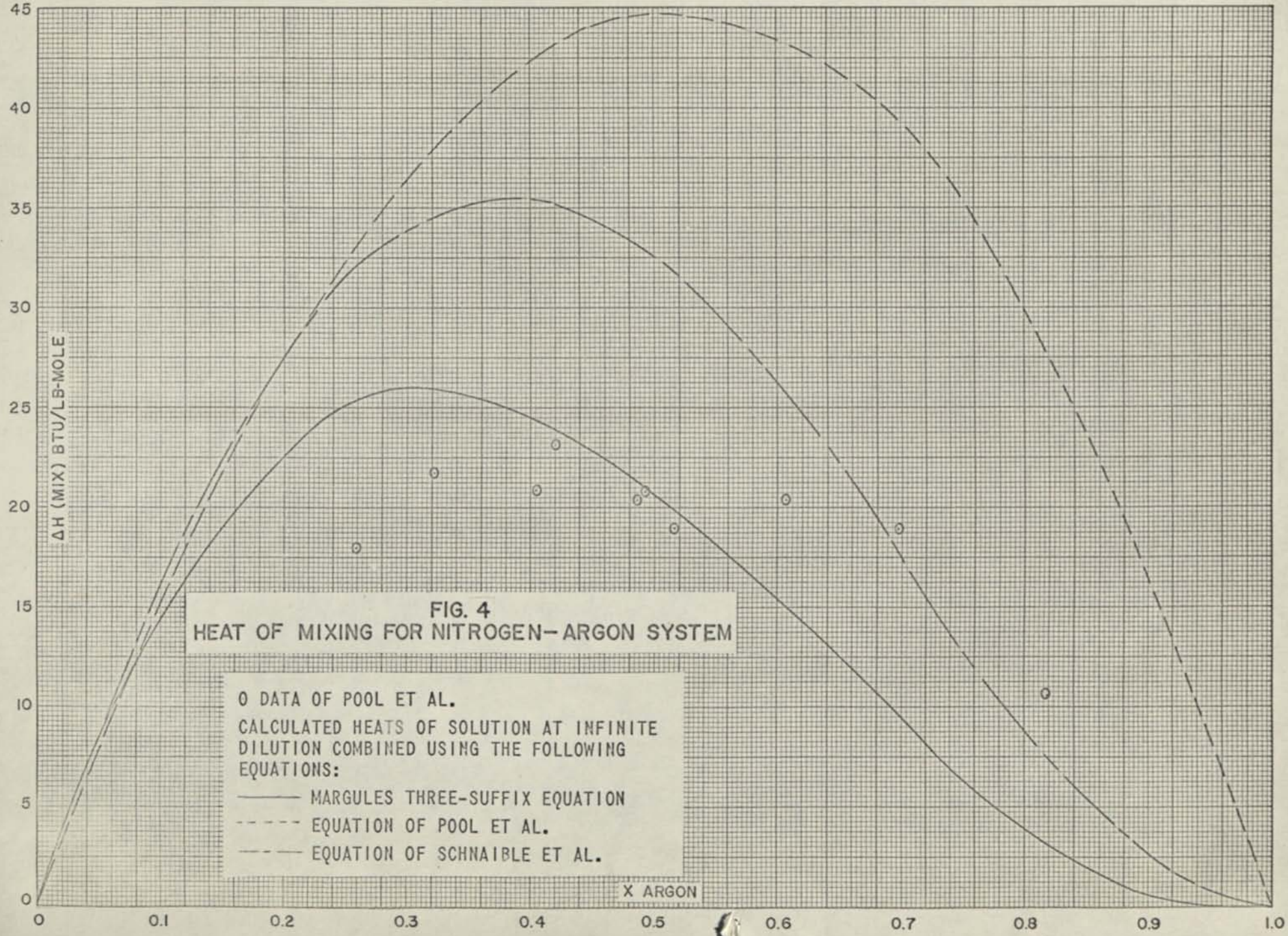


FIG. 4
HEAT OF MIXING FOR NITROGEN–ARGON SYSTEM

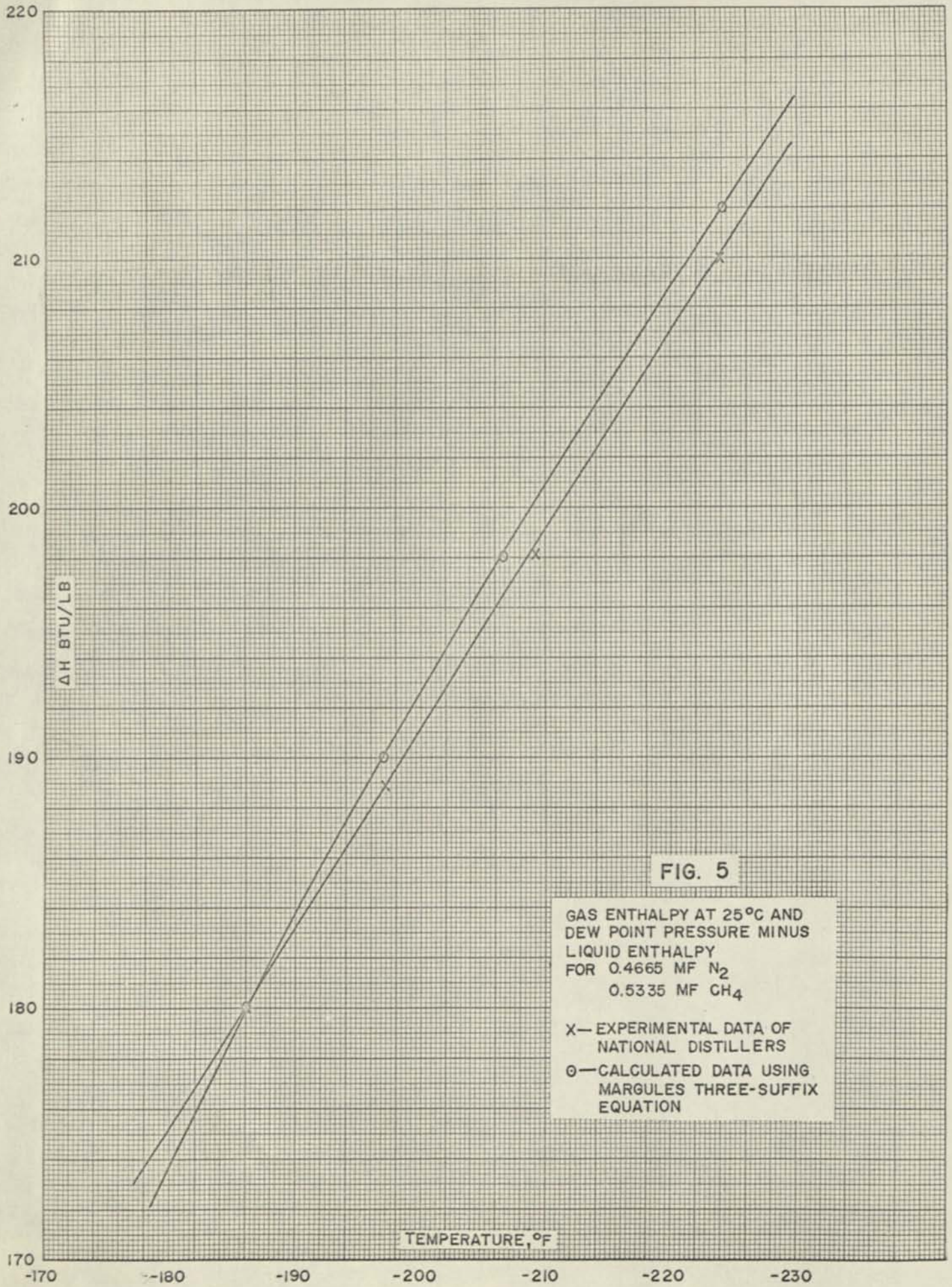
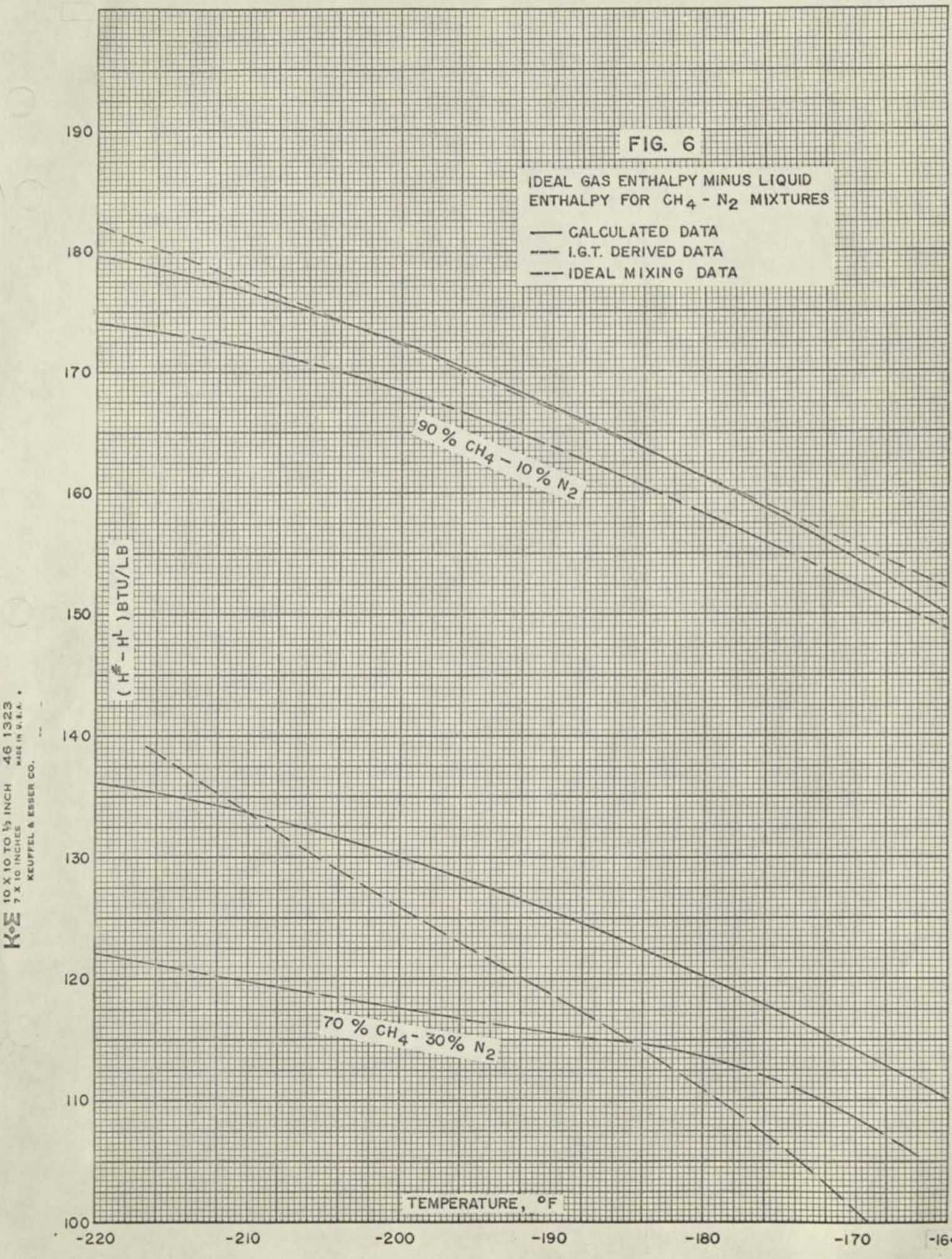


FIG. 5

GAS ENTHALPY AT 25°C AND DEW POINT PRESSURE MINUS LIQUID ENTHALPY FOR 0.4665 MF N_2 0.5335 MF CH_4

X— EXPERIMENTAL DATA OF NATIONAL DISTILLERS

⊙— CALCULATED DATA USING MARGULES THREE-SUFFIX EQUATION



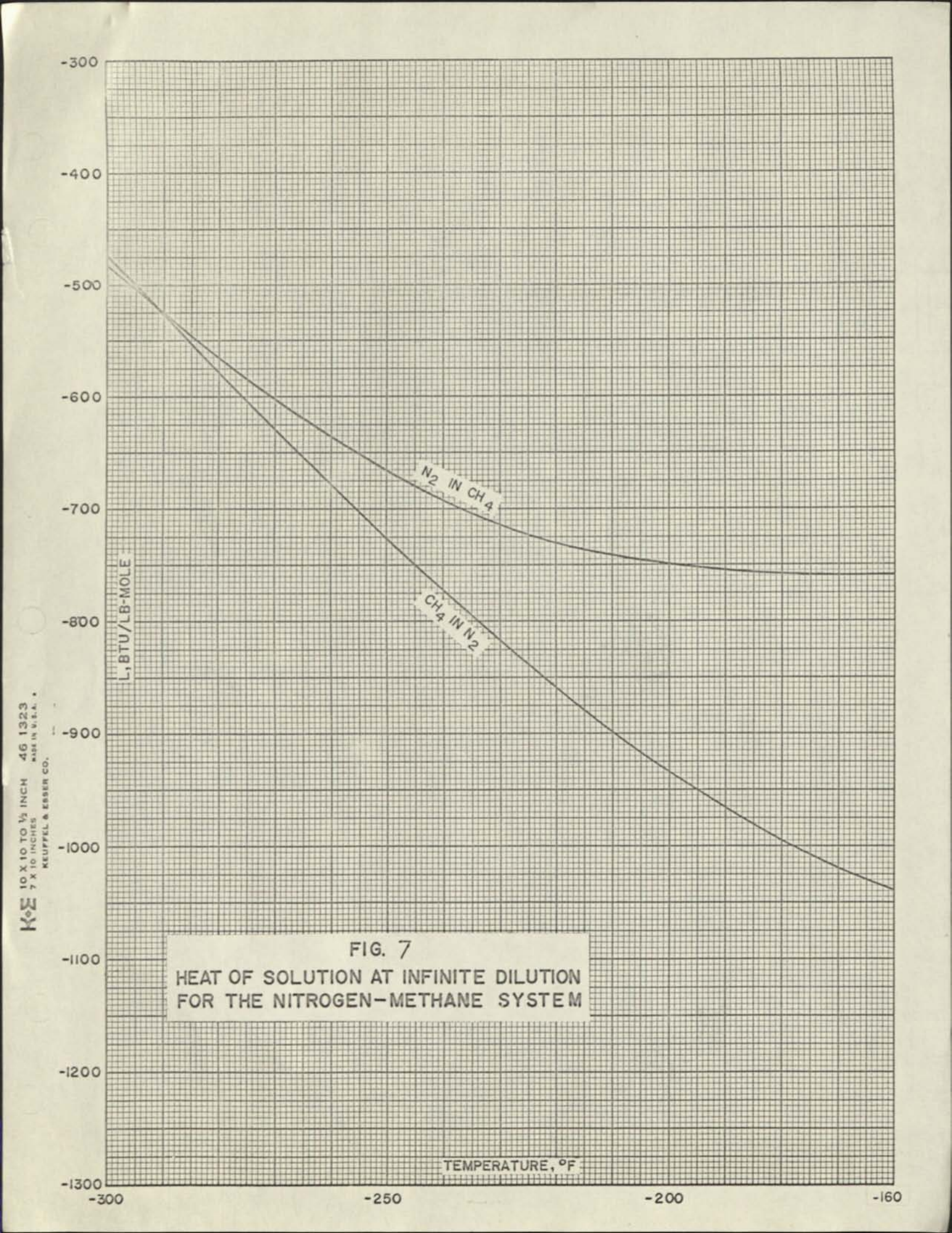


FIG. 7

HEAT OF SOLUTION AT INFINITE DILUTION FOR THE NITROGEN–METHANE SYSTEM

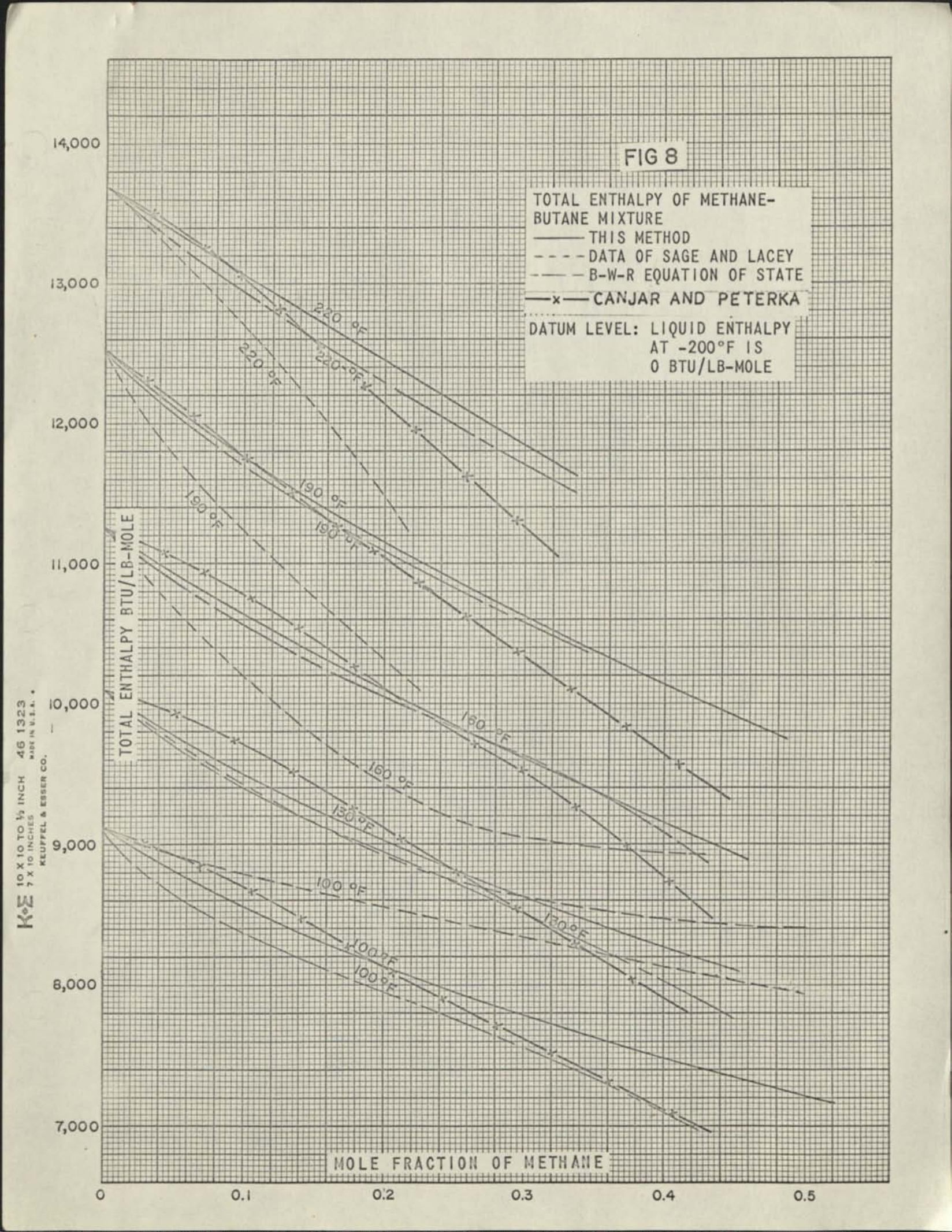
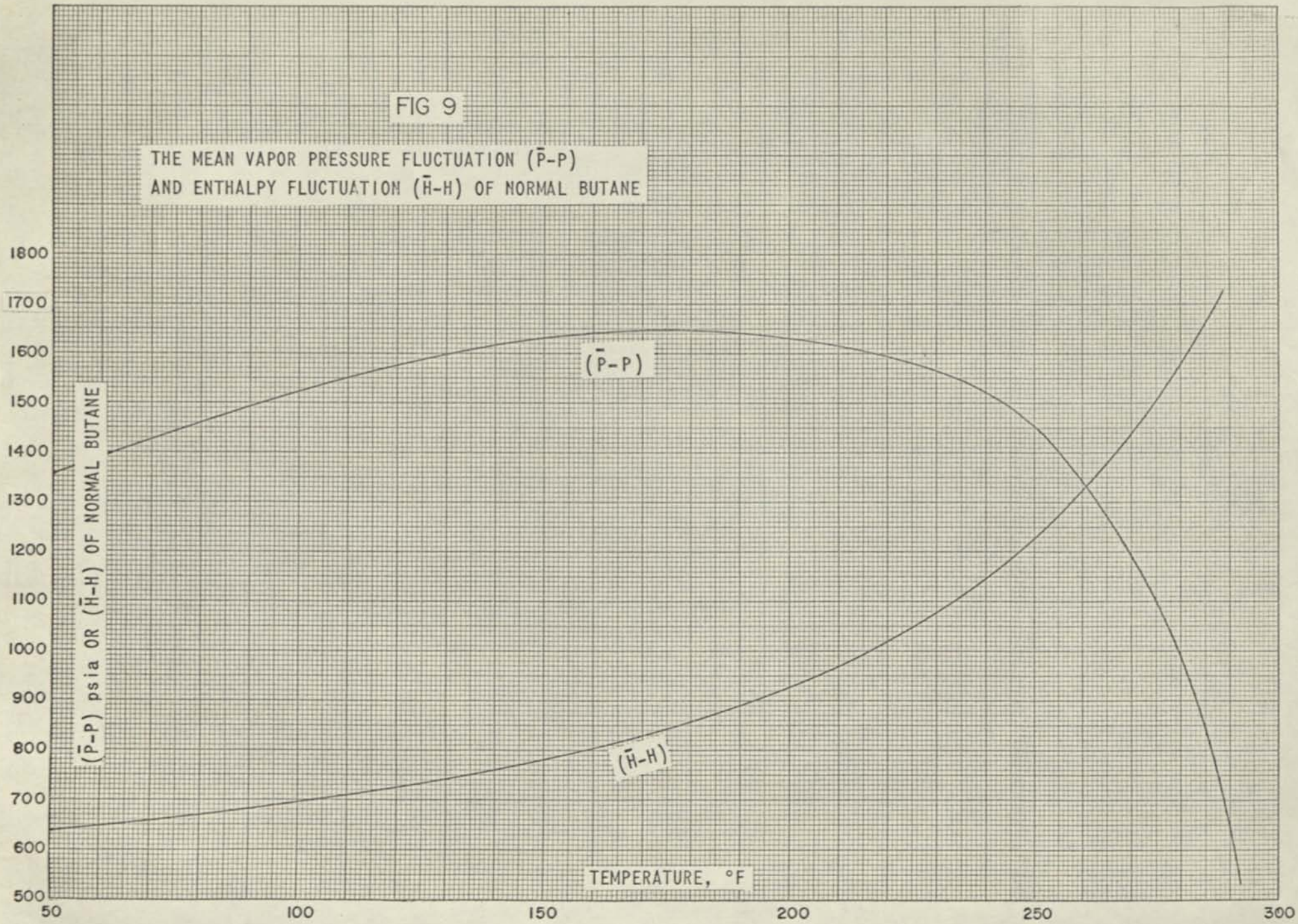


FIG 8
TOTAL ENTHALPY OF METHANE-BUTANE MIXTURE
THIS METHOD
DATA OF SAGE AND LACEY
B-W-R EQUATION OF STATE
CANJAR AND PETERKA
DATUM LEVEL: LIQUID ENTHALPY AT -200°F IS 0 BTU/LB-MOLE
TOTAL ENTHALPY BTU/LB-MOLE
MOLE FRACTION OF METHANE
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
0
0.1
0.2
0.3
0.4
0.5
220 °F
190 °F
160 °F
130 °F
100 °F

FIG 9

THE MEAN VAPOR PRESSURE FLUCTUATION ($\bar{P}$-P)
AND ENTHALPY FLUCTUATION ($\bar{H}$-H) OF NORMAL BUTANE



NOMENCLATURE

A_{ij}	Activity coefficient at infinite dilution of component i in component j
Cp	Specific Heat at constant pressure
H	Enthalpy
$\bar{H}$	Mean enthalpy fluctuation
H^*	Ideal gas enthalpy
H°	Pure component liquid enthalpy
H_A	Acceptance enthalpy
H^E	Heat of mixing
H^L	Liquid enthalpy
H^M	Liquid enthalpy of a mixture
$H^\circ s$	Pseudo liquid enthalpy
H	Liquid enthalpy at infinite dilution
K	Constant
k	Boltzmann's constant
L	Heat of solution at infinite dilution
P	Pressure
P'	Vapor pressure
$\bar{P}'$	Mean fluctuation of vapor pressure
P_A	Acceptance pressure
R	Gas constant
T	Temperature
Tc	Critical temperature
T'	Temperature at which solvent vapor pressure equals solute vapor pressure at temperature T
V	Liquid molal volume

X	Liquid mole fraction
Zc	Critical Compressibility
Z_N	Partitian function
γ	Liquid activity coefficient
$\phi(r)$	Intermolecular potential
σ, ε	Force constants

Subscripts

a	More volatile component
b	Less volatile component
ba	Less volatile component solute in more volatile component solvent
T	Constant temperature
P	Constant pressure
Tr	Constant reduced temperature.
Zc	Constant critical compressibility

282 Manuel Street
Newark,
Delaware.
9 - 3 - 65

Professor Harding Bliss, Editor,
A. I. Ch. E. Journal
Yale University,
225 Prospect Street,
New Haven, Conn.

Re: #7284 - " The Prediction of Liquid Enthalpies from Pure Component Properties "

Dear Professor Bliss:

I enclose three copies of the revised paper, as requested, incorporating most of the suggestions made by you and the reviewers. The only comment about which I have been able to do nothing is that of Dr. Ellington, concerning the magnitude of error involved when using the Ridlich - Kwong equation to calculate wirial coefficients for sub-saturated vapors. My information on this subject is based on work done by the M.W.Kellogg Co. The Company are uncertain whether to publish this work as a paper, or whether to keep the information to themselves and classify it. In either case they do not want me to add anything to what I have already stated.

Concerning the remarks of Dr. Griskey, the man seems to be gridding some private ax, which for a reviewer is unfortunate. I draw your attention to his remark: " --- some questionable industrial data (National Distillers) --- " (Page 1, line 11), a remark he can have no possible grounds other than bias for making. It is also customary, especially when writing a bad

equation (22) which was developed for the Margules equation. For the van Laar equation it is

$$H^E = \frac{1}{\frac{1}{L_1 x_1} + \frac{1}{L_2 x_2}}$$

and the evaluation of the constants from experimental data has been mentioned by Karr and Scheibel (Chem. Eng.Prog. Symp. Series 50, No. 10,73(1954). I have done considerable work on correlating heats of solution by this method and find that the van Laar equation is generally somewhat better particularly if the data cover a limited range of compositions. When the heats of infinite dilution are equal both equations become identical and when they are nearly equal inaccuracies in the integral heat of solution data make it impossible to select the better equation. One significant point is that the van Laar equation never gives the inflexion point shown by the Margules equation in figure 3 and if this is clearly evidened by the data, the choice of equation is established.

The author did not give the heats of infinite dilution used to calculate the curves in his figure 3 but according to the presence of the inflexion point the value of L_A was more than twice L_{O_2}. I have correlated the data to values of $L_A = 93$ and $L_{O_2} = 117$ and the calculated curve passes through the points almost within the reproducibility of the measurements as evidenced by their slight scattering. It thus appears that the author's method for predicting heats of infinite dilution does not apply to the argon - oxygen system.

The method was doubtless developed for hydrocarbon mixtures where the heats of dilution are small and I think the manuscript should explain in much greater detail how the author developed and tested his method for predicting the heats of solution. This is essential because it is so highly empirical and on the basis of the

present manuscript appears almost arbitary. Also the use of of the van Laar equation may be an improvement in his technique and he should give it some consideration.

It appears that the author has already done a considerable amount of work in developing his technique and I am certain that when it is published he would want it to represent the best that could be devised up to that time. I should be very pleased to discuss with him my different methods for correlating heat of solution data which he can use to verify his basis hypothesis. With this additional work he should be able to provide much greater support to his theory and increase its chances for acceptance as a basis for design.

E.G.Scheibel

E.G.Scheibel

THE INTERPLAYERS

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ERWIN PISCATOR

&

BERTOLT BRECHT

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From the Novel by Jaroslav Hasek

DIRECTED & DESIGNED BY PHILLIP RAYHER

Drawings and Marionettes by Ruth Bennett

Based on the Original Concept by Georg Grosz & Erwin Piscator

---

hey gave me a revolver and said: now shoot our foe!
ut as I fired on his ranks I laid my brother low.
– BERTOLT BRECHT

The Place: The Austrian-Hungarian Empire

The Time: The Great War, 1914 - 1918

There will be one ten-minute intermission.

