



Department of
Civil & Environmental Engineering

ROY G. PERRY COLLEGE OF ENGINEERING

PRAIRIE VIEW A&M UNIVERSITY

ASSESSMENT REPORT

CVEG 3303

Hydraulics

INSTRUCTOR: *Dr. Emmanuel U. Nzewi, P.E.*

Fall 2021

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*An ability to communicate effectively with a range of audiences
[ABET OUTCOME 3]*

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*An ability to develop and conduct appropriate experimentation,
analyze and interpret data, and use engineering judgment to
draw conclusions
[ABET OUTCOME 6]*

1.1

ABET-Formatted Course Syllabus

CVEG 3303 Fall 2021

Hydraulics

1.	Course number and name:	CVEG 3303 - Hydraulics
2.	Credits and contact hours:	3 credit hours; 5 contact hours * Subject Area: Engineering Topics
3.	Instructor's or course coordinator's name:	Dr. Emmanuel Nzewi
4.	Text book: Title:	Fluid Mechanics with Engineering Applications
	Author:	Finnemore, E.J., and Franzini, J.B.
	Publisher, Year & Edition:	McGraw-Hill, 2002, 10 th Edition
	a. Other Supplemental material	Class Notes provided by the Instructor
5.	Specific course information	
	a. Brief description of the content of the course (catalog description)	CVEG 3303 Hydraulics: 3 semester hours (2-3). Fluid statics; pressure on submerged bodies; continuity equation; Bernoulli equation; principles of momentum and energy; fundamentals of hydraulic modeling; open channel flow; pressure conduit flow; flow measurement; laboratory sessions on selected topics.
	b. Prerequisites or Co-requisites	CVEG 2301 Engineering Mechanics I
	c. ** Indicate whether a required, elective, or selected elective (as per definition provided) course in the program	Required

6.	a. Specific goals for the course specific outcomes of instruction (e.g. The student will be able to explain the significance of current research about a particular topic.) <i>Students will be able to:</i>	b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course. <i>The specific goals for the course specific outcomes listed on the left column will address the following student learning outcomes:</i>
	1. analyze hydraulics problems using the principles of science and mathematics	
	2. analyze hydrostatic pressure distribution in fluid and the effects of these forces on solid boundaries	
	3. apply the fundamental conservation equations in hydraulics and solve hydraulic problems	
	4a. interpret and present results in a technical report format	Outcome 3 <i>An ability to communicate effectively with a range of audiences</i>
	4b. conduct experiments for better understanding of fluid mechanics concepts	Outcome 6 <i>An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions</i>
7	Brief list of topics to be covered	Course Introduction (1 hour) Fluid Properties (3 hours) Hydrostatics (6 hours) Basic Fluid Flow Concepts (2 hours) Bernoulli Equation, flow along a Streamline (3 hours) Continuity and Energy Equations (6 hours) The Momentum Equation (4 hours) Incompressible Flow in Pressure Conduits (6 hours) Pipe Friction, Moody Diagram, Regimes of flow (6 hours) Basics of Steady Uniform Flow in Open Channels (4 hours) Exams (3 hours)

* For all Engineering programs, indicate subject area from the following: **Math, Basic science, Engineering topic or Other**

** **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group

1.2

**Detailed
Course Syllabus**

SYLLABUS

CVEG 3303 - Hydraulics Fall 2021

General Course Information

Information Item	Information
Instructor(s):	Dr. Emmanuel U. Nzewi, PE
Section # and CRN:	P01; 17732
Office Location:	Rm 329 SR Collins
Office Phone:	(936) 261-1658
Email Address:	eunzewi@pvamu.edu
Office Hours:	<i>(subject to change):</i> Mon: 11:00 AM – 2:00 PM CT
Mode of Instruction:	Face-to-Face
Course Location:	Rm 225 SR Collins (via Zoom, if necessary); Lab : 109G CL Wilson
Class Days & Times:	LECTURES: Tue/Thurs: 12:30 PM – 1:20 PM CT; LAB: Thurs: 2:00 – 4:50 PM
Catalog Description:	CVEG 3303 Hydraulics: 3 semester hours (2-3). Fluid statics; pressure on submerged bodies; continuity equation; Bernoulli equation; principles of momentum and energy; fundamentals of hydraulic modeling; open channel flow; pressure conduit flow; flow measurement; laboratory sessions on selected topics.
Prerequisites:	CVEG 2301
Co-requisites:	None
Computer Use:	Each Student <u>must</u> have a working PVAMU account and <u>functional</u> eCourses (Canvas) access. Each student <u>must</u> have internet access <u>adequate</u> to maintain audio and video connection during Zoom class sessions. Lockdown browser is required during ONLINE exams and as necessary during the course. Access to a printer is required.
Required Text(s):	Finnemore, E.J., and Franzini, J.B. (2002). Fluid Mechanics with Engineering Applications, 10 th Edition, McGraw-Hill, New York, NY
Recommended Text(s):	None
Other Materials	Course notes provided in eCourses References may be introduced, as necessary, during the course of the semester.

Student Learning Outcomes:

Course Goals or Overview:	
	To develop the ability to apply knowledge of mathematics, science and engineering in solving engineering problems
Accrediting Body: <i>SACS and ABET</i> Course Objectives: At the end of this course, the student will 1) Be able to analyze hydraulics problems using the principles of science and mathematics 2) Be able to analyze hydrostatic pressure distribution in fluid and the effects of these forces on solid boundaries 3) Apply the fundamental conservation equations in hydraulics and solve hydraulic problems 4) Conduct experiments for better understanding of fluid mechanics concepts, and interpret and present results in a technical report format	

Mapping of Program Educational Objectives onto Student Outcomes

PEO	Program Educational Objectives	CE Student Outcomes						
	<i>Graduates from the Civil Engineering program will:</i>	[1]	[2]	[3]	[4]	[5]	[6]	[7]
PEO 1	Have careers in civil engineering or related fields that lead to increasing levels of responsibility and leadership	X	X	X	X	X	X	X
PEO 2	Obtain professional licensure/certifications	X	X					
PEO 3	Complete graduate studies in civil engineering or related fields	X	X	X	X		X	X
PEO 4	Engage in professional development and service	X	X	X	X		X	X

Mapping of CE Course and Student Outcomes [Beginning Fall 2019] Updated Fall 2021

Previous Course No.	New Course No.	Course Title	CE Student Outcomes/SOs						
			[1]	[2]	[3]	[4]	[5]	[6]	[7]
CVEG 3063	CVEG 3303	Hydraulics			√		R	√	

- 1) an ability to identify, formulate, and solve **complex** engineering problems by applying principles of engineering, science, and mathematics
- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- 3) an ability to communicate effectively with a range of audiences
- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Method of Determining Final Course Grade

This course will utilize the following instruments to determine student letter grades		
Course Grade Requirement	Value	Total
1) Two exams (16% each)	32%	320
2) Homework Assignments	15%	150
3) Class Participation (Classwork) & Attendance	10%	100
4) Lab and Lab Reports	15%	150
5) TaskStream Assignment	3%	30
6) Final Exam (Comprehensive)	25%	250
Total:	100.00%	1000

Grading Criteria and Conversion:

A = 90 - 100%

B = 80 - 89%

C = 70 - 79%

D = 60 - 69%

F = 00 - 59%

Detailed Description of Major Assignments:

Assignment Title or Grade Requirement	Description
Exams	Two (2) written tests designed to measure knowledge of presented course material
Homework Assignments	Written assignments designed to engage students and reinforce course material. Also to provide formative assessment and student feedback over the course of the semester
Class Participation & Attendance	Attendance will be recorded during course. Classwork (short problems) will be assigned to promote student engagement. Online polls or quick response questions maybe part of the course. The Classwork may require submissions in eCourses (Canvas) or to be submitted in class.
Lab and Lab Reports	Labs will be conducted and data will be obtained for generating reports. Lab reports will be graded.
TaskStream	Taskstream assignment for course – via eCourses/Canvas
Final Exam	Comprehensive closed book examination at the end of the course.

Additional Notes:

- Attendance in the class is **mandatory** and students are expected to report to class on time. **Attendance will be taken at the beginning of class and may be taken at the end of class.** Read the attached University Class Attendance Policy.
- Turn cell phones and other electronic devices off prior to the start of class. They must remain off while class is in session. *If you are expecting an emergency call, please keep the cell phone in silence mode and exit the classroom to take the call. **For online (Zoom) class sessions ALWAYS place your microphone on MUTE and your video OFF during the class unless otherwise instructed.***
- Course review will be provided for the Mid-term and Final exams as announced by the Instructor.
- No makeup test(s) will be given. Missed test(s) you will receive zero (0.0) grade. Excused absences will require documentation. A written excuse is required via email to the Instructor. **Failure to sit for and complete the Final Exam will result in an automatic "F" grade for the course.**
- Late homework will not be accepted.** Please refer to Homework submission requirements.
- For grading/class related appeals (see the PVAMU Undergraduate Catalog)
- Cheating on an exam or homework with minimally result in a grade of zero (0.0). Other forms of academic dishonesty could result in a grade of "F" for the course AND administrative referral with the maximum penalty recommended. **Please refer to the CEE Policy to Eradicate Cheating.**

Taskstream

Taskstream is a tool that Prairie View A&M University uses for assessment purposes. One of your assignments may be required to be submitted as an "artifact," an item of coursework that serves as evidence that course objectives are met. If applicable, more information will be provided during the semester by your department, but for general information, you can visit Taskstream via the link in eCourses.

This course requires a Taskstream Assignment.

Course Procedures

Submission of Assignments:

Assignment Submission

Dates to submit assignments will be provided to you at the time the assignment is handed out. **LATE ASSIGNMENTS WILL NOT BE ACCEPTED!** Your homework should be complete, neat, and professionally presented.

Use the following format for all of your homework:

1. Use **only engineering paper (no graph paper)** for submitting your homework
2. Your homework should have the following on top of the first sheet
 - a. Your name
 - b. Course name and section
 - c. Homework number
 - d. Date
3. Show all steps for arriving to the final answer clearly. Include all appropriate sketches.
4. Reference all figures, tables, constant values, equations, and conversions used to complete the problem.
5. Include all the appropriate units throughout the solution. Points will be deducted for answers presented without the appropriate units.
6. **Start a new page for every new problem.**
7. Problems should be in the order assigned.
8. An elaborate set of guidelines will be provided for Lab reports.

Exam Policy:

Exams should be taken as scheduled. No makeup examinations will be allowed except under documented emergencies (See Student Handbook).

CEE POLICY TO ERADICATE CHEATING (PROTECT INTEGRITY OF EXAMS)

Cheating is unprofessional, unethical and is antithetical to our core value of "Excellence in Civil Engineering Education," and WILL NOT BE TOLERATED at any level. To combat this serious problem, the Civil & Environmental Engineering (CEE) Department has adopted the following rules to eradicate cheating.

- If a student cheats on a test/assignment, the student shall receive an **automatic zero** for the test/assignment.
- A student who has been determined to have cheated in a course will IMMEDIATELY relinquish his/her leadership position in any of the department's professional organizations.
- If a student cheats multiple times in a course, the student will receive a **grade of "F"** for the course.
- The calculators allowed for use in exams may be **restricted** to the **latest** Fundamentals of Engineering (FE) approved calculators. For the latest National Council of Examiners for Engineering and Surveying (NCEES) Fundamentals of Engineering (FE) approved calculators visit ncees.org or <https://ncees.org/exams/calculator/> [This NCEES policy protects the integrity of NCEES exams and has been adopted to do likewise for department's exams.]

EXAM GUIDELINES

- 1) All cellphones/smartwatches **MUST** be placed in a book bags during exams and turned off. Book bags **MUST** be placed in front of the classroom and away from students. Students without a book bag must place cellphone/smartwatch (turned off) on Instructor's desk – no exceptions
- 2) Any student possessing a cellphone/smartwatch or any other unauthorized device **WILL** receive an automatic zero for the test/assignment. This is cheating.
- 3) Calculator covers are **DISALLOWED** during tests and must be placed in students' book bags during exams.
- 4) There shall be **NO SHARING** of resources during the exam
- 5) Restroom Visit: if you need to use the restroom, do so before opening the exam. Once the exam begins, you must submit your work to the instructor if you leave the classroom to visit the rest room (your exam terminates).

Additionally, please see the **Section on Academic Misconduct (below)**.

16 WEEK CALENDAR (Subject to change)

Week 1: Topic(s)	Course Introduction
Chapter(s):	Chapters 1/Introductory material
Assignment(s):	None
Week 2: Topic	Fluid Properties
Chapter(s):	Chapter 2/Class notes
Assignment(s):	Classwork
Week 3: Topic(s)	Hydrostatics
Chapter(s):	Chapter 3/Class notes
Assignment(s):	Homework # 1: Select Assigned Problems
Week 4: Topic(s)	Hydrostatics (continuation)
Chapter(s):	Chapter 3/Class notes
Assignment(s):	Exam #1
Week 5: Topic(s)	Basic Fluid Flow Concepts
Chapter(s):	Chapter 4/Class notes
Assignment(s):	Exam #1
Week 6: Topic(s)	Basic Fluid Flow Concepts (continuation)
Chapter(s):	Chapter 4/Class notes
Assignment(s):	Classwork
Week 7: Topic(s)	Bernoulli Equation and fluid flow along a Streamline
Chapter(s):	Chapter 5/Class notes
Assignment(s):	Classwork
Week 8: Topic(s)	Bernoulli Equation and fluid flow along a Streamline (continuation)
Chapter(s):	Chapter 5/Class notes
Assignment(s):	Classwork
Week 9: Topic(s)	The Momentum Equation
Chapter(s):	Chapter 6/Class Notes
Assignment(s):	TaskStream & Homework #2-Select Assigned Problems
Week 10: Topic(s)	Incompressible Flow in Pressure Conduits
Chapter(s):	Chapter 8/Class notes
Assignment(s):	Classwork
Week 11: Topic(s)	Incompressible Flow in Pressure Conduits (continuation)
Chapter(s):	Chapter 8/Class notes
Assignment(s):	Exam #2
Week 12: Topic(s)	Basics of Steady Uniform Flow in Open Channels
Chapter(s):	Chapter 10/Class notes
Assignment(s):	Classwork
Week 13: Topic(s)	Basics of Steady Uniform Flow in Open Channels (continuation)
Chapter(s):	Chapter 10/Class notes
Assignment(s):	Classwork
Week 14: Topic(s)	Hydraulic Machinery (Pumps) & Similitude and Dimensional Analysis
Chapter(s):	Chapter 15 & Chapter 7/Class notes
Assignment(s):	Homework #3-Select Assigned Problems
Week 15: Topic	Course Review
Chapter(s):	Course material
Assignment(s):	None
Week 16: Topic	Final Exam

Student Support and Success

John B. Coleman Library

The John B. Coleman Library's mission is to enhance the scholarly pursuit of knowledge, to foster intellectual curiosity, and to promote life-long learning and research through our innovative services, resources, and cultural programs, which support the Prairie View A&M University's global mission of teaching, service, and research. It maintains library collections and access both on campus, online, and through local agreements to further the educational goals of students and faculty. Website: <https://www.pvamu.edu/library/>; Phone: 936-261-1500

Academic Advising Services

Academic Advising Services offers students a variety of services that contributes to student success and leads towards graduation. We assist students with understanding university policies and procedures that affect academic progress. We support the early alert program to help students get connected to success early in the semester. We help refer students to the appropriate academic support services when they are unsure of the best resource for their needs. Faculty advisors support some students in their respective colleges. Your faculty advisor can be identified in PantherTracks. Advisors with Academic Advising Services are available to all students. We are located across campus. Find your advisor's location by academic major at www.pvamu.edu/advising. Phone: 936-261-5911

The University Tutoring Center

The University Tutoring Center (UTC) offers free tutoring and academic support to all registered PVAMU students. The mission of the UTC is to help provide a solid academic foundation that enables students to become confident, capable, independent learners. Competent and caring staff and peer tutors guide students in identifying, acquiring, and enhancing the knowledge, skills, and attitudes needed to reach their desired goals. Tutoring and academic support are offered face-to-face in the UTC, in virtual face-to-face sessions (<https://www.pvamu.edu/student-success/sass/university-tutoring-center/>), and through online sessions (<https://www.pvamu.edu/pvplace/>). Other support services available for students include Supplemental Instruction, Study Break, Academic Success Workshops, and Algebra Study Jam. Location: J. B. Coleman Library, Rm. 307; Phone: 936-261-1561; Email: pv tutoring@pvamu.edu; Website: <https://www.pvamu.edu/student-success/sass/university-tutoring-center/>

Writing Center

The Writing Center provides well-trained peer tutors to assist students with writing assignments at any stage of the writing process. Tutors help students with various writing tasks from understanding assignments, brainstorming, drafting, revising, editing, researching, and integrating sources. Students have free access to Grammarly online writing assistance. Grammarly is an automated proofreading and plagiarism detection tool. Students must register for Grammarly by using their student email address. In addition, students have access to face-to-face and virtual tutoring services either asynchronously via email or synchronously via Zoom. Location: J. B. Coleman Library, Rm. 209; Phone: 936-261-3724; Website: <https://www.pvamu.edu/student-success/writing-center/>; Grammarly Registration: <https://www.grammarly.com/enterprise/signup>

Academic Early Alert

Academic Early Alert is a proactive system of communication and collaboration between faculty, academic advisors, and PVAMU students that is designed to support student success by promptly identifying issues and allowing for intervention. Academic Early Alerts help students by providing a central location to schedule advising appointments, view advisor contact information, and request assistance. Students who recognize that they have a problem that is negatively affecting their academic performance or ability to continue school may self-refer an Academic Early Alert. To do so, students will log in to PV Place and click on Academic Early Alert on the left sidebar. Phone: 936-261-5902; Website: <https://www.pvamu.edu/student-success/early-alert/>

Student Counseling Services

The Student Counseling Services unit offers a range of services and programs to assist students in maximizing their potential for success: short-term individual, couples, and group counseling, as well as crisis intervention, outreach, consultation, and referral services. The staff is licensed by the State of Texas and assists students who are dealing with academic skills concerns, situational crises, adjustment problems, and emotional difficulties. Information shared with the staff is treated confidentially and in accordance with Texas State Law. Location: Hobart Taylor, 2nd floor; Phone: 936-261-3564; Website: <https://www.pvamu.edu/healthservices/student-counseling-services/>

Office of Testing Services

Testing Services serves to create opportunities by offering a suite of exams that aid in the students' academic and professional success. Currently, we administer entrance (HESI A2), college readiness (TSI assessment), Prior Learning (CLEP, DSST), and proctored exams. Location: Wilhelmina Delco, 3rd Floor, Rm. 305; Phone: 936-261-3627; Email: aetesting@pvamu.edu; Website: www.pvamu.edu/testing

Office of Diagnostic Testing and Disability Services

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, contact the Office of Disability Services. As a federally-mandated educational support unit, the Office of Disability Services serves as the repository for confidential disability files for faculty, staff, and students. For persons with a disability, the Office develops individualized ADA letters of request for accommodations. Other services include learning style inventories, awareness workshops, accessibility pathways, webinars, computer laboratory with adapted hard and software, adapted furniture, proctoring non-standardized test administrations, ASL interpreters, ALDs, digital recorders, Livescribe, and a comprehensive referral network across campus and the broader community. Location: Hobart Taylor, Rm. 1D128; Phone: 936-261-3583; Website: <https://www.pvamu.edu/disabilityservices/>

Center for Instructional Innovation and Technology Services (CIITS)

Distance Learning, also referred to as Distance Education, is the employment of alternative instructional delivery methods to extend programs and services to persons unable to attend college in the traditional manner. The Center for Instructional Innovation and Technology Services (CIITS) supports student learning through online, hybrid, web-assist, and 2-way video course delivery. For more details and contact information, visit: <https://www.pvamu.edu/dlearning/distance-learning-2-2/students-2/>; Phone: 936-261-3283

Veteran Affairs

Veterans Services works with student veterans, current military and military dependents to support their transition to the college environment and continued persistence to graduation. The Office coordinates and certifies benefits for both the G.I. Bill and the Texas Hazlewood Act. Location: Evans Hall, Rm. 102; Phone: 936-261-3563; Website: <https://www.pvamu.edu/sa/departments/veteranaffairs/>

Office for Student Engagement

The Office for Student Engagement delivers comprehensive programs and services designed to meet the co-curricular needs of students. The Office implements inclusive and accessible programs and services that enhance student development through exposure to and participation in diverse and relevant social, cultural, intellectual, recreational, community service, leadership development, and campus governance. Location: Memorial Student Center, Rm. 221; Phone: 936-261-1340; Website: <https://www.pvamu.edu/studentengagement/>

Career Services

Career Services supports students through professional development, career readiness, and placement and employment assistance. The Office provides one-on-one career coaching, interview preparation, resume and letter writing, and career exploration workshops and seminars. Services are provided for students at the Northwest Houston Center and College of Nursing in the Medical Center twice a month or on a requested basis. Distance Learning students are encouraged to visit the Career Services website for information regarding services provided. Location: Anderson Hall, 2nd floor; Phone: 936-261-3570; Website: <https://www.pvamu.edu/careerservices/>

University Rules and Procedures

Academic Misconduct

Academic dishonesty is defined as any form of cheating or dishonesty that has the effect or intent of interfering with any academic exercise or fair evaluation of a student's performance. The college faculty can provide additional information, particularly related to a specific course, laboratory, or assignment.

You are expected to practice academic honesty in every aspect of this course and all other courses. Make sure you are familiar with the *University Administrative Guidelines on Academic Integrity*, which can be found on the [Academic Integrity webpage](#). Students who engage in academic misconduct are subject to university disciplinary procedures.

As listed in the *University Administrative Guidelines on Academic Integrity*, the University Online Catalog, and the Student Code of Conduct, the following are examples of prohibited conduct. This list is not designed to be all-inclusive or exhaustive. In addition to academic sanctions, any student found to have committed academic misconduct that is also a violation of criminal law may also be subject to disciplinary review and action by the Office of Student Conduct (as outlined in the Student Code of Conduct).

Forms of Academic Dishonesty:

1. **Cheating**: Deception in which a student misrepresents that he/she has mastered information on an academic exercise that he/she has not learned, giving or receiving aid unauthorized by the instructor on assignments or examinations. Examples: unauthorized use of notes for a test; using a "cheat sheet" on a quiz or exam; any alteration made on a graded test or exam which is then resubmitted to the teacher;
2. **Plagiarism**: Careless or deliberate use of the work or the ideas of another; representation of another's work, words, ideas, or data as your own without permission or appropriate acknowledgment. Examples: copying another's paper or answers, failure to identify information or essays from the internet and submitting or representing it as your own; submitting an assignment which has been partially or wholly done by another and claiming it as yours; not properly acknowledging a source which has been summarized or paraphrased in your work; failure to acknowledge the use of another's words with quotation marks;
3. **Collusion**: When more than one student or person contributes to a piece of work that is submitted as the work of an individual;
4. **Conspiracy**: Agreeing with one or more persons to commit an act of academic/scholastic dishonesty; and
5. **Multiple Submission**: Submission of work from one course to satisfy a requirement in another course without explicit permission. Example: using a paper prepared and graded for credit in one course to fulfill a requirement and receive credit in a different course.

Nonacademic Misconduct

The university respects the rights of instructors to teach and students to learn. Maintenance of these rights requires campus conditions that do not impede their exercise. Campus behavior that interferes with either (1) the instructor's ability to conduct the class, (2) the inability of other students to profit from the instructional program, or (3) campus behavior that interferes with the rights of others will not be tolerated. An individual engaging in such disruptive behavior may be subject to disciplinary action. The Office of Student Conduct will adjudicate such incidents under nonacademic procedures.

Sexual Misconduct

Sexual harassment of students and employees at Prairie View A&M University is unacceptable and will not be tolerated. Any member of the university community violating the university's sexual harassment policy will be subject to disciplinary action. In accordance with the Texas A&M University System guidelines, your instructor is obligated to report to the Office of Title IX Compliance (titleixteam@pvamu.edu) any instance of sexual misconduct involving a student, which includes sexual assault, stalking, dating violence, domestic violence, and sexual harassment, about which the instructor becomes aware during this course through writing, discussion, or personal disclosure. The faculty and staff of PVAMU actively strive to provide a learning, working, and living environment that promotes respect that is free from sexual misconduct, discrimination, and all forms of violence. If students, faculty, or staff would like assistance or have questions, they may contact the Title IX Coordinator at 936-261-2144 or titleixteam@pvamu.edu. More information can be found at www.pvamu.edu/titleix, including confidential resources available on campus.

Pregnancy, Pregnancy-related, and Parenting Accommodations

Title IX of the Education Amendments of 1972 prohibits sex discrimination, which includes discrimination based on pregnancy, marital status, or parental status. Students seeking accommodations related to pregnancy, pregnancy-related conditions, or parenting (reasonably immediate postpartum period) are encouraged to contact Student Disability Services or the Dean of Students' Office for additional information and to request accommodations.

Non-Discrimination Statement

Prairie View A&M University does not discriminate on the basis of race, color, sex, religion, national origin, age, disability, genetic information, veteran status, sexual orientation, or gender identity in its programs and activities. The University is committed to supporting students and complying with The Texas A&M University System non-discrimination policy. It seeks to establish an environment that is free of bias, discrimination, and harassment. If you experience an incident of discrimination or harassment, we encourage you to report it. If you would like to speak with someone who may be able to afford you privacy or confidentiality, there are individuals who can meet with you. The Director of Equal Opportunity & Diversity has been designated to handle inquiries regarding the non-discrimination policies and can be reached at Harrington Science Building, Suite 109 or by phone at 936-261-1744 or 1792.

Class Attendance Policy (See the University Online Catalog for Full Attendance Policy)

Prairie View A&M University requires regular class attendance. Attending all classes supports the full academic development of each learner, whether classes are taught with the instructor physically present or via distance learning technologies such as interactive video and/or the internet. Excessive absenteeism, whether excused or unexcused, may result in a student's course grade being reduced or in the assignment of a grade of "F." Absences are accumulated beginning with the first day of class during regular semesters and summer terms. Each faculty member will include the University's attendance policy in each course syllabus.

Student Academic Appeals Process

Authority and responsibility for assigning grades to students rest with the faculty. However, in those instances where students believe that miscommunication, errors, or unfairness of any kind may have adversely affected the instructor's assessment of their academic performance, the student has a right to appeal by the procedure listed in the University Online Catalog and by doing so within thirty days of receiving the grade or experiencing any other problematic academic event that prompted the complaint.

Technical Considerations

Minimum Recommended Hardware and Software:

- Intel PC or Laptop with Windows 10 or later version; Mac with OS High Sierra*
- Smartphone or iPad/Tablet with Wi-Fi*
- High-speed Internet access
- 8 GB Memory
- Hard drive with 320 GB storage space
- 15" monitor, 800x600, color or 16 bit
- Sound card w/speakers
- Microphone and recording software
- Keyboard & mouse
- Most current version of Google Chrome, Safari, or Firefox

Note: Be sure to enable Java & pop-ups in the Web browser preferences

* Smartphones, Google Chrome books, and Android tablets may not be supported. iPads are the only tablets supported.

Participants should have a basic proficiency of the following computer skills:

- Sending and receiving email
- A working knowledge of the Internet
- Microsoft Word (or a program convertible to Word)
- Acrobat PDF Reader
- Windows or Mac OS
- Video conferencing software

Netiquette (online etiquette)

Students are expected to participate in all discussions and virtual classroom chats as directed. Students are to be respectful and courteous to others on discussion boards. Foul or abusive language will not be tolerated. Do not use ALL CAPS for communicating to others AS IT CAN BE INTERPRETED AS YELLING. Avoid slang terms such as "wassup?" and texting abbreviations such as "u" instead of "you." Limit and possibly avoid the use of emoticons. Be cautious when using humor or sarcasm as tone is sometimes lost in an email or discussion post, and the message

might be taken seriously or sound offensive.

Video Conferencing Etiquette

When using Zoom, WebEx, or other video conferencing tools, confirm the visible area is tidy, clear of background clutter, inappropriate or offensive posters, and other distractions. Ensure you dress appropriately and avoid using high traffic or noisy areas. Stay muted when you are not speaking and avoid eating/drinking during the session. Before the class session begins, test audio, video, and lighting to alleviate technology issues.

Technical Support

Students should go to <https://mypassword.pvamu.edu/> if they have password issues. The page will provide instructions for resetting passwords and contact information if login issues persist. For other technical questions regarding eCourses, call the Center for Instructional Innovation and Technology Services at 936-261-3283 or email ciits@pvamu.edu.

Communication Expectations and Standards

Emails or discussion postings will receive a response from the instructor, usually in less than 48 hours. Urgent emails should be marked as such. Check regularly for responses.