– Cast of Characters –

Josef Schweik, a dog seller	*James Hillgartner*
Mrs. Muller, his charwoman	*Florence Larios*
Bretschneider, a police spy	*Charles Moll*
Palivec, proprietor of The Flagon	*Irving Israel*
Police Inspector Braun	*Cyril Clayton*
A Hospital Orderly	*James Sullivan*
Soldiers	*Vincent Bartz, Arthur Weiss, Patrick D. O'Neill, Wayne Mooney, Charles Rule*
Staff Warder Slavik	*Charles Moll*
Field Chaplain Otto Katz	*Irving Israel*
Prisoner in Chapel	*James Sullivan*
Lieutenant Lukash	*Brantley Kearns*
Madame Katy, Lukash's ladyfriend	*Anne Scholefield*
Sapper Vodicka, Schweik's friend	*Patrick D. O'Neill*
A Maid	*Bonnie Jo Zeld*
Colonel Kraus Von Zillergut	*Arthur Weiss*
Major-General Von Schwarzberg	*Dan Brown*
A Train Conductor	*Patrick D. O'Neill*
M.P. Corporal	*Wayne Mooney*
M.P. Lieutenant	*Cyril Clayton*
An Old Peasent Woman	*Florence Larios*
Drunken Harmonica Player	*Dan Brown*
An Old Shepherd	*Wayne Mooney*
Police Private	*James Sullivan*
Police Desk Sergeant	*Arthur Weiss*
Old Servant Woman	*Kate Genins*
Stockade Warder	*Charles Moll*
Corporal Marek	*Charles Rule*
Quartermaster Sergeant Vanek	*Patrick D. O'Neill*
Private Baloun	*Cyril Clayton*
Lieutenant Dub	*Cyril Clayton*

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Construction Crew . . . *Tom Tate, Charles Rule, Patrick D. O'Neill, Tom Allen, James Sullivan, Ted Skinner, Vincent Bartz*

Marionette Execution and Painting . . *Peter Maslan & Tom Schmidt*

Stage Manager and Property Master . . . . . *Ted Skinner*

Assistant Stage Manager . . . . . *Vincent Bartz*

Assistant to the Director . . . . . *Bonnie Jo Zeld*

Lighting Design . . . . . *Dale Altvater*

Sound Technician . . . . . *John Martin*

Original Music . . . . . *Wayne Mooney*

Photography and Slides . . . . . *Bob McClurg*

Captions . . . . . *Bob McClurg & Michael Burns*

Costume Crew . . . *Marilyn Wells, Shirley Luchi, Norma Veltri, Sandra Casali, Roma King, Diane Rule, Kate Genins, Bonnie Jo Zeld, Phyllis Axe, Marilyn Sacula*

Projectionists . . . *Michael Stone, Jack Burian, Walter Atchison*

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NAME	Osborne, Adam	CH.Engr.
ADDRESS	282 Manuel St., Newark, Del.	
LANGUAGE	☐ German ☒ French ☐ Other (Specify):	
RESULT	☒ Passed ☐ Failed	School of Graduate Studies: Passed CEB,
DATE	3/6/65	
EXAMINER	Departmental	Modern Languages: S. Boorton

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53053 OSBORNE ADAM GR 50 29 -9 11 7 65 F

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COURSE SYMBOL & NO.	COURSE TITLE	MID. SEM. DEF. RES.	C.C. DEF.	CR. HR.	FINAL GRADE	QUAL. PTS.	MID SEM. GR.
CHE 835	APPLD CHEM KINETICS			3	L	--	
CHE 873	RESEARCH			3	S	--	

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FINAL GRADES

A	— Excellent	4 quality points per credit
B	— Good	3 quality points per credit
C	— Fair	2 quality points per credit
D	— Poor	1 quality point per credit
F	— Failure	0 quality points per credit
Z	— Failing — Unofficial Withdrawal	0 quality points per credit
P	— Passing	Has no quality point value
L	— Listener (formerly audit)	—Registration without credit or grade. Class attendance required, but participation in class is not required.

LW — Listener Withdrawn
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YF — Suspended or Expelled — failing in semester's work
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WF — Official Withdrawal — failing in semester's work at time of withdrawal

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I — Incomplete
S — Satisfactory Progress
U — Unsatisfactory Progress
N — No Grade Reported - See regulations

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A Inadequate preparation of assignments.
B Failure to attend class regularly.
C Failure in daily recitation.
D Failure in class quizzes or examination.
E Poor classroom attitude: Inattention, laziness, etc.
F Inadequate foundation or background for course.
G Weak in mechanical techniques.
H Has language, speech or reading difficulty.
I Miscellaneous (See adviser for details).

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ADAM OSBORNE
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PARENT
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CHE 865	DISTILLATION			3	A	12	
CHE 826	CHE THERMODYNAMICS			3	B	09	
ME 864	ENGINEERING ANALYSIS			3	A	12	
CHE 861	HEAT TRANSFER			3	A	12	
CHE 873	RESEARCH			2	S	--	
CHE 869	MASTERS THESIS			3	S	--	

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CREDIT HOURS								W CC	

FINAL GRADES

A	— Excellent	4 quality points per credit
B	— Good	3 quality points per credit
C	— Fair	2 quality points per credit
D	— Poor	1 quality point per credit
F	— Failure	0 quality points per credit
Z	— Failing — Unofficial Withdrawal	0 quality points per credit
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CHE 825	CHE THERMODYNAMICS			3	B	09	
CHE 869	MASTERS THESIS			3	S	--	
CHE 871	SEMINAR			1	B	03	
ME 863	ENGINEERING ANALYSIS			3	B	09	
CHE 860	FLUID MECHANICS			3	B	09	

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CREDIT HOURS								W CC	

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282 MANUEL STREET
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CONTROL NO.	STUDENT NAME	CLASS	MAJOR	HIGH SCHOOL	STATUS	DATE	TYPE REPORT

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CHE 969	PHD DISSERTATION			6	S	--	

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PREV. CUMULATIVE		CURRENT TERM			CUMULATIVE TO DATE		

EFZ	S.G.	N.D.	PR. WK.	SEX	RES	FRAT.	DORM	CR HR DEF
CREDIT HOURS								

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COURSE SYMBOL & NO.	COURSE TITLE	MID. SEM. DEF. REQ.	C.C. DEF.	CR. HR.	FINAL GRADE	QUAL. PTS.	MID SEM. GR.
CHE 881	PROCESS DESIGN			3	L	--	
ST 650E	APPLIED STATISTICS			3	L	--	
CS 6155	LIN & NON-LIN PROGRM			3	A	12	
CHE 969	PHD DISSERTATION			1	S	--	

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PREV. CUMULATIVE		CURRENT TERM			CUMULATIVE TO DATE		

EFZ	S.G.	N.D.	PR. WK.	SEX	RES	FRAT.	DORM	CR HR DEF
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D Failure in class quizzes or examination.
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F Inadequate foundation or background for course.
G Weak in mechanical techniques.
H Has language, speech or reading difficulty.
I Miscellaneous (See adviser for details).

STUDENT

FOR ACADEMIC REGULATIONS SEE REVERSE SIDE

REPORT OF GRADES

RECORDS OFFICE
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE 19711
R-766-DX

STUDENT
PARENT
HIGH SCHOOL

ADAM OSBORNE
282 MANUEL STREET
NEWARK DEL 19711

FINAL GRADES

A — Excellent — 4 quality points per credit
B — Good — 3 quality points per credit
C — Fair — 2 quality points per credit
D — Poor — 1 quality point per credit
F — Failure — 0 quality points per credit
Z — Failing - Unofficial Withdrawal — 0 quality points per credit
P — Passing — Has no quality point value
L — Listener (formerly audit) - Registration without credit or grade. Class attendance required, but participation in class is not required.
LW — Listener Withdrawn
Y — Suspended or Expelled - passing in semester's work
YF — Suspended or Expelled - failing in semester's work
W — Official Withdrawal - passing in semester's work at time of withdrawal
WF — Official Withdrawal - failing in semester's work at time of withdrawal

TEMPORARY GRADES

AB — Absent from final examination, passing in semester's work
AF — Absent from final examination, failing in semester's work
I — Incomplete
S — Satisfactory Progress
U — Unsatisfactory Progress
N — No Grade Reported - See regulations

FOR EXPLANATION, SEE ACADEMIC STATUS ON REVERSE SIDE

MID SEMESTER DEFICIENCY REASONS

A Inadequate preparation of assignments.
B Failure to attend class regularly.
C Failure in daily recitation.
D Failure in class quizzes or examination.
E Poor classroom attitude: Inattention, laziness, etc.
F Inadequate foundation or background for course.
G Weak in mechanical techniques.
H Has language, speech or reading difficulty.
I Miscellaneous (See adviser for details).

53053 OSBORNE ADAM GR 50 9029- 111 1 66 F

CONTROL NO.	STUDENT NAME	CLASS	MAJOR	HIGH SCHOOL	STATUS	DATE	TYPE REPORT

COURSE SYMBOL & NO.	COURSE TITLE	MID. SEM. DEF. REQ.	C.C. DEF.	CR. HR.	FINAL GRADE	QUAL. PTS.	MID SEM. GR.
CHE 873	RESEARCH			6	S	--	
CS 612	OPTIMIZATION I			3	A	12	
CS 687	NUMERICAL ANALYSIS I			3	LW	--	

F-FINAL; M-MIDSEM.; R-REVISED

CR. HRS.	QUAL. PTS.	CR. HRS.	QUAL. PTS.	INDEX	CR. HRS.	QUAL. PTS.	INDEX
PREV. CUMULATIVE		CURRENT TERM			CUMULATIVE TO DATE		

EFZ	S.G.	N.D.	PR. WK.	SEX	RES	FRAT.	DORM	CR HR DEF
CREDIT HOURS								

ADAM OSBORNE
282 MANUEL STREET
NEWARK DEL 19711

STUDENT
PARENT
HIGH SCHOOL

MAILING

FOR ACADEMIC REGULATIONS SEE REVERSE SIDE

REPORT OF GRADES

RECORDS OFFICE
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE 19711
R-766-DX

53053 OSBORNE ADAM GR 50 9029- 111 1 67 F

CONTROL NO.	STUDENT NAME	CLASS	MAJOR	HIGH SCHOOL	STATUS	DATE	TYPE REPORT

COURSE SYMBOL & NO.	COURSE TITLE	MID. SEM. DEF. RES.	C.C. DEF.	CR. HR.	FINAL GRADE	QUAL. PTS.	MID SEM. GR.
CHE 969	PHD DISSERTATION			8	S	--	
RU 105	ELEM ORAL RUSSIAN			4	L	--	

F-FINAL, M-MIDSEM., R-REVISED

CR. HRS.	QUAL. PTS.	CR. HRS.	QUAL. PTS.	INDEX	CR. HRS.	QUAL. PTS.	INDEX
PREV. CUMULATIVE		CURRENT TERM			CUMULATIVE TO DATE		

EFZ	S.G.	N.D.	PR. WK.	SEX	RES	FRAT.	DORM	CR HR DEF
CREDIT HOURS								

FINAL GRADES

A	— Excellent	4 quality points per credit
B	— Good	3 quality points per credit
C	— Fair	2 quality points per credit
D	— Poor	1 quality point per credit
F	— Failure	0 quality points per credit
Z	— Failing - Unofficial Withdrawal	0 quality points per credit
P	— Passing	Has no quality point value
L	— Listener (formerly audit) - Registration without credit or grade. Class attendance required, but participation in class is not required.	

LW — Listener Withdrawn
Y — Suspended or Expelled - passing in semester's work
YF — Suspended or Expelled - failing in semester's work
W — Official Withdrawal - passing in semester's work at time of withdrawal
WF — Official Withdrawal - failing in semester's work at time of withdrawal

TEMPORARY GRADES

AB — Absent from final examination, passing in semester's work
AF — Absent from final examination, failing in semester's work
I — Incomplete
S — Satisfactory Progress
U — Unsatisfactory Progress
N — No Grade Reported - See regulations

FOR EXPLANATION. SEE ACADEMIC STATUS ON REVERSE SIDE

MID SEMESTER DEFICIENCY REASONS

A Inadequate preparation of assignments.
B Failure to attend class regularly.
C Failure in daily recitation.
D Failure in class quizzes or examination.
E Poor classroom attitude: Inattention, laziness, etc.
F Inadequate foundation or background for course.
G Weak in mechanical techniques.
H Has language, speech or reading difficulty.
I Miscellaneous (See adviser for details).

STUDENT

FOR ACADEMIC REGULATIONS SEE REVERSE SIDE

REPORT OF GRADES

RECORDS OFFICE
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE 19711
8-766-DX

STUDENT
PARENT
HIGH SCHOOL

ADAM OSBORNE
282 MANUEL STREET
NEWARK DEL 19711

53053 OSBORNE ADAM GR 50 9029- 111 7 67 F

CONTROL NO.	STUDENT NAME	CLASS	MAJOR	HIGH SCHOOL	STATUS	DATE	TYPE REPORT

COURSE SYMBOL & NO.	COURSE TITLE	MID. SEM. DEF. RES.	C.C. DEF.	CR. HR.	FINAL GRADE	QUAL. PTS.	MID SEM. GR.
CHE 969	PHD DISSERTATION			1	A	04	
RU 566	RDGS FOR PHD CAND			3	Z	00	

F-FINAL, M-MIDSEM., R-REVISED

CR. HRS.	QUAL. PTS.	CR. HRS.	QUAL. PTS.	INDEX	CR. HRS.	QUAL. PTS.	INDEX
PREV. CUMULATIVE		CURRENT TERM			CUMULATIVE TO DATE		

EFZ	S.G.	N.D.	PR. WK.	SEX	RES	FRAT.	DORM	CR HR DEF
CREDIT HOURS								

FINAL GRADES

A	— Excellent	4 quality points per credit
B	— Good	3 quality points per credit
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TEMPORARY GRADES

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S — Satisfactory Progress
U — Unsatisfactory Progress
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FOR EXPLANATION. SEE ACADEMIC STATUS ON REVERSE SIDE

MID SEMESTER DEFICIENCY REASONS

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C Failure in daily recitation.
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FOR ACADEMIC REGULATIONS SEE REVERSE SIDE

REPORT OF GRADES

RECORDS OFFICE
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE 19711
8-766-DX

STUDENT
PARENT
HIGH SCHOOL

ADAM OSBORNE
282 MANUEL STREET
NEWARK DEL 19711

53053 OSBORNE ADAM GR 50 9029- 111 6 67 F

CONTROL NO.	STUDENT NAME	CLASS	MAJOR	HIGH SCHOOL	STATUS	DATE	TYPE REPORT

COURSE SYMBOL & NO.	COURSE TITLE	MID. SEM. DEF. RES.	C.C. DEF.	CR. HR.	FINAL GRADE	QUAL. PTS.	MID SEM. GR.
RU 1025	ELEMENTARY RUSSIAN			3	L	--	
CHE 969	PHD DISSERTATION			9	S	--	

F-FINAL, M-MIDSEM., R-REVISED

CR. HRS.	QUAL. PTS.	CR. HRS.	QUAL. PTS.	INDEX	CR. HRS.	QUAL. PTS.	INDEX
PREV. CUMULATIVE		CURRENT TERM			CUMULATIVE TO DATE		

EFZ	S.G.	N.D.	PR. WK.	SEX	RES	FRAT.	DORM	CR HR DEF
CREDIT HOURS								

FINAL GRADES

A	— Excellent	4 quality points per credit
B	— Good	3 quality points per credit
C	— Fair	2 quality points per credit
D	— Poor	1 quality point per credit
F	— Failure	0 quality points per credit
Z	— Failing - Unofficial Withdrawal	0 quality points per credit
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L	— Listener (formerly audit) - Registration without credit or grade. Class attendance required, but participation in class is not required.	

LW — Listener Withdrawn
Y — Suspended or Expelled - passing in semester's work
YF — Suspended or Expelled - failing in semester's work
W — Official Withdrawal - passing in semester's work at time of withdrawal
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FOR EXPLANATION. SEE ACADEMIC STATUS ON REVERSE SIDE

MID SEMESTER DEFICIENCY REASONS

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E Poor classroom attitude: Inattention, laziness, etc.
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H Has language, speech or reading difficulty.
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STUDENT

FOR ACADEMIC REGULATIONS SEE REVERSE SIDE

REPORT OF GRADES

RECORDS OFFICE
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE 19711
8-766-DX

STUDENT
PARENT
HIGH SCHOOL

ADAM OSBORNE
282 MANUEL STREET
NEWARK DEL 19711

AT TIME OF ENTRY — NAME, ADDRESS

Osborne, Adam
9131 Lamont Ave.
Elmhurst, New York 11373

PARENT

PERMANENT ACADEMIC RECORD
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE

SCHOOL OF GRADUATE STUDIES

STUDENT IN GOOD STANDING UNLESS OTHERWISE NOTED. OFFICIAL TRANSCRIPTS BEAR SIGNATURE STAMP EMBOSSED WITH UNIVERSITY SEAL.

BIRTH DATE 3-6-39 | BIRTH PLACE Bangkok, Siam

SEC. SCHOOL/COLLEGE University of Birmingham | LOCATION England | DATE GRAD. 1961 | RANK IN CLASS

ENTRANCE UNITS: LAT. | FR. | GER. | SP. | ENTRANCE CONDITIONS | ENTRANCE STATUS | MATRICULATION DATE 9-64 | PREVIOUS DEGREES B.S.

Course Symbol and No.	Course Title	Sem. Cr.	Grade	Qual. Pts.
	1ST SEM 64-65 GR CHEMICAL ENGR			
N53053				
CHE 825	CHE THERMODYNAMICS	3	B	09
CHE 869	MASTERS THESIS	3	S	--
CHE 871	SEMINAR	1	B	03
ME 863	ENGINEERING ANALYSIS	3	B	09
CHE 860	FLUID MECHANICS	3	B	09
* /	**010/030-3.00** / - *			
	2ND SEM 64-65 GR CHEMICAL ENGR			
N53053				
CHE 865	DISTILLATION	3	A	12
CHE 826	CHE THERMODYNAMICS	3	B	09
ME 864	ENGINEERING ANALYSIS	3	A	12
CHE 861	HEAT TRANSFER	3	A	12
CHE 873	RESEARCH	2	S	--
CHE 869	MASTERS THESIS	3	SB	--
	1ST SUM 1965 GR CHEM.ENGR.			
N53053				
CHE 835	APPLD CHEM KINETICS	3	L	--
CHE 873	RESEARCH	3	S A	--
	1ST SEM 65-66 GR CHEMICAL ENGR			
53053				
CHE 873	RESEARCH	6	S B	--
CS 612	OPTIMIZATION I	3	A	12
CS 687	NUMERICAL ANALYSIS I	3	L W	--
	2ND SEM 65-66 GR CHEMICAL ENGR			
N53053				
CS 6155	LIN & NON-LIN PROGRM	3	A	.
CHE 969	PHD DISSERTATION	1	S	
CHE 881	PROCESS DESIGN	3	L	.
ST 630	APPLIED STATISTICS	3	L	.
6/12/66	DEGREE GRANTED M.CH.E.			

Credit Hours	Qual Pts.	Cr. Hrs.	Inst. Pts.	Index	Cr. Hrs.	Qual. Pts.	Index	FINAL POSTED LINE
PREVIOUS		CURRENT TERM			CUMULATIVE			

ACTION: 3-6-65 Passed French Reading Knowledge Test.

S-601-B

Osborne, Adam
9131 Lamont Ave.
Elmhurst, New York 11373

PERMANENT ACADEMIC RECORD
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE

SCHOOL OF GRADUATE STUDIES

STUDENT IN GOOD STANDING UNLESS OTHERWISE NOTED. OFFICIAL TRANSCRIPTS BEAR SIGNATURE STAMP EMBOSSED WITH UNIVERSITY SEAL.

BIRTH DATE 3-6-39 | BIRTH PLACE Bangkok, Siam

SEC. SCHOOL/COLLEGE University of Birmingham | LOCATION England | DATE GRAD. 1961 | RANK IN CLASS

ENTRANCE UNITS: LAT. | FR. | GER. | SP. | ENTRANCE CONDITIONS | ENTRANCE STATUS | MATRICULATION DATE 9-64 | PREVIOUS DEGREES B.S.

PARENT

Course Symbol and No.	Course Title	Sem. Cr.	Grade	Qual. Pts.
	1ST SEM 64-65 GR CHEMICAL ENGR			
N53053				
CHE 825	CHE THERMODYNAMICS	3	B	09
CHE 869	MASTERS THESIS	3	S	--
CHE 871	SEMINAR	1	B	03
ME 863	ENGINEERING ANALYSIS	3	B	09
CHE 860	FLUID MECHANICS	3	B	09
* /	**010/030-3.00** / - *			
	2ND SEM 64-65 GR CHEMICAL ENGR			
N53053				
CHE 865	DISTILLATION	3	A	12
CHE 826	CHE THERMODYNAMICS	3	B	09
ME 864	ENGINEERING ANALYSIS	3	A	12
CHE 861	HEAT TRANSFER	3	A	12
CHE 873	RESEARCH	2	S	--
CHE 869	MASTERS THESIS	3	SB	--
	1ST SUM 1965 GR CHEM.ENGR.			
N53053				
CHE 835	APPLD CHEM KINETICS	3	L	--
CHE 873	RESEARCH	3	S A	--
	1ST SEM 65-66 GR CHEMICAL ENGR			
53053				
CHE 873	RESEARCH	6	S B	--
CS 612	OPTIMIZATION I	3	A	12
CS 687	NUMERICAL ANALYSIS I	3	L W	--
	2ND SEM 65-66 GR CHEMICAL ENGR			
N53053				
CS 6155	LIN & NON-LIN PROGRM	3	A	.
CHE 969	PHD DISSERTATION	1	S	
CHE 881	PROCESS DESIGN	3	L	.
ST 630	APPLIED STATISTICS	3	L	.
6/12/66	DEGREE GRANTED M.CH.E.			

Course Symbol and No.	Course Title	Sem. Cr.	Grade	Qual. Pts.
	1ST SUM 1966 GR CHEMICAL ENGR			
N53053				
CHE 969	PHD DISSERTATION	6	S	--
	1ST SEM 66-67 GR CHEMICAL ENGI			
N53053				
CHE 969	PHD DISSERTATION	8	S	--
RU 105	ELEM ORAL RUSSIAN	4	L	--
	2ND SEM 66-67 GR CHEMICAL ENGI			
N53053				
RU 1025	ELEMENTARY RUSSIAN	3	L	--
CHE 969	PHD DISSERTATION	9	S	--

Credit Hours	Qual Pts.	Cr. Hrs.	Inst. Pts.	Index	Cr. Hrs.	Qual. Pts.	Index	FINAL POSTED LINE
PREVIOUS		CURRENT TERM			CUMULATIVE			

ACTION: 3-6-65 Passed French Reading Knowledge Test. 4-1-67 Passed Russian Reading Knowledge Test.

S-601-B

83835 OSBORNE CYNTHIA MAY EX 49 0-- 6 67 F

CONTROL NO.	STUDENT NAME	CLASS	MAJOR	HIGH SCHOOL	STATUS	DATE	TYPE REPORT

COURSE SYMBOL & NO.	COURSE TITLE	SEM. DEF. RES.	C.C. DEF.	CR. HR.	FINAL GRADE	QUAL. PTS.	MID SEM. GR.
FR 652E	CONTEMP FR LIT			3	L	--	

F-FINAL; M-MIDSEM.; R-REVISED

CR. HRS.	QUAL. PTS.	CR. HRS.	QUAL. PTS.	INDEX	CR. HRS.	QUAL. PTS.	INDEX
PREV. CUMULATIVE		CURRENT TERM			CUMULATIVE TO DATE		

EFZ	S.G.	N.D.	PH. WK.	SEM. RES.	FRAT.	DORM	CR HR DEF
CREDIT HOURS							

FINAL GRADES

A — Excellent	4 quality points per credit
B — Good	3 quality points per credit
C — Fair	2 quality points per credit
D — Poor	1 quality point per credit
F — Failure	0 quality points per credit
Z — Failing - Unofficial Withdrawal	0 quality points per credit
P — Passing	Has no quality point value

L — Listener (formerly audit) - Registration without credit or grade. Class attendance required, but participation in class is not required.

LW — Listener Withdrawn
Y — Suspended or Expelled - passing in semester's work
YF — Suspended or Expelled - failing in semester's work
W — Official Withdrawal - passing in semester's work at time of withdrawal
WF — Official Withdrawal - failing in semester's work at time of withdrawal

TEMPORARY GRADES

AB — Absent from final examination, passing in semester's work
AF — Absent from final examination, failing in semester's work
I — Incomplete
S — Satisfactory Progress
U — Unsatisfactory Progress
N — No Grade Reported - See regulations

FOR EXPLANATION, SEE ACADEMIC STATUS ON REVERSE SIDE

MID SEMESTER DEFICIENCY REASONS

A Inadequate preparation of assignments.
B Failure to attend class regularly.
C Failure in daily recitation.
D Failure in class quizzes or examination.
E Poor classroom attitude: Inattention, laziness, etc.
F Inadequate foundation or background for course.
G Weak in mechanical techniques.
H Has language, speech or reading difficulty.
I Miscellaneous (See adviser for details).

STUDENT

FOR ACADEMIC REGULATIONS SEE REVERSE SIDE

REPORT OF GRADES

RECORDS OFFICE
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE 19711

STUDENT
OSBORNE CYNTHIA MAY
282 MANUEL STREET
NEWARK DEL 19711

PARENT

HIGH SCHOOL

25

PERMANENT ACADEMIC RECORD
UNIVERSITY OF DELAWARE
NEWARK, DELAWARE

SCHOOL OF GRADUATE STUDIES

STUDENT IN GOOD STANDING UNLESS OTHERWISE NOTED. OFFICIAL TRANSCRIPTS BEAR SIGNATURE STAMP EMBOSSED WITH UNIVERSITY SEAL.

Osborne, Adas
6131 Lemont Ave.
Elmhurst, New York 11373

BIRTH DATE 1-6-30 BIRTH PLACE Lymm, Cheshire

SEC. SCHOOL COLLEGE University of Birmingham LOCATION England DATE GRAD. 1951 RANK IN CLASS

ENTRANCE UNITS | LAT. | PH. | GER. | AP. | ENTRANCE CONDITIONS | ENTRANCE STATUS | MATRICULATION DATE | PREVIOUS DEGREES B.Sc.

PARENT

Course Symbol and No.	Course Title	Sem. Cr.	Grade	Qual. Pts.
	1ST SEM 64-65 GR CHEMICAL ENGR			
N53053		3	B	09
CHE 825	CHE THERMODYNAMICS	3	S	--
CHE 869	MASTERS THESIS	1	B	03
CHE 871	SEMINAR	3	B	09
ME 863	ENGINEERING ANALYSIS	3	B	09
CHE 860	FLUID MECHANICS			
* /	**010/030-3.00** /			
	2ND SEM 64-65 GR CHEMICAL ENGR			
N53053				
CHE 865	DISTILLATION	3	A	12
CHE 826	CHE THERMODYNAMICS	3	B	09
ME 864	ENGINEERING ANALYSIS	3	A	12
CHE 861	HEAT TRANSFER	3	A	12
CHE 873	RESEARCH	2	S	--
CHE 869	MASTERS THESIS	3	S	--
	1ST SUM 1965 GR CHEM.ENGR.			
N53053		3	L	--
CHE 835	APPLD CHEM KINETICS	3	S	--
CHE 873	RESEARCH		A	
	1ST SEM 65-66 GR CHEMICAL ENGR			
53053		6	S	--
CHE 873	RESEARCH	3	A	12
CS 612	OPTIMIZATION I	3	L	--
CS 667	NUMERICAL ANALYSIS I		W	
	2ND SEM 65-66 GR CHEMICAL ENGR			
N53053		3	S	--
CS 615B	LIN & NON-LIN PROGRM	1	S	--
CHE 869	PHD DISSERTATION	3	L	--
CHE 861	PROCESS DESIGN	3	L	--
ST 630	APPLIED STATISTICS			
6/12/66	DEGREE GRANTED M.CH.E.			
	1ST SUM 1966 GR CHEMICAL ENGR			
N53053		6	S	--
CHE 969	PHD DISSERTATION			
	1ST SEM 66-67 GR CHEMICAL ENGI			
N53053		8	S	--
CHE 969	PHD DISSERTATION	4	L	--
RU 105	ELEM ORAL RUSSIAN			
	2ND SEM 66-67 GR CHEMICAL ENGI			
N53053		3	L	--
RU 1025	ELEMENTARY RUSSIAN	9	S	--
CHE 969	PHD DISSERTATION			

Credit Hours	Qual. Pts.	Cr. Hrs.	Qual. Pts.	Index	Cr. Hrs.	Qual. Pts.	Index	FINAL POSTED LINE
PREVIOUS		CURRENT TERM			CUMULATIVE			

Course Symbol and No.	Course Title	Sem. Cr.	Grade	Qual. Pts.
	1ST SUMMER 67 GR CHEMICAL ENGI			
N53053		1	A	04
CHE 969	PHD DISSERTATION	3	Z	00
RU 566	REQS FOR PHD CAND			
53053	2ND SEM 67-68			
6/9/68	DEGREE GRANTED - PH.D.			
	DISSERTATION. THE SOLUTION OF UNSTEADY STATE MULTICOMPONENT DISTILLATION USING PARTIAL DIFFERENTIAL EQUATIONS			

Credit Hours	Qual. Pts.	Cr. Hrs.	Qual. Pts.	Index	Cr. Hrs.	Qual. Pts.	Index	FINAL POSTED LINE
PREVIOUS		CURRENT TERM			CUMULATIVE			

ACTION: 3-0-65 Passed French Reading Knowledge Test. 4-1-67 Passed Russian Reading Knowledge Test.

NAME OF CANDIDATE	TEST DATE		EXAMINATION NUMBER	DESIGNATED INSTITUTION	APTITUDE TEST				ADVANCED TEST		
	MONTH	YEAR			VERBAL		QUANTITATIVE		CODE	SCORE	PERCENT
					SCORE	PER CENT	SCORE	PER CENT			
OSBORNE ADAM	01	64	478679		530	65	740	99	37	630	80

GRADUATE RECORD EXAMINATIONS – REPORT OF SCORES
NATIONAL PROGRAM FOR GRADUATE SCHOOL SELECTION

ADVANCED TEST CODES:

24 Biology	34 Education	47 Geology	64 Literature	75 Physical Education	87 Sociology
27 Chemistry	37 Engineering	54 Government	67 Mathematics	77 Physics	91 Spanish
31 Economics	44 French	57 History	74 Philosophy	81 Psychology	

THIS TRANSCRIPT IS NOT VALID FOR TRANSMISSION OF SCORES TO AN INSTITUTION
UNLESS RECEIVED DIRECTLY FROM: EDUCATIONAL TESTING SERVICE

DO NOT DETACH

DO NOT DETACH

GRADUATE RECORD GRADUATE RECORD

DIRECTIONS FOR FILLING OUT OVAL SPACE

This address slip will be used to mail you your copy of the score report. In the oval space below enter your name and the address at which you wish to receive the report.

Adam

Name Mr. A. Osborne
Number and Street 9131 Lamont Ave., Elmhurst
P.O. City & State New York 11373 N.Y.

The figure given in the "PER CENT" box under each test taken shows the per cent of students in the basic reference group for that test who received a lower scaled score than the one reported here. The basic reference groups consist of senior students in selected colleges and universities. For more detailed information and advice on the interpretation of these test results, consult the accompanying interpretive material or see your dean or adviser.

TRANSCRIPT SERVICE IS AVAILABLE THROUGH THE EDUCATIONAL TESTING SERVICE at

1947 CENTER STREET
BERKELEY, CALIFORNIA 94704 OR PRINCETON, NEW JERSEY 08540

FOR A FEE OF $1.00 PER TRANSCRIPT.

INFORMATION ON THE TESTS TAKEN AND THE DATE AND PLACE OF EXAMINATION SHOULD ACCOMPANY EACH REQUEST.

478679
Examination Number

DO NOT DETACH DO NOT DETACH

WARNING TO APPLICANTS

CONCERNING THE CLOSING DATES FOR SUBMITTING COMPLETED REGISTRATION FORMS AND FEES

The DEADLINES for the receipt by Educational Testing Service in Princeton, New Jersey or Berkeley, California of your completed test registration forms and fees for established centers are:

Closing Dates	Examination Dates
November 1, 1963	November 16, 1963
January 3, 1964	January 18, 1964
February 21, 1964	March 7, 1964
April 10, 1964	April 25, 1964
June 26, 1964	July 11, 1964

DEC 51

Educational Testing Service cannot be held responsible for late requests for registration forms or for delays in mail service. You can avoid the misfortune of having your registration form returned to you unaccepted by mailing it in sufficient time to reach Educational Testing Service with the accompanying test fee not later than the closing date appropriate to the testing date for which you are registering. **Registration forms received after the appropriate closing date, as listed above, will not be accepted.**

APPLICATION FOR ADMISSION TO GRADUATE SCHOOL

Please note that registration for the Graduate Record Examinations does NOT constitute application for admission to a graduate school. Application for admission to a graduate school must be made by filing appropriate papers with the particular graduate school(s) in which you are interested, as directed by the admissions office(s) of the institution(s) concerned.

D43P219-203906

GRADUATE RECORD GRADUATE RECORD

PROCEEDINGS AT A CONGREGATION OF THE UNIVERSITY OF BIRMINGHAM

15TH JULY, 1961

DEGREES IN APPLIED SCIENCE AND IN LAW

Proceedings at a Congregation of the University of Birmingham 15th July, 1961

The Procession will enter the Hall at 11 o'clock.
(*The audience is requested to remain seated during the Procession.*)

Organ Music before and after the Congregation will be played by the University Organist, Dr. G. Thalben-Ball.

The CHANCELLOR will declare the Congregation open.

The PUBLIC ORATOR, Professor O. Hood Phillips, will present to the CHANCELLOR for the conferring of Degrees:

Doctor of Science (*honoris causa*)

Sir Herbert Manzoni

Doctor of Laws (*honoris causa*)

Leslie Farrer-Brown

The DEAN OF THE FACULTY OF SCIENCE, Professor Stacey G. Ward will present to the Chancellor for the conferring of Degrees:

Doctor of Philosophy

Theodore King Chaplin (Civil Engineering)
William Gerwyn Thomas (Mining)
Edmund Harvey Wright (Mechanical Engineering)

Doctor of Philosophy—*continued*

Clive Davies (Minerals Engineering)
John David Filby (Physical Metallurgy)
Jeffrey Harold Foley (Physical Metallurgy)
Keith John Bruce McEwan (Industrial Metallurgy)
John Watson Purdie (Minerals Engineering)
Michael John Spurr (Chemical Engineering)
Brian Walker (Industrial Metallurgy)

Master of Science

Kenneth Frank Bird (Highway and Traffic Engineering)
Ian Blackwood Davies (Chemical Engineering)
Cyril Davis (Civil Engineering)
Peter Robin Hills (Operational Research)
Ian Denman Jowett (Engineering Production)
Sukumar Mukherjee (Foundation Engineering)
Michael John Fielding Olden (Chemical Engineering)
Stephen David Padfield (Civil Engineering)
Arthur John Rickard (Industrial Metallurgy)
James Shao (Electrical Engineering)
Paul William Webb (Electrical Engineering)

Bachelor of Science with Honours

School of Mechanical Engineering

Class I

David Hobson
Geoffrey Hobson
Gerald Kay Mucklow

Class II (Division I)

Derrick Thomas Anney
Keith Caney
David Clough
John Richard Crump
Gerald Peter Diamond
John Frederick Groves
Timothy John Morris
Michael John Rouse

Class II (Division II)

Roger David Campin
Anthony Arthur Peter Heathcock
David Joseph Petty
Trevor George Randall

Bachelor of Science with Honours—*continued*

School of Civil Engineering

Class I

George Price Chapman
Bernard William Wilkinson

Class II (Division I)

Laurence Gregory Edgar
Terence Douglas Knight
John Alun Lewis
Brian John Morris
Geoffrey Peter Webb
Ronald Wood

Class II (Division II)

Nathan Chibuike Esomeju
Geoffrey David Fairless
Alkan Kizildeli
Peter Dominic Lester
Robert Allen Percival
John Frederick Richards
Aubert Joseph Diago Pereira
Edryd Shaw
Michael John Short
Anthony Lynn Steer

Class II (Division II)

Peter Bowron
Donald Freeman
Charles Rodney Fry
Leonard Lake
Jack Lloyd
George Trevor Oliver
Brian Robertson Slattery

Class III

Abdul Razak Bahaman
Miles Foulger
Joseph Pickering

School of Electrical Engineering

Class I

Roger Stephen Burman
Weng-Meng Cheong
John Graham Gardiner
Gordon John Hackett
Kenneth Lawson Hughes
Bruno John Vieri

Class II (Division I)

David John Dunn
Barry John Kendall
James Laidler
Robert Vincent Latin

School of Chemical Engineering

Class I

Ahmad Qidwai
John Stephen Smith
Keith Henry Taylor

Class II (Division I)

Paul Martin Lawford Asher
Richard William Boaz
Roger Stewart Campbell
Anthony Peter Clark
Ernest Edward Collins
Gordon Robin Bellamy Creed
John Stratton Edgley
Colin Byard Eldridge
David Roger Ellis
Colin Malcolm Elton

Bachelor of Science with Honours—*continued*

School of Chemical Eng.—*cont.*

Class II (Division I)—*cont.*

Eric Cedric Field
Eric Graham Fishlock-Lomax
Philip Arthur Millward
Peter Edward Nicolls
Frederick George Proctor
Michael Charles Fydell Rogers
Brian Seymour
Trevor Bradbury Thomas

Class II (Division II)

Roger Hignett Booth
James Donald Cargill
Ian Roland Davies
Reginald Eric Edwards
James Stanley George
Kamran Habibi-Golpayegani
Peter Graham Harvey
Jack Lamb
Arthur Robert Witherow Large
Kenneth Charles Ling
David Lockwood
Martin Anthony O'Donnell
Adam Osborne
Victor Maurice Palmer
Robert John Stanhope Petherbridge
Colin Stuart Pitts
Robert Allen Raitt
Michael Robinson
Michael John Rogers
Brian Clifford Shrimpton
Christopher John Sismey
John James Walster
Anthony Edward Watson
George Henry West
John Colin Laugharne Williams
Barry Neville Willington

School of Petroleum Production Engineering

Class I

David Fielding Weaver

Class II (Division I)

Waleed Al-Jazrawi
Roger John Christian
Thomas Eric Hughes

Class II (Division II)

Amir Sayed Reza Bahbahani

School of Physical Metallurgy

Class I

Graham Edward Hollox

Class II (Division I)

Anthony Ball
Anthony Clifford Barber
Rowland Michael Cornell

Class II (Division II)

Alan John Blatherwick
Dexter William Smith

Class III

Robert Joel Dean
Graham Vincent Lett

Bachelor of Science with Honours—*continued*

School of Industrial Metallurgy

Class II (Division I)

Keith Ian Johnson
Keith Ramsey
John Raymond Rushe
Alan Warburton
Dudley Mansbridge Yorke

Class II (Division II)

Norman Graham Allen
John Michael Bennett
Robin Lees
Jeffrey Duncan Robbins

Class II (Division II)

Anthony Gordon Wetton

Class III

Terence Flavell

School of Mining

Class I

Alan Cochrane Kennedy
Brian White

Class II

Ian Edward Clarke

Class II (Division I)

Edward Bryan Herbert
Charles Jeremy Dowglass Lane
Donald Edward Lane
Keith McCarthy
Donald Tromans

Bachelor of Science

Applied Science

Gwyn Roderick Akeroyd (Metallurgy)
David John Alderslade (Electrical Engineering)
Abdul Husain Hasan Al-Hakim (Petroleum Production Engineering)
Mohammad-Ali Alizadeh-Shabani (Petroleum Production Engineering)
Norman Allen (Industrial Metallurgy)
Abdul Munim Hassan Al-Samarraie (Chemical Engineering)
Peter John Baldwin (Civil Engineering)
John Anthony Bixby (Chemical Engineering)
Charles Ian Bort (Metallurgy)
Raymond Thomas Canning (Civil Engineering)
Barry Carlton (Civil Engineering)
Alan George Coates (Chemical Engineering)

Bachelor of Science—*continued*

Applied Science—*continued*

Clara Harriet Creed (Mechanical Engineering)
Michael Patrick Cronin (Civil Engineering)
Carl Anthony Davies (Chemical Engineering)
Joseph Charles Gladstone Davies (Chemical Engineering)
Philip Wilfred Dawson (Chemical Engineering)
Alexander Roy Duff (Civil Engineering)
Frederick Richard Keith Edwards (Chemical Engineering)
Michael George Edwards (Metallurgy)
Arthur David Elks (Civil Engineering)
Lyndon Benjamin Evans (Chemical Engineering)
John Nigel Firth (Civil Engineering)
Roger Gibson (Industrial Metallurgy)
David Goate (Electrical Engineering)
Edward Anthony Goss (Chemical Engineering)
Marwood William Graham (Chemical Engineering)
Frank Gunning (Chemical Engineering)
John Hagarty (Chemical Engineering)
Keith Hawksworth (Mining)
David John Allday Hobbs (Electrical Engineering)
Michael Arthur Hopcroft (Metallurgy)
Norman Frederick Hughes (Civil Engineering)
James Humphreys (Mechanical Engineering)
Philip Edward Humphries (Mechanical Engineering)
John Neville Jennings (Civil Engineering)
Peter Michael Lagoe (Metallurgy)
Michael Ernest Lambert (Civil Engineering)
David Lang (Mechanical Engineering)
Gordon Charles Lawson (Electrical Engineering)
Trevor Anthony Layne (Chemical Engineering)
Richard John Lefevre (Chemical Engineering)
Frank Lengyel (Electrical Engineering)
David John Lewis (Electrical Engineering)
Richard Alan Lewis (Civil Engineering)
Kenneth David Mann (Mechanical Engineering)
Ian Geoffrey Moore (Electrical Engineering)
Derek Henry Mulhall (Chemical Engineering)
Neville Charles Nelder (Civil Engineering)

Bachelor of Science—*continued*

Applied Science—*continued*

Martyn Nicholas (Electrical Engineering)
David Randall Norton (Chemical Engineering)
David John Outen (Civil Engineering)
Michael Savvas Papadopulos (Electrical Engineering)
Kenneth Parker (Mechanical Engineering)
Niranjan Chunibhai Patel (Civil Engineering)
William David James Price (Chemical Engineering)
Joseph Quinn (Chemical Engineering)
Michael Railton (Chemical Engineering)
David George Read (Mechanical Engineering)
David Ralph Richards (Electrical Engineering)
Alan George Scott (Civil Engineering)
Reza Husami Shah (Electrical Engineering)
Bejar Hazim Shemdin-Agha (Petroleum Production Engineering)
Terence Norman Smart (Civil Engineering)
Harold Arnold Somers (Chemical Engineering)
John Stephen Spicer (Civil Engineering)
John Victor Stirland (Chemical Engineering)
David Gibson Swales (Chemical Engineering)
Peter Jeremy Thomson (Civil Engineering)
John Unwin (Civil Engineering)
James Russell Varney (Metallurgy)
Robin Warne (Chemical Engineering)
Michael John Waters (Chemical Engineering)
Randal Campbell Whittaker (Electrical Engineering)
Martin Saby Williams (Civil Engineering)
David Leonard Willis (Civil Engineering)

The following Degrees will be conferred *in absentia*:

Doctor of Science

Gordon Thomas Wright (Electrical Engineering)

Doctor of Philosophy

Gordon Herbert Laurie (Physical Metallurgy)

Master of Science

Arthur Michael Conning (Electrical Engineering)
Stylianos Vouyoucalos (Chemical Engineering)

Bachelor of Science
Applied Science

Kasim Mohamed Ali Arafat (Petroleum Production Engineering)

Gottfried Boakye Osei-Mensah (Chemical Engineering)

MR. LESLIE FARRER-BROWN will address the Congregation.

The DEAN OF THE FACULTY OF LAW, Professor O. Hood Phillips, will present to the Chancellor for the conferring of Degrees:

Master of Laws

Derek Peter Clephan

Bachelor of Laws with Honours

Class I

David Henry Ford

Class II (Division I)

Kikis Michael Angelides
Donald David Davis
John Alfred Garrard
Ann Rosemarie Green
John Geoffrey Arthur Headley
Terence Edwin Sewell
Paul Anthony Spencer

Bachelor of Laws with Honours—*continued*

Class II (Division II)

Una Jessie Austin
Christodoulos Chrysanthou
Mark Lupton Dawbarn
Christian Torleif Lester Forgaard
Philip Barry Monkman
Geoffrey Owen Moss
Ronald Malcolm Walmsley Naylor
Michael Howard Wallis Noble
Barrie Herbert Oakley
Christopher Richard Poncia
William Neville Roper
Abdul Rahman Sheikh Ali
Roger Denzil Howard Smith
Roger Phillip Smith
John Zakovics

Class III

Martin John Shelley Axtell
Thomas Lloyd Barker
Barbara Mary James
Yetunde Olayinka Onayemi
John Ronald Passey
Robert Ivan Rouse
Peter Morgan Thomas
Kai Tak Wong

Bachelor of Laws

Peter Antony Henry Plant
Fitz-roy Xavier Smith

Vice-Chancellor's Prizeman

The PUBLIC ORATOR will present:

Ahmad Qidwai

The CHANCELLOR will declare the Congregation closed.

God Save the Queen

The Procession will leave the Hall, followed by the Graduates.

(*The audience is requested to remain seated until the Procession and Graduates have left the Hall.*)

PROGRAMME OF ORGAN MUSIC

(University Organist, Dr. G. Thalben-Ball)

BEFORE THE CEREMONY

Fantasia and Fugue in C minor .. *C. P. E. Bach*

Chorale Prelude "Liebster Jesu" .. .. *J. S. Bach*

Fantasia in G .. .. *J. S. Bach*

AFTER THE CEREMONY

Sonata (first movement) .. .. .. *Elgar*

(*For Lists of Diplomas, Scholarships and Prizes see next pages*)

DIPLOMAS

Postgraduate Diploma in Malting and Brewing

Division I

William Lawrence Hampton

Diploma in Malting and Brewing

Division II

John Robert Alexander Kendall
Brian John Lee
Edward Michael Sutton Rudgard

DIPLOMAS AND CERTIFICATES

Diploma in Graduate Studies

MATHEMATICAL STATISTICS

Neville Paul Fowler
Anthony Paul Round

MATHEMATICAL PHYSICS

Winston Khan
Colin McDermott
David Rudyard Owen
Edgardo Santos Pacheco (*with Distinction*)
John Frank Reading

SCHOLARSHIPS AND PRIZES

The "Birmingham Post" Prize for English Poetry

Joseph Anthony Lavin

Faculty of Science

Nominations to Research Scholarships have still to be made by the Board of the Faculty of Science and will be announced later

Ascough Prize

David John O'Dell

Austin Prize

Roger John Webster

British Ropes Limited Prize

John Francis Hughes

Sir John Cadman Medals

Alan Cochrane Kennedy
Ahmad Qidwai

J. Tertius Collins Prize in Metallurgy

John Donald Speight

Corbett Prizes

Mark Anthony Armstrong
Colin David Froggatt
Alan John Ellis

S. J. Ellis Memorial Prize

Geoffrey Hobson

Frankland Prize

Michael Johnson

Heslop Memorial Prize

Philip Smith

Kinvig Prize in Geography

Moyra Christine Wilson

Moss Prize (Mining)

Alan Cochrane Kennedy

Nadejde Prize

Geoffrey Hobson

Nash Prizes

George Leonard Lewis

Neville Moss Memorial Prizes

Keith McCarthy
Philip Arthur Millward

Nobel Industries Limited Prize

Brian White

Panton Geological Prize

Peter Eric Loney

D.A.N. Sandifer Design Prize

David Hobson

S. W. J. Smith Prize

Gilbert John Bartlett Pyle

Taylor Woodrow Prize

John Edward Acton

University Undergraduate Prizes

John William Alcock
Philip John Cadle
Peter Alfred Curnuck
Keith Weatherby Gibson
Thomas Joseph McMahon
Gerald Kay Mucklow
Raymond George Plevey
Brian George Stathem
Keith Henry Taylor
Ian Patrick Trayer
Anthony Charles Warren
Kenneth Stuart Williams

Faculty of Law

Nominations to Prizes and Research Scholarships have still to be made by the Board of the Faculty of Law and will be announced later.

Stanford & Mann Ltd., Birmingham

PROGRAM OF THE CONFERRING OF DEGREES AT THE UNIVERSITY OF DELAWARE

THE 117th COMMENCEMENT

SUNDAY
JUNE 12, 1966
5:00 P.M.

ALMA MATER

Words by ROBERT CURRY *Music by* A. J. LOUDIS

Hail to thee, proud Delaware, in loyalty we stand,
We give thee thanks for glorious days beneath thy guiding hand.
Full often will we praise thy name, thy colors proudly bear,
We lift our voices now to sing, "All hail to Delaware!"

Order of Exercises

Processional

Grand March ..... *Clare Grundman*
March Processional ..... *Clare Grundman*

INVOCATION

The Reverend Paul E. McCoy
District Superintendent
The Seaford District
Peninsula Conference
The Methodist Church

ADDRESS

Frederick Seitz
President
The National Academy of Sciences

MUSIC

Moorside March ..... *Gustav Holst*
Combined Concert and Symphonic Bands

CONFERRING OF DEGREES

John Alanson Perkins, Ph.D.
President of the University of Delaware

Singing of
University of Delaware
ALMA MATER

BENEDICTION

The Reverend Paul E. McCoy

Recessional

Ceremonial for Band ..... *Frank Erickson*

The audience is requested to remain until after recession of the Platform Group.

The music preceding the exercises was contributed by the
Combined Concert and Symphonic Bands.

ASSOCIATE DEGREES

CANDIDATES PRESENTED BY PROVOST JOHN W. SHIRLEY

MARY LINDA ALLEN	*Applied Science*
MARY ELIZABETH ALUISE	*Applied Science*
REBECCA ANN BERNDT	*Applied Science*
PATRICIA ANN BOYDEN	*Applied Science*
MARCIA TERRELL BRYCE	*Applied Science*
NOEL KEITH BRYSON	*Applied Science*
BARBARA LEE BURGER	*Applied Science*
FRANK X. CAPPARELL*	*Arts*
WILLIAM FRANKLIN CAREY*	*Accounting*
LOUISE ELAINE MATTHEWS COLBOURN	*Applied Science*
RAYMOND FILBERT CONNER	*Accounting*
PATRICIA ALDONA YASONIS CORY	*Arts*
HARRIET LOU DAVIS	*Applied Science*
DONNA LEIGH STREET DESCHEEMAEKER	*Applied Science*
SUSAN JANE DOUGHERTY	*Applied Science*
JOHN VICTOR DRZEWICKI	*Science*
ELIZABETH JANE DUNLAP	*Applied Science*
MARY ANN ELLIOTT	*Applied Science*
LESLIE ANN ENNIS	*Applied Science*
MERLE CLIFFORD FAUSNAUGH	*Science*
ANTONIO GUTIERREZ	*Chemistry*
CARLA MARGARET HAAS	*Applied Science*
ROBERTA ANN HENSEL	*Applied Science*
LINDA LEE HINES	*Applied Science*
THOMAS NELSON HOFFMANN	*Chemistry*
GEORGE KENNETH HOREIS	*Applied Science*
BRUCE LESTER HUDSON	*Applied Science*
MARY JANE IRVIN	*Applied Science*
DIANNE CLAIRE JACOBS	*Applied Science*
DAVID ROBERT JAQUETTE	*Applied Science*
JOHN SCOTT JOHNSTON*	*Applied Science*
JOSEPH CLARENCE KELLEY, JR.	*Chemistry*
LORETTA MCLEAN KLECKNER	*Applied Science*
JANET NOBLE MAGILL	*Applied Science*
DONNA JEAN MARCONI	*Applied Science*
JAMES FRANKLIN MARINE, JR.	*Applied Science*
SUE ELIZABETH MARSH	*Applied Science*
KHALID ISSA MASSO	*Science*
JAMES MICHAEL MCDOWELL	*Applied Science*
JOHN ESTEN MCFANN	*Science*
LINDA JEAN MILLER	*Applied Science*
CONNIE MAE MOORE	*Applied Science*
RICHARD GUSTAVE NEUMANN	*Applied Science*
WILLIAM JAMES OUTTEN	*Applied Science*
WILLIAM KUTCHER PHILHOWER, III	*Applied Science*
THOMAS JOSEPH RUFF	*Applied Science*
FRANCIS ANTHONY RYBINSKI, JR.	*Accounting*
MARY ANN ELIZABETH SCHARP	*Applied Science*
DONALD CHARLES SCOTT	*Applied Science*
MARIANNE ELVIRA SIMEONE	*Applied Science*
SUSAN MITCHELL STOW	*Science*
HOWARD FARRING SWAIN, JR.	*Applied Science*
MICHELLE MARIE TETREAULT*	*Applied Science*
POLLY ALISON TROUT	*Applied Science*
JOHN EUGENE TRZCINSKI*	*Applied Science*
GILBERT ORVILLE WARD	*Science*
LINDA CLAIRE WILSON	*Applied Science*
DAVID WILLIAM WINKLER	*Applied Science*
MELANIE FRANCES ZAVISHLOCK	*Applied Science*

**In Absentia*

BACCALAUREATE DEGREES

COLLEGE OF ARTS AND SCIENCE

CANDIDATES PRESENTED BY DEAN WILLIAM C. ARCHIE

Bachelor of Arts

ROBERT WILSON ABBOTT, JR.
EDWARD ELLIS ADAMS*
DAVID NELSON ALLEN
TERRY HAMILTON ALLEN
WALTER BRADLEY ALLEN
LESLIE ELLEN ANDERSON
CAROLINE TOY ANDREWS
RICHARD MEREDITH ANDREWS
MARDGES ELIZABETH BACON*
MATTHEW GARFIELD BAILEY
DIANA RUTH BARNETT
PETER FRANKLIN BARR
FRANK RICHARD BARTUCCA
MARTINA FRANCES BATTAGLIA
BARBARA LEE BERRY
ANN DWIGHT BORDEN
BEVERLY RUTH BOWMAN
VIRGINIA LEE BOYER
MARTIN ANTHONY BRADY, JR.*
JACK RUSSELL BROOKS
KENT DAVIS BROWN
JOYCE CAROL BUCKWORTH
MARY ANN BUFFINGTON
JOHN JOSEPH BURKE, JR.
MYRA ANN CAMPBELL
NELSON WAYNE CANNON
RITA LOUISE CASTLE*
DAVID CAVES JR.
GERMAINE ARLINE HIGGINS CHAGNON
RUSSELL CARLYLE CHAMBERS
DIANA CHANG*
SUZANNE JEANNE BENSON CHERRIN
MARIA ANN CICCHETTI
BEATRICE ELIZABETH PRYOR CLARK
JOHN FRANCIS CLEARY
ELLIOTT COLLINS
BARBARA ANN COLLINS CONN
NANCY JAYNE HILTY COOK
CAROL LOUISE CORNELL
RUTH ANN COZZA
DAVID LAIRD CRAVEN
JOSEPH HARRY CUNNINGHAM, JR.
JANET BRYAR DARSIE
CLINT GODDARD DEDERICK, JR.
LOUIS CARMINE DEGEORGIA
KAY FOSTER DEXTER
JUDITH DIANE DILL
MARGARET MARY DONLAN
JOHN THOMAS DONOHUE, III
NOLA MARIE DOUBET
MICHAEL FRANCIS DUGAN
MARIE PATRICIA GIBLIN EARLE*
ALOIS STOCEK ELMER, JR.
BARBARA SUZANNE EPPES
CAROLYN LOUISE BOON ETCHESON*
FRANCES RUTH FRAZER EVANS
FRED WALKER EVANS
PHOEBE MARYLEE FASSIG
JOSEPH MICHAEL FAY
RICHARD COX FELSINGER*
JEFFREY NEAL FISCHER
JOHN THOMAS FITZPATRICK, JR.*
MICHAEL JOSEPH FLEMING
GARLAND LEE FORBES
ROBERT GLENN FORBES, JR.
BETSY GRAY FOWLER
CAROLE ANN FREES
CARA LYNN ROSENDALE FRIES
LAWRENCE JOHN FUTTY
FRANCES JEAN GARTHWAITE
CAROLE ANN GILBERT*
JOSEPH ELLIOTT GILMOUR, JR.
JOHN MARTIN GLAUBITZ
THOMAS HARPER GLEDHILL*
EUGENE JAMES GOODING, JR.*
HOWARD LEWIS GREEN
JANE BERNADETTE GRIER
GEORGE EDGCOMB GROTZ
ROBERT CARROLL GUENVEUR
LAZARO GUERRA
CLINTON WILSON HALL, JR.
MARGERY ANNE HALLETT
PAUL HENRY HARRINGTON
JOHN ERLING HAUGE
WILLIAM ANDERSON HAYDEN, JR.
IRMA JANE HAYES
DOROTHY CAROL HEARNE
HAROLD HERMAN HEINKEL, JR.*
JOAN GAIL COLTON HELFAND
AMALIJA JOAN FLOGL HODGINS
JULIA ANN HARTLEY HOFFMAN
MERLE JEANNE HOPKINS
JOHN WADE HOWARD, JR.
SARAH ANN HUME
RUTH ANNE HUMME
JOSEPH ALEXANDER HURLEY*
JUNE ELLEN HUXTABLE
HOPE ILIA ISLAMOFF
CHRISTINE RAE JANES
CRAIG WILLARD JESTER
BARBARA GAIL JOHANTGEN
FRAN FAUST JOHNSON
HARVEY CURTIS JOHNSON
WILLIAM SVANTE JONASSEN, JR.
BARBARA ELLEN JONES
DALE LARAINE JONES