Discussion Requirement

Online courses often require minimal to no face-to-face meetings. However, conversations about the readings, lectures, materials, and other aspects of the course can occur in a seminar fashion. The use of the discussion board will accomplish this. The instructor will determine the exact use of discussion boards.

It is strongly suggested that students type their discussion postings in a word processing application such as Word and save it to their PC or a removable drive before posting to the discussion board. This is important for two reasons: 1) If for some reason your discussion responses are lost in your online course, you will have another copy; 2) Grammatical errors can be greatly minimized by the use of the spell-and-grammar check functions in word processing applications. Once the post(s) have been typed and corrected in the word processing application, copy and paste to the discussion board.

COVID-19 Campus Safety Measures

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, PVAMU has adopted policies and practices to limit virus transmission.

- **Self-monitoring** - Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.
- **Face Coverings** - Face coverings (cloth face covering, surgical mask, etc.) are recommended in classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource, and support offices, and outdoor spaces where 6 feet of physical distancing is challenging to maintain reliably.
- **Physical Distancing** - Physical distancing should be maintained between students, instructors, and others in course and course-related activities where possible.

Personal Illness and Quarantine - Students required to quarantine are to participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities. Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence. To receive an excused absence, students must provide appropriate documentation to the Office for Student Conduct, studentconduct@pvamu.edu.

End of Semester Course Assessment Report

This summary contains the following Information

1. Performance Statistics

- **Total number of students in class**
- **The class average performance (stated as %) in each course outcome assessed in this class and the two previous times course was assessed.**
- **The acceptable class average for the class in each outcome area as set by your Department.**
- **Percentage of students who scored below the expected average in each outcome.**

2. Implementation Summary

- **Brief summary of plans implemented during the semester based on last assessment report**

3. Perceived Problems

- **Instructor's critical evaluation of perceived problems that affected students' performance.**

4. New Plans for Addressing Problems

- **Instructor's plans for addressing the perceived problems the next time the class is taught.**

5. Overall Trend over last three assessment periods

- **Instructors summary of overall performance trend for each outcome measured over the last three periods.**

**ASSESSMENT RESULTS FOR CURRENT AND PAST THREE
ASSESSMENT PERIODS *[if available]***

Program Outcomes Assessed in this course

ABET Outcome 3	<i>An ability to communicate effectively with a range of audiences</i>
ABET Outcome 6	<i>An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions</i>

**Assessment Summary of Class Semester Averages for Outcomes:
Fall 2021**

Expected semester class average = 70%

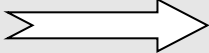
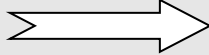
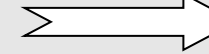
	ABET Outcomes	
	3	6
Semester	Class Average (%)	Class Average (%)
Fall 2021 <u>15 students*</u>	63	63
Fall 2020 <u>22 students*</u>	66	Data not available
Fall 2019 <u>19 students*</u>	72	Data not available
Comments on data	Data reported are for students completing the course for the assignments included in the assessment analysis. Comparative data for some of the earlier periods were not available. Therefore only two (2) earlier periods are reported in this table for <i>Outcome 3</i>. This is the first assessment of <i>Outcome 6</i> for this course.	

END OF SEMESTER COURSE OUTCOME ASSESSMENT REPORT

CVEG 3303 – Hydraulics - Fall 2021

Report Prepared by: Emmanuel U. Nzewi, *PhD, PE*

Report Date: December 23, 2021

Semester	Analysis Type	Number of Students	Outcome 3 Ability to communicate effectively with a range of audiences				Outcome 6 An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions			
			Expected Class Average	Expected Percent of students at or above average	Class Average	% Students meeting Expected Average	Expected Class Average	Expected Percent of students at or above average	Class Average	% Students meeting Expected Average
Fall 2021	Direct	15*	70	70	63	20	70	70	63	33
Fall 2020	Direct	22*	70	70	66	45	70	70	N/A	N/A
Fall 2019	Direct	19*	70	70	72	74	70	70	N/A	N/A
Implementation Summary	Items implemented from previous report or after meeting previous instructor 		The students were provided a very detailed but concise set of guidelines for developing lab reports. The guidelines were discussed in detail in class. Some students followed the guidelines closely and others (several) did not fully adhere to the guidelines. Ignoring the guidelines resulted in less than desirable results.				This is the first Outcome 6 assessment in this course.			
Perceived Problems	Perceived problems are directly related to the PC and the sub items under them 		The Instructor observed that students' abilities varied widely in this course. It appeared many students were not adequately prepared for the course. Although "Active Learning" practices were used to increase student engagement in the course to ensure key concepts were comprehended by students, the apparent deficiency was acute for some students. It is recommended that rigor in preceding courses be monitored. In addition, there appears to be a need to be more rigid with submission deadlines. Finally, an increase in the number of assignments should be explored.				This is the first assessment of Outcome 6 in the course. Students appeared to engage well during labs. However, due to lab groupings, some tended to depend on others to complete the lab experiments – resulting in below average reports. This is an area where closer lab monitoring could be practiced to ensure that each student is fully engaged during experiments. The lab is well-equipped and a variety of experimental setups are available to illustrate and reinforce fluid mechanics and hydraulics concepts.			
Plans for Addressing Problems	Plans for address specific measures to address PC and their sub areas 		The review of foundational Algebra, other mathematics concepts including graphing techniques were necessary and should be continued. Students' apparent weak math skills appeared to be an issue and attention to this area is necessary – especially in preceding math and foundational engineering courses.				It could be necessary to introduce a final lab exam in the course. This could minimize the dependence of students on others and should improve individual competency.			
Overall Trend over Periods	Ascertain if there were improvements over previous semesters		The trend appears to be toward lower average scores. This can be remedied by raising the bar in the preceding courses and planning ahead to improve student engagement from day one in the course.				Not applicable			
Were Expectations Met?			NO				NO			

**Grade Sheet Showing
Student and Class Performance in Outcomes**

Grade Sheet Showing Student & Class Performance in Course Outcomes
CVEG 3303 – Hydraulics - Fall 2021

ABET Outcome 3			ABET Outcome 6		
<i>An ability to communicate effectively with a range of audiences</i>			<i>An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions</i>		
	99.8			99.3	
	84.8			84.5	
	65.0			62.8	
	67.0				
	65.5			77.5	
	53.0			41.3	
	57.3			45.8	
	60.5			60.3	
				51.8	
	94.8			95.8	
	63.0			57.0	
	53.5			59.8	
	36.5			41.5	
	56.0			71.0	
	56.0			49.8	
	37.5			40.8	
Average = 63%			Average = 63%		
% Students > Expected AVG [70] = 20%			% Students > Expected AVG [70] = 45%		

**OUTCOME-SPECIFIC ASSIGNMENTS
USED TO ASSESS OUTCOME**

ASSIGNMENTS FOR ABET OUTCOME 3

An ability to communicate effectively with a range of audiences

DEPARTMENT OF

CIVIL & ENVIRONMENTAL ENGINEERING

OUTCOME SPECIFIC ASSIGNMENT

COVER SHEET

CVEG 3303
Hydraulics

Fall 2021

Instructor: Dr. Emmanuel U. Nzewi, PE

Title of Assignment

- 1) Lab 01- Hydrostatic Forces on Submerged Surfaces
- 2) Lab 03 – Graphical Data Analysis

Outcome Measured Using this Assignment

ABET Outcome 3

An ability to communicate effectively with a range of audiences

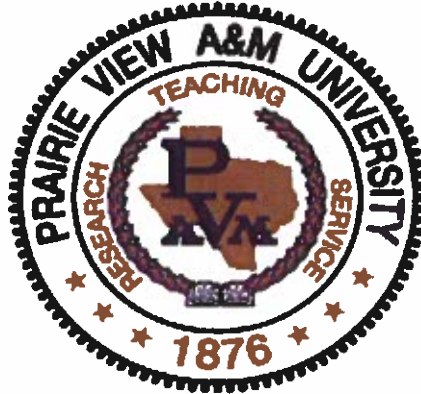
**Brief Description of the suitability of this assignment for the
outcome**

Lab 01 – Lab Report on hydrostatic forces on submerged surfaces (lab reporting/report writing)
Lab 03 – Graphical Data Analysis for presenting data in visual form.

Lab 01 -
Hydrostatic
Forces on
Submerged
surfaces

ABOVE
AVERAGE

Prairie View A&M University
Roy G. Perry College of Engineering
Civil & Environmental Engineering Department



995

CVEG 3303 P81 – Hydraulics Laboratory
Fall 2021

Laboratory #1

Hydrostatic Forces on Submerged Surfaces

Date: Thursday, October 15th, 2021 - 2:00 PM

Group Members (Group #1)

Maalvika A.	Student 1
Austin B.	Student 2
Maurice B.	Student 3
Amani F.	Student 4

Submitted to: Dr. Emmanuel U. Nzewi

Submitted by: Maalvika Aggarwal, Student 1

Date Submitted: Thursday, October 28th, 2021

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TITLE:

Laboratory Number 01- Hydrostatic Forces on Submerged Surfaces

OBJECTIVE:

The objective is to determine the depth to the center of pressure, H with the help of a hydrostatic pressure system, for both a partial and a complete immersion. Then, compare the theoretical and experimental values of depth to the center of pressure for both partially and fully submerged surfaces. Also, graphs will be plotted to get the slope and intercept.

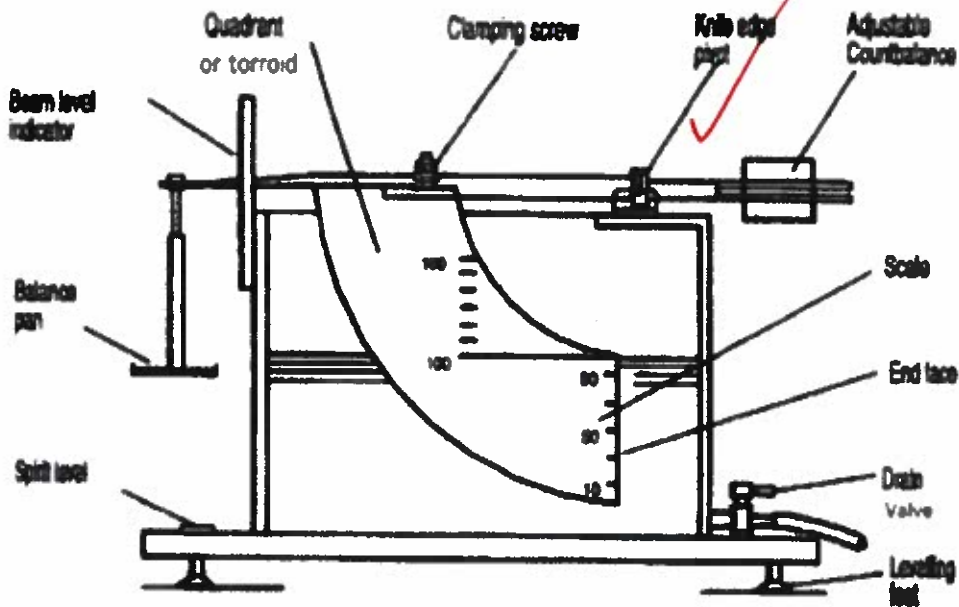
*confirm equation for
depth to
center of
pressure*

INTRODUCTION TO THE THEORY:

I. Hydrostatic pressure:

The pressure exerted by a fluid at equilibrium at a given point within the fluid, due to the force of gravity. Hydrostatic pressure increases in proportion to depth measured from the surface because of the increasing weight of fluid exerting downward force from above.

Figure 1: Hydrostatic Pressure Apparatus



II. Equations for Partially Submerged Surface:

Depth to center of pressure = H

a= Toroid diameter, b= Toroid width, d= Toroid height, m= mass added, y= depth reading, ρ = density, and L= Balance arm.

$$H_{\text{experimental}} = a + d - \frac{y}{3}$$

$$H_{\text{theoretical}} = \frac{2mL}{\rho b y^2}$$

$$\frac{m}{y^2} = \frac{\rho b}{2L} \left(a + d - \frac{y}{3} \right)$$

When the $\frac{m}{y^2}$ is plotted against the y,

Slope: $-\frac{\rho b}{6L}$

Intercept: $\frac{\rho b(a+d)}{2L}$ ✓

III. Equations for Fully Submerged Surface:

Depth to center of pressure = H

a= Toroid diameter, b= Toroid width, d= Toroid height, m= mass added, y= depth reading, ρ = density, and L= Balance arm.

$$\bar{y} = y - \frac{d}{2}$$

$$H_{\text{experimental}} = a + \frac{d}{2} - \frac{d^2}{12\bar{y}}$$

$$H_{\text{theoretical}} = \frac{mL}{\rho b d (y - \frac{d}{2})}$$

$$\frac{m}{y^2} = \frac{\rho b d}{L} \left(a + \frac{d}{2} - \frac{d^2}{12\bar{y}} \right)$$

When the $\frac{m}{y}$ is plotted against the $\frac{1}{y}$,

Slope: $\frac{\rho b d^3}{12L}$

Intercept: $\frac{\rho b d}{L} \left(a + \frac{d}{2} \right)$

EQUIPMENT AND ANALYSIS TOOLS:

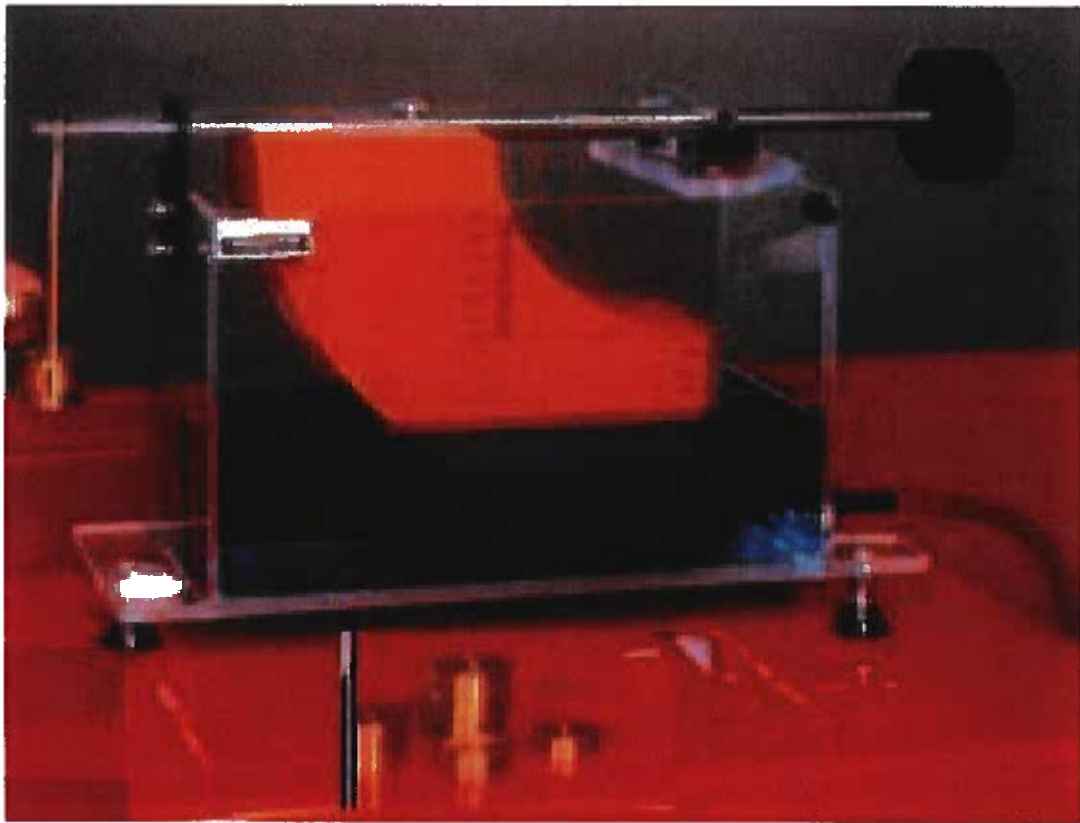
- Hydrostatic pressure apparatus.
- Water.