In Absentia

RALPH BRANDON JONES, JR.
FRANKLIN ARTHUR KALINOWSKI, JR.
HARVEY BERNARD KARP
JOHN RICHARD KATELEY, JR.
ELEANOR GRETA KAUFFMAN
CHARLOTTE ANN KELLY
GLENN ALAN KILLE
BEVERLY ANNE KING
FREDERICK DURAND KING, III
THOMAS EDWARD KIRCH
RAYMOND LEWIS KIRKPATRICK, JR.
CAROL MAE KISSEL
ELEANOR CLAY KNOWLTON
JOYCE ELIZABETH KORIA
MARION LEE KOWALCZYK
CHARLES PAUL KOZLOWSKI*
RUTH JEANNE KARRAKER KREIDER
JUDITH ANN KUSHELOFF
GEORGE RUSSELL LAMPLUGH
LORINDA LILLIAN LANDGRAF
BURKE EDWARD LANE
MARIE ANN ROSE LANK
ELIZABETH WIGTON BOURS LAYTON
MARTHA LEONORE LAZARUS
LINDA LEE
LINDA KAREN LEE*
JOAN SANDRA LEFLER
RONALD MICHAEL LENAT*
LUCY ANN LESTARDO
MATTHEW LYGATE, JR.
HELEN ELIZABETH MENDENHALL LYNAM
JOHN COOPER LYNCH
WILLIAM OLIVER MACARTHUR, JR.
SUSAN MISSIMER MACLARY
BARBARA JANE MACNICOL
CAROL EMILIE MAIER
ANGELA MALANGA
MIRIAM RUTH KRANTZ MANOFF
DAVID EARL MARSH
CLARENCE MAST, JR.
NEIL GEORGE MCANENY
ROBERTA EMMA MCCLOSKEY
MICHAEL JONATHAN MCCRANN
KENNETH DOUGLAS MCCULLOUGH
MARY ELIZABETH GAUGER MCHENRY
KATHLEEN ANNE MEEHAN
ROBERT FRANCIS MELDER
ELLEN MELINDA MENSINGER
MARIAN KATHRYN MILLER
JANE STRONGE MURCH
CAROLE JO SAUNDERS OBERLE
JOSEPH FRANCIS O'DONNELL*
MARYANN BERNADETTE OLIVERE
MICHAEL WALTER OSOWSKI
ANN FLICK GARRISON OWEN*
ARCHER A. OWENS, JR.
ROBERT EVAN OWENS, JR.
ELISABETH KRAMER PAGE
VIRGINIA LYNNE PANKOWSKI
LEWIS FRANK PAQUETTE
KAREN RUTH PARKS
DAVID COOPER PATTERSON
MICHAEL JOSEPH PERROTTI
RONALD WILLIAM PETERSON
DONALD PETROSKI
FREDERIC WOOD PETZE*
CHARLES SAINT CLAIR PIE, II
WILLIAM ISAAC POLLARI
DAVID ALAN POTTER
PAUL ALLEN POWELL
CARYL AIMEE PROUD
JAMES PERRIN PURVIS, JR.
CAROLEE B. PYLE
ROBERT GRIER RALSTON
JAMES ALLEN RAMBO
MARION ELAINE RANK
SUZANNE HEINEMANN RAYMOND
ROBERT STANLEY REITZES
ROBERT WAYNE REYNOLDS
CAROL GERTRUDE PHILLIPS ROBINSON
JOHN BALL ROBINSON, JR.
RICHARD MORRIS ROSENFELD
PETER LOWELL ROSENWALD
CARL KENNETH ROSHONG
RODNEY LAIRD RUSSELL
DONNA CHRISTINE DREISBACH RYAN*
SUSANN RUTH SALUS
CAROL ANN SARRO
RICHARD HERMAN SCHLIEM, III
JAMES JUDE SCHMIDT
WOLDEMAR SCHOCK
DANIEL EDWARD SCHOOLEY
JACK HARRY SCHWARTZ
KATHERINE MARY SEITZ
PAUL MATTHEW SELINKOFF
CARMELYN CHRISTINA SEMBIANTE
JOHN ROBERT SHERIDAN
JOHN CHARLES SHEW*
MELVIN DONALD SHORE
ELSA ELIZABETH SIEMER
FRANCIS JOHN SMAGALLA
JUDITH IRENE SMITH
RAYMOND LEONARD SNEATH, JR.
ROBERT STEVEN SPIEGEL
WILLIAM JOHNSON SPURLIN
DANIEL KASSVAN STAT
EDWARD MARTIN STRAUSS
VALERIE CHRISTINE SULLIVAN
DONALD SERGE SUMNER
CONNIE SUE MATTHIESSEN TARBURTON
MARY VIRGINIA THORNTON
JOHN MICHAEL TOBIN*
VIRGINIA ANN FIELD TOMPKINS
GARETH EUGENE TONNESSEN
VIRGINIA ANN TRIBIT TOPKIS
DIANE MARY TRIMBLE
MARK WILLIAM ULLMAN*
ALLAN MARSHALL VAN BLERKOM
THOMAS WALTER VAN GROFSKI
DANGA JUDITH VILEISIS*
GORDON WAYNE VOGEL*
FLORENCE EILEEN WAGNER
ELIZABETH CHRISTINE WALKER

In Absentia

Charles William Walz
Mercer Logan Wellford
James Craik Tucker Wells
Lloyd Francis Wells, Jr.*
Robert Frank Welshmer
Jo Ann Wendler
Pamela Jane Field West
Helene Ann Western
Robert Shaw Wetherall
Carol Ruth Whitmarsh
Barbara Katherine Wicks
Sally Anne Wilfson
Allan Rawson Williams, Jr.
Dorothy Rae Moore Williams
George Rogers Williams*
Kenneth See Williamson
Nancy Rowan Wootten*

Bachelor of Science

Harold Stanley Bruner, Jr.
Franklin Buckalew, III
Roger Alan Davis
George Frank Detrick
James Robert France
Ralph Walker Hart, Jr.
Walter Benjamin Moore, Jr.
Edward Rawson Pray
Clarence Frank Shaw, III
Bonnie Lou Edwards Smith
William Ramsay Webster
Joyce Marie Weis
Glen Nelson Wheeler

Bachelor of Science in Nursing

Catherine Perry Jeffries Aievoli
Maria Donna Avanzato
Madeline Kay Barton
Ruth Loveland Batt*
Linda Jane Deily
Jean Marie Martin Duffey
Eva Douglas Wise Everhart
Nancy Estelle Miller Fitzpatrick
Martha Delle Greer Grady
Linda Greenhouse
Janet Louise Kimble Helmuth
Lynn Barbara Chalbert Herman
Annette Lea Silverman Jacobs
Janet Lynne Johnson
Joan Lee Johnson
Joyce McLaughlin
Kathie Ann Parks
Mary Susan Reeder
Jacquelyn Louise Myers Rohrbaugh
Eve Reid Smith Suchanec
Eileen Joan Whiting Szabo
Margaret Jean Trout
Carol Marie Van Wyck

In Absentia

COLLEGE OF AGRICULTURAL SCIENCES

Candidates presented by Dean William E. McDaniel

Bachelor of Science in Agriculture

Carl Birger Abildso
Ralph Thomas Alls
William Lewis Ashley*
David Allan Baker
George Rollin Brown*
Charles Hanford Browning, Jr.
James Arthur Burcham
Merritt Burke, III
Robert Lowe Carmean
Gordon Willard Eaton
Vaughn Ira Elliott
Richard Lee Feulner
Jeffery Bryan Frey
Gary Vick Gerberg*
Edward George Hahn
Kenneth Marshall Hastings*
Donald Wallace Helmuth
Lee Clifton Hoffecker*
Robert Aaron Jacobson
James Paul Jones
James Francis Jordan
Spangler Klopp
Suzanne Karol Kracke
Donald James Lowe, Jr.
John Marion McGinnis, Jr.
Joshua Edward McIlvaine, Jr.
Donald Lee Melson, Jr.
Paul Richard Morgan
James Paul Mueller
John Francis Newell, Jr.
John Joseph Neylan, III
Ralph Jackson O'Day, Jr.
Darwin Bayne Palmer, Jr.*
Archie Douglas Peel
Malcolm Timothy Rayne
Ronald David Savidge
George William Seelig*
Philemon Lloyd Sheats, III
Enola Jane Newton Teeter
Edward Francis Terczak, Jr.
Harold Gordon Ulmer, Jr.
Robert Leonard Vair
Irvin Claude Ware
Wendel Ronald West
Claude Stanton Willey
Harold Parker Williams, Jr.*
Kenneth Lee Woodall
Ernest Jacob Zimmerman, Jr.*

In Absentia

COLLEGE OF ENGINEERING

CANDIDATES PRESENTED BY DEAN EDWARD W. COMINGS

Bachelor of Chemical Engineering

ERNEST LEE BANNISTER, JR.
WILLIAM MICHAEL BUTTING*
JAMES BERGER CAMDEN
CHARLES EDWARD CARROLL
BARTON CARROLL CLARK
THOMAS BAYARD COLBOURN
DOUGLAS ANDERSON COX
JOHN STEPHEN LAWRENCE CRAVEN
DOUGLAS EARLE CREGAR
MILFORD DARLINGTON
PAUL WAYNE FELTZ
ROBERT FRANKLIN GATES, JR.
STANLEY ALLEN HEARN
KENNETH JAMES HIMMELSTEIN
ALBERT RUSSELL HOGE
MARTIN LEE JOHNSON*
KENNETH JAMES KERR*
WILLIAM PENUEL LONG, JR.
LADISLAV VINCENT MAJOCH
JAMES JOSEPH MCCRYSTAL
ROBERT EDWARD PHELPS
DANIEL LEE SHAFFER

Bachelor of Civil Engineering

JACKSON ELLIOTT LANCE BEAUCHAMP*
WILLIAM WILSON BRADLY
ROBERT GEORGE FERSCH
GEORGE CONSTANT GOVATOS
WILLIAM SMITH HARTSOG*
WILLIAM THOMAS KELLEY
RALPH LEE KERR, JR.
CARL MARK KOCH
HENRY JAMES MCDERMOTT†
JAMES MATTHEW SHROUDS*
JAMES FREDERICK STANTON
JOHN DOUGLAS WERNER

Bachelor of Electrical Engineering

JOHN LEONARD BARBER
ARTHUR CLAY BROSTRAND, JR.
WILLIAM RALPH CASSEL†
LAWRENCE LEROY DIMMICK, JR.
ROBERT EDGAR FRIEDMAN
GERARD JOHN GALLUCIO, JR.
ALEXANDER CHARLES KRAMER, JR.
TIMOTHY TING CHANG LIU
STEVEN WAYNE LUCAS
ROBERT LEROY MARTZ
LAWRENCE PATRICK MAULO, JR.
DOUGLAS JOHN MURRAY
LEE HARVEY NICHOLS, III
DAVID RICHARDS NORRIS*
ROBERT LAWRENCE PUSEY
JOHN ABERNATHY SMITH
ROBERT WILLIAM SPITTLE, JR.
DAVID BRUCE VANNOY
JOHN EUGENE VOSHELL
ERIC KELLER WALTON
CRAIG MCKENZIE WELLMAN
MICHAEL FRANK WILSON

Bachelor of Engineering Administration

ROBERT ERNEST BEBON
LEONARD ADRIAN BIRD
TIMOTHY BRUCE FALKINBURG
NICOLAS LIBERMAN
WILLIAM ANTHONY LOTZ
EDWARD VINCENT LOWER, JR.
NORMAN JOHN NEIDE
PETER GEORGE POWELL

Bachelor of Mechanical Engineering

WALTER DAVID ANTKIEWICZ
STEPHEN ROBERT CONARY
PAUL NICHOLAS COSTELLO
JOHN HOWARD CRONIN, JR.
EDWARD DARLINGTON
JOHN AUGUST DEGE, JR.
RALPH BENSON DILL, III
SETH THOMAS EBERHARDT
SAMI MEHMET GUNYUZLU
HERBERT EDWARD ELLIOTT, III*
WILLIAM ANTHONY LOTZ
ROBERT CHARLES MADER, JR.
MICHAEL JACKSON PRICE
GEORGE DURKIN RUCK
JAMES ROBERT RUSSELL
ALTON PARKER SMITH, JR.
RICHARD ALLEN STOUDT
ROLAND PIERCE TRASK, II
JOSEPH CHARLES VANKOSKI
DAVID ARTHUR VAUGHAN

**In Absentia*

†*Dean's Scholar*

COLLEGE OF EDUCATION

CANDIDATES PRESENTED BY DEAN ROY M. HALL

Bachelor of Arts

PATRICIA ANN APPEL
VIRGINIA ELAINE ARTZ
CAROL SUSAN BAGGALEY
CAROLE ANN BROWN
MARY ANN WILLIAMS DEFOE
ROBERT FRANKLIN EASTMAN
CHARLES JOHN GRIFFITHS
HELGA HERGLOTZ
BARRY VIBBERT HOLLINGSWORTH
AIJA RIPA HORTON*
MARY JANE KERN
ERVIN HERBERT LANGE*
THOMAS FRANCIS LAPINSKI
ROBERT HARRISON MARSHALL
ANTHONY JOHN MONTCALMO
GYURI NEMETH
ANNE-LISE STROMNESS PAULSEN*
CAROL ANN PRY
JAMES EDWARD QUIRK
MICHAEL LARSON RICHARDS
SUSAN RUNGE
WILLIAM ALBERT STODDART, III
BEVERLEY LEE LIPSCOMB WALKER

Bachelor of Science in Education

KAREN LEE ANDERSON
JEAN TEMPLE DONOVAN ANNAND
JEAN MARIE ARNOLD
PATRICIA ANN BEATTY
MARJORIE MAE BECKWITH
CONSTANCE ELLEN BIRDSALL
CAROL ANN BLEVINS
VAUGHN WINGATE CHARLTON
EDMUND JESSE CHMIELEWSKI
OTTO JOSEPH CLARICURZIO
PATRICIA ANTOINETTE CLATCH
CHRISTINE LEA CLEMMER
MARGERY FRANCES DEMPSEY
VIRGINIA PAIGE MILES DEWEY
BARBARA JEANNE DUNNING
EDNA CATHERINE KOURY DURBOROW
SUSAN ANN DUROSS
LYN VILLERIUS EGGINK*
RACHEL WEAVER SAVAGE ELLIS
ALINE MARIE EWING
SUSAN CHRISTINE FEENEY
ELIZABETH ROBERTS FIRESTONE
SUSAN MARGARET KINKAID FISHER
HELEN MARTINA FOLSOM
BEVERLY GAIL ARGO FRENCH
MARY DIANE GAVIN
RICHARD TERRELL GRAHAM
KATHLEEN BETTY HOFFMAN GRANDELL
LINDA CAROL GRAY
ISABEL PHYLLIS SMITH GREENHAUGH
ALEXIS NORA FARRELL GRILLO
SUNDAY FLORES PAOLI HAFFEN
BRIGITTE JOHANNA KITTLEMANN HEINZEL
ANITA MELDOESKY HERSH
JOAN CAROLYN HETRICK
CATHERINE ENID HICKMAN*
KATHIE DIANE LEWIS HIMES
JUDITH ANNE HORMBY HOLLINGSWORTH
JUDITH KAY HOPPERSTEAD
SANDRA JANE HUMEL
CAROL ANN JOHNSON
RITA DIANE JOHNSON
KATHERINE BRANNER KING
ANNE LEAH EPSTEIN KORNBLUM
ROSE ANN MILLER KROEBER
LINDA MARY KRYSTOPOLSKI
CAROLYN ANN KUHN
MARCIA KAY LADAGE
MARILYN JOYCE LEEDS
CAROL MARILYN LUTZ
MARY LEE LUTZ
HESTER COX MCNEILLY
ROBERTA SANDRA MERITZ
CAROL LYNN MOORE
JEAN FRANCES MOORE
BETTY LARGENT MORAN
DIANNE MARIE MOSHIER
MARY ANN NAGHSKI
CHRISTINA MARY OSTERLUND
ELMA MAY DARRAH PAGE
ELISSA TERESA PANARO
HELEN LEONE SCHWARTZ PEARSON
DIANE DONNA VAN-NAME PEIRCE*
JOANNE DOROTHY PIERSON*
KAREN LEE WICKSTROM PLEASANTON*
MARY ELIZABETH FILLINGAME POWELL
MARY ANNE PUSEY
CECILY KING REEVE
FLORENCE DELORES ROSE
PHOEBE BRYNA ROSHBERG
CAROL SUE ROSIN
FLORENCE REEDER RUTTER
SARA ANN SAPP
DIANE MARIE SCATASTI
SANDRA RUTH SHANK
JUDITH MARIE SHEPPARD
CAROLE DEBORAH SHUTTLEWORTH SMITH
DOROTHY MAY PEPPER SMITH
NORA ALICE SMITH
JUSTINE FRANCES SPACEK
JUDY BARBARA SCHREIBER STEIN

**In Absentia*

Cheryl Ann Stevens
Geraldine Elizabeth Finan Stewart
Karen Ruth Sundt
Susan Marie Taylor
Barbara Jean Tebbens
Rita Mary Ucciferro
David Harold Unruh
Beverly Anita McCallion Valiant
Nancy Louise Varady
Nancy Sue Weidemann
Joan Lydia Wilson
Elizabeth Nalletta Winnington
Caroline Teresa Zappa
Elizabeth Ann Zimmerman*

Bachelor of Science in Physical Education

Terry William Arnold*
James Arnold Brown
Bruce Earl Carlyle*
Arlene Margaret Coleman
Suzanne Elizabeth Dean
Priscilla Diano
Joseph Donald Donolli
Mary Lou Evans
Wilma May Harrington
Katherine Squire Herbert
Joan Evans Kelley
Richard George Leach
Barbara Lee Matthews
Thomas Joseph Michaels
Barbara Gail Roberts
Heather Lynne Toulson

*In Absentia

COLLEGE OF HOME ECONOMICS

Candidates presented by Dean Irma Ayers

Bachelor of Science in Home Economics

Virginia Anne Alexander
Ildiko Maria Bodo
Joan Seaton Callahan
Joyce Dolores Clement
Brenda Grace Collins
Dorothy Georgene Curtiss
Carole Nona D'Anna
Martha Linda Dawson
Margaret Ann Lyons Dessauer
Caroline Ayres Dumont
Marion Joy Galaini
Barbara Gibson
Gail Joanne Kauffman Gore
Sherrill Ann Harkins
Kathryn Elizabeth Herge
Marguerite Holbrook
Patricia Helen Houchin
Mary Elizabeth Travis Isaacs
Betty Lou Jeuell
Marie Louise Johnson
Anna Marie Keck
Deborah Ann Kelly
Susan Hollis Markham
Barbara Lois Marley
Linda Kay Terry Martin
Marguerite Hilda Bohm Maxwell
Barbara Folger Meldrum
Janice Lynn Mercer
Carolyn Ruth Murray
Dian Isabel Nacrelli
Audrey Ona Reese
Elizabeth Rae Richardson
Norma Irene Rise
Susan Jane Robbins
Andrea Theresa Sauvola
Betty Louise Chadwick Scott
Valerie Lyn Shea
Holly Alexia Shertzer*
Carol Jean Small
Carol Lee Soltow
Ann Helen Spanagel
Sara Catherine Valliant

COLLEGE OF BUSINESS AND ECONOMICS

CANDIDATES PRESENTED BY DEAN RUBEN V. AUSTIN

Bachelor of Arts

JAMES SALVATORE ARIGANELLO
ROBERT HAMBLETON DUNLAP
STEVEN ROLF KARLSEN
EDWARD AUGUSTUS KEELING, III
WILLIAM HENRY MACKEY
STEPHEN MACY MERCHANT
ROBERT MILTON REARDON, JR.
LAWRENCE CHRISTOPHER SCHWAB
NANCY ELLEN STRUYK
JAMES BERNARD TOBIN
BERNARD HENRY WOOD, JR.
JEFFREY ERROL ZERBY

Bachelor of Science

MICHAEL BRUCE ABER
RUSSELL CHARLES BARLOW
ROBERT DOUGLAS BARRY, JR.
ALFRED JOHN BELLINI, JR.
JAMES GORDON BITTER
CHARLES KELSEY BROWN
DONALD RICHARD BRUNNER
ROBERT DONNAN BURRIS
JAY THOMAS CHANDLER
LAWRENCE NICHOLAS CIFONI
JOHN WILMER COVERDALE, JR.
ANTHONY ALFRED CURRAN
ROBERT WILSON DEIBLER, JR.
ROBERT NOBLE DOWNES, JR.*
BASIL LOUIS DUBROSKY
FRANCIS JAMES DUGAN
SHARON ELIZABETH LAWTON EVANS
SAMUEL WHARTON FADER, JR.
MICHAEL JOSEPH FAHEY
JOHN RIGIS FERRICK
JOSEPH HERBERT FISHER
DEAN WALKER FITCH
WESLEY HASTING FRITH*
ROGER LEWSON GOLDYN
STEPHEN MOSS GRIMBLE
WILLIAM PATRICK HARRINGTON
MAURICE JOSEPH HICKEY, JR.
JOHN WILLIAM HIMES
JACK RADCLIFF ISTNICK*
LOUIS ALAN JACOBY
WILLIAM JAMES JENNINGS, JR.
PAUL LEGRAND JOHNSTONE, JR.
SAMUEL CARL JORGENSEN
EUGENE MICHAEL JULIAN
MICHAEL VINCENT KEHNAST
JAMES STEWART KING
LINDA LOU LESLIE
DANIEL FISHER MARPLE, JR.
JOHN WELDIN MAWDSLEY
JAMES MELVILLE
THOMAS VINCENT MULRINE
DIRK LEE MUMFORD
SIMON NATHANSON
JOHN BROWN PEACH
DALE JOSEPH PETERSON*
PAUL JAMES PIPER*
JAMES PRIDE PRETTYMAN, III
KLAUS DIETER REICHELT
THOMAS PAUL RICHARDSON
PAUL JOHN SALVO
FRANCIS XAVIER SCHOFIELD
PHILIP MICHAEL SHAR
RICHARD BYRON SKELLEY
JAMES WOODROW SMACK
EDWARD JOSEPH STEGEMEIER, JR.
SALLY ANN STIEBER
RICHARD JAMES STODDARD
EDWARD WILLIAM SZCZORBA
DAVID READ TARDITI
PAUL GILBERT TRUAX
ROBERT SPENCER TRUITT*
PETER HENRY WILLIAM VAN DER GOES
WILLIAM LEON WALLS, JR.
ROBERT WAYNE WANDEL, JR.
WALTER ALLEN WEBSTER
DONALD MARVIN WILLIAMS
RONALD LEE WOOTTEN
JEREMIAH FLETCHER WRIGHT, JR.

In Absentia

Degrees with Distinction and Honors

COLLEGE OF ARTS AND SCIENCE

CANDIDATES PRESENTED BY PROVOST JOHN W. SHIRLEY

Bachelor of Arts

NANCY ALLEN (with honors)
JUDITH COLE ANDERSON (with honors)
ROLF NORBERT CARLSTEN, JR. (with honors)
DONALD SIDNEY CORAM (with honors)
EVELYN JANE PAPEN CUTHRELL (with honors)
MARY CYGELMAN (with honors)
ANTOINETTE MARIE DELISI (with honors)
RALPH CONRAD EAGLE, JR. (with honors)
JANICE LYNN FIVEHOUSE (with honors)
ELOISE FLYNN (with honors)
AUBREY NELL FONDREN (with honors)
SIEGFRIED WERNER FUCHS (with honors)
MARY ELLEN GAUNT (with honors)
ELLEN ANNE GLUTTING (with honors)
KAREN HELENE HANSEN (with honors)
MARY ELIZABETH HUGHES (with honors)
LORETTA MATILDA JURAS (with honors)
VIRGINIA ELAINE KENT (with honors and distinction in Biological Sciences)
HELEN LOUISE LIST (with honors and distinction in English)
MARION ELIZABETH LITTLER (with honors)
HAROLD CLAYTON LIVESAY (with distinction in History)
KENNETH EDGAR MACLARY (with honors)
JANET RAE BAKER MCCARTY (with honors)
PAULA ANNE MURPHEY (with honors)
KATHRYN MARIE PANCOAST (with honors)
JUDITH ANNE POWERS (with honors)
JUDITH ANNETTE LINCOLN ROBERTS (with honors)
KENNETH RICHARD SANDLER (with honors)
STEVEN MARK SERBIN (with honors)
PRISCILLA WISHNICK SIEGEL (with honors)
LINDA GAIL SLATER (with honors)
CHARLES WATERS THOMPSON, JR. (with distinction in English)
MARY ANN HANGEN TUSCHAK (with honors)
JAMES DORSEY WRIGHT (with high honors)
MARILYN FRANCES WULFF (with honors)
EDWARD CHARLES YUREWICZ (with honors)

Bachelor of Science

STEPHEN BERTOLET BRUMBACH (with honors)
KATHRYN DENFELD FRENCH (with honors)
WILLARD W. WHITE, III (with distinction in Physics)

COLLEGE OF AGRICULTURAL SCIENCES

Bachelor of Science in Agriculture

HOWARD THOMAS JOSEPH DUFFEY, III (with distinction in Horticulture)
JOHN TURNER MACNAMEE (with high honors)
ROBERT HARVEY NICHOLSON (with honors and distinction in Agricultural Economics)

COLLEGE OF ENGINEERING

Bachelor of Chemical Engineering

ELLIOT STEVEN PARKIN (with honors)

Bachelor of Electrical Engineering

WILLIAM HABICHT, II (with honors)
WILLIAM CHARLES WAGNER, II (with honors)

Bachelor of Mechanical Engineering

ROBERT CHARLES BILL (with honors)
WILLIAM WARD EMSLEY (with honors)
DAVID CARL REICHARD, III (with honors)

COLLEGE OF EDUCATION

Bachelor of Arts

RUTH ELAINE PRANGE OATMAN (with honors)

Bachelor of Science in Education

BARBARA BABCOCK BOYNTON (with honors)*
SHEILA SMITH GORRAFA (with honors)
LINDA JOAN HAYTER (with honors and distinction in Elementary Education)
JAYNE ANN LEADER HETHERINGTON (with honors)
PATRICIA ALLEN MACKY (with honors)
SHIRLEY JEANNE SHARP PHILHOWER (with honors)
DELLA LARAE MCENTIRE RUSSELL (with honors)*
DORIS ANN GREENLY STEVENSON (with honors)

COLLEGE OF HOME ECONOMICS

Bachelor of Science in Home Economics

ELLEN ELISABETH AUNGST (with honors)
ALICE CATHERINE BECKLEY (with high honors and distinction in Food and Nutrition)†
VIRGINIA MAE BOYCE (with honors)
NANCY JEAN CLENDANIEL (with honors)
PATRICIA MICHELLE FLOWERS (with honors)
ANDREA ELLEN GUSS (with high honors)†
DONNA LEE HANSEN (with honors)
ELAINE FARROW ISAACS (with honors)
SALLY ELEANOR NICKLES (with honors)
ALICE ANN WILLIS (with honors)†

COLLEGE OF BUSINESS AND ECONOMICS

Bachelor of Arts

RALPH VON DEM HAGEN (with honors)†
RICHARD MICHAEL YOUNG (with high honors)

**In Absentia*
†*Dean's Scholar*

SECOND LIEUTENANTS IN THE UNITED STATES ARMY RESERVE

OATH ADMINISTERED BY COLONEL EDWARD G. ALLEN
PROFESSOR OF MILITARY SCIENCE

Adjutant General's Corps

ROBERT CARROLL GUENVEUR†
DAVID ALAN POTTER†

Armor

JOHN REGIS FERRICK
ARCHER A. OWENS, JR.

Artillery

DONALD WALLACE HELMUTH†
PAUL LEGRAND JOHNSTONE, JR.†
RICHARD BYRON SKELLEY*‡

Chemical Corps

JOSEPH ELLIOTT GILMOUR, JR.*‡

Corps of Engineers

ROBERT GEORGE FERSCH
EUGENE MICHAEL JULIAN*

Medical Service Corps

JOHN MARTIN GLAUBITZ*

Military Police Corps

MICHAEL JONATHAN MCCRANN†

Ordnance Corps

STEPHEN ROBERT CONARY
BASIL LOUIS DUBROSKY
WILLIAM ANTHONY LOTZ

Quartermaster Corps

HARVEY CURTIS JOHNSON†
GEORGE RUSSELL LAMPLUGH

Signal Corps

RAYMOND LEWIS KIRKPATRICK, JR.*‡
STEVEN WAYNE LUCAS*‡
JOHN ABERNATHY SMITH
ROBERT WILLIAM SPITTLE, JR.†

Transportation Corps

FRANK RICHARD BARTUCCA
JAMES PAUL MUELLER
THOMAS VINCENT MULRINE†
JAMES PERRIN PURVIS, JR.
KLAUS DIETER REICHELT
JAMES WOODROW SMACK
THOMAS WALTER VAN GROFSKI†
RALPH VON DEM HAGEN*

†To be commissioned at Summer Camp
‡To be commissioned in Regular Army
*Distinguished Military Graduate

ADVANCED DEGREES

CANDIDATES PRESENTED BY DEAN C. ERNEST BIRCHENALL

Master of Arts

JANET BALLARD ABBEY, B.S., Beaver College* — *Psychology*
M.S., University of Pennsylvania
DOROTHY TODD VOSHELL ATALLA, B.A., University of Delaware — *English*
JUDITH LEE BOWMAN, A.B., Lebanon Valley College — *Spanish*
RICHARD STUART BREMILLER, B.S., United States Merchant Marine Academy — *Mathematics*
M.S., Drexel Institute of Technology
MICHAEL JOHN BURNS, B.S., University of Scranton — *History*
WILFORD PRESTON COLE, B.A., University of Delaware — *Early American Culture*
BRIAN PAUL DAMIANI, B.A., LaSalle College — *History*
RUSSELL FRANCIS DENNIS, B.A., University of Delaware — *American Studies*
BARRY LANCE DUMAN, A.B., George Washington University — *Economics*
LUCIUS FULLER ELLSWORTH, B.A., College of Wooster — *History*
JUDITH WEYMOUTH GILES, A.B., College of William and Mary in Virginia — *Psychology*
LEWIS BROWN GOODLEY, A.B., Western Maryland College* — *Biological Sciences*
VIRGINIA BLACK GREEN, B.A., University of Delaware — *Art*
JAMES JOSEPH HALEY, B.S. in Econ., University of Pennsylvania — *History*
ALISON KAYE TARTT HEINEMANN, B.A., The University of Texas — *English*
FREDRIK JO HEINEMANN, B.A., University of Michigan — *English*
MARY MADELINE HOLMES, A.B., Chestnut Hill College — *Spanish*
JOHN CARL KEEGEL, A.B., Rutgers, The State University — *Mathematics*
DAVID ALAN KUPFERBERG, B.A., American International College* — *Economics*
RONALD JAY LAMBDEN, B.A., University of Delaware — *History*
PHYLLIS MARION RIXEY LANGLEY, B.A., Mary Washington College of the University of Virginia — *French*
MARY ALICE MCCLEARY LANGSDORF, B.S. in Ed., Ohio University — *English*
JULIE GATEWOOD LATANÉ, A.B., University of North Carolina at Chapel Hill — *Psychology*
BURTON ARNOLD LESH, B.A., University of Notre Dame* — *Political Science*
CAROLYN LEWIS, B.A., University of Arkansas — *American Studies*
LYN THOMAS LOCKHART-MUMMERY, B.A., University of Delaware — *Guidance*
STANLEY IRWIN MALLACH, B.A., Rutgers, The State University* — *Early American Culture*
TIMOTHY BERNARD MALONEY, B.A., King's College, New York — *Dramatic Arts and Speech*
JAMES SPENCER MALOTT, B.A., Stanford University — *Art*
ROBERT COURTNEY MOTTLEY, JR., A.B., Washington and Lee University* — *History*
JAMES MICHAEL MULROONEY, B.A., University of Delaware — *Psychology*
RICHARD LEWIS MURCHISON, B.A., Maryville College, Tennessee — *Economics*
BARBARA KAY MARTIN NAEF, A.B., Duke University — *History*
KATHLEEN MARY NEILS, B.A., College of Saint Catherine — *History*
LESLEY CHREE O'MALLEY, B.A., Marymount Manhattan College — *History*
DONALD EDWARD OSMUN, B.A., University of Delaware* — *Biological Sciences*
JOSEPH ANTHONY PALERMO, B.S., University of Scranton — *History*
THEODORE ZUK PENN, B.S., Virginia Polytechnic Institute — *History*
THOMAS OLIVER PERRY, B.A., Bloomfield College and Theological Seminary — *History*
EILEEN PETERS, B.A., Rutgers, The State University — *Political Science*
RUSSELL GLEN PETERSON, B.A., Lawrence University — *Art*
SIDNEY SMITH RAWLINS, B.A., Utah State University of Agriculture and Applied Science — *Spanish*
KAMALA CAMBHAM REDDY, B.A., Osmania University, India* — *English*
M.A., Osmania University, India
JOHN HUBERT RENSHAW, B.S. in Ed., State College, East Stroudsburg — *History*
GEORGE SEYMOUR RENT, A.B., Marietta College* — *Sociology*
EVAN SHERWOOD SEYMOUR, B.A., Macalester College — *English*

**In Absentia*

RAMESH GHELABHAI SHAH, B.Comm., Gujarat University, India — *Economics*
B.A., Gujarat University, India
L.L.B., Gujarat University, India
M.Comm., Gujarat University, India
M.B.A., University of Pennsylvania
ROBERT LEWIS SHARP, B.A., Glassboro State College — *History*
WAYNE SYLVANUS SMITH, B.S., University of Delaware — *History*
LIDIA GARIBIANS SOHODSKI, B.A., University of Delaware — *French*
FRANCIS XAVIER SPLANE, B.A., University of Delaware — *Economics*
BETTY ISLA STRAUSS, A.B., University of Missouri — *American Studies*
JOSEPH WILLIAM SURVANT, B.A., University of Kentucky — *English*
NANCY KATHARINE PAUL TAITT, B.A., University of Delaware* — *Secondary Education*
JANICE KEIKO TAKAHASHI, A.B., Whittier College* — *History*
ALLAN IRVING TEGER, A.B., Lafayette College — *Psychology*
SHUANG-FUU TSOU, B.A., National Taiwan University, China* — *Mathematics*
M.A., National Taiwan University, China
DOLORES MARIE VEZZI, B.A., Duquesne University — *Mathematics*
PETER LOUIS VISCUSI, B.A., LaSalle College — *History*
ELISABETH BRIGHAM WALTON, B.A., University of Oregon* — *Early American Culture*
M.A., The Pennsylvania State University
JOHN WELLS WARD, B.S. in Educ., University of Virginia* — *History*
STANTON ALBERT WARREN, B.A., State University of New York, College at New Paltz — *Economics*
JOAN WHITE WATSON, B.A., Geneva College — *History*
MAYNARD PRESSLEY WHITE, JR., B.A., Brown University — *American Studies*
ANNE WILSON WILLIAMS, B.A., University of Birmingham, England — *French*
DAVID FRANKLIN WILSON, B.A., Hofstra University — *Biological Sciences*
JOHN GARY WIRTH, B.S., University of Wisconsin — *English*

Master of Science

LUIS ALBERT-MELIA, Civil Engr., University of Chile, Chile — *Chemistry*
STANLEY EDWARD ANDERSON, JR., B.A., Northwestern University — *Chemistry*
M.B.A., Northwestern University
JOHN JOSEPH AVIOLI, B.S., State College, West Chester — *Mathematics*
ROBERT CHARLES BANASH, B.S., University of Illinois — *Statistics and Computer Science*
DAVID EDWARD BERRY, B.S., University of Delaware — *Physics*
MARIANNE DOLORES BOBBIN, B.S., Drexel Institute of Technology — *Secondary Education*
RICHARD ANDREW BOOTH, B.S., The Pennsylvania State University — *Animal and Poultry Science*
MARLENE GRACE FISHER BUTLER, B.S., Juniata College — *Food and Nutrition*
STANLEY CHARLES BUTLER, B.S., Juniata College — *Mathematics*
LARRY VICTOR CALDWELL, B.A., Franklin and Marshall College — *Physics*
CAROLYN CECILIA COCHRANE, B.S., Bucknell University — *Chemistry*
RONALD VINCENT CRONISE, B.A., Western Maryland College* — *Chemistry*
RICHARD JAMES CROUSE, B.S., Albright College — *Mathematics*
JOHN ALBERT DARLING, B.A., Earlham College — *Physics*
RONALD IVEY DAVIS, B.S., Pratt Institute* — *Chemistry*
WILLIAM CHAPPELL DEANS, A.B., Duke University* — *Chemistry*
THOMAS CLYDE ELLWANGER, JR., B.S., University of Delaware — *Horticulture*
LEIGHTON PHREANER EVERHART, JR., B.A., University of Delaware* — *Biological Sciences*
ROBERT BYRD FAUST, B.S., University of South Carolina — *Statistics*
NORMAN TERRY FELBERG, B.S., The Pennsylvania State University — *Chemistry*
FLORENCE ELEANOR FISCHER, B.S., Ursinus College — *Secondary Education*
THOMAS ALVIN FRETZ, B.S., University of Maryland — *Horticulture*
WESLEY OLIVER FRITZ, JR., B.S., Southwest Missouri State College — *Chemistry*
WILLIAM EMERSON GLEDHILL, B.A., University of Delaware — *Biological Sciences*
CARL GOTZMER, JR., B.S. in Chem., Lafayette College — *Chemistry*
RICHARD JAMES GOUGER, B.S., University of Maryland* — *Entomology*
CRAIG JUSTUS WEBSTER GUNSUL, B.A., Reed College — *Physics*

**In Absentia*

Janet Elizabeth Dreves Hall, B.A., Gettysburg College* — *Mathematics*
Robert Burton Hall, B.A., Gettysburg College* — *Physics*
Michael Moncure Harris, B.S., University of Delaware — *Agricultural Economics*
Stanley Edmund Jones, B.A., University of Delaware* — *Mathematics*
Clair Stuart Kelley, B.S., Union College, New York — *Physics*
Charles Alvah Kennedy, A.B., Dickinson College* — *Physics*
Charles Whan Kim, B.S., Lowell Technical Institute — *Chemistry*
Kenneth Graydon King, B.A., Cornell University — *Chemistry*
David George Larson, B.A., Concordia College, Minnesota — *Entomology*
Robert Burrows Lauer, A.B., Franklin and Marshall College — *Physics*
Kay Ruth Hansen Leibrand, B.S., Montana State University — *Mathematics*
Charles Alfred Lesser, B.S., University of Rhode Island — *Entomology*
Paul Anthony Lotto, B.S.M.E., Bucknell University — *Statistics and Computer Science*
James Edwin McCully, B.S., University of Delaware — *Horticulture*
Fred William Melchior, Jr., B.S., Ag., University of Delaware — *Animal and Poultry Science*
William Henry Mermagen, B.S., Fordham University — *Physics*
Nelson Laurence Miller, B.S., University of Massachusetts — *Horticulture*
Donald James Monaco, B.S., University of Delaware — *Chemistry*
Stanley Truman Ockers, B.S., State College, West Chester — *Physics*
William Joseph Olkowski, B.S., University of Delaware* — *Entomology*
Hisanori Omura, B.S., Osaka City University, Japan — *Chemistry*
Francis Joseph Papp, IV, B.S., University of Notre Dame — *Mathematics*
Woo Chang Park, B.A., University of Minnesota* — *Chemistry*
John Paul Podgorski, B.A., University of Minnesota* — *Chemistry*
Hugh Criswell Price, B.S., The Ohio State University — *Horticulture*
Leonard Joseph Putnick, B.S., Saint Joseph's College, Pennsylvania — *Physics*
James Oliver Rice, B.S., Agricultural and Technical College of North Carolina — *Chemistry*
John Knox Rosenberger, B.S., University of Delaware — *Animal and Poultry Science*
Robert Merrell Stehman, B.S., University of Illinois — *Physics*
Malcolm Samuel Taylor, B.S., Towson State College* — *Mathematics*
George Toby Thompson, B.S., University of Delaware — *Agricultural Economics*
Roy Calvin Timmer, B.S., Bob Jones University — *Chemistry*
Mary Ann Findeisen Upton, B.S., Ursinus College — *Chemistry*
William Henry Wagner, S.B., Massachusetts Institute — *Statistics and Computer Science*
Charlotte Mae Lynch Wheatley, B.S., Salisbury State College — *Elementary Education*
LeRoy Eldridge Wheatley, B.S., University of Maryland — *Agronomy*
Richard Charles Whiteside, B.S., University of Delaware — *Entomology*
Frederick Jacob Wiebel, Jr., B.S., University of Delaware — *Plant Pathology*
Lloyd Eugene Williams, B.S., The Pennsylvania State University — *Chemistry*
Edward Louis Wisk, B.S., University of Delaware — *Agronomy*

Master of Business Administration

Paul Erdman Becker, Jr., B.S., United States Naval Academy
Robert Eugene Bell, B.S., Temple University
Ralph Thomas Griggs, B.S. Bus. Adm., Pennsylvania Military College
Paul Hugo Holmberg, Jr., B.S., Saint Mary's College, Minnesota
Paul Orman Kelly, B.S., Massachusetts Institute of Technology
Albert Joseph Martin, Jr., B.A., University of Delaware
Kenneth Eugene Pyle, B.S., Virginia Polytechnic Institute
Leonard Walter Quill, B.S., University of Delaware
Francisco Henriquez Sabin, Jr., B.S. in B.A., Boston University
Paul Edmund Stubbe, B.S., Cornell University
James Edward Van Epp, Sc.B., Brown University

Master of Education

Rocelia B. Jones Allen, B. Mus. Ed., Chicago Conservatory College
Anita Marian Redding Angermeier, B.S. in Ed., The Pennsylvania State University

**In Absentia*

Alice Maxine Hood Barnett, A.B., Atlantic Christian College
Caroline Joyce Powers Bazzano, B.Ed., State College, West Chester
Kathleen Marie Flynn Becker, B.S., Drexel Institute of Technology
Eugenia Ellen Bullard Blosser, B.A., Western Reserve University
Georgia Boines, B.S., University of Delaware
Azalia Hackley Smith Briggs, B.S., Virginia State College
Dorothy Lee Smith Browning, A.B., Atlantic Christian College
John William Burchfield, B.S., State College, Shippensburg
Francis Anthony Castelli, B.A., University of Delaware
Lawrence Richard Catuzzi, B.S. in Ed., University of Delaware*
Glenn Michael Craig, B.S., The Pennsylvania State University
Willa Gene Christianson Cramton, B.A., Hamline University
Janet deLuca Daniels, B.S. in Chem., Tufts University
Martha Ann Mendenhall Daum, B.A., University of Delaware
Jane Wingate Forman Davis, B.A., University of Delaware*
John Clarence Deal, B.S. in Ed., State College, Slippery Rock
Jane Eleanora Wueschinski deGrange, B.S. in Ed., State College, Millersville
Joanne Fleanor Denney, B.S., University of Delaware
Janice Elnora Denning, B.S., State College, West Chester
Harry Richard Edwards, B.Sc. Ed., State College, Bloomsburg
Francis Joseph Fierro, B.A., University of Delaware
Judith Anne Frederick, B.S., University of Delaware
Dolores Louise Ross Fritz, B.A., The Pennsylvania State University
Howard Gaines, Jr., A.B., Fairmont State College
Jeanne Foster Pastorino Gardner, B.A., Montclair State College
Howard Oliver Gerken, Jr., B.A., Gettysburg College
Helen Hilda Nadelstein Gerner, B.S. in Ed., Temple University
Walter John Gerzin, B.E., Saint Cloud State College
Herman Harold Glass, B.A., Duke University*
Martin Cecil Groundland, B.S., University of Delaware
Rosa Lee Agnor Harris, B.S., Madison College
John Sherman Head, Jr., B.S., East Tennessee State University
Michael George Heinecken, B.S., University of Delaware
Lura Lee Best Herzog, B.S. in Ed., University of Nebraska
David Richard Hirst, B.A. in Ed., University of Pittsburgh
Geoffrey Brian Isherwood, B.S. in E.E., Tufts University
Donald Carlton James, B.A., University of Delaware
Charlotte Ann Jones, B.S. in Ed., University of Delaware
Paul Samuel Julian, B.S., State College, West Chester
Margaret Kelley Justice, B.S., Salisbury State College
William Vincent Kehoe, B.A., Montclair State College
Patricia Joan Roberts Kimmel, B.S., State College, West Chester
LaVerne Theresa McLean Kleckner, B.S. in Ed., State College, Kutztown
Clara Geer Lindquist Klug, A.B., Oberlin College
Henry Waldemar Koenig, Jr., B.S., University of Maryland
John Joseph Kovacs, B.A., Monmouth College
Harry Kutch, B.S., State College, West Chester
Jane Louise Buck Laskaris, B.A., University of Delaware
M.A., University of Delaware
Loretta Pauline Lazarczyk, B.S., University of Delaware
Salvatore Madrechesia, B.A., Temple University
Jesse Malin, B.A., College of Wooster
Alan Wren Maloney, B.S., Elizabethtown College
Charles Fred Maxwell, B.A., Long Island University, Mitchel College
William Tome McLain, B.A., University of Delaware
Robert Charles Mehan, Jr., B.S. in Ed., State College, Millersville
Mary Lillian Born Meier, B.A., The University of Texas
George Boysen Meldrum, B.A., Duke University
Guizelous Ofella Molock, B.S., Delaware State College

**In Absentia*

Rose Linda Bovino Morelli, A.B., The City University of New York, Hunter College
Ethel Hobbs Morgan, B.S., State College, West Chester
Edward Dwight Morris, B.A., University Philippines*
David Hudson Moyer, B.A., Elizabethtown College
Joseph Francis Mozzani, B.S. in Ed., State College, West Chester
Stanley Truman Ockers, B.S., State College, West Chester
Charles Ellis Orr, B.S. in Ed., State College, Edinboro*
Luis Carlos Page, Diploma, University of Panama, Panama
Helen Ruth Fulton Palmer, B.S., State College, Clarion
John Patton, Jr., B.S. in Ed., State College, West Chester*
Helen Mae Krachenfels Reed, A.B., Wilkes College
William Edward Robb, Jr., B.S., University of Delaware
Mary Ann Arlene Rozsas, B.A., Ursinus College
Louise Warren Stayton Schafer, B.A., University of Delaware
Kurt Walter Schleicher, B.S. in Ed., University of Virginia
Glenn Walter Shaffer, B.S. in Ed., State College, Millersville
Joseph John Slobojan, B.A., University of Delaware
Robert James Sokol, B.A., University of Delaware
Alfred Henry Speers, B.S., The Pennsylvania State University
Lois Evelyn Swain, B.A., University of Toronto, Canada*
B.Ed., Ontario College of Education, Canada
Charles Joseph Sweeney, Jr., B.A., University of Delaware*
Franklin Duff Sykes, B.A., University of Delaware
Mildred Mae Moffett Taylor, B.S., Temple University
Susan Blake Thomas, B.S., Beaver College
Ann Marie Phelan Warnell, B.S. in Ed., Alverno College
Duane Llewelyn Weiss, A.B., Thiel College
Gail Jean Gabriel Welch, B.S. in Ed., State College, Shippensburg
Dorothy Rebecca Levers Wilkinson, B.S. in Ed., Salisbury State College
Addie Rose Gwinn Wilson, B.S., Concord College
Rhoda Lebovitz Witlin, B.S. in Ed., The City University of New York, City College
Walter Frank Wolfe, B.S., West Virginia Institute of Technology
Kenneth Edwin Woodward, B.A., Ursinus College
John Edward Yanaitis, B.S., State College, Bloomsburg
Young Ja Yoon, B.A., Ewha Woman's University, Korea
James August Yori, B.S., Mount Saint Mary's College

Master of Applied Sciences

Michael Hugh McGlincy, B.S., University of Delaware — *Mathematics*
Edward Louis Miller, B.A., University of Bridgeport — *Statistics and Computer Science*

Master of Chemical Engineering

David Thomas Buzzelli, B.S., University of Minnesota*
Thomas Robert Clapp, B.Sc. Eng., Queens University at Kingston, Canada*
James Joseph Cudahy, B.Ch.E., Newark College of Engineering
James Edward Feig, B.S. Ch.E., Drexel Institute of Technology
Kazutoshi Fujimura, B.Ch.E., Kyoto University, Japan
David Fanton Gilbert, B.S. Ch.E., Worcester Polytechnic Institute
Merritt Conaway Kirk, Jr., B.Ch.E., University of Delaware
Edward William Lyckman, B.S., University of California, Berkeley
Harry Edward McCarthy, P.R.E., Colorado School of Mines*
Adam Osborne, B.Sc., Birmingham University, England
Jerome David Robinson, B.Ch.E., The City University of New York, City College
Keith Frederick Shoneman, B.S.Ch.E., The Pennsylvania State University

In Absentia

Jay Milton Steinberg, B.A., University of Pennsylvania
B.S. Ch.E., University of Pennsylvania
Henry Hughson Wall, III, B.S., Louisiana State University

Master of Civil Engineering

Salim Ahmad, B.E., Civil, University of Karachi, Pakistan*
Ta Chao, B.S., Provincial Cheng Kung University, China
Christian France Davis, B.C.E., University of Delaware
Mohammad Izadi-Vahedi, B.S., University of Tehran, Iran
Jagadeesh Rudrappa Yalakki, B.E., University of Mysore, India
Farrokh Neghabat, B.Sc., Brigham Young University
Abdol-Razagh Razzaghy, Eng. G.R., Institute of Gembloux, Belgium*
Joseph Maurice Spang, Jr., B.S.C.E., Pennsylvania Military College
Siavosh Zand-Yazdani, B.C.E., University of Tehran, Iran

Master of Electrical Engineering

Robert Scott Crowder, Jr., B.E.E., University of Alabama
Abdul Qadri Haideri, B.S., Agra University, India
M.S., University of Karachi, Pakistan
B.E.E., George Washington University
Martin John Holleran, B.S., University of Scranton
Tibor Francis Loeffler, B.S.E.E., University of Missouri at Rolla
Arun Manilal Mehta, B.S., Gujarat University, India
D.R.E., The St. Xaviers College, India
Richard Stanley Nietubicz, B.E.E., Newark College of Engineering
John Philip Stancin, Jr., B.E., Youngstown University
Edward Thomas Trotter, B.E.E., University of Delaware
Chong Kwan Un, B.E.E., University of Delaware

Master of Mechanical Engineering

Richard Hunt Downing Bullock, Jr., B.M.E., University of Delaware
Ignazio Crivelli-Visconti, Laurea., University of Naples, Italy*
Edward Ohannes Dingilian, B.Sc., University of Alexandria, United Arab Republic*
Mohinder Kumar Gupta, B.E., Mech., Delhi University, India
Thomas Franklin Hahn, B.M.E., University of Delaware
David Ellis Hook, B.S.M.E., University of Connecticut
Philip Chuan-Ren Hsiang, B.S. in M.E., National Taiwan University, China
Omar Elhadi Ramadan, B.Sc., Engr., Cairo University, United Arab Republic*
Frederick Paul Stecher, B.M.E., University of Delaware
Peter Albert Tuschak, A.B., Dartmouth College
B.M.E., Dartmouth College
Albert Anthony Vicario, Jr., B.M.E., University of Delaware

In Absentia

Doctor of Philosophy

BETZABÉ MARIA DYER ALLISON — *Biological Sciences*

B.A., University of California, Berkeley

Dissertation: A Cytochemical Study of Lipid Granules in Aging Populations of *Tetrahymena Pyriformis*

RICHARD DAVID BEHRINGER — *Psychology*

B.A., University of Delaware
M.A., University of Delaware

Dissertation: Some Structural and Functional Factors in the Estimation of Proportions

WILLIAM JOSEPH BENTON — *Biological Sciences*

D.V.M., University of Georgia
M.S., University of Delaware

Dissertation: Indirect Hemagglutination and Bentonite Flocculation with Rous Sarcoma Virus

BRIAN WILLIAM BUSSEY — *Chemical Engineering*

B.Ch.E., McGill University, Canada
M.Ch.E., University of Delaware

Dissertation: Effect of Surfactants on Mass Transfer Rates at a Gas-Liquid Interface

STANLEY JOSEPH CHLYSTEK — *Chemistry*

B.S., Duquesne University
M.S., Duquesne University

Dissertation: Pyromellitic Acid Derivatives Part I: Aryl Pyromellitimides Part II: 1,4,6,9-pyromellitaztetrone and Related Compounds

LEON NEIL DELARM — *Applied Sciences - Civil Engineering*

B.S., University of Missouri at Rolla
M.S., University of Kansas

Dissertation: Structural Dynamics: A Discrete Field Approach

JOHN MICHAEL EDMUNDOWICZ — *Chemistry*

B.S., Philadelphia College of Pharmacy and Science
M.S., University of Delaware

Dissertation: Studies on the Biosynthesis of D-amosamine

JOSEPH EPSTEIN — *Chemistry*

A.B., Temple University
M.S., University of Pennsylvania

Dissertation: Factors Affecting Nucleophilicity in Displacement of Fluoride Ion from Isopropyl Methylphosphonofluoridate

CHAVA FISCHLER — *Physics*

M.Sc., The Hebrew University, Israel

Dissertation: Combined Optical and Electrical Effects in Single Crystals of ZnS:Mn

FRANK FOX — *History*

B.S., Temple University
M.A., University of Pennsylvania

Dissertation: French-Russian Commercial Relations in the Eighteenth Century and the French-Russian Commercial Treaty of 1787

RICHARD LEE HIVELY — *Chemistry*

B.S., Indiana University
M.S., University of Delaware

Dissertation: A Study of the Chemistry of Marijuana

DANIEL STEPHEN HODGINS — *Chemistry*

B.S., Elizabethtown College

Dissertation: The Active Site of Lactate Dehydrogenase

DAVID MAURICE HOFFMAN — *Chemistry*

B.S., Texas Technological College
M.S., Texas Technological College

Dissertation: Further Studies on the Mechanism of Chlorinolysis in Acetic Acid

ROBERT DALE HOGE* — *Psychology*

B.A., Kenyon College
M.A., University of Delaware

Dissertation: Two Investigations of the Effects of Response Uncertainty and Degree of Knowledge on the Decision Process

BERNARD JOSEF KRAUS — *Chemical Engineering*

B.Ch.E., Villanova University
M.Ch.E., University of Delaware

Dissertation: The Thermal Conductivity of the Carbon Dioxide-Nitrogen System

ANTHONY LAWRENCE LAGANELLI — *Applied Sciences - Mechanical Engineering*

B.S.M.E., Rochester Institute of Technology
M.M.E., University of Delaware

Dissertation: Mass Transfer Cooling on a Porous Flat Plate in Carbon Dioxide and Air Streams