DESCRIPTION OF PROCEDURE:

1. Record the given dimensions Toroid diameter (a), Toroid width (b), Toroid height (d), and Balance arm (L).
2. Adjust the screwed mass on the adjustable counterbalance to the level the balance arm. Also, if possible, balance the bubble on the surface of apparatus such that it is in the center. Refer to figure 3 for the set-up of apparatus.
3. Pour the water into the tank to raise the water level in steps requiring in the addition of 50-g approximately to the balance pan.

4. At each step, level the balance arm by slowly admitting water into the tank and then slowly draining some of the water, as needed, until the system is balanced. ✓
5. Use the scale reading on the side of the toroid to measure the level of water in the tank, y (mm).
6. Take at least 6 readings of water level for when the surface is partially submerged in water and another 6 reading after the surface is fully submerged in water.

Figure 3: Set-up of the Hydrostatic pressure system



DATA AND TEST RESULTS:

Geometric measurements of the apparatus for Partially/Fully Submerged surface:

- Toroid diameter, $a = 0.100$ m
- Toroid width, $b = 0.075$ m
- Toroid height, $d = 0.100$ m
- Balance arm, $L = 0.275$ m
- Density, $\rho = 1000$ kg/m³

Table 1: Partially Submerged Surface Data:

Added Mass (m) (g)	Added Mass (m) (Kg)	Depth reading (y) (mm)	Depth reading (y) (m)
50	0.05	48	0.048
80	0.08	59	0.059
100	0.1	66	0.066
150	0.15	82	0.082
200	0.2	96	0.096
250	0.25	108	0.108

Table 2: Fully Submerged Surface Data:

Added Mass (m) (g)	Added Mass (m) (Kg)	Depth reading (y) (mm)	Depth reading (y) (m)
300	0.3	116	0.116
350	0.35	129	0.129
380	0.38	135	0.135
400	0.4	140	0.14
420	0.42	146	0.146
450	0.45	157	0.157

REPORT PRESENTATION:

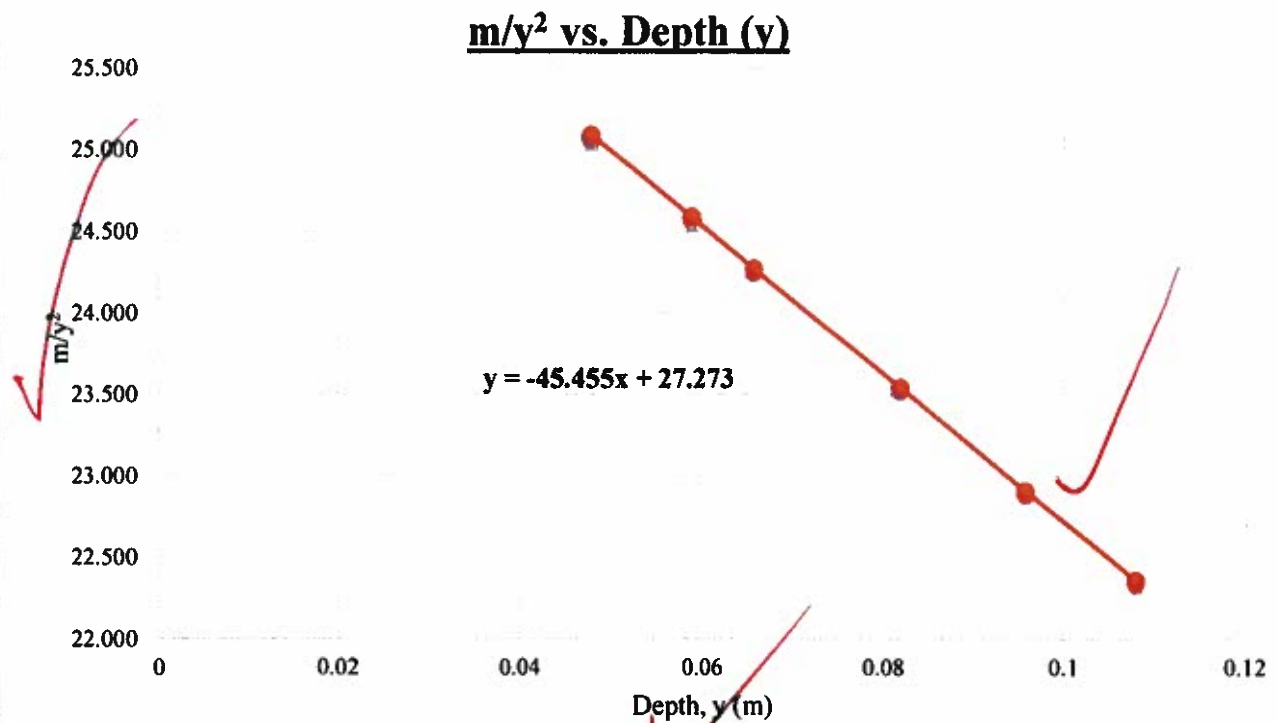
Calculations:

Next page

Table 3: Partially Submerged Surface Calculations:

Added Mass (m) (Kg)	Depth reading (y) (m)	$\frac{m}{y^2}$	Depth to center of pressure, H (m) (Experimental)	Depth to center of pressure, H (m) (Theoretical)	Percent Error (%)
0.05	0.048	25.091	0.184	0.159	15.619
0.08	0.059	24.591	0.180	0.169	7.001
0.1	0.066	24.273	0.178	0.168	5.732
0.15	0.082	23.545	0.173	0.164	5.546
0.2	0.096	22.909	0.168	0.159	5.565
0.25	0.108	22.364	0.164	0.157	4.340

Graph 1: m/y^2 vs. y (depth):



* SAMPLE CALCULATIONS FOR PARTIALLY SUBMERGED SURFACE

$$a = 0.100 \text{ m}, b = 0.075 \text{ m}, d = 0.100 \text{ m}, L = 0.275 \text{ m}$$

$$\rho = 1000 \text{ kg/m}^3$$

$$\frac{m}{y^2} = \frac{\rho b}{2L} \left(a + d - \frac{y}{3} \right)$$

For mass of 0.5 kg and $y = 0.048 \text{ m}$:-

$$\begin{aligned} \frac{m}{y^2} &= \frac{(1000)(0.075)}{2(0.275)} \left(0.100 + 0.100 - \frac{0.048}{3} \right) \\ &= 136.364 (0.184) \\ &= \boxed{25.091} \end{aligned}$$

$$\begin{aligned} \text{Center of pressure, } H_{\text{experimental}} &= a + d - \frac{y}{3} \\ &= 0.100 + 0.100 - \frac{0.048}{3} = \boxed{0.184 \text{ m}} \end{aligned}$$

$$H_{\text{theoretical}} = \frac{2mL}{\rho b y^2} = \frac{2 \times 0.05 \times 0.275}{1000 \times 0.075 \times 0.048^2} = \boxed{0.159 \text{ m}}$$

$$\begin{aligned} \text{Percent error} &= \left| \left(\frac{H_{\text{theo}} - H_{\text{exp}}}{H_{\text{exp}}} \right) \right| 100 = \left| \left(\frac{0.159 - 0.184}{0.159} \right) \right| 100 \\ &= \boxed{15.619 \%} \end{aligned}$$

$$\text{Slope of graph} = \frac{-\rho b}{6L} = \frac{-1000(0.075)}{6(0.275)} = -45.455$$

$$\text{Intercept} = \frac{\rho b(a+d)}{2L} = \frac{1000(0.075)(0.200)}{2(0.275)} = 27.273$$

Therefore, the equation of graph :-

$$\boxed{-45.455x + 27.273}$$

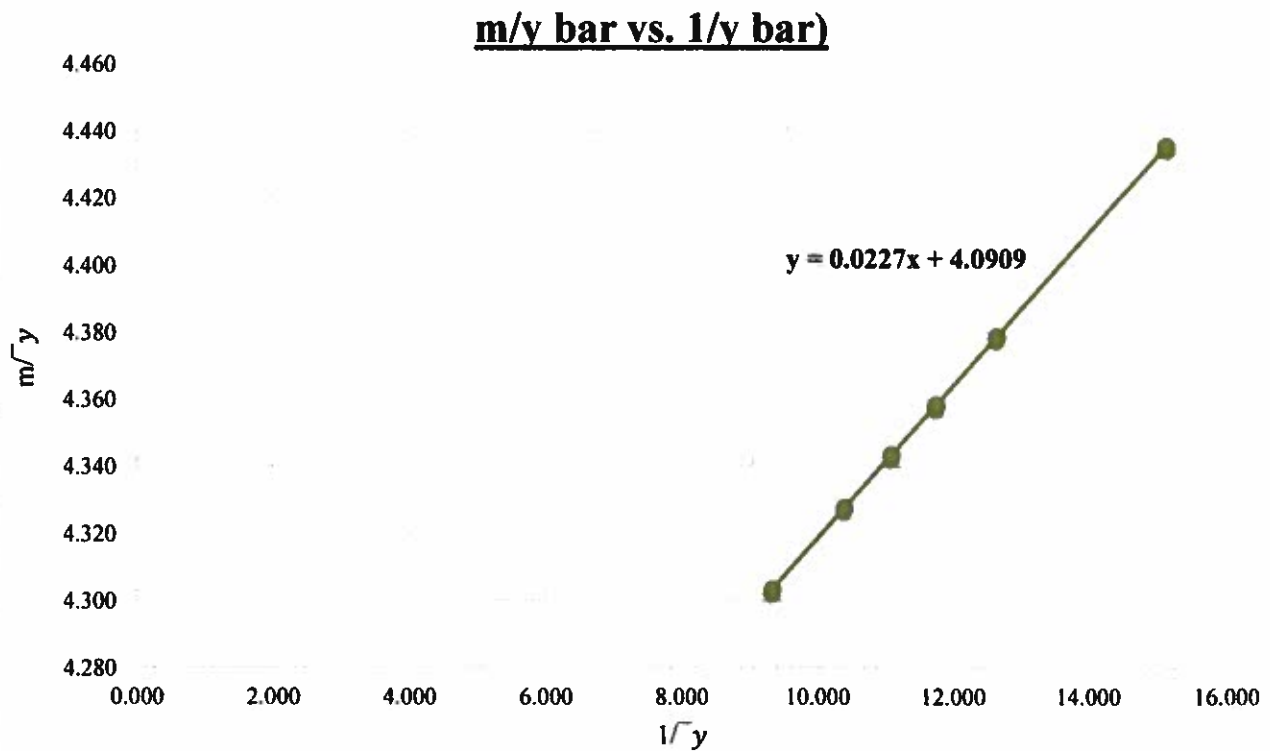
* THESE CALCULATIONS WERE REPEATED FOR ALL READINGS *

Table 4: Fully Submerged Surface Calculations:



Added Mass (m) (Kg)	Depth reading (y) (m)	$\bar{y}$ $y - \frac{d}{2}$	$\frac{m}{\bar{y}}$	$\frac{1}{\bar{y}}$	Depth to center of pressure, H (m) (Experimental)	Depth to center of pressure, H (m) (Theoretical)	Percent Error (%)
0.3	0.116	0.066	4.435	15.152	0.163	0.167	2.424
0.35	0.129	0.079	4.379	12.658	0.161	0.162	1.169
0.38	0.135	0.085	4.358	11.765	0.160	0.164	2.512
0.4	0.14	0.090	4.343	11.111	0.159	0.163	2.273
0.42	0.146	0.096	4.328	10.417	0.159	0.160	1.082
0.45	0.157	0.107	4.303	9.346	0.158	0.154	2.323

Graph 2: m/y bar vs. $1/y$ bar:



SAMPLE CALCULATIONS FOR FULLY SUBMERGED SURFACE:

$$a = 0.100 \text{ m}, b = 0.075 \text{ m}, d = 0.100 \text{ m}, L = 0.275 \text{ m}$$

$$\rho = 1000 \text{ kg/m}^3$$

For mass added 0.3 kg and depth reading, $y = 0.116$,

$$\bar{y} = y - \frac{d}{2} = 0.116 - \frac{0.100}{2} = \boxed{0.066}$$

$$\frac{m}{\bar{y}} = \frac{\rho b d (a + \frac{d}{2} + \frac{d^2}{12\bar{y}})}{L} = \frac{(1000)(0.075)(0.100)}{0.275} \left(0.100 + \frac{0.100}{2} + \frac{0.100^2}{12(0.066)} \right)$$

$$= (27.27)(0.163) = \boxed{4.435}$$

$$\frac{1}{\bar{y}} = \frac{1}{0.066} = \boxed{15.152}$$

$$H_{\text{experimental}} = a + \frac{d}{2} + \frac{d^2}{12\bar{y}} = (0.100) + \frac{(0.100)}{2} + \frac{(0.100)^2}{12(0.066)}$$

$$= \boxed{0.163}$$

$$H_{\text{theoretical}} = \frac{mL}{\rho b d (y - d/2)} = \frac{(0.3)(0.275)}{1000(0.075)(0.100)(0.116 - \frac{0.100}{2})}$$

$$= \boxed{0.167}$$

$$\% \text{ error} = \left(\frac{H_{\text{theo}} - H_{\text{exp}}}{H_{\text{theo}}} \right) 100 = \frac{0.167 - 0.163}{0.167} (100)$$

$$= \boxed{2.424\%}$$

$$\text{Slope} = \frac{\rho b d^3}{12L} = \frac{1000(0.075)(0.100)^3}{12(0.275)} = \boxed{0.0227}$$

$$\text{Intercept} = \frac{\rho b d (a + \frac{d}{2})}{L} = \frac{1000(0.075)(0.100)}{0.275} \left(0.100 + \frac{0.100}{2} \right)$$

$$= \boxed{4.091}$$

$$\text{So, equation: } \boxed{0.0227x + 4.0909}$$

* THESE CALCULATIONS WERE REPEATED FOR ALL DATA READINGS *

SOURCES OF ERROR:

There can be many sources of error that could have contributed to the percentage of error in the experiment. For the partially submerged surface, there was a maximum percentage error of 15.6%, while for fully submerged surface, there was a maximum percent error of just 2.5%.

One of the errors could be the misinterpretation of data readings. This is because, the reading must be accurate, and the observer's eyes must be perpendicular to the scale to ensure the readings are precise. Also, another sources of error could be the balance arm as it got a little bent, halfway through the experiment as its screw was a little loose. The professor fixed the balance arm with a screwdriver and the experiment was continued. In the end, it was also important to ensure that the while pouring, the water goes does not touch the quadrant as it might affect the balance arm.

pouring

CONCLUSION:

This experiment was conducted successfully to find the H (depth to the center of pressure). It was performed using a hydrostatic pressure system. The mass added and the water depth readings were recorded and analyzed to further perform calculations for depth to center of pressure and slope and intercept of the graphs.

For the partially submerged surface, it can be seen that the values of H theoretical and experimental are quite similar. The maximum percentage of error between them is 15.6%. Since the error is within the acceptable parameters, this tells us that the experiment was somewhat successful. The graph for m/y^2 vs y behaved in a negative linear fashion when plotted. It had a slope of -45.45 and intercept of 27.27.

Similarly, for the fully submerged surface, the values of H theoretical and experimental had an exceedingly small percent error. The maximum percent error between them was 2.5%. The graph plotted of m/y bar against the $1/y$ bar behaved in a positive linear fashion. It had a slope of 0.0227 and an intercept of 4.0909.

Generally, hydrostatic pressure is also used in our day to day lives. It helps to study and observe the properties of fluids when they are present in the state of equilibrium. It is the pressure exerted by the molecules of the fluid due to the force of gravitation existing within themselves or between the molecules and the walls of the container. For example, the pressure exerted by the blood on the walls of the blood vessels is a typical example of hydrostatic force in everyday life. Fluid static force is also accountable to drive fluids out of the capillaries for the purpose of filtration. Other than that, Overall, this experiment was successful, and it strengthened the knowledge of hydrostatic pressure.

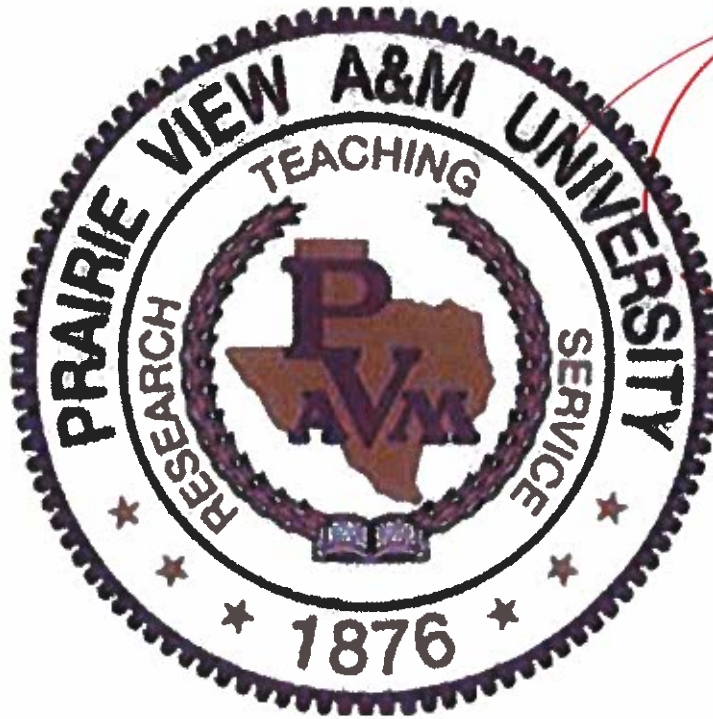
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Sharma, Chitra. “Hydrostatic Force Examples in Daily Life.” Studious Guy, Studious Guy, 21 May 2021, <https://studiousguy.com/hydrostatic-force-examples/>.

AVERAGE



CVEG 3303 P81
Hydraulics Lab
Fall 2021

Laboratory 01 Hydrostatic Forces on Submerged Surfaces

Lab Date: October 21, 2021

Submitted To: Dr. Emmanuel Nzewi

Submitted by: Hunter Rodgers

Date Submitted: November 1, 2021

Group 4 Members

Hunter Rodgers

Trinity Scott

Allyssa Reynolds

Darrell Patterson

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Objective

The objective of this laboratory exercise was to determine the Hydrostatic force on an object while it was partially submerged and ~~fully~~ submerged.

*not quite
To confirm the
equation*

Introduction

Fluids can be liquids or gasses. A fluid is a substance that cannot resist shear stress. Therefore, a fluid will deform under shear stress. Hydrostatic Pressure is the pressure that any fluid exerts in a confined space. All fluids exert hydrostatic pressure. Pressure is scalar at a point in a fluid; it is the same value in all directions.

Procedure

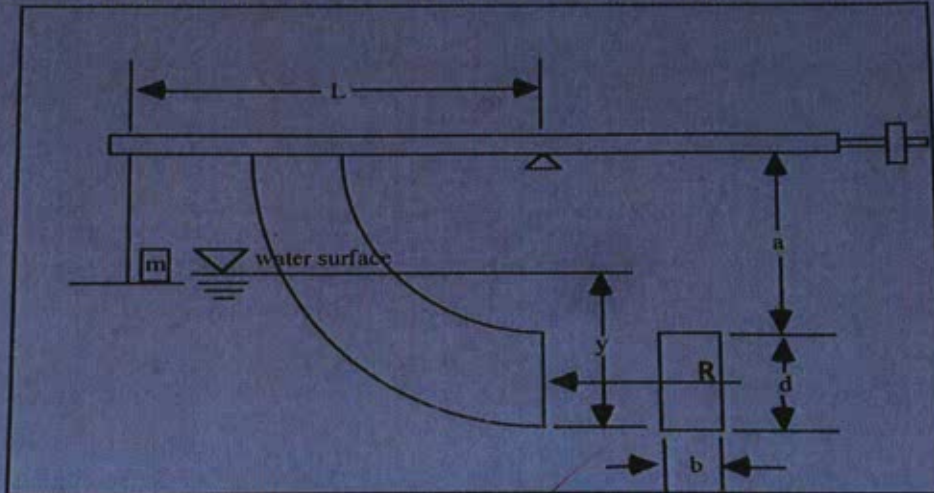
- Record the given dimensions a , b , d , and L .
- Adjust the screwed mass on the adjustable counterbalance to level the balance arm.
- Pour water into the tank to raise the water level in steps (requiring the addition of 50 grams approximately) to balance the pan.
- At each step level the balance on by slowly admitting water into the tank and then slowly draining some of the water (as necessary) until the system is balanced
- Use the scale reading on the side of the toroid to measure the level of water in the tank, $y[\text{mm}]$.
- Take at least six readings of mass and water level

*Refer to the
Diagram*

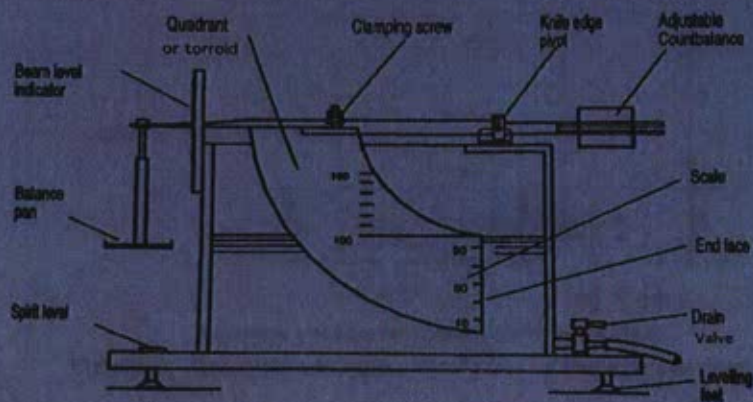
Equipment

Hydrostatic Pressure Apparatus

$L = 0.275 \text{ m}$; $a = 0.100 \text{ m}$; $d = 0.100 \text{ m}$; $b = 0.075 \text{ m}$; density = ~~9810~~ ¹⁰⁰⁰ kg/m^3



Hydrostatic Pressure Apparatus



Data presentation

Partially Submerged Readings

Added Mass (g)	Depth Reading
50	41
90	62
130	75
170	87
210	98
200	95

units!

??

Fully Submerged Readings

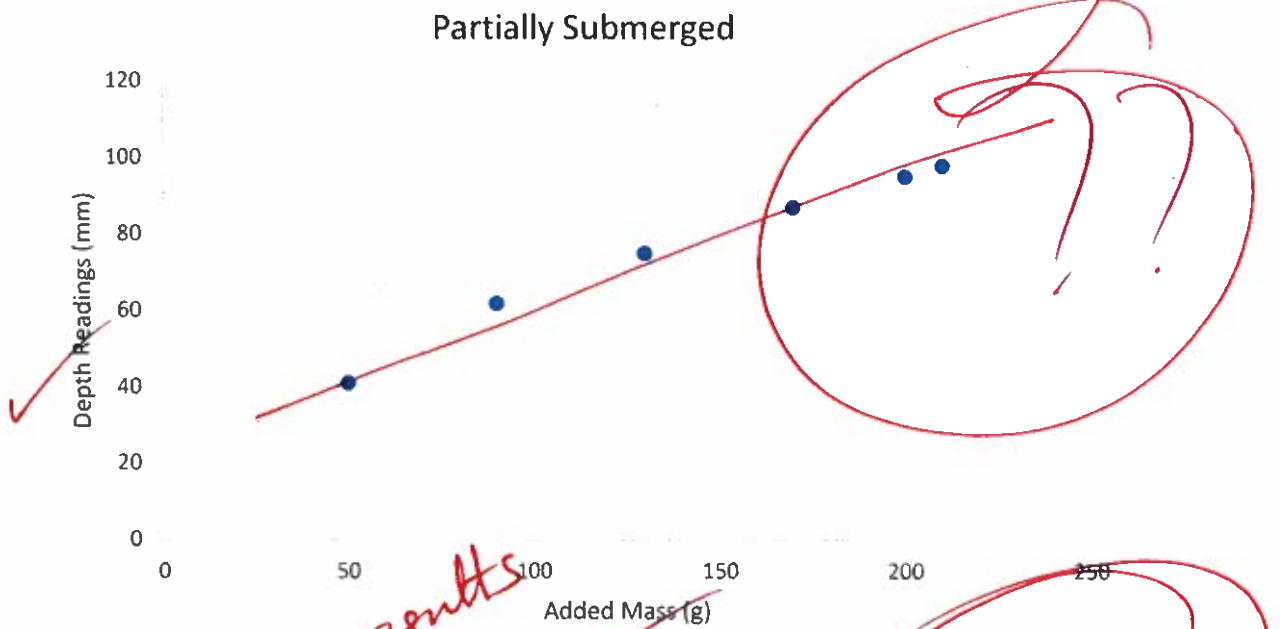
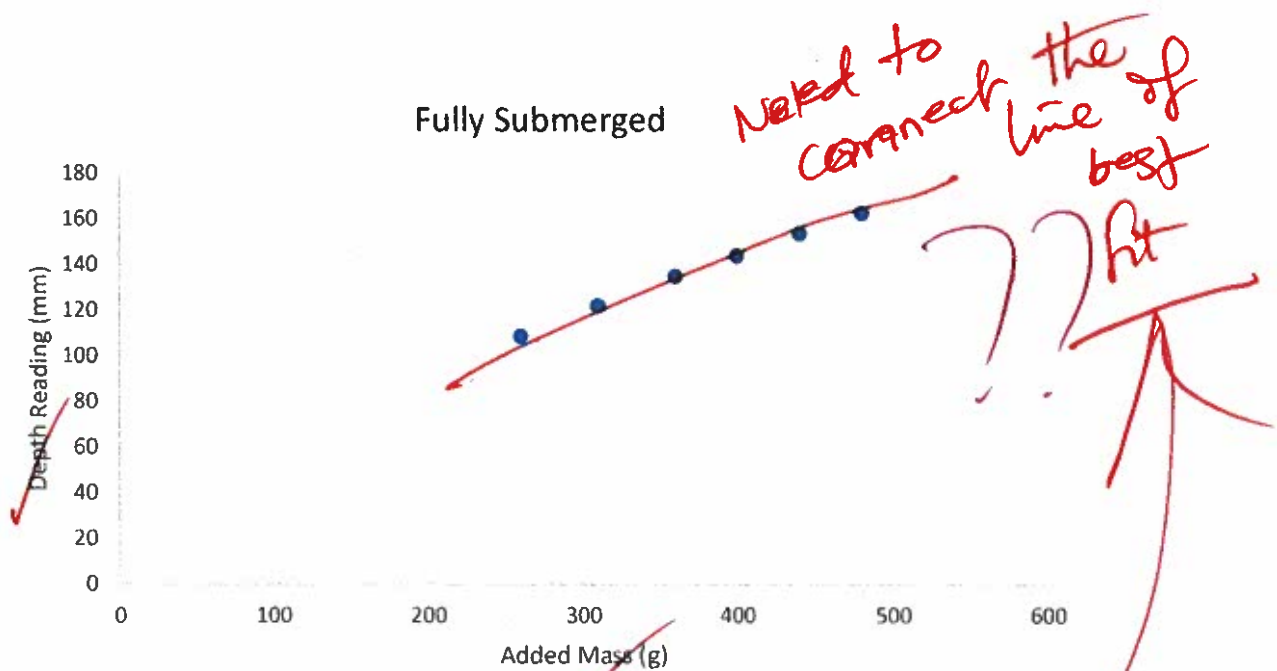
Added Mass (g)	Depth Reading
260	109
310	122
360	135
400	144
440	154
480	163

Tables Not Complete

units

-30

Report presentation



describe results
in discussion

-50

Sources of error

A source of error for this lab could have been false data reading. While looking at the measurement on the side of the tank, the meniscus makes it difficult to accurately see the scale reading on the side of the toroid. The beam level indicator is another source of error. There is a possibility that the beam was not leveled completely in the middle which could affect our data.