RAYMOND THOMAS LEIBFRIED — *Chemistry*

B.S., Bates College

Dissertation: Studies on the Oxidation of Organic Molecules by Molecular Oxygen

**In Absentia*

KENNETH KARL LIGHT — *Chemistry*

B.S. in Chem., Lebanon Valley College

Dissertation: Preparation of Heterocyclic Compounds by the Wittig Reaction: Preparation of Pyrrolizine Compounds; Preparation of 1-benzoxepin

THOMAS JOSEPH MIZIANTY — *Biological Sciences*

B.S., University of Scranton
M.S., University of Delaware

Dissertation: The Use of Tetrazolium Salts in the Study of the Succinoxidase System in Two Species of the Genus *Bracon*

RUDOLPH RICHARD RIZZO — *Applied Sciences - Mechanical Engineering*

B.S.M.E., University of Delaware
M.S.M.E., Rensselaer Polytechnic Institute

Dissertation: Some General Solutions to Piezoelectric Problems of Electroelasticity

HENRY ALPHONSO ROBERTSON, JR. — *English*

B.S., Randolph-Macon College
M.A., Loyola University, Illinois

Dissertation: A Critical Analysis of William Byrd II and His Literary Technique in *The History of the Dividing Line* and *The Secret History of the Line*

JOHN CLIFFORD SHAFFER — *Physics*

B.S., Franklin and Marshall College
M.S., University of Delaware

Dissertation: A Theoretical Study of Impurity States, Impurity Pairs, and Energy Transfer in ZnS and Related Materials

STANLEY SEYMOUR SHAPIRO — *Chemistry*

B.S., The City University of New York, Brooklyn College

Dissertation: Mechanism of Clostridium Butylicum Lactic Acid Racemase

CLARENCE RONALD SIMPKINS — *Chemical Engineering*

B.S., University of Tennessee
M.Sc., University of Tennessee

Dissertation: Dynamics and Control of Tubular Chemical Reactors

LEONARD HARRIS SMILEY — *Chemistry*

B.S., University of Pennsylvania
M.S., Villanova University

Dissertation: The Oxidative Degradation of Polystyrene

LELAND DALE SMUCKER — *Chemistry*

B.S., Kent State University
M.S., Miami University

Dissertation: Synthetic Applications of Vinyltriphenylphosphonium Bromide

JOHN FRANCIS SONTOWSKI — *Applied Sciences - Mechanical Engineering*

B.M.E., University of Delaware
M.M.E., University of Delaware

Dissertation: The Stability of Flow of a Gas Over a Liquid

CHARLES WINFIELD STEWART, SR. — *Chemistry*

B.S., University of Delaware

Dissertation: The Significant Structures Theory of Polyethylene

GERALD JAMES STINE — *Biological Sciences*

B.S., Southern Connecticut State College
M.A., Dartmouth College

Dissertation: NADP- and NAD-dependent Glutamic Dehydrogenases, Succinic Dehydrogenase and Nadase Activities During the Asexual Cycle of *Neurospora Crassa*

GEORGE DEWEES SUMMERS* — *Applied Sciences - Civil Engineering*

A.B., Western Maryland College
M.S., The Pennsylvania State University

Dissertation: Theoretical Analysis of Rectangular Isotropic and Orthotropic Laminated Plates

RONALD WALTER SWANSON* — *Chemical Engineering*

B.S., Lehigh University
M.Ch.E., University of Delaware

Dissertation: Characteristics of the Gas-liquid Interface in Two-phase Annular Flow

RICHARD DALE SWOPE — *Applied Sciences - Mechanical Engineering*

B.M.E., University of Delaware
M.M.E., University of Delaware

Dissertation: Kelvin-Helmholtz and Point of Inflection Instabilities in Stratified Flows Near a Solid Boundary

DALMAS ARNOLD TAYLOR — *Psychology*

B.A., Western Reserve University
M.S., Howard University

Dissertation: Some Aspects of the Development of Interpersonal Relationships: Social Penetration Processes

EDWARD ALBERT THOMPSON* — *Psychology*

B.A., Denison University
M.A., University of Delaware

Dissertation: Complexity of the Self Concept: Contrast and Assimilation Effects in the Perception and Acceptance of Strangers

**In Absentia*

ERNEST ALAN UEBLER — *Chemical Engineering*

B.S., University of Illiniis
M.Ch.E., University of Delaware

Dissertation: Pipe Entrance Flow of Elastic Liquids

MICHAEL THEODORE WAROBLAK — *Chemistry*

B.S., West Virginia Wesleyan College
M.S., University of Delaware

Dissertation: The Effect of Methyl Substitution on Ring Closure in the Pyrolysis of Bromoesters

ROBERT KIRK WICKER, II — *Chemistry*

B.S., Juniata College
M.S., University of Delaware

Dissertation: Activity Coefficients of Alkali Halides and Nitrates in N-methylacetamide

JOHN MORTIMER WILLIAMS — *Chemical Engineering*

B.A., The Rice University
B.S.Ch.E., The Rice University

Dissertation: A Study of the Surface Self-diffusion of Iron

JACK CHARLES WILLS — *English*

B.S.For., West Virginia University
M.A., University of Delaware

Dissertation: Charlotte Bronte's Literary Theories

ROBERT LEESE WINEHOLT — *Chemistry*

A.B., Gettysburg College

Dissertation: Rearrangement of a 1,2-diazabicyclic Ketone to a Tetrahydrodiazepinone

SCOTT ROSIN WOODALL — *Applied Sciences - Mechanical Engineering*

B.M.E., University of Delaware
M.M.E., University of Delaware

Dissertation: Free Extensional Oscillations of a Thin Elastic Beam Experiencing Extremely Large Deflections

JAMES ROBERT JOSEPH WOODYARD — *Physics*

B.Ed., Duquesne University
M.S., University of Delaware

Dissertation: Low Energy Sputtering Studies

ROBERT ALFRED YATES — *Chemical Engineering*

B.S., Worcester Polytechnic Institute
M.S., Worcester Polytechnic Institute

Dissertation: The Motion of Spherical-cap Bubbles in Superheated Liquids

TOBIAS OREGON YELLIN* — *Chemistry*

B.S., Philadelphia College of Pharmacy and Science
M.S., Philadelphia College of Pharmacy and Science

Dissertation: Purification, Properties and Antilymphoma Activity of Guinea Pig Serum Asparaginase

ALBRIGHT GRAVENOR ZIMMERMAN — *History*

B.S., Temple University
A.M., Temple University

Dissertation: The Indian Trade of Colonial Pennsylvania

ROBERT ELLIOT ZUMWALT — *Chemical Engineering*

B.S.*, Texas Agricultural and Mechanical University
M.Ch.E., University of Delaware

Dissertation: Analysis of Experiments in Single Crystal X-ray Diffractometry

HONORARY DEGREES

Doctor of Laws

CLARENCE A. FULMER

Doctor of Laws

WILLIAM WINDER LAIRD

Doctor of Laws

BALDWIN MAULL

Doctor of Science

FREDERICK SEITZ

ACADEMIC COSTUME

The use of the academic costume, which seems to have originated in the English universities of Oxford and Cambridge, has been traditional in university life since medieval times. In England and other European countries academic attire generally is distinctive with each university so that very colorful ensembles of diverse styles are commonly used abroad.

Unlike European academic apparel, the academic costume of American universities follows a regular pattern, the styles and colors having been established by an intercollegiate agreement in 1895. Cap, hood, and gown are prescribed in style. Color variations indicate differences in the field of knowledge represented and the conferring institutions.

The mortarboard cap is identical for holders of bachelor's and master's degrees. For holders of the doctorate, the cap may be made of velvet and the tassel may be gold. Candidates for the bachelor's degree wear the tassel on the right side of the cap, changing it to the left side after the degree has been conferred.

The bachelor's gown is designed with full sleeves. The master's gown, designed with sleeves closed at the base and slit at the elbow, appears to have half-sleeves which leave the forearm uncovered. The doctor's gown has bell-shaped sleeves with velvet bars and is faced with velvet around the collar and down the front edges.

Hoods representing the three levels of degrees differ primarily in size. Many institutions, including Delaware, do not use hoods for the baccalaureate degree, only for the master's and doctoral degrees. The colors of the hood lining are characteristic of the conferring college. The University of Delaware colors are blue and gold; University of Pennsylvania, red and blue; Columbia, blue and white; etc.

The color of the velvet border of the hood indicates the branch of knowledge represented. For example, the color for Agriculture is maize; for Arts and Letters, white; for Education, light blue; for Engineering, orange; for Home Economics, maroon; and for Economics, copper.

The order of march for the University of Delaware commencement procession is as follows: Associate Degree candidates; Bachelors in the Advanced ROTC Program; Bachelors in the College of Arts and Science, Agricultural Sciences, Engineering, Education, Home Economics, and Business and Economics; Bachelors with Distinction and Honors; Master's Degree candidates; Doctors of Philosophy; Faculty; Recipients of Honorary Degrees; the President; the Deans; and other principals. Distinctive banners preceding groups in the procession mark the different academic areas, with border colors signifying the branch of learning represented by each.

PROGRAM OF THE CONFERRING OF DEGREES AT THE UNIVERSITY OF DELAWARE

THE 119th COMMENCEMENT

SUNDAY
JUNE 9, 1968
5:00 P.M.

ALMA MATER

Words by ROBERT CURRY *Music by* A. J. LOUDIS

Hail to thee, proud Delaware, in loyalty we stand,
We give thee thanks for glorious days beneath thy guiding hand.
Full often will we praise thy name, thy colors proudly bear,
We lift our voices now to sing, "All hail to Delaware!"

Order of Exercises

Processional

Academic Processional March ..... *Carl Engel*

INVOCATION

The Reverend Michael Szupper, Ph.D.
Newman Chaplain

ADDRESS

Dr. William Maurice Ewing
Director
Lamont Geological Observatory of Columbia University

MUSIC

Music for a Ceremony ..... *John J. Morrissey*
Combined Concert and Symphonic Bands
J. R. King, *Conductor*

CONFERRING OF DEGREES

John W. Shirley, Ph.D.
Acting President of the University of Delaware

Singing of
University of Delaware
ALMA MATER

BENEDICTION

The Reverend Michael Szupper

Recessional

March Processional ..... *Clare Grundman*

The audience is requested to remain until after recession of the Platform Group.
The music preceding the exercises was contributed by the
Combined Concert and Symphonic Bands.

The Academic Procession

The conferral of degrees is in the order of the lowest degree to the highest degree and by colleges in the order of seniority.

The Order of March

Entering from the north end of the stadium left:

- Associate Degree Candidates
- Advanced ROTC Candidates
- Bachelor Degree Candidates, College of Arts and Science
- Bachelor Degree Candidates, College of Agricultural Sciences
- Bachelor Degree Candidates, College of Engineering

Entering from the south end of the stadium:

- Bachelor Degree Candidates, College of Education
- Bachelor Degree Candidates, College of Home Economics
- Bachelor Degree Candidates, College of Business and Economics
- Bachelor Degree Candidates, College of Nursing
- Bachelor Degrees awarded with Honors, High Honors and Distinction
- Master's Degree Candidates
- Doctor's Degree Candidates

Entering from the north end of the stadium center:

- The Banner Carriers
- The University Faculty
- The Platform Group

ASSOCIATE DEGREES

Candidates Presented by Vice President George M. Worrilow

Associate in Arts

Barbara Deighton Glatz*

Associate in Science

James Joseph Coll*
Kermit Allen Groh
Mary Kay Whetsell Harmon*
Anna Belle Weldin Lewis
Frederick Wayne Parlier
Ruta Lendins Zadziorski

Associate in Applied Science

Julia Augustis Adams
Sue Ann Ainsworth
Carolyn Ann Jones Alexander
Donna Lee Armstrong
Linda Adele Arndt
Susan Elliott Barth*
Carole Lynne Bingham
Linda Lea Blackwell
Bernard Bonk Jr.
Mary Louise Bradley
Wayne Allen Brown
Nancy Alice Callaway
Paul Francis Cataldi
Stephen Daniel Cherry*
Robert Michael Cooke
John Sharp Davis
Carlton Robert Dawson
Jamée Frances de Boer*
Jeffrey Herbert Dobbs
David Allan Dobraniecki
Learis Blanche Leach Donovan
Iantha Jane Garner*
Rebecca Louise George
Joyce Ann Gilmore
Nicholas Thomas Gregory
Kenneth Malvern Haines
Ann Elizabeth Haldeman
Susan Mary Harbourne
Carol Ann Hart
Wayne Joe Hartnett
Steven Lyle Hengel
Kathleen Ruth Hill
Clifford William Hudson
Roger James Hudy
Leonard Bruce Johnson
Patricia Roxanne Jones
Luther James Kemble
Howard Sheldon Kirshner
Jeffrey David Kirshner
Carol Jean Kline
Sharon Elizabeth Koopmann
Michael Patrick Levitsky
Margaret Ann Weaver Luzak
Norma Jean Malin
John Douglas Marine
Jane Frances Marsilii*
David Walter Masten
Anne Marguerite McMahon
Leroy Allison Millett*
Aubrey Chandlee Moore Jr.
Roseann Nardo
David Leroy Nye
Christine Anastasia Okoniewski
Beverly Sue Paul
William Commons Philips III
Lena Zutz Spivack Plunguian
Phyllis Louise Price
Robert Lewis Reed II*
Ann Ringler Richards
Patricia Anne Robinson
Beau William Sauselein
Susan Lynn Short
Eva Ann Skripchuk
Alexa Jean Smarte
Deborah Rose Stigliano
Walter Daniel Wagamon
Gary Allen Ward*
Catherine White
Martin Brent Wickersham
Carol Regina Sandbach Wisor
Lois Jane Wivel
Michael Aleksander Zarebicki*

Associate in Applied Technology

Gregory Weller Clarke
Stephen Lawrence Moore
Michael Joseph Otley
Arthur Jeffrey Thomas
Ronald James Worden

**In Absentia*

BACCALAUREATE DEGREES

COLLEGE OF ARTS AND SCIENCE

CANDIDATES PRESENTED BY DEAN ARNOLD L. LIPPERT

Bachelor of Arts

CARL ANTHONY AGOSTINI
GAIL ELLEN ANDERSON
RONALD CARL ANDERSON
FRED FRANCIS ARMSTRONG III
JOANNE ELIZABETH ARMSTRONG
WILLIAM ARTHUR BAILEY
MARGUERITE ANNE BAKER
RICHARD SCOTT BAKER
WILLIAM DAVID BAKER
ALICE CAROLINE BALDWIN
ROBERT WILLIAM BALY
THEOPHILUS ALEXANDER BARHAM III
PHYLLIS SHIRLEY BARNES
SARAH ADELIA HOWARD BARNES
DONALD BARTLETT II*
ANNE LOUISE LE GATES BARTON
PAUL GEORGE BASEHORE
RICHARD MARK BAUMEISTER
PAMELA CAROLE BEAMAN
RUTH SHELTON BEARD*
CHRISTINE DEBORAH BELFORD
EARL HEALEN BENNETT II
LYON BRADLEY BERGH
LAWRENCE JOSEPH BIDDLE
DONALD EDWARD BIEHN
BARBARA ANN BIESINGER
GERALD ROBERT BIRL
JOAN D. BLOOM
GARY JAY BLUME
JOHN HENRY BRAUNLEIN
JEANNE KAYE MCDONALD BRENNESHOLTZ
KATHRYN JEANNE BREWER
LAWRENCE EDWARD BROPHY*
JAMES RICHARD BRUNNER
BONITA ANN BRUNO
CAROLYN DIANE BUCHANAN
JAMES LAWRENCE BUDD
MARY LOUISE BUDISCHAK
EDMUND JOSEPH CAIN JR.
PATRICIA ANNE CANNON
VICKI LYNN ROTH CARMEAN
BRUCE DOUGLAS CARRICK
BEVERLY GRAHAM CARTER
LILLIAN NAOMI MARY RILEY CASSEL
WILLIAM FRANK CATTELL
RAMON MICHAEL CECI
CATHERINE DIANE CHAPIN
RICHARD JAY CHERRIN
JAMES ROBERT CHILCUTT
MARYANN PATRICIA CLEMENTE
LAURENCE ALLEN CLIFTON
JANICE LYNN CLOR
OLNEY HUNTER CLOWE
ROBERT MASTEN CLUNIE
ROBERTA LOUISE CLUNN
CATHERINE JOANNE DUNCAN COMP
ROGER WILLIAM CONANT*
WILLIAM MICHAEL CONLEY III
KATHRYN ANN COUDEN
DOUGLAS COX
MARNA HAVARD CUPP
PATRICIA JEAN DALY
LINDA BERWIND DANE
ROBERT SANDERS DARDEN
ALMA ELEANOR DARLING
KENNETH MARSHALL DAVIS
THOMAS ROBERT DECAMPLI*
MARGARET RUTH DENITHORNE
WILLIAM KENNETH DERICKSON
MARTHA ANN DERIGHT
RITA MARIE DEVLIN
JOSEPH JOHN DICK
ALFRED DOMINIC DIEMEDIO*
JOAN MARIE DINEEN
EUGENIA MARGARET DISABATINO
PERCY LOWRY DONAGHAY
ROBERT HUGHES DONAWAY*
MARGARET ELLEN DONOVAN
MARY CECELIA DONOVAN
MARILYN JOAN DOTO
JAMES MICHAEL DOUGHERTY
THOMAS ALBERT DOWNS
JOAN CAROLE DRAPER
VINCI MARIA IANNUCCI DRUEDING*
MAUREEN THERESA DUFFY
WILLIAM KIRKUS DUGDALE*
JAMES CALVIN EBERLY
JULIE O'BRIAN EDWARDS
PATRICIA LEE EGGERT
ELLIOTT HENRY EHRLICH*
GRACE LEE ELLIOTT
MARY RANDALL EPPRIDGE
JOHN LEONARD ERICKSON JR.
SANDRA ESTHER ESPOSITO
JEANNE MILLER EWING
MORTON ALFRED FALLER
SUSAN CAROL FAUNCE
PETER THOMAS FEENEY
PETER ANTHONY FERRARA
GEORGE ALLAN FORD*
JAMES CLAIR FORD*
LYNNE HECKART FRAZER
ROBERT STEPHEN FREEMAN
ELLEN MARCIA COBIN FREIREICH
JUDITH ANN GIBBONS
JEANNE YVONNE GILMORE

**In Absentia*

WILLIAM ALLEN GLASENAPP
MARGARET MARY CRATHER GLOYD
RAYMOND STEVEN GOLDBACHER
ROBERT DAVID GOLDBERG
STEVEN DAVID GOLDBERG
WAYNE CARSON GOODING
FREDDY LEE GOODMAN
JANET JUNE BARTHOLOMEW GOSSER
ANTONIO MEDARDO GRANDA
BARBARA ELAINE GRAY
GERALD ELMER GRAY
KATHRYN FREDRICA GREEN
RONALD TERRY GREENE*
PHYLLIS ELIZABETH BUONO GRIFFITHS
DONALD BRUCE GRIMME
LOWELL LESLIE GROUNDLAND
MICHAEL JAMES GUERRIERO
SIDNEY WILMER GUEST II
KENNETH CHARLES HAAS
KAREN MAY HAND
LEWIS JAMES HANKINS
LINDA DARLENE HARDY
MARGARET THELIN TURNER HARDY
WILLIAM DEVIER HARLOW*
ELIZABETH ELLEN GULLEDGE HARMER
JAMES PATRICK HARTNETT
ELSIE VIRGINIA BRUCE HARVEY
EDWIN LEO HASSENSTEIN III
PAUL EARL HESS
MARGARET CAROL HITCHENS
JON DAVID HOEY
CALVERT THEODORE HOFFERBERT JR.
JERE DOUGLASS HOOVER
PATRICIA JAYNE HOWELL
SUZANNE HUDSON
DAVID NORMAN HURLBUT
CHARLES WINGATE HURLEY JR.
DARLENE BETH HUSZTI
SANDRA LEE HYNSON
TERRY LEE IRWIN
VIRGINIA ANN IVIN
DIANE LOUISE SERFF JABLONSKI*
THEODORA REBECCA HUGHES JACKSON*
JOSEPH MILLARD JACOBS JR.
STEPHEN MORRIS JENKINS
MARGARET ANN JOHNSON
THEODORE SHARPLESS JONES JR.*
RICHARD ERNEST JUDSON
LINDA LOUISE KEISER
JOHN BARTHOLOMEW KENNEDY*
JAMES KENNETH KENTON
VIRGINIA MARGARET KILOREN*
MARTHA JANE KINKAID
JOHN COOKE KINNAMON
IRA CHARLES KIRCH
LESLIE ANN KASPER KORALEK
BARRY MEREDITH KROLL
CAROLYN EDWINA KUHWALD
JOHN ARTHUR LARSON
ROBERT ANTHONY LATINA*
JOSEPH ALBERT LATTOMUS
MICHAEL GEORGE LAUGHREY
PAMELA CLAIRE ADAM LAWTHER
WENDELL CARRIER LAWTHER
ROBERT JOSEPH LENNON JR.
NANCY CLAIRE LEWIS
ELBERTA BERNICE LIEBERMAN
FRANK JOSEPH LINZENBOLD JR.
MEREDITH ANNE LITTLER
MARY ERICA LOEWENSTEIN
KARL FREDERICK LOUCKS II*
ROBERT RICHARD LOWICKI
DAVID ELLSWORTH LYNN
MARGARET SYBIL LYONS
MARIANNE PATRICIA MACKLIN
BARBARA EILEEN MADDEN*
CAROL JO MADDEN
WILLIAM FRANCIS MAGARGAL
LESLIE JANET MALONEY
THOMAS FRANKLIN MANGOLD JR.
JOHN ROLLAND MANZKE
RAYMOND STEPHAN MARKOWSKI
CONSTANCE VIRGINIA MARSHALL
PETER STEPHEN MARTIN
JEANNINE ANDREA MARTINO
JOHN JOSEPH MATARESE JR.
JOHN DOUGHTY MATLACK*
DAVID PHILIP MATTHEWS
FREDRIC CHARLES MAY
SUSAN HELENA MCCALL
PATRICK FRANCIS MCCANN*
ROBERT JAMES MCCARTER JR.*
BRAD EARL MCCORD*
ANN LOUISE MCINTOSH
ROBERT PARKER MCMULLEN JR.
EDWARD ROBERT MCNAMARA
CHARLES PALMER MCVAUGH JR.
RICHARD BROWN MEAD
DAVID JAMES MEADOWS
DONNA JEAN MINNER
FRAN GAIL MITCHELL
VIRGINIA MARIE MONAGHAN
CRAIG ALAN MOORE
JAMES LAYTON MOORE
JUDITH ANN HUTNICK MULHERN
JAMES THOMAS MURPHY
SYLVIA BERLIN MUTNICK
JERRY MAX NORTON
JOHN MICHAEL O'DONNELL JR.
ANTHONY DAVID ORGA JR.
KAREN ANN-MICHELLE MAUCHER OSWALD
ARTHUR WILLIAM PANARO
JANE ANN PAUL
ANDRE JOHN PECQUEUR
NANCY ANN MOORE PHELPS
WILLIAM FRANK PLACK III
EDWARD GERARD POLLARD JR.
THOMAS MICHAEL POVLITZ
JAMES LEE PRYOR JR.
BURTON FRANKLIN PYLE II
RICHARD MICHAEL QUINN
RONALD RAY RAMBO
SAMUEL REYNOLDS RASH
MICHAEL STANTON RAYBOURN
JAMES WILLIAM RAYNE

**In Absentia*

Linda Adele Reader
Mary Louise Reese
Judith Gail Repp
Carol Anne Richardson*
Arden Lee Roberts
Charlotte Elizabeth Posey Robinson
Phillip Wiley Roeder
Fredric Manley Rohm
Joan Helaine Kaufmann Rosen
Janet Susan Rosenbaum
Sharyn Jane Calloway Royle
Harold Edwin Rubin*
John Frank Rybinski
David Karl Sachse
Piret Saksen
George Thomas Sandbach
Carl Nelson Schlatter
Susan Mary Scott
Tracy Anne Shane
Alan Arthur Shapiro
Janet Dee Shapiro
Robert Edward Shipley
Carol Ann Shreffler
Carol Adriane Shrier
Noelle Theresa Sickels
Alan Murray Silverman
Rosemary Elizabeth Simeone
Warren Don Simmons
Elizabeth Prior Sinclair
Lynne Singer
Arthur William Smith Jr.
Christine Marie Smith
Ronald Clarence Smith
Tamar Anne Kucharsey Smith
Nancy Beatrice Sobolewski
John Brugger Southard
Steven Stylianos Stavrakis
Jean Kathryn Stearns
Maurice Steinberg
Dwight Davis Stewart
Bohdan Roman Tanchuk
Dorinda Tanzella
Joyce Louise Tatman
Marguerite McQuarrie Taves
Warren Ellsworth Taylor
Philippe Tenret
Harry Kendall Fooks Terry*
Lois Blanche Thien
Kathryn Marbeth Thomas*
Esther Olney Toothman
Leo Eldon Treadway
Kathleen Ann Trepper
Blaine Peter Turner
Arthur Winfield Twitchell
Mary Linda Vannoy
Sigmund John-Paul Van Raan
Caroline Mary Vargas
Janice Lee Vickers
Roland Hallett Vinyard
Athene Vlamis
Gloria von Berg*
David Lawrence Von Kleeck
Robert Emerson Voorhees Jr.
Gene Hyman Waldman
John Samuel Walker
Anne Carol Ward*
Joel Edwards Wasley Jr.
Gary Richard Weaver
Sally Webb
Lynne Catherine Weidel
Nancy Louise Weldy
David Andrew Wheeler*
James Sterling Winterringer III
Harry Thomas Winward
Henry Alexander Wise III
Kenneth John Wissler
William Edward Wolstenholme
Mary Eidora Woodmansee
James Bronna Wright
Richard Lawrence Wright
Michael John Wriston
John Rudolph Wyks Jr.
Frank Lee Yeager
Barry Edward Zakar
Ronald Mark Zychowski

Bachelor of Science

Paul Donaldson Allen III
Paul James Andrisani
Pamela Bailey
Bayard Oscar Baylis
Robert Alan Beaver
Thomas Borderieux
Eunice Frances Ziegler Craig
Edward Scheid Custer Jr.
Joseph Henry Del Nero
Edward Gerald Ezrailson
Merle Clifford Fausnaugh
James Walton Felch
Thomas Joseph George
Barbara Carol Holoviak
Joanne Lynch Horn
Michael Everett Jenkins
Carole Jean Murphy Jones
Maurice Bruce Jones
Robert Thomas Kern Jr.
Ralph Thomas Kilmon Jr.
Heikki Koiv
Thomas William MacKnight
Janet Margaret Cross Maslanka
Raymond Lawrence McCarthy Jr.
Bruce Neil McMaster
Carolyn Mary McNeice
John Baker Melpolder
Thomas Joseph Nelson
William Lloyd Osburn
Janet Victoria Paccione
Salvatore Francis Palermo

**In Absentia*

Robert Allen Pribush
Nancy Lynn Reynolds
Joseph Patrick Rigney
Judith Elaine Rosenberg
John Adam Roslan
Thomas Wesley Scattergood
Charles Anthony Scheib
Francis Joseph Schiavelli
Horst Friedrich Schran*
John Robert Suchanec
Raymond Wilson Talley
Carol Elaine Van Dyke
Caryll Ann Wack
Elaine Sara Walles
Edward Howard Webster

**In Absentia*

COLLEGE OF AGRICULTURAL SCIENCES

CANDIDATES PRESENTED BY DEAN WILLIAM E. MCDANIEL

Bachelor of Science in Agriculture

ROBERT WHITNEY ARMSTRONG*
MARK ROBESON BAILEY
MARTHA CHARLES BIGGS
WILLIAM EVAN BRABSON JR.
CONRAD BENARR DANCY*
CARL PHILLIP DAVIS
WARREN ALLEN DAVIS*
PHILIP RICHARD DODSON
CASHAR WEBSTER EVANS JR.
LINDA ANN FERRARO
WILLIAM EDWARD HANDY
FREDERICK JAMES HARRISON JR.
PETER LAYTON HEUBERGER
CRAIG HILL
CHARLES BOVARD HOMAN
LEON WARWICK HONE
WILLIAM HENRY HORWITZ
EDWARD NEVERSON HOWELL III
BRUCE LESTER HUDSON
JAMES BUNTING KREWATCH
ROBERT LOUIS LAWSON
WILLIAM H C LAYTON
DAVID WALTER LLOYD
ZANE NEIL MARKOWITZ
JAMES MICHAEL MCDOWELL
WILLIAM RAY MEARS
WALTER FRANKLIN MEGONIGAL JR.*
EUGENE FRANK PRATT
EDWARD JOE SAND
ALAN STEPHEN SLOBOJAN
RICHARD WATTERS SMALL
ALFRED ROBERT SONCHEN III
W. STEPHEN SOOY
ROBERT TIFFANY SPALDING
DEBORAH ANN SUTHERLAND STEVENS
STEPHEN EDWARD STOCKWELL
THOMAS CURTIS TAYLOR*
WILLIAM FRANK TAYLOR
JOHN MILTON TOOTHMAN
SAMUEL DERBY WALKER JR.
FRANCIS JOSEPH WEBB
ALLEN M. WENGER
DAVID JOHN WHITLOCK
LINDA CLAIRE WILSON
WILLIAM RICHARD WOMACH

In Absentia

COLLEGE OF ENGINEERING

CANDIDATES PRESENTED BY DEAN EDWARD W. COMINGS

Bachelor of Chemical Engineering

ROBERT ALAN BARCUS
FREDERICK CARL BINTER JR.
JOHN HENRY BUEHLER
THOMAS JOSEPH COLLINS
CHARLES EUGENE FEIGLEY
WALTER ZABUD FLETCHER*
BRUCE CHARLES GELSINGER
JOHN EDWIN GREER JR.*
RICHARD HENRY HAAR
RICHARD ALAN HAMILTON
JOHNNY LYNN HENDERSON
ABBAS HONARDOOST
JAMES LYNN HOPKINS
RICHARD JOSEPH HORVATH
DOUGLAS WELZIN JOHNSON
BRUCE BRADFORD KITCHIN
KENNETH BYRON KYTE
DAVID MERCUR LUKOFF
RONALD RICHARD MAZIK
JOSEPH HAMILTON MCMAKIN
JAMES MERRILL PROBER
DOUGLAS ARTHUR ROBINSON
RICHARD DEE SCOTT
GARY JOSEPH SEGER
JOHN HOWARD SPEIDEL JR.
THOMAS HOWERTON VANDERFORD JR.
PHILIP EARL WALTER
GEORGE DAVID WINN JR.
JOHN BOTELER YOURTEE

Bachelor of Civil Engineering

JOHN WORTHINGTON AUSTIN
CALVIN DAVID DISNEY
ROBERT JOSEPH FISHER JR.
JAMES FRANK LANE III
ROBERT ROY LARASON
GLENN BRUMLEY PUSEY JR.
ROBERT YORK ROCHELEAU
PAUL CLIFFORD SHIVERY JR.
JOHN JOSEPH ZDEB JR.