Friction effects

more

-25

Conclusion

The objective of the lab was achieved. Using the data collected as shown on pg 5, we were able to ~~determine the hydrostatic force on the object while it was partially submerged and fully submerged.~~

more

-25

Not really. The equation was confirmed/not confirmed

References

- In class Handout

?? Not proper reference

-25

Assignments?

-100

-260

BELOW
AVERAGE

Prairie View A&M University



CVEG 3303 Hydraulics

Lab Assignment #1:

Hydrostatic forces on submerged surfaces

Due: November 1, 2021

Submitted By: Erik Smith

Submitted to: Dr. Emanuel Nzwei

620
520
Canvas Online L

ONLINE ONLY
NO HARD COPY

Dated of expt.?

Group?
Group members
use report
format
provided

20

Page Numbers?

Objectives

The objective was to figure out the effects of water on an object and how much weight it would take to balance the object in partial water submersion. The second objective was to figure out how much weight and water would it take to become balanced in full submersion.

Not really

the Bernoulli Equation is being investigated

Introduction

A water barometer is a device that uses water to measure barometric pressure. The device uses the force of gravity, combined with pressure in the air, to create a vacuum, which in turn gives a reading that indicates the barometric pressure changes that are taking place in a specific area.

Abstract:

For this laboratory experiment we were tasked to follow the laboratory procedures to analyze the hydrostatic forces on submerged surfaces. The idea of submersion is when a solid substance is partially or completely covered by a fluid. A liquid is as gas or liquid that as a substance that cannot resist shear stress, which means it will continue to deform when placed under shear stress.

tasked

This related to this laboratory experiment because all fluids exert hydrostatic pressure and that is what we are tasked to measure and analyze. This pressure is calculated by Pressure is a scalar at a point in a fluid, it is the same value in all directions.

Introduction of theory:

Hanging caption

Next Page

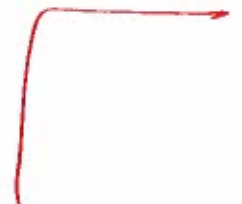
- For a partially submerged surface:
 - o $A = b \cdot y$
 - o $\bar{y} = y/2$
 - o Specific weight $\Rightarrow \gamma = \rho \cdot g$
 - o Force on the rectangular surface of the torroid:
 - $R = (1/2) \cdot g \cdot \rho \cdot b \cdot y^2$
 - $Y(p) - \bar{Y} = 12 / b \cdot y^2 = y/6$
 - o The moment of R about the knife-edge axis is given by:
 - $M = g \cdot m \cdot L$
 - $mL = (1/2) \rho \cdot b \cdot y^2 (a + d - (y/3))$
- For completely submerged substances:
 - o Force on the torroid:
 - $R = g \cdot \rho \cdot \bar{y} \cdot b \cdot d$
 - o $Y(p) - \bar{Y} = (b \cdot d^3 / 12) / (b \cdot d^2 / 2) = (d^2 / 12 \cdot \bar{y})$
 - o $mL = \rho \cdot \bar{Y} \cdot b \cdot d (a + (d/2) + (d^2 / 12 \bar{y}))$

Definitions And Significance:

No Need

- **Fluid:**
 - o The definition when it comes to engineering is; a substance that continually deforms under an applied shear stress regardless if the magnitude of the applied stress.
- **Shear stress:**

Page?



- Force that causes deformation of a material by slippage along a plane or planes parallel to the imposed stress.

- **Hydrostatic pressure:**

- The distributed force a liquid in equilibrium exerts on surfaces that are in direct contact with said fluid.

- **Atmospheric pressure:**

- The pressure above any area in the earth's atmosphere caused by the weight of air.

- **Barometric pressure:**

- Measurement of the weight exerted by air molecules in the atmosphere at a given point.

Not necessary

Materials and Methods:

- **Hydrostatic pressure apparatus:**

- Beam level indicator
- Balance pan
- Spirit level
- Drain valve
- End face
- Adjustable counterbalance
- Knife edge pivot

provide a diagram

page

30

- Clamping screw
- Pitcher of water
 - Used to regulate the amount of water in the apparatus

Procedures:

- Record given dimensions a, b, d, and L.
- Adjust the screwed mass on the adjustable counter balance to level the balance arm.
- Pour water into the tank to raise the water level in steps, to balance pan.
- At each step, level the balance arm by slowly admitting water into the tank and then slowly draining some of the water until the system is balanced.
- Use the scale reading on the side of the toroid to measure the level of water in the tank, y [mm]
- Take at least six readings- of mass and water level.

Results & Analysis:

A. Partial Submersion:

- $L = 0.275 \text{ m}$
- $a = 0.100 \text{ m}$
- $d = 0.100 \text{ m}$
- $b = 0.075 \text{ m}$
- $\rho = 9810 \text{ kg/m}^3$
- Slope of graph is: $-\frac{\rho \cdot b}{6L} \rightarrow y = mx + b$

Page

$$\blacksquare y = -\frac{(9810)(0.075)}{6(0.275)} = -445.90$$

$$- \frac{m}{y^3} = \frac{\rho \cdot b}{2 \cdot L} \left(a + d - \frac{y}{3} \right)$$

○ Value for equation above:

$$\blacksquare 148.833$$

meaning?

B. Complete Submersion:

- Type equation here.

incomplete

Sources of error?
Discussion of results

102

References:

Should be last!

- [https://en.wikiversity.org/wiki/Fluid Mechanics for Mechanical Engineers/Introduction](https://en.wikiversity.org/wiki/Fluid_Mechanics_for_Mechanical_Engineers/Introduction)
- <https://www.britannica.com/science/shear-stress>
- <http://adaptivemap.ma.psu.edu/websites/fluidstatics/hydrostaticpressure.html>
- <https://www.setra.com/blog/what-is-barometric-pressure>

Please learn how to organize and arrange your work

Your Report should be arranged as presented in the Report Guidelines for the Course

- 36

Appendix:

- Raw data:

Partial submersion

Added Mass g	Depth reading mm
5000g	41 mm
9000g	59 mm
130000g	72 mm
170000	84 mm
210000	94 mm
Fully	Submerged
250000 g	104 mm
300000 g	117 mm
350000g	128 mm
400000 g	140 mm
450000g	153 mm

- Partially submerged = $(m/(y)^2)$

o $5000/(41)^2 = 2.97442$

$9000/(59)^2 = 2.585464$

$130000/(72)^2 = 25.07716$

$170000/(84)^2 = 24.09297$

$210000/(94)^2 = 23.76641$

Discuss

- **Fully submerged:**

o $250000/(104)^2 = 23.114$

$300000/(117)^2 = 21.91541$

$350000/(128)^2 = 21.3623$

$400000/(140)^2 = 20.40816$

$450000/(153)^2 = 19.22338$

*This Project does not have
Sufficient Information*

*Your Report is largely
incomplete*

Assignments

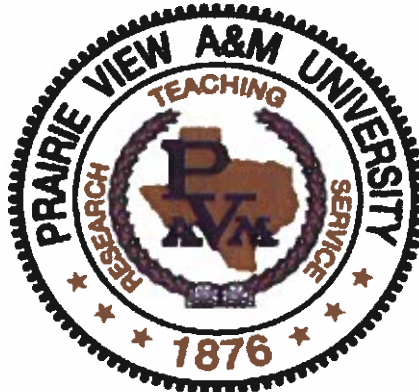
- 200

Lab 03

Graphical Data Analysis

ABOVE
AVERAGE

Prairie View A&M University
Roy G. Perry College of Engineering
Civil & Environmental Engineering Department



1000
H

CVEG 3303 P81 – Hydraulics Laboratory
Fall 2021

Laboratory #3
Graphical Analysis

Date: Thursday, October 28th, 2021 - 2:00 PM

Group Members (Group #1)

Maalvika A.	Student1
Austin B.	Student2
Maurice B.	Student3
Amani F.	Student4



Submitted to: Dr. Emmanuel U. Nzewi
Submitted by: Maalvika Aggarwal, Student1
Date Submitted: Wednesday, November 10th, 2021

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TITLE:

Laboratory Number 03- Graphical Analysis.

OBJECTIVE:

The objective of this experiment is to develop the ability to collect, analyze, interpret, and communicate the data results of an experimental exercise using linear, semi-log, and log-log graphs. The purpose is to review some essential graphical techniques by plotting and analyzing data.

INTRODUCTION TO THE THEORY:

I. Rules of Graph Construction:

- Each graph should have a descriptive title and each axis should be labelled with units specified.
- Data points must be clearly indicated with a legend, if more than one series of data are plotted together.
- Data points should always be connected with a smooth line.
- Unless otherwise stated, curve should be assumed to be fitted by least-squares method.
- Always try to have a (0,0) origin on graph, if practical.

EQUATIONS FOR GRAPHS:

Linear Function:

This is the expression for a straight line in rectangular (x, y) coordinates. The data will plot as a straight line.

$$y = a + bx$$

$$\text{Where, } b = \text{slope} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\text{And } a = \text{intercept} = y_1 - bx_1 = y_2 - bx_2$$

- Exponential Function:

An exponential relationship will not plot as straight line. To linearize this function, logarithms are taken on both sides.

$$y = ab^x$$

$$\text{Where, } B = \frac{\log y_2 - \log y_1}{x_2 - x_1}, \quad b = \log^{-1} B$$

$$\text{And } A = \log y_1 - \log_{b^{x_1}} = \log y_2 - \log_{b^{x_2}},$$

$$a = \frac{y_1}{b^{x_1}} = \frac{y_2}{b^{x_2}}$$

- Power Function:

This relationship plots as a curve on Linear graph. Log-Log graph is used to obtain a straight line.

$$y = ax^b$$

$$\text{Where, } b = \frac{\log y_2 - \log y_1}{\log x_2 - \log x_1}$$

$$\text{And } A = \log \frac{y_1}{x_1^b}, \quad a = \frac{y_1}{x_1^b}$$

DESCRIPTION OF PROCEDURE:

1. Plot the data set assigned to you, according to your student Code.

2. On a single sheet of linear graph paper, plot the rainfall data for Cypress, TX assigned to you for each return period, Time 0-120 minutes and Time >120 minutes (or > 2 hrs.)

Clearly distinguish between the data sets.

3. Plot Cypress, TX for return period of time 0-120 minutes on semi-log paper.
4. Plot Cypress, TX for return period of time over 120 minutes on log-log paper.
5. Find the equation represented by each of the graphs plotted.
6. Then, plot data and show all work for data set #1, 2, and 3 A.

DATA AND TEST RESULTS:

- Student data code= 198

Table 1: Data Set #1 A:

v (ft/sec)	Q (cfs)
0.98	5.00
1.98	7.00
3.00	9.00
4.05	11.00
5.00	13.00
6.04	15.10
7.01	16.90
8.00	19.00
9.20	21.50

Table 2: Data Set #2 A:

h (ft/)	Q (cfs)
0.25	1.66
0.50	1.84
0.75	2.03
1.00	2.25
1.25	2.49
1.50	2.76
1.75	3.05
2.00	3.37
2.25	3.74

Table 3: Data Set #3 A:

R (ft)	V (ft/sec)
1.04	1.50
2.00	2.12
3.00	2.59
4.10	3.00
4.00	3.35
6.00	3.67
7.03	3.96
8.00	4.24
9.00	4.50

Table 4: Rainfall Intensity-Duration-Frequency Data for Cypress, TX for time 0-120 minutes:

Time (hr)	Time (min)	Rainfall Intensity (mm/hr.) (Return Period= 50 years)
0.083	5	226.06
0.167	10	185.42
0.250	15	157.48
0.333	20	139.70
0.500	30	114.30
0.667	40	97.79
0.833	50	86.36
1.00	60	76.20
2.000	120	45.72

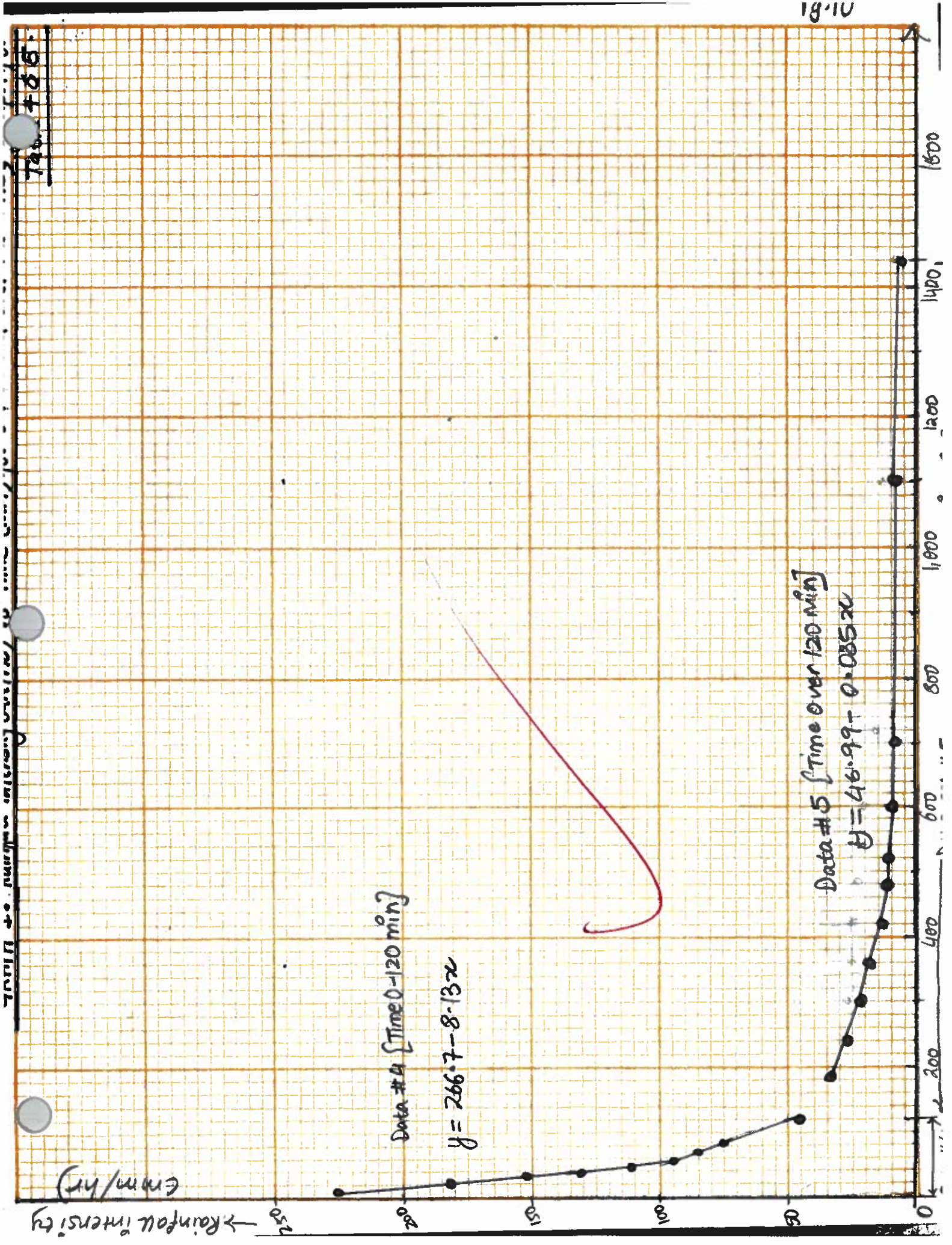
Table 5: Rainfall Intensity-Duration-Frequency Data for Cypress, TX for time over 120 minutes:

Time (hr)	Time (min)	Rainfall Intensity (mm/hr.) (Return Period= 50 years)
3.000	180	31.75
4.000	240	26.67
5.000	300	22.86
6.000	360	20.32
7.000	420	18.29
8.000	480	16.76
9.000	540	15.49

10.000	600	14.48
12.000	720	12.45
18.000	1080	9.14
24.000	1440	7.11

REPORT PRESENTATION:

Next Page



19-10

748 + 88

Calculations for Graph 1.