Bachelor of Electrical Engineering

JOHN FRANCIS BIZJAK
ROBERT SAMUEL BREEN JR.
DONALD EUGENE CAIN
WILLIAM KENDRICK CARY JR.
ROBERT ALAN DALTON
JAMES JOSEPH DE COURCELLE III
CARL AUBREY DOUGHTEN JR.
GARY JOSEPH HAGAN
HENRY MACEWAN JOHNSON III*
RICHARD BING-YIN LAM
JAMES HARRY MEACHAM
GEORGE WARNER PHILLIPS*
ROBERT WALTER RAHE
GEORGE ANTHONY REIBLE JR.
BRUCE ARTHUR TERRELL
KENNETH FENWICK VEITH JR.

Bachelor of Mechanical Engineering

NORMAN DALE BEST
ROBERT EDMUND BLEY JR.
RUSSELL JOHN BONADONNA JR.
GARY PETER CHANKO
DONALD RAYMOND COHEE*
RICHARD PAUL DAVITT
MELVIN RAY FAHNESTOCK*
JAMES ANDREW FRANCIS
DEAN SCOTT GILCHRIST
JOHN PHILIP GREINER
CLINTON HEWITT HUBBARD JR.
MARILYNNE ELIZABETH MAZOCK JACOBS
ALBERT FRANCIS KIRBY JR.
PETER EUGENE KRAPE
STANLEY LEVINE
BRENT LUTHER MARSH
GERALD LEE MITCHELL
JAMES DAVID NICOLL*
OREN BURTON PHILLIPS JR.
ROBERT HARRINGTON PIGFORD
PATRICK JOSEPH REYNOLDS
JAMES HENRY ROONEY III
EUGENE NORRIS STERLING JR.
FRANK JOSEPH VOSHELL
STEVEN KENT ZARING

Bachelor of Arts and Bachelor of Chemical Engineering

JOSEPH WILLIAM BREEN*

In Absentia

Bachelor of Arts and Bachelor of Mechanical Engineering

CARL FREDRIC RIEGEL

NORMAN WILLIS STOUFFER

Bachelor of Engineering Administration

Chemical Engineering

FREDERICK CARL BINTER JR.
RONALD RICHARD MAZIK
ROBERT ROY PETERS

Civil Engineering

PHILIP JAMES BLATTAU
CARL WILLARD FUNCH
ROBERT CARROLL PARKE*

Electrical Engineering

ALFRED ROBERT KEIBLER JR.
JOANNE KATHRYN LIGH
MATTHEW CAMERON MINKER III
LAWRENCE JAMES MOORE
ANDREW LAURENCE SULLIVAN

Mechanical Engineering

OLEN MCCREADY BOYCE
GERALD MADEIRA DAILEY
WILLIAM DELEON EATON*
PETER NAIRN FERRICK*
GEORGE TOWNSEND SINGLEY III
JOHN ROBERT SLACK
JOHN ROBERT STARZMANN
GEORGE MARK STOFEGA JR.
JAMES CURTIS WEBB*

*In Absentia

COLLEGE OF EDUCATION

CANDIDATES PRESENTED BY DEAN ROY M. HALL

Bachelor of Arts

DONALD STUART ARMSTRONG
PAMELA ALWYN MOUNT BUCKLEY
JACK FRANCIS CHELUCCI
NANCY MARIE WAGGONER COLLEY
NANCY CARLYLE GIBBONS CULLEN
THOMAS FREDRICK CURLEY
PENELOPE TORBERT DEAN
WALTER ANTHONY DELGIORNO
PAUL MICHAEL DILL
CAROL MAY DOBSON
DORIS BAILEY DONALDSON
JO LINDA DOUGLASS*
BERNARD LAWRENCE DWORSKY
MARION JEAN FELTON FETTERMAN
ROBERT HARRISON HALLSTED JR.
VIVIENNE JUNE MASORS HENRICHSON*
ANNE ELIZABETH HICKMAN HERBOLDT
HARLAN EDWARD HIGHFIELD JR.
JOYCE RYAN JACKSON
ELAINE EDITH JAQUES
ELEANOR KAPLAN
JOHN LESLIE KINSLER
BARBARA ANN MITTEN LLOYD
BRENDA GAY LUNDBLAD
JOHNNYE SUE MILLER
JACKLYN THOMS MITCHELL MURRAY
DAVID NEAL MUXO
JULIE ANN NERLINGER
KATHARINE ELIZABETH VREELAND
ROY LESTER WHEELOCK
ELLEN VIRGINIA WHITFORD
LYNDA JEAN ZAHN

Bachelor of Science in Education

JOHN LAWRENCE APOSTAL*
JUDITH ZULETTE ATTWILL
RUFUS BARKER BAUSELL JR.
ROBERTA JEAN BECHER
SUSAN LANGDON BENSON
MARGARET MARY BENZI
MARY CATHERINE BEYMER
LESLIE JOAN BINDER
DORIS LOUISE BLANSFIELD
DONNA MARIE BLISS
SUZANNE ELIZABETH BOYER
BARBARA ANNE JOHNSON BRYANT
ALICE LINDA BURNS
PATRICIA ANN CAIN
MARIAN CHRISTINE CAPANO
PATRICIA ANN TALBOT CHALMERS
MAUREEN DOROTHY CLARK
VIRGINIA FAYE CLEMENS
MARY ELLEN COVERDALE
MARILYN JEANNE COX
MICHAEL ANTHONY DAVITT SR.*
SUSAN LEE LOEFFLER DELANEY
ANNA TERESA CLEMENTE DERRICK*
JOANN MARIA DEVINE
DIANA CAROL JEWELL DIEMEDIO
CHRISTINE FAYE DOLE
MARGARET DICKERSON DOORDAN
GALE ELIZABETH DRISCOLL
JOYCE PAULINE DZIENIS
CATHERINE MARY EHRET
SUZANNE COLLEEN ELLIOTT
JOAN ANN ESCHENBACH
MARGARET BRUCE ESHAM
DIANNE FAYE NEHRING FARABI*
JOSEPHINE ALICE PERRONE FERNANDEZ
BARBARA LEE FRANK
JOSEPHINE CLIFTON GABY
ANNE TANGUAY FLICK GARRISON
MARY LYNN GOTSCH
HARRIETTE YANCEY GRAVES
RICHARD HOWARD GRIFFITH
BEVERLY ANN GROVE
EILEEN OLIVE PLUMLINE HAHN
LESLEY CHRISTINE HALL
JO ANNE STATON HART
SUSAN PIERCE HAVEY
CATHRYN LELAND HENDRICKSON
IRIS LOUISE HOGUE
SONIA CARRIE HOPKINS
MARGARET FRANCES HYATT
MARIANNE SCOTT JOHNS
KATHLEEN KABIS
KAREN ELISABETH KAMPHAUS
BERNADETTE KLONOWSKI
CAROLYN JESSICA KRAJEWSKI
JUDITH LOUISE LADD
BETTY FOSTER LARRIMORE
VIRGINIA HELEN FRESE LARSON
VICKIE RENEE LA SAGE
NORMA JEAN SAVAGE LAWLOR
BARBARA JANE LERCH
MARGARET ELIZABETH LIPSCOMB
CHRISTINE REGINA LOGUE
DEBORAH CAROL LUDLOW
DOLORES LYNNE LYNCH
MARIAN ANN COLONNA MARION
MARGARET KATHRYN LUBERGER MARRIOTT
PAMELA LYNN LEARNED MCCRYSTAL
BEVERLY JEAN MICK MCGUIRE
BRUCE THOMAS MCQUILLIN
SHARON ELIZABETH MEARNS
MERI JO MONTAGUE
JANE ESTHER MURRAY
CHERYL LORRAINE SHORT MYERS
KATHERINE JOSLYN NIEDERRITER

*In Absentia

Barbara Jean Nocella
Mary Margret Noonan
Barbara Lee Staulcup Nyers
Marilynn Ruth Jarrell Ottinger
Kristin Belle Otto
Catherine Olga Pappas
Vincent Chester Parker
Klara von Borstel Pasquino
Genaro Joseph Pennachi
Jeanne Caroline Pepper
Ellen Custis Perry
Diane Pauline Pfister
Carol Ann Polen
Evelyn May Raphael*
Patricia Ann Rebar
Helen Marie Reynolds
Jane Elma Roblee
Evelyn Lucille Sharp Russell
Barbara Jean Sanders
Barbara Ann Reed Sarra
Claire Louise Schultheis
Katharine Stokes Shippen
William Arthur Shrouds
Ruth Benjamin Siegel
Carole Ann Sitewicz
Carol Margaret Smerbeck
Sandra Susan Sparks
Evelyn Marie Spencer
Judith Aileen Spicher
Marie Elizabeth Staniszewski
Penelope Ann Stucker
Anne Wight MacMillan Thomson
Dorothy Marie Thorp
Elizabeth Ann Tosi
Elizabeth Jeannie Townsend
William Edward Tyrrell
Alexis Ann Ventresca
Lesley Julia Ward
Joanne Lonergan Warren
Bernadette Ann Socorso Watson
Binnie Cecile Weinstein
Lois Aurelia Wiebel
Margaret Ellen Wilhelm*
Pamela Jean Wilson
Teena Louise Wilson
Gail Louise Wintczak
Patricia Jane Woods
Kristine Anne Wyshock

Bachelor of Science in Physical Education

Vincent Joseph DeLeo
William Warren Denbrock
Sara Tucker Garrison*
Eugene Fredrick Garritt
Stuart Cyril Green
Rita Alice Hall
Barbara Stafford Bohning Hammond
Margaret Virginia Happoldt
Elizabeth Louise Heacock
David Andrew Jones*
Patricia Anne Kellogg
Jean Elizabeth Knight
Robert Allen Layton Jr.
Bernard Francis Luby
Anita Marcial
Michael Anthony McGlinchey*
Russel Wayne Meredith
Gloria Jean Rafferty
Scott Frederick Rice
Linda Jean Smith
Lynda Louise Stuber
Heather Ann Stuttard
Francis Xavier Subach
Nancy Lou Young Turner
Daniel Wayne Vale
Sharyn Anita Wingate

Bachelor of Science in Business Education

Allen Lewis Beitman
Patricia Austin Blackinton
Catherine Elin Graden
Barbara Jean Passmore Leedom
Susan Lorraine Rasmussen Pollard

*In Absentia

COLLEGE OF HOME ECONOMICS

Candidates Presented by Dean Irma Ayers

Bachelor of Science in Home Economics

Alicia Esperanza Bocage Albanell*
Patricia Ann Beecher
Norma Jean Bennett
Nancy Anne Bowen
Joan Cameron
Patricia Cameron Minker Cannon
Margery Lee Cardwell
Barbara Berry Coburn
Patricia Arlene Pase Conley
Mary Louise Corby
Candace Mason Croft
Kathleen Alice McMahon Dahlenburg
Anita Magtarethe Dillenkofer
Marjorie Anne Ferry
Gayle Annette Gormsen
Judith Ann Gross
Jean Carol Hale
Sharon Louise Hale
Barbara Elizabeth Hastings
Elizabeth Ann Hastings
Virginia Jean Hencken
Margaret Nancy Hopkins
Janice Lee Huber
Carolyn Marie Knepler
Jean Ann Krim
Cynthia Mae Lingo
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Roberta Claire Henisee Meacham
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Laurinda Jean Reiter
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Susan Carla Smith
Patricia Ann Tase
Clorice Delema Thomas
Donna Lynn Thomas
Stephanie Louise Trussell
Susan Gail VanDyke
Linda Joan VanVliet
Linda Kathryn Woodworth
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*In Absentia

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JUDITH LESLIE WOODWARD (with honors)

**In Absentia*

Bachelor of Science

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EUGENE PHILLIP HAMILTON (with honors and distinction in Mathematics)
WARREN FRANCIS KNOFF (with honors)
GERALD CLYMER KRATZ (with honors)
REED EDWIN PYERITZ (with honors and distinction in Chemistry)
CARL ERIC SIEKE (with honors)
ROGER LEE SOWERBY (with honors)
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GLENN WARREN INGRAM (with high honors)

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GLENN WARREN INGRAM (with high honors and distinction in Mechanical Engineering)
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JEFFREY PHILLIP STEIN (with honors)

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Jane Ann McGowen (with honors)
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Nancy Jane Lees Smith (with honors)

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Wayne Robert Shugart (with honors)

Bachelor of Science

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Richard Willis Irish (with high honors)†
Robert Andrew Locke (with high honors)†
John Edward Riblett (with honors)

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Anne Barbara Churchill Rinehart (with honors)
Carol Ann Schlereth (with honors)
Harriet Anne Shew (with honors)

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Professor of Military Science

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David Ellsworth Lynn*
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†To be commissioned in the Regular Army
‡To be commissioned at Summer Camp

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STEVEN DAVID GOLDBERG‡
JOHN JOSEPH MATARESE JR.
DAVID KARL SACHSE

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CARL ANTHONY AGOSTINI‡

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DOUGLAS ROY WEHR

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*Distinguished Military Graduates
‡To be commissioned at Summer Camp

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GAIL MARIE ARTNER, B.A., University of Detroit — *History*
SHIRLEY RUTH HEDMAN ASHWORTH, A.B., East Carolina University — *Sociology*
MALCOLM BARRY BAIRD, A.B., Wilkes College — *Biological Sciences*
JOSEPHINE MARIE BOMBA, B.S. in Ed., University of Delaware — *Art*
EDWARD JAMES BUTLER, A.B., Pontifical College Josephinum — *Sociology*
BRIGITTE LUDWINA CALLAY, B.A., University of Delaware — *French*
STUART WILLIAM CAMPBELL, B.A., Kenyon College — *History*
EDWARD ARTHUR CRUMRINE, A.B., Franklin and Marshall College — *Political Science*
MICHAEL PATRICK DOOLEY, B.A., Duquesne University — *Economics*
DONA JACQUELYN HOLT DUTE, B.A., University of Delaware — *History*
REIMER CORNELIUS ECK, Diploma, University of Hamburg, Germany — *History*
DOROTHY ELAINE ELLESIN, B.A., Lake Forest College — *Early American Culture*
SUE ANNE DODSON ERIKSEN, B.S., State College, East Stroudsburg — *Spanish*
BERNARD JACKSON FELCH, B.A., Williams College — *Art*
JOSEPH JOHN FERRANDINO, B.A., Paterson State College* — *Philosophy*
NORMAN JACK FOGEL, B.S., State College, Millersville* — *Political Science*
BENNO MARCUSE FORMAN, B.A., Washington and Lee University — *Early American Culture*
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RICHARD GORDON FREEDBERG, A.B., Haverford College — *Dramatic Arts and Speech*
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EMMY LOU DENNY GOOCH, B.A., Wilson College — *Biological Sciences*
DONALD ANDREW GRINDE JR., A.B., Georgia Southern College — *History*
ELTON WAYLAND HALL, B.A., Trinity College, Connecticut — *Early American Culture*
JOHN ALFRED HAMILTON JR., B.S., Frostburg State College — *Political Science*
ZIEGLER HEILMAN, B.A., Elizabethtown College — *Biological Sciences*
M.S., University of Pennsylvania
MARY FRANCES BONNER HODGSON, B.A., Duke University — *English*
HELEN LOUISE HINRICHSEN JONES, A.B., Radcliffe College — *Mathematics*
M.A., Radcliffe College
PATRICIA ELLEN KANE, B.A., Chatham College* — *Early American Culture*
CARL BOWMAN KAUFMANN, A.B., Dartmouth College* — *History*
MARY LOU BRODERICK KENNEDY, B.A., Saint Mary's College, Indiana* — *Dramatic Arts and Speech*
FREDERICK STEPHEN KILLE, B.S., Salisbury State College — *Art*
NANCY RUBIN KING, B.S., State University of New York College at Cortland — *Dramatic Arts and Speech*
JUDITH ESTERLINE KIRKPATRICK, B.A., Ursinus College — *English*
MARILYN ANN KLUEPFEL, B.S., Saint John's University, New York — *Mathematics*
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KURUMI TAKEI NATHUKA, B.F.A., Tokyo Art University, Japan — *Art*

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JOHN KEVIN O'CONNOR, B.A., Franklin and Marshall College — *Sociology*
ETHELBERT NELSON OTT, B.A., University of Delaware — *Art*
GAIL FRANCES MCCLAIN OWENS, A.B., Thiel College — *Biological Sciences*
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PETER CHARLES PERIALAS, B.S., State College, Bloomsburg — *History*
ROBERT JOSEPH PETERSON, A.B., Assumption College — *History*
CHARLES FREDRICK PLATZ, B.F.A., Philadelphia College of Art — *Art*
LOUIS STANCLIFT PUTNAM, B.A., Yale University — *English*
ANNA MARIA CARCHEDI RAHEJA, B.A., University of Delaware* — *French*
DAVID OVERLY ROBBINS, B.A., Lycoming College — *Psychology*
RITA ROSANS, B.S., State College, West Chester* — *English*
MARCH ANN AGRONS RUBIN, B.A., Rutgers, The State University — *Spanish*
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MARGARET ANNE SCOTT, B.S., University of Delaware — *Art*
JAY MICHAEL SEMEL, A.B., Temple University — *English*
LEWIS INMAN SHARP, B.A., Lewis and Clark College* — *Early American Culture*
RAYMOND VOIGT SHEPHERD JR., B.S., Columbia University — *Early American Culture*
THIRA SHOWCHAYIA, B.A., Thanmarsat University, Thailand* — *Economics*
RALPH BENJAMIN SINGER JR., B.A., State College, Millersville — *History*
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LORETTA ANN WAGNER SYMONS, B.A., University of Delaware — *English*
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DUK JOONG YOON, B.A., Seoul National University, Korea — *Sociology*
EDWIN SHEER ZIPPE, B.A., University of Delaware — *History*

Master of Science

ALAN DOUGLAS ADAMS, B.S., University of Delaware — *Chemistry*
ANTHONY ANTON, A.B., Columbia University — *Chemistry*
M.S., University of Arkansas
JOHNNY LEROY ARMSTRONG, B.S., Texas College of Arts and Industries — *Chemistry*
DON VICTOR AURAND, B.S., University of Miami — *Biological Sciences*

**In Absentia*

ROBERT LEWIS BAILEY, B.S., University of Delaware — *Agricultural Economics*
CYRUS BARIMANI, B.S., Bethany College — *Chemistry*
DEAN CAREY BELT, B.S., The Pennsylvania State University — *Horticulture*
NALINI LABHSHANKER BHATT, B.S., University of Bombay, India — *Chemistry*
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RICHARD MARSHALL BURR, B.Sc., Philadelphia College of Pharmacy and Science* — *Entomology*
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JOSE JOAQUIN D'ARRUDA, B.S., Lowell Technological Institute — *Physics*
ROGER LOWELL DAUM, B.S. in Ed., State College, Clarion — *Biological Sciences*
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DONALD EDWIN DELANEY, B.S., Dickinson College — *Chemistry*
JOSEPH JOHN DESTEFANO, B.A., University of Connecticut — *Chemistry*
ARUN PANDURANG DEWASTHALI, B.S., Bombay College, India — *Mathematics*
WALLACE DE WITT III, B.A., Western Maryland College — *Biological Sciences*
DAVID REED DREWS, B.A., Denison University* — *Psychology*
JAMES NEWELL ECKSTEIN, B.S., Loyola College, Maryland — *Biological Sciences*
SHARON KAY MCKINSTRY EFFENBERGER, B.S., Iowa State University of Science and Technology* — *Child Development*
THOMAS MACKEY EVANS, B.A., University of Delaware* — *Entomology*
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SANDRA DEE CALHOUN GAUGER, B.S., University of Delaware — *Home Economics Education*
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JESSIE ALBERTA REED GREVE, B.S., Maryville College — *General Home Economics*
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M.A., University of Utah
ORIN WALTER MARKS, B.S., University of Colorado — *Mathematics*
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RICHARD HARRY MOORE, B.S., Cornell University — *Agricultural Economics*
JAMES PAUL MUELLER, B.S., University of Delaware — *Agronomy*
FRED THOMAS NEALON, A.B., Wilmington College, Ohio* — *Statistics*
MARINO JOHN NICCOLAI, B.S., Auburn University — *Mathematics*
EBENEZER KWEKU OBENG-ASAMOA, B.Sc., University of Ghana, Ghana* — *Biological Sciences*
SHELDON I PLUMER, B.A., The City University of New York, Hunter College — *Psychology*
FRED ADEDAYO ROBERTS, N.P.C., Monmouthshire Institute of Agriculture, Wales, United Kingdom — *Animal Science*
BARRY HOWARD RODIN, B.S., Roosevelt University — *Mathematics*
RICHARD ANDREW ROONEY, B.S., State College, Millersville — *Chemistry*
M.Ed., University of Delaware
VIRGINIA LEE GRAVES SHORT, B.S., University of Delaware — *Home Economics Education*
KARL WILLIAM SIMPSON, B.A., Thiel College — *Entomology*
DAVID BRENNAN SMITH, B.A., University of New Hampshire — *Chemistry*
DONALD HENRY SMITH, B.A., University of Delaware — *Entomology*

**In Absentia*

THOMAS HAROLD STEVENS, B.S., Cornell University — *Agricultural Economics*
DENNIS ALAN STEVENSON, B.A., Gettysburg College — *Physics*
KARLENE ANN DOUGLASS STINSON, B.S., Illinois State University — *Home Economics Education*
ROGER PRICE STRADLEY, B.S., University of Delaware — *Animal Science*
JAMES RUSSELL THOMAS JR., B.E.P., Auburn University — *Mathematics*
JERRY THOMAS, B.S., Louisiana Polytechnic Institute — *Statistics*
CHARLES GARY WADE, B.S., Ursinus College — *Chemistry*
JERRY LEE WEBB, B.S., University of Missouri — *Agricultural Economics*
SARAH SIMPSON WEBB, B.S. in H.E., University of Delaware — *Home Economics Education*
JOHN HOBSON WHEALTON, B.S., Lowell Technological Institute — *Physics*
SANDRA RAE SCHWAB WILLIAMS, B.S., University of Delaware — *Home Economics Education*

Master of Business Administration

ROBERT JAMES AKENS, B.S.Eng., United States Naval Academy
DONALD PETER ALLEGRETTO, B.S., Dickinson College
CHESTER WILLIS ALLEN III, B.S., University of South Carolina
BRUCE ALLEN APPLEQUIST, B.Ch.E., University of Minnesota
JOHN WESLEY BAILEY II, B.S., University of Alabama
DAVID LEE BENNETT, B.M.A.E., University of Delaware
DAVID PAUL BIEHN, B.A., University of Delaware
WILLIAM CHARLES BOETTGER, B.S., Villanova University*
DAVID WAYNE CAREY, B.S., Cornell University
FRANCIS XAVIER CUNNINGHAM, A.B., Brooklyn College
CHARLES HENRY DONOVAN SR., B.S., Villanova University
RALPH ALEXANDER GERRICK, B.B.A., Pace College
RICHARD JAMES GODFREY, A.B., Dartmouth College
B.A., Dartmouth College
WILLIAM FRANCIS GREEN, B.S. in B.A., Northeastern University
NEIL ALLAN HANSEN, A.B., Columbia University
B.S.Ch.E., Columbia University
GEORGE GORDEN HARDING, B.S., New England College
RONALD WILLIAM HEVEY, B.S.E.E., University of Wisconsin
JAMES ALBERT HORTY JR., B.S., La Salle College*
HARDY HARTMUT ALBERT KAFFENBERGER, B.S.E.E., Northwestern University
RICHARD ALLEN KEESLING, B.S.I.E., Purdue University
FREDERICK VALENTINE KLOPP, B.S.Ch.E., Lehigh University
RICHARD JAMES KREMPASKY, B.S., Indiana University of Pennsylvania
ALBERT LUKE LACKMAN, B.S., University of Delaware
FLORIAN MADINA, B.Ch.E., The City University of New York, City College
RICHARD HARRY MEER, B.S., Lafayette College
M.S., Cornell University
THOMAS SHANE MERTES, B.Ch.E., University of Delaware
M.Ch.E., University of Delaware
JOSEPH EMANUEL MINICHINO, B.S., Seton Hall University
JOHN JOSEPH MORAN, B.S., United States Merchant Marine Academy
DAVID EARL NICKLES, B.S., Massachusetts Institute of Technology
M.S., Massachusetts, Institute of Technology
KENNETH WAYNE PETKE, B.A., Northwestern University
JOSEPH FRANCIS PRZYWARA JR., B.S., University of Delaware
CHARLES REESE, B.S., Indiana University of Pennsylvania
B.S.I.E., University of Pittsburgh
EDWARD SINCLAIR RODEKOHR, B.S.Ch.E., University of Missouri
HENRY ALFONS SAMSEL, B.S., Drexel Institute of Technology
JOSEPH GIFFORD SCARBOROUGH JR., B.S.M.E., University of Maryland
ERNEST ADOLF SCHWAB, B.S., Syracuse University
M.S., Syracuse University

**In Absentia*

FRANK JOHN SKOMORUCHA JR., B.S., University of Delaware
JOHN ABERNATHY SMITH, B.E.E., University of Delaware
ORLIN EDWARD TRANDAHL, A.B., Columbia University
IRVIN MICHAEL TUCKER, B.E.S., The Johns Hopkins University
RAYMOND RICHARD TULEYA JR., B.S., The Pennsylvania State University
JAMES MACKEY WHITE, B.S., Duke University
EITAN ZUR, B.S., Philadelphia College of Textiles and Science

Master of Education

MARY HERRICK ASHWORTH ANDERSON, B.A., Middlebury College; M.A., Wellesley College
JOHN WILMER BANKES, B.A., University of Delaware
BARRY WILSON BARKER, B.E.Ed., Eastern Illinois University*
RONALD EARL BAUGHMAN, B.S. in Ed., Indiana University of Pennsylvania
ROBERT ANDREW BEHL, B.S., Pennsylvania Military College
MARY KELLEY CONAWAY BEYER, B.S., University of Pittsburgh
PAUL GEORGE BILLY, A.B., Muhlenberg College
MELVIN BLECHMAN, B.A., University of Delaware
FRANK BRUBAKER BRADLEY, B.A., Franklin and Marshall College
FRANCES ELIZABETH BARNES BRUCE, B.A., Hanover College
LARRY KENT BUCKLEY, B.S., Alderson-Broaddus College
JAMES ARTHUR BURCHAM, B.S. in Ag., University of Delaware
JOHN WILLIAM CAMPBELL, B.S., Mount Saint Mary's College, Maryland
ARTHUR GENE CARLISLE, B.A., University of Delaware
RAYMOND WAYNE CARMEAN, B.S., University of Delaware
ANGELO LOUIS CATALDI, B.S., University of Delaware
RUTH LOUISE WITALIS CHUBATY, A.B., Boston University
THOMAS LEE COMER, B.S., Salisbury State College
JOSEPH THOMAS CONAWAY, A.B., Villanova University
MARTHA ELIZABETH HARRY COPE, A.B., Temple University
RUSSELL KENYON CORBETT JR., B.A., University of Delaware
JEAN LOUISE HOFFMAN COSSABOON, B.S., University of Delaware
JAMES THOMAS DELANEY, A.B., Mount Saint Mary's College, Maryland
MARGARET JANE PHILLIS DILLNER, B.S. in Ed., Indiana University of Pennsylvania
CAROL ANN NORTH DIXON, B.A., Syracuse University
HELEN MARGARET KEENEN FETZER, B.A., Denison University
BARBARA JEAN BUNGART FINNAN, B.S., Saint Francis College, Pennsylvania
ELIZABETH ANN NACE FLOOD, A.B., University of Delaware
LOIS ROBERTSON FRITSCHE, B.A., Rutgers, The State University
JUDITH ANNE GAILEY, B.S. in Ed., University of Oklahoma
MARTHA SNOW JACKSON GILBERT, B.S., University of Delaware*
JACK PAUL GOLDBERG, B.S., Moravian College
ESTHER RUTH FISHER GOODMAN, B.S., The City University of New York, City College
SHEILA GORRAFA, B.S. in Ed., University of Delaware
RICHARD TERRELL GRAHAM, B.S., University of Delaware*
EULA MAE BUNTING GRAVES, B.S., University of Delaware
JACOB HABER, B.A., University of Delaware
SUNDAY FLORES PAOLI HAFFEN, B.S. in Ed., University of Delaware
MARTHA HOWE MCCONNELL HALL, B.S., Stetson University
GEORGE F. HANEY, B.S., State College, Cheyney†
MURIEL SANDRA SILVA HARDING, B.A., Notre Dame College, New Hampshire
MIRIAM THEODORA STRIGLE HEINEL, B.A., Cornell University
JOHN FRANCIS HERRMANN, B.A., Glassboro State College
RICHARD ALVIN HITE, B.S., Juanita College
JEANETTE MARION REILLY INGOLD, B.A., University of Delaware*
DOROTHY LEE THOMPSON IRVING, B.S., University of Maine
GEORGE LAMAR JOHNSON, B.S., Fort Valley State College
FRANCES KATHRYN MONTGOMERY JOSEPH, B.S., Duke University

**In Absentia*
†*Posthumously*

Shirley Ann Chapnitsky Karfunkle, B.A., University of Wisconsin
Barbara Jean Keller, B.S. in Ed., University of Delaware
John Bernard Kelly, B.S., Appalachian State Teachers College
Thomas Joseph Kelly Jr., B.A., Wagner College
Verne Laurenz Lietz, B.A., Arkansas Polytechnic College
Richard Peter Lonie, B.S., State College, East Stroudsburg
Barbara Ann Willing Macken, B.S., Towson State College*
Susan Amy Fair Mackey, B.A., Purdue University
Hannah Ann Ale McDonough, B.S., University of Delaware
Dorothy Cedor McNamee, B.S., State College, Bloomsburg
Jean Ann McNeil, B.S., The Pennsylvania State University
Christopher Clossie Mench Sr., B.S., University of Maryland
Marion Joan Rahm Modi, B.A., Michigan State University
Naomi Elizabeth Latsha Moore, B.S., State College, West Chester
Winifred Faye Moss, B.S.Ed., Ohio University
Gyuri Nemeth, B.A., University of Delaware
Caroline Ayres Du Mont Nietubicz, B.S., University of Delaware
Sister Mary Eamon O'Neill, I.H.M., B.S., Marywood College
M.A., Villanova University
Victoria Vaiden Worden Owen, A.B., Goucher College
Barbara Anne Parkinson, B.A., University of Delaware
Suzanne Parrott, B.S., Delaware State College
Joyce Lorane Peaco, B.A., Howard University
Robert Duane Pearce, B.S., University of Pennsylvania
John Peters, B.A., University of Kentucky
John Ernest Pickett Jr., B.S., State College, Millersville
Cynthia Wetmore Van Cleve Ramsey, B.A., Vassar College
Maubra Jane Bundick Randolph, B.A., University of Delaware
Dorothy Jean Huber Rayner, B.S., The Pennsylvania State University*
David Joseph Rehrmann, B.S., State College, West Chester
Maynard Donald Reinbold, A.B., Muhlenberg College
Susan Ann Hoffman Rew, B.S., Syracuse University*
Leonard George Ricci, B.S., State College, West Chester
Meredith Roberts, B.S., State College, Millersville
Lynne Etta Savchak, B.S., State College, West Chester
Joseph Gregory Scalise, B.S., State College, West Chester
Rebecca Elaine Hall Scarborough, B.A., University of Delaware
Mahlon Ian Schlegel, B.S., State College, Lock Haven
Donald Frederick Schneck, B.S., University of Pittsburgh
Varsha Ramesh Shah, B.A., University of Gujarat, India*
Barbara Adrene Wenger Shaw, B.A., Gettysburg College
Lucille Karrow Sherman, A.B., Rutgers, The State University
Carole Gwyneth Atkins Sherr, B.S.Ed., State College, Millersville
Horace Edward Short Jr., B.S., University of Delaware
Francis John Smagalla, B.A., University of Delaware
Anne Marguerite Porter Smith, A.B., Smith College
Thomas Richard Soukup Jr., B.A., Wesleyan University
Carol Johanne Vincent Staudt, B.S., Cornell University;
M.S., Cornell University*
Roy Landis Stover, B.S.Sec.Ed., State College, Millersville
William Alfred Streamer Jr., A.B., Denison University
Nalini Palat Subramanian, B.A., University of Kerala, India
Regina Alma Borinsky Swoope, B.A., University of Delaware
Wilma Geraldine Lee Thompson, B.A., Winthrop College
Ramon Gene Thorson, B.A., San Jose State College
James William Henry Trent, B.S., West Virginia Institute of Technology
Evelyn Eugenia Nichols Tryon, A.B., Otterbein College
Thomas Walter Van Grofski, B.A., University of Delaware
Jack Huey Vinokur, B.S., Temple University
Rymal Lynn Wenger, B.S.Ed., Concord College*
Helen Theresa Nunez Wilson, B.S., East Tennessee State University
James Lytle Wilson, B.S., Indiana University of Pennsylvania

In Absentia

Lucille Ingram Wilson, B.A., University of Delaware
Donald Herbert Wolfe, B.S.Ed., The Pennsylvania State University
Nancy Armwell Moore Wolfe, B.A., University of Maryland
Kenneth Edwin Woodward, B.A., Ursinus College
Richard Lincoln Woodward, B.S., State College, Mansfield
Francis Granville Wright, B.S., State College, West Chester
Frank Galen Wyrick, B.S. in Ed., State College, Shippensburg
Frederick Charles Zell Jr., B.S., Indiana University

Master of Applied Sciences

Lutgard Camiel DeJonghe, T.E. Chem., *Metallurgy*
Institute Voor Hogere Technische Studies, Belgium
Stephen Cartwright Dexter, B.M.E., University of Delaware *Metallurgy*
Floyd Kaene Swope Jr., B.S.Ch.E., Case Institute of Technology *Statistics*

Master of Chemical Engineering

James Berger Camden, B.Ch.E., University of Delaware
Peter Gregory Ham, B.Ch.E., University of Delaware
Jean-Michel Maurice Hamard, Diplome, Ecolé Nationale Supérieure des Mines de Paris, France
Marie Kasparkova, M.S., University of Prague, Czechoslovakia*
Donald Laurens Kerr, B.S., Worcester Polytechnic Institute
John Lazare, B.S.Ch.E., Drexel Institute of Technology
Robert Thomas Pavlica, B.Ch.E., The City University of New York, City College
Joel Jay Roisman, B.Ch.E., Cooper Union
Donald Charles Sundberg, B.S.Ch.E., Worchester Polytechnic Institute*
James Joseph Wilson, B.S.Ch.E., Bucknell University

Master of Civil Engineering

Jacob Feldman, B.C.E., University of Delaware
Uldis Karins, B.C.E., University of Delaware
Stuart Webster McKenzie, B.S., University of Puget Sound
Ken-ren Yang, B.S.C.E., Cheng Kung University, China
Ken-ren Yang, B.S.C.E., Cheiug Kung University, China

Master of Electrical Engineering

James Franklin Bennett, B.A. and B.E.E., University of Delaware
Donald Livingston Clark, B.E.E., University of Delaware
Divyanshu Ramendra Jha, D.E.E., Government Polytechnic Institute, India*
Joseph Edward Knox, B.E.E., Villanova University
Richard Edwin Kutzleb, B.S.E., Princeton University
Steven Wayne Lucas, B.E.E., University of Delaware
Lee Harvey Nichols III, B.E.E., University of Delaware
Sumantrai Dayalbihai Patel, B.E. (Elect.), Sardar Vallabhbhai Vidyapeeth, India

Master of Mechanical and Aerospace Engineering

Robert Craig Allen, B.S.M.E., Bucknell University
Parviz Dadras, B.S., Abadan Institute of Technology, Iran
Jack Robert Maison, B.S.M.E., The University of Kansas
Vipin Mehta, B.Sc.Mech.Eng., Banaras Hindu University, India
Mohsen Shahinpoor, B.Sc.Ch.Engg., Abadan Institute of Technology, Iran
James Joseph Woods, B.S. in M.E., Pennsylvania Military College
Cheng-ih Wu, B.S., National Taiwan University, China

In Absentia

Doctor of Philosophy

STANLEY LAWRENCE ALEKMAN — *Chemistry*
B.A., The City University of New York, City College
Dissertation: A Kinetic Investigation of Chromic Acid Oxidation

MONTHER YOUSIF AL-JANABI — *Chemistry*
B.Sc., Baghdad University, Iraq
M.S., University of Illinois
Dissertation: Transition Metal Dinitrile Coordination Complexes

ROBERT JOHN ANDERSON — *Chemical Engineering*
B.S.C.E., Illinois Institute of Technology
M.Ch.E., University of Delaware
Dissertation: Interchange in Horizontal Annular Two-Phase Flow

RICHARD ALLAN ASHLEY — *Biological Sciences*
B.S., University of Delaware
M.S., University of Delaware
Dissertation: Several Factors Affecting Adsorption of Atrazine and Diphenamid by Soils

THURSTON ELMO BANKS — *Chemistry*
B.Ch.E., Kansas State University
Dissertation: Studies in the 2-Acyl and 2-Aroyl-1, 3-Indandione System

HARRY FREDERICKS BELL — *Chemistry*
B.S., Elizabethtown College
Dissertation: The Reaction of Peroxide with Oxidants in Alkaline Media

JOHN WILLIAM BRIGHT* — *Chemical Engineering*
B.A., The Rice University
B.S.Ch.E., The Rice University
Dissertation: Molecular Migration on Solid Adsorbent Surfaces

JOSEPH RUDOLPH CHERNEY
Applied Sciences—Mechanical and Aerospace Engineering
B.S.M.E., University of Notre Dame
M.S.M.E., Worcester Polytechnic Institute
Dissertation: An Analytical and Experimental Investigation of a Transpiration Cooled Cylinder Subjected to a Cross Flow

MARSHALL HILLEL COHEN — *Chemistry*
B.S.,Dickinson College
Dissertation: Studies on the Thio-Claisen Rearrangement

**In Absentia*

STEPHEN ROSS CONNOR — *Biological Sciences*
B.S., Ursinus College
M.S., University of Delaware
Dissertation: Canker Formation on Apple Bark by *Botryosphaeria ribis*

DANIEL JEROME CONVERSE — *Behavioral Sciences*
B.A., University of Notre Dame
M.Ed., Kent State University
Dissertation: Improving Reading Skills of Disadvantaged Junior High School Students Through an Oral Language Program

RONALD LEE CRAMER — *Behavioral Sciences*
Th.B., Baptist Bible Seminary
M.S., State University of New York, College at Cortland
Dissertation: An Investigation of the Spelling Achievement of Two Groups of First-Grade Classes on Phonologically Regular and Irregular Words and in Written Composition

CRAIG EVAN DANIELS — *Psychology*
B.S.Ch.E., Tufts University
M.Ed., University of Delaware
Dissertation: An Experimental Investigation of the Yerkes-Dodson Law in Terms of Test Anxiety, Task Difficulty, and Verbal Instructions

GARY LEE DRISCOLL — *Chemistry*
B.S., The Pennsylvania State University
Dissertation: The Nature of Oxidative Cleavage of Secondary Alcohols

CARL DAVID EBEN — *Chemical Engineering*
B.S., Massachusetts Institute of Technology
M.Ch.E., University of Delaware
Dissertation: Inequalities for Multistage Optimization

STUART FIELDING — *Psychology*
B.A., Monmouth College
M.S., Howard University
Dissertation: Auditory Adaptation: Evidence of Duplexity

JEFFREY ALAN FRIEDHOFFER — *Applied Sciences—Electrical Engineering*
B.E.E., University of Delaware
M.E.E., University of Delaware
Dissertation: A Study of the Magnetogasdynamic Equations as Applied to Shock and Blast Waves

ROBERT FORD GINN — *Chemical Engineering*
B.S., University of Colorado
M.S., Lawrence University
M.Ch.E., University of Delaware
Dissertation: An Engineering Evaluation of Viscoelastic Constitutive Equations

JAMES LEE GOOCH — *Biological Sciences*
B.S., West Virginia University
M.S., West Virginia University
Dissertation: Natural Selection and Genetic Drift of Sternopleural Bristle Number and Distribution in *Drosophila melanogaster*

THADDEUS FRANCIS GORA JR. — *Physics*
B.S., Rensselaer Polytechnic Institute
Dissertation: Theory of Graded Mixed Semiconductors—Electronic Energy Structure and Transport Properties

WALTER DORSEY HAMMOND — *Behavioral Sciences*
B.A., Washington College
M.Ed., University of Delaware
Dissertation: Certain Differences in the Syntactic Structure of Creative Writing at Four Elementary Grade Levels

DONALD LEE HARTLEY* — *Psychology*
B.A., Heidelburg College
M.A., University of Delaware
Dissertation: Sources of Reinforcement in Learned Avoidance

JON DAVID HARTZLER — *Chemistry*
B.A., Goshen College
Dissertation: Polyhydrouracils and Polyiminoimidazolidinones

PETER ALLEN HOLMES — *Psychology*
A.B., Franklin and Marshall College
M.A., Bryn Mawr College
Dissertation: The Effect of Stimulus Intensity and Unconditioned Responsivity on Sensory Preconditioning Using the CER

FRANK JOSEPH HOPP JR. — *Biological Sciences*
B.A., Rutgers, The State University
M.S., University of Delaware
Dissertation: Geotropic Bending in the Rhizoids of the Alga, *Chara rusbyana* Howe

DONALD PAUL HOSTER — *Chemistry*
B.S., Union University, New York
M.S., University of Delaware
Dissertation: Further Studies on the Mechanism of Chloride and Acetate Pyrolysis

ENOCH DOZIER HOUSER — *Biological Sciences*
B.S., Alabama State College
M.S., Villanova University
M.A., Bryn Mawr College
Dissertation: Molecular Size and Properties of Staphylococcal Hemolysins

SHELDON KAVESH — *Chemical Engineering*
B.S.Ch.E., Massachusetts Institute of Technology
M.C.H.E., Polytechnic Institute of Brooklyn
Dissertation: Lamellar and Interlamellar Structure in Melt Crystallized Polyethylene

**In Absentia*

WAYNE RAYMOND KIME — *English*
B.A., Stanford University
M.A., University of Delaware
Dissertation: Washington Irving's *Astoria:* A Critical Study

HENRY KURATLE III — *Biological Sciences*
B.S., University of Delaware
M.S., University of Delaware
Dissertation: The Mode of Action and Basis for Selectivity of Linuron Herbicide

THEODORE DUKE LANGLEY — *Psychology*
B.A., University of Virginia
M.A., University of Delaware
Dissertation: Sensory Evoked Potentials in the Cat as a Function of Microinjections of Neurohumors into the Brainstem

SHIANG-YU LEE — *Applied Sciences—Mechanical and Aerospace Engineering*
B.S.Eng., National Taiwan University, China
M.M.E., University of Delaware
Dissertation: Wave Propagation and Vibration of a String Undergoing Axial Motion

WILLIAM JOSEPH MANNING — *Biological Sciences*
B.S., Michigan State University
M.S., University of Delaware
Dissertation: The Effects of Plant Amendments and Their Associated Microflora on *Rhizoctonia solani* Kuehn

ALBERT EDWARD MILLAR JR. — *English*
B.A., University of Richmond
M.A., University of South Carolina
Dissertation: Spiritual Autobiography in Selected Writings of Sewall, Edwards, Byrd, Woolman, and Franklin: A Comparison of Technique and Content

CARL EDWARD MINNIER — *Chemistry*
B.S., Bucknell University
Dissertation: Acylations of Purines and Benzimidazole-2-Thione

AJIT PURSHOTTAMDAS MITHAIWALA — *Applied Sciences—Civil Engineering*
B.C.E., University of Delaware
M.C.E., University of Delaware
Dissertation: Micro and Macro Analysis of Cylindrical Ribbed and Latticed Shells

DANIEL JOSEPH MONAGLE — *Chemistry*
B.S., Mount St. Mary's College, Maryland
M.S., Duquesne University
Dissertation: Polymerization and Copolymerization Characteristics of 1, 2-Dimethyl-5-Vinyl Pyridinium Methyl Sulfate

RICHARD LYNCH MUMFORD — *History*
B.A., University of Delaware
M.Ed., University of Delaware
Dissertation: Constitutional Development in the State of Delaware, 1776-1897

DUANE GUY NICHOLS — *Chemical Engineering*

B.S.Ch.E., West Virginia University
M.Ch.E., University of Delaware

Dissertation: An Analytical Solution of a Dispersed Flow Model—A Study of Fission Product Transport and Deposition

LYNN CARROLL OATMAN — *Psychology*

B.A., University of Nebraska
M.A., University of Nebraska

Dissertation: The Effect of Attention on Auditory Evoked Potentials in Unanesthetized Cats

ADAM OSBORNE — *Chemical Engineering*

B.Sc., University Birmingham, England, United Kingdom
M.S., University of Delaware

Dissertation: The Solution of Unsteady State Multicomponent Distillation Using Partioal Differential Equations

WILLIAM RICHARD PATTERSON — *Applied Sciences—Metallurgy*

B.S.Met.E., University of Pittsburgh
M.S.Met.E., University of Pittsburgh

Dissertation: The Effect of Surface Alloying on the Plastic Deformation Behavior of Copper

JIMMIE DONALD PATTON — *Chemistry*

B.Ch.E., Cornell University

Dissertation: Heats of Mixing of Solutions of Electrolytes of Different Charge Types

JEAN KAREN COBERG PETERSON* — *Chemistry*

B.Sc.(Chem.), Philadelphia College of Pharmacy and Science

Dissertation: Dilute Solution Studies of a Linear Polyurethane and Its Nitrogen-Substituted Derivatives and Grafted Copolymers

RICHARD MERLE PETERSON† — *Chemistry*

B.Sc., Philadelphia College of Pharmacy and Science

Dissertation: The Gamma Radiolytic Decomposition of Cysteine and Related Compounds in Dilute, Aqueous Solution

ROBERT ANTHONY RAINES — *English*

B.A., University of Saint Thomas, Texas
M.A., University of Delaware

Dissertation: Thomas Drue's *The Duchess of Suffolk:* A Critical Old-Spelling Edition

PALANICHAMY PILLAI RAJU — *Applied Sciences—Civil Engineering*

B.E., Madras University, India
M.Sc., Madras University, India

Dissertation: Shallow Shells of Pyrolytic Graphite Type Materials

**In Absentia*
†Posthumously

ELEANOR FRANCES FLEMING ROBERTS — *Behavioral Sciences*

B.S., Purdue University
M.Ed., University of Delaware

Dissertation: An Investigation of Developmental Levels of Children's Definitions of Selected Nouns

JEROME DAVID ROBINSON — *Chemical Engineering*

B.Ch.E., The City University of New York, City College
M.Ch.E., University of Delaware

Dissertation: Direct Determination of Intermolecular Potentials from Physical Property Measurements

VEDANTAM MURALI KRISHNA SASTRI* — *Applied Sciences—Mechanical and Aerospace Engineering*

B.Tech.(Mech.), Indian Institute of Technology, India
M.E., Indian Institute of Science, India

Dissertation: Analytical and Experimental Study of the Influence of an Unheated Solid Starting Length in a Transpired Boundary Layer

HERBERT MEYER SCULL JR.* — *Chemical Engineering*

B.S., University of Tennessee
M.Ch.E., University of Delaware

Dissertation: The Effect of Mixing on the Performance of a Controlled Cyclic Desorption Column

FRED ALLAN SEYER* — *Chemical Engineering*

B.Sc.Ch.E., University of Alberta, Canada
M.Ch.E., University of Delaware

Dissertation: Turbulence Phenomena in Drag Reducing Systems

SHIRISH KALYAUBHAI SHAH* — *Chemistry*

B.Sc., Gujarat University, India

Dissertation: The Radiolysis of p-Nitrosodimethyl Aniline in Aqueous Solutions

JOHN GUTHRIE THOMPSON — *Chemistry*

B.S., Davis and Elkins College

Dissertation: Reactions of Phosphonium Salts: Reactions of Cyclopropyl- and Cyclobutyl-Triphenylphosphonium Bromides: Reactions of Cyclopropylmethyl- and Butyl-Triphenylphosphonium Halides

CHARLES CURTIS THORNTON — *Psychology*

B.A., University of Delaware
M.A., University of Delaware

Dissertation: Response to Disagreement in Dyads

RONALD PHILIP UPTON — *Chemistry*

B.S., New Bedford Institute of Technology

Dissertation: Infrared Photometric Titrations Utilizing the Carbonyl Region

ROBERT DOUGLAS VARRIN — *Applied Sciences—Civil Engineering*

B.S.E., Princeton University
M.S.E., Princeton University

Dissertation: Model Analysis of Unsteady Flow to Multiaquifer Wells

**In Absentia*

HENRY HUGHSON WALL III — *Chemical Engineering*

B.S., Louisiana State University and Agricultural and Mechanical College
M.Ch.E., University of Delaware

Dissertation: Correlating and Predicting Dilute Solution Equilibria Involving Homologous Compounds

DAVID FRANKLIN WILSON — *Biological Sciences*

B.A., Hofstra University
M.A., University of Delaware

Dissertation: The Basis for Double Contractions and for Slow Relaxations in Nonstriated Muscle in the Mantle of a Pelecypod, *Spisula solidissima*

PAUL LOUIS WOLF — *Biological Sciences*

B.S., Elizabethtown College
M.S., University of Delaware

Dissertation: A Comparison of Ion Levels and Urea Concentrations in Untreated and Corticosterone-Treated *Raja eglanteria,* the Clearnose Skate

TSU-TE WU — *Applied Sciences—Mechanical and Aerospace Engineering*

B.S., National Taiwan University, China
M.S., University of Florida

Dissertation: Some Problems Involving Dislocations in Elastic Nonhomogeneous and Homogeneous Bodies in a State of Two-Dimensional Deformation

HARRY ZWICK — *Psychology*

B.A., Earlham College
M.A., Columbia University

Dissertation: Behaviorally Determined Dark-Adaptation Functions in the Turtle, (*Pseudemys scripta elegans*)

HONORARY DEGREES

Doctor of Laws

GEORGE P. EDMONDS

Doctor of Science

WILLIAM MAURICE EWING

Doctor of Laws

JOHN ALANSON PERKINS

ACADEMIC COSTUME

The use of the academic costume, which seems to have originated in the English universities of Oxford and Cambridge, has been traditional in university life since medieval times. In England and other European countries academic attire generally is distinctive with each university so that very colorful ensembles of diverse styles are commonly used abroad.

Unlike European academic apparel, the academic costume of American universities follows a regular pattern, the styles and colors having been established by an intercollegiate agreement in 1895. Cap, hood, and gown are prescribed in style. Color variations indicate differences in the field of knowledge represented and the conferring institutions.

The mortarboard cap is identical for holders of bachelor's and master's degrees. For holders of the doctorate, the cap may be made of velvet and the tassel may be gold. Candidates for the bachelor's degree wear the tassel on the right side of the cap, changing it to the left side after the degree has been conferred.

The bachelor's gown is designed with full sleeves. The master's gown, designed with sleeves closed at the base and slit at the elbow, appears to have half-sleeves which leave the forearm uncovered. The doctor's gown has bell-shaped sleeves with velvet bars and is faced with velvet around the collar and down the front edges.

Hoods representing the three levels of degrees differ primarily in size. Many institutions, including Delaware, do not use hoods for the baccalaureate degree, only for the master's and doctoral degrees. The colors of the hood lining are characteristic of the conferring college. The University of Delaware colors are blue and gold; University of Pennsylvania, red and blue; Columbia, blue and white; etc.

The color of the velvet border of the hood indicates the branch of knowledge represented. For example, the color for Agriculture is maize; for Arts and Letters, white; for Education, light blue; for Engineering, orange; for Home Economics, maroon; for Economics, copper; and for Nursing, apricot.

The order of march for the University of Delaware commencement procession will be in three files as follows: 1) Associate Degree candidates; Bachelors in the Advanced ROTC Program; Bachelors in the College of Arts and Science, Agricultural Sciences, and Engineering; 2) Bachelors in Education, Home Economics, Business and Economics, Nursing; Bachelors with Distinction and Honors; Master's Degree candidates and Doctors of Philosophy; 3) Faculty; Recipients of Honorary Degrees; the President; the Deans; and other principals. Distinctive banners preceding the Faculty procession mark the different academic areas, with border colors signifying the branch of learning represented by each.

DEPARTMENT OF CHEMICAL ENGINEERING
UNIVERSITY OF CALIFORNIA
BERKELEY CAMPUS

CHEMICAL ENGINEERING COLLOQUIUM

Monday at 4:10 p.m.

120 Latimer Hall

November 25	Dr. Adam Osborne Shell Development Company Emeryville	The Calculation of Unsteady State Multi-component Distillation Using Partial Differential Equations

11/18/68

News of Bay Area Business and Industry

John C. Shields, a former sales manager at International Harvester's farm equipment district here, was promoted to general supervisor of plow and harrow sales for the national IH organization.

Robert H. Hastings, Piedmont, joined Security National Bank as vice president-manager of the bank's real estate department.

Gerd D. Wallenstein, vice president, planning, Lenkurt Electric Co., San Carlos, is the newly-elected vice chairman of an International Telecommunications Union study group.

Four Shell Development Co. research engineers were invited to participate in the 61st annual meeting of the American Institute of Chemical Engineers in Los Angeles early next month. They are Dr. A. A. Bondi, Oakland; Dr. Robert W. Schwaar, Berkeley; Dr. Gordon D. Towell, Orinda, and Dr. Adam Osborne, San Francisco.

Robert W. Eriksen was appointed Northern California district manager for Sambo's, and H. Oliver Dixon was nmed regional manager of the restaurant chain for Northern California and Nevada.

Howard F. Lucas succeeds George H. Schreiner as vice president, finance, and treasurer of American President Lines, San Francisco.

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE

SCHOOL OF GRADUATE STUDIES

July 7, 1967

TO WHOM IT MAY CONCERN:

Adam Osborne

has completed all of the requirements for the degree of

Ph.D. - Chemical Engineering - effective 7/7/67.

The degree will be conferred at our next Commencement in June, 1968.

Sincerely,

A. Elise Delano
Assistant to the Dean

AED:hhl