1) Rainfall Intensity (mm/hr) vs. Time (min); for 0-120 min

$$x_1 = 5 \quad x_2 = 10$$
$$y_1 = 226.06 \quad y_2 = 185.42$$

$$b = \frac{y_2 - y_1}{x_2 - x_1} = \frac{185.42 - 226.06}{10 - 5} = \frac{-40.64}{5}$$

$$b = -8.13$$

$$a = y_1 - bx_1 = 226.06 - (-8.13)(5)$$

$$a = 266.7$$

Therefore, equation:

$$y = 266.7 - 8.13x$$

2) Rainfall Intensity (mm/hr) vs. Time (min); for over 120 mins.

$$x_1 = 180 \quad x_2 = 240$$
$$y_1 = 31.75 \quad y_2 = 26.67$$

$$b = \frac{y_2 - y_1}{x_2 - x_1} = \frac{26.67 - 31.75}{240 - 180} = \frac{-5.08}{60}$$

$$b = -0.085$$

$$a = y_1 - bx_1 = 31.75 - (-0.085)(180)$$

$$a = 46.99$$

Therefore, equation:

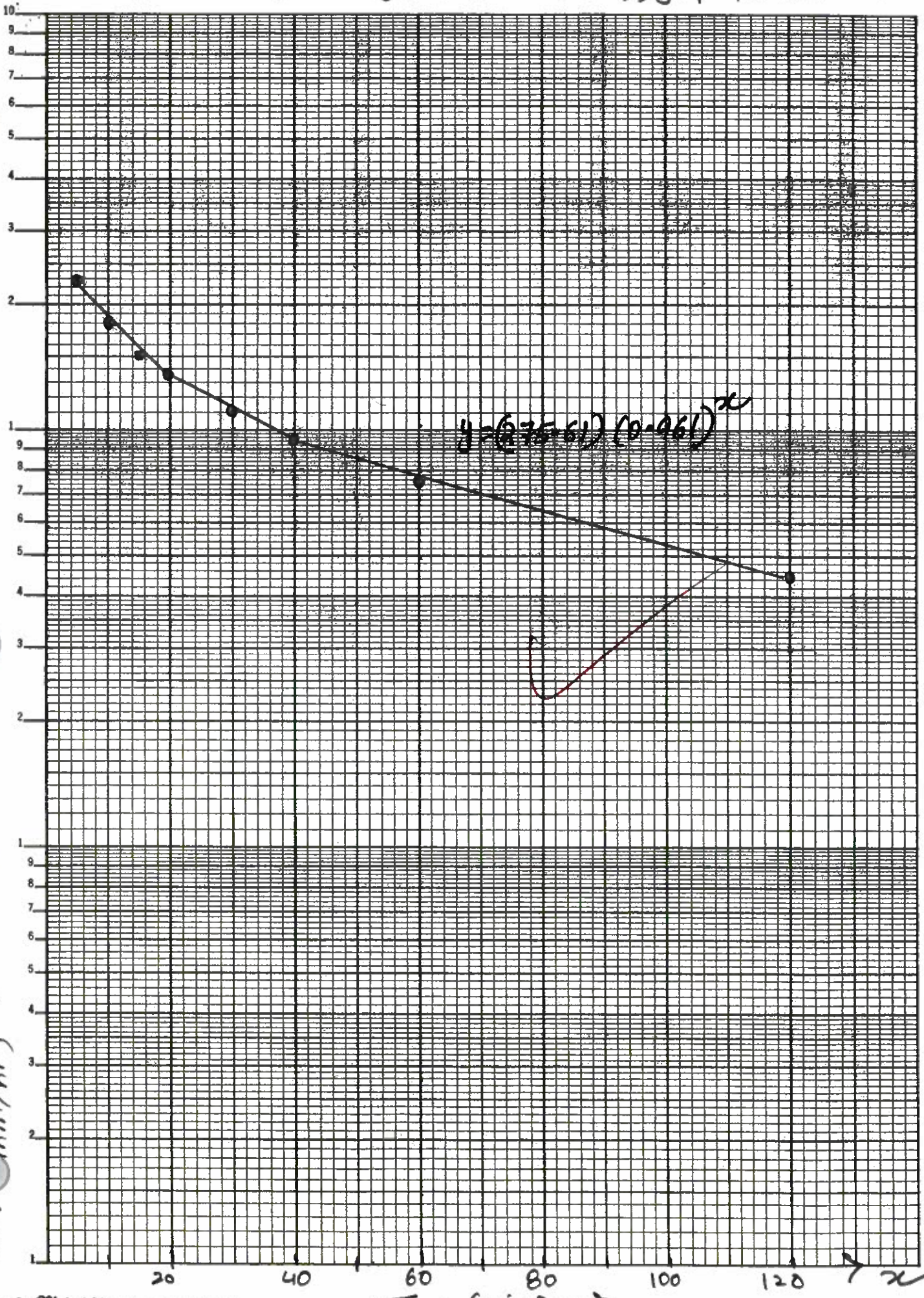
$$y = 46.99 - 0.085x$$

QK41412: Rainfall intensity (mm/hr) vs. time (min); graph for Table 4:

y

KEE SEMI-LOGARITHMIC 40 5492 3 CYCLES X 70 DIVISIONS MADE IN U.S.A. KEUFFEL & ESSER CO.

Rainfall intensity (mm/hr)



40 5492

Calculations for Graph 2 (Rainfall intensity vs. Time mm/hr min)

$$x_1 = 5 \quad x_2 = 10$$

$$y_1 = 226.06 \quad y_2 = 185.42$$

$$B = \frac{\log y_2 - \log y_1}{x_2 - x_1} = \frac{\log 185.42 - \log 226.06}{10 - 5}$$

$$B = \frac{-0.086}{5} = -0.017$$

$$b = \log^{-1} B = 10^{-0.017}$$

$$b = 0.961$$

$$a = \frac{y_1}{b^{x_1}} = \frac{226.06}{0.961^5}$$

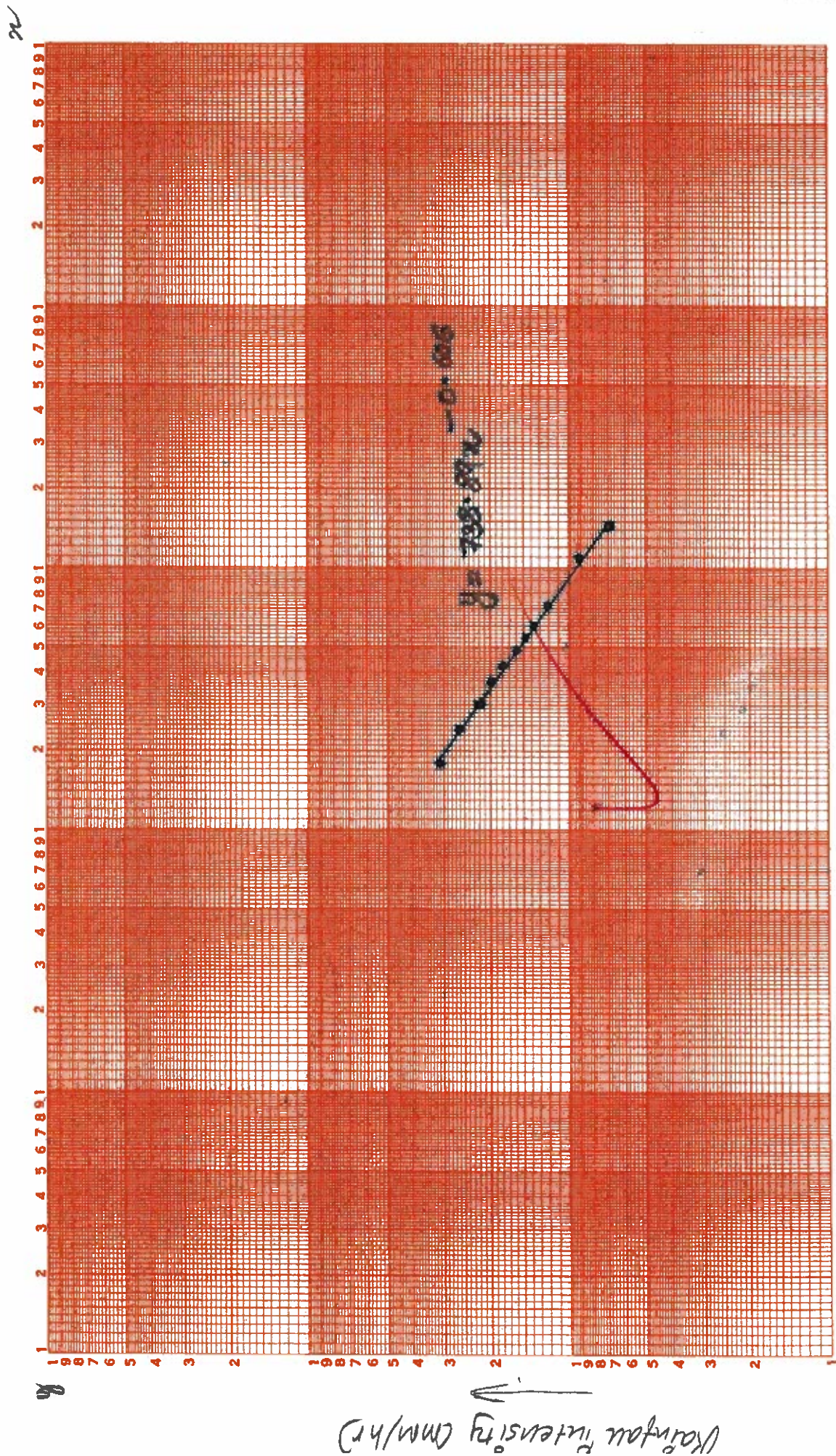
$$a = 275.61$$

Equation of graph $\Rightarrow y = ab^x$

Hence,

$$y = (275.61)(0.961)^x$$

Graph 3: Rainfall intensity (mm/hr) vs. Time (min); graph for Table 5:



→ Time (min)

Rainfall Intensity (mm/hr)

Calculations for Graph 3 [Rainfall Intensity vs. Time
mm/hr min]

$$x_1 = 180 \quad x_2 = 240$$

$$y_1 = 31.75 \quad y_2 = 26.67$$

$$b = \frac{\log y_2 - \log y_1}{\log x_2 - \log x_1} = \frac{\log 26.67 - \log 31.75}{\log 240 - \log 180}$$

$$b = \frac{-0.075}{0.125} = -0.606$$

$$a = \frac{y_1}{x_1^b} = \frac{31.75}{180^{-0.606}}$$

$$a = 738.89$$

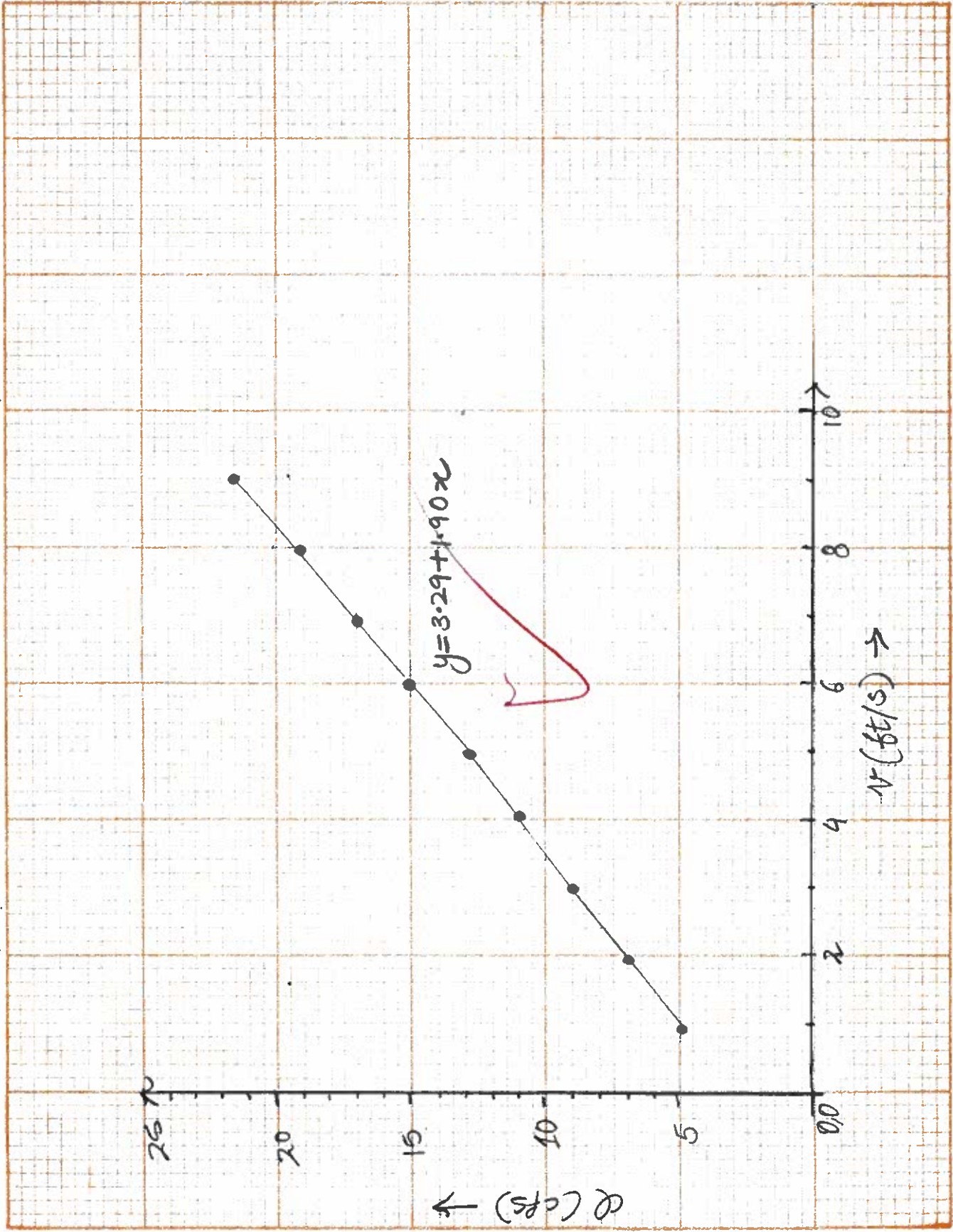
Equation of graph: $y = ax^b$

Hence,

$$y = 738.89 x^{-0.606}$$

FORM E
APPROVED FOR USE IN
PURDUE UNIVERSITY

GRAPH 4: Q (cfs) vs. V (ft/s); Graph for data in Table 1:



Calculations for Graph 4 (Q(cfs) vs. V(ft/s))

$$x_1 = 3.00 \quad x_2 = 4.05$$

$$y_1 = 9.00 \quad y_2 = 11.00$$

$$\text{slope} = b = \frac{y_2 - y_1}{x_2 - x_1} = \frac{11.00 - 9.00}{4.05 - 3.00}$$
$$= \underline{1.90}$$

$$\text{Intercept} = a = y_1 - bx_1 = 9 - (1.90)(3)$$
$$= 9 - 5.71$$
$$= \underline{3.29}$$

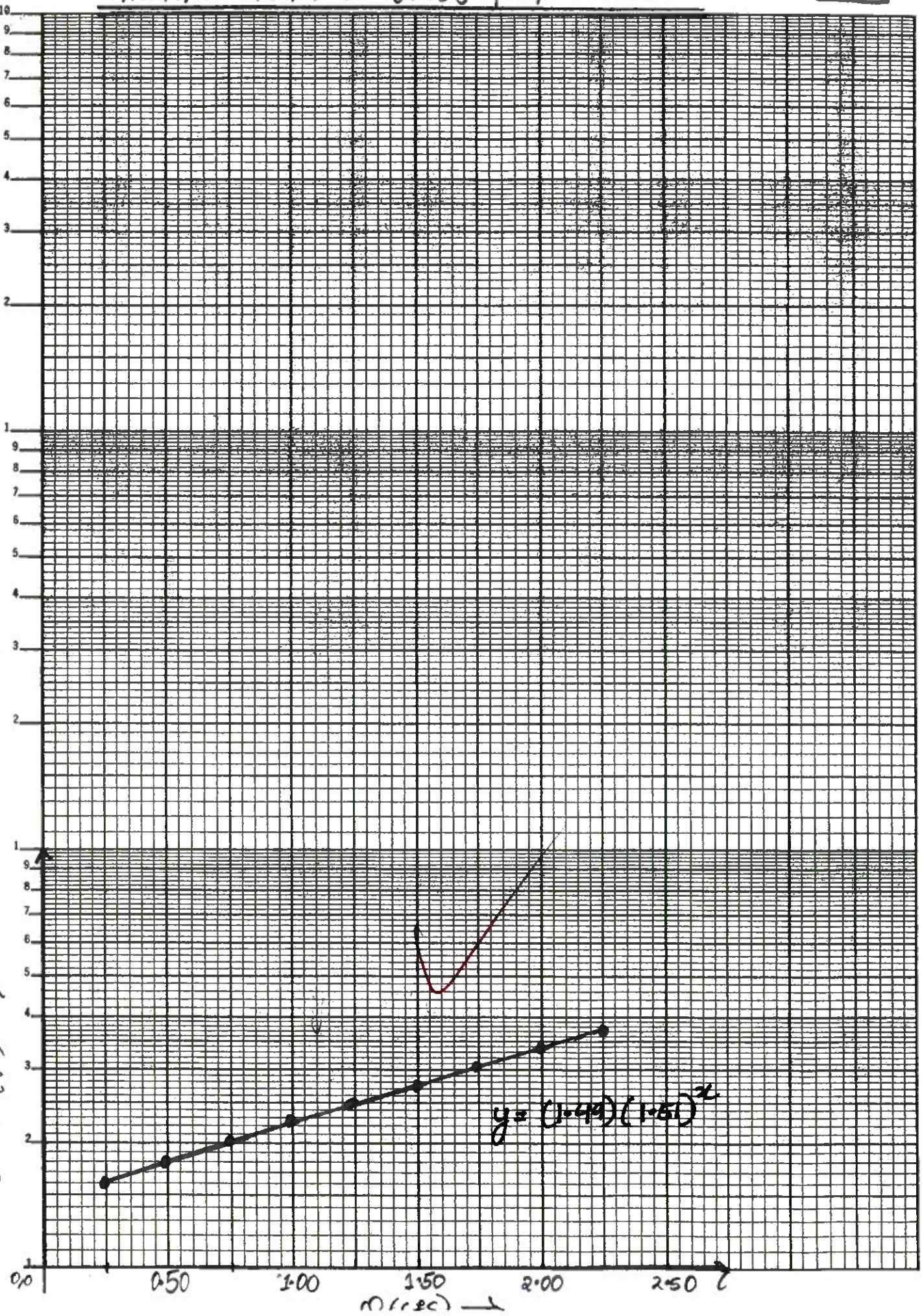
Equation of the $\Rightarrow y = a + bx$
graph

Hence, equation :-

$$y = 3.29 + 1.90x$$

K&E SEMI-LOGARITHMIC 46 5492
3 CYCLES X 70 DIVISIONS
MADE IN U.S.A.
KEUFFEL & ESSER CO.

h (ft) →



Calculations for Graph 5 ($Q(cfs)$ vs. $h(ft)$)

$$x_1 = 0.25$$

$$x_2 = 0.5$$

$$y_1 = 1.66$$

$$y_2 = 1.84$$

$$B = \frac{\log y_2 - \log y_1}{x_2 - x_1} = \frac{\log 1.84 - \log 1.66}{0.5 - 0.25}$$

$$B = \frac{0.04}{0.25} = 0.18$$

$$b = \log^{-1} B$$

$$b = 10^{0.18}$$

$$b = \underline{1.51}$$

$$A = \log y_1 - \log b^{x_1}$$

$$A = \log 1.66 - \log 1.51^{0.25}$$

$$A = 0.18$$

$$a = \frac{y_1}{b^{x_1}} = \frac{1.66}{1.51^{0.25}} = \underline{1.49}$$

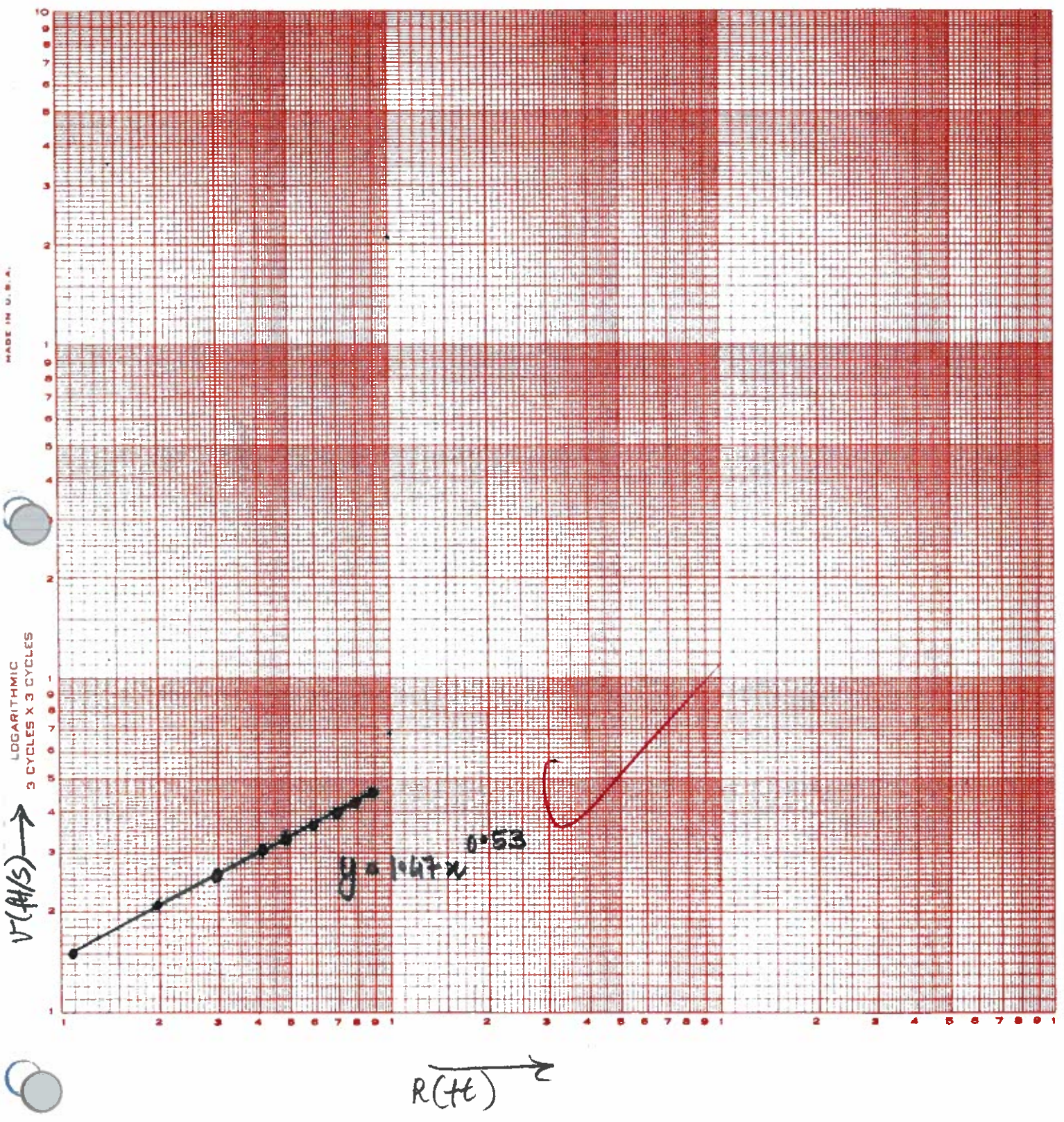
Equation of graph $\frac{1}{2}$ $y = ab^x$

Hence, equation is :

$$y = (1.49)(1.51)^x$$

EVERETT 100...

GRAPH 6: $V(\text{ft/s})$ vs. $R(\text{ft})$; graph for Table 3:



Calculations for graph 6 [v(ft/s) vs. R(ft)]

$$x_1 = 1.04 \quad x_2 = 2.00$$

$$y_1 = 1.50 \quad y_2 = 2.12$$

$$b = \frac{\log y_2 - \log y_1}{\log x_2 - \log x_1} = \frac{\log 2.12 - \log 1.50}{\log 2.00 - \log 1.04}$$

$$b = \frac{0.15}{0.28} = \underline{0.53}$$

$$A = \log\left(\frac{y_1}{x_1^b}\right) = \log\left(\frac{1.50}{1.04^{0.53}}\right)$$

$$A = 0.17$$

$$a = \frac{y_1}{x_1^b} = \frac{1.50}{1.04^{0.53}}$$

$$a = \underline{1.47}$$

Equation of graph = $y = ax^b$

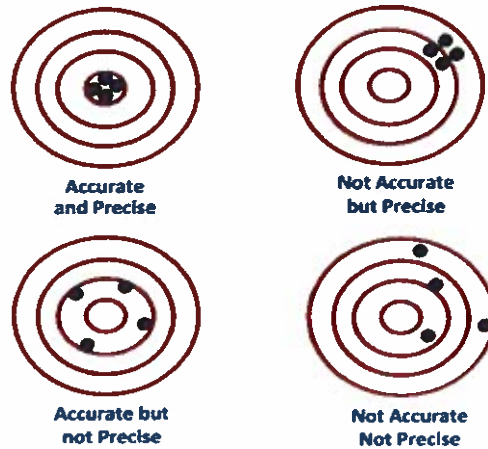
Hence, equation is

$$y = 1.47x^{0.53}$$

KEY TERMS:

1. **Least count:** The least count of a measuring instrument is the smallest change in the measured quantity that can be resolved on the instrument's scale. The least count is related to the precision of an instrument; an instrument that can measure smaller changes in a value relative to another instrument, has a smaller "least count" value and so is more precise. For example, a stopwatch used to time a race might resolve down to a hundredth of a second, its least count.
2. **Precision:** Precision refers to the closeness of two or more measurements to each other. Precision is sometimes referred to as repeatability or reproducibility. A measurement which is highly reproducible tends to give values which are close to each other. Precision is independent of accuracy. You can be very precise but inaccurate, as described above. You can also be accurate but imprecise.
3. **Accuracy:** Accuracy refers to the closeness of a measured value to a standard or known value. Since a true or accepted value for a physical quantity may be unknown, it is sometimes not possible to determine the accuracy of a measurement.

Figure 1: Accuracy vs. Precision



4. **Human or personal errors:** Human error is an unintentional action or decision. These are somethings that have been done which were not intended and not desired by a set of rules, or that led the task or system outside its acceptable limits. There are three types of human error: slips, lapses, and mistakes. These types of human error can happen to even the most experienced and well-trained person.
5. **Systematic errors:** Systematic errors are errors that affect the accuracy of a measurement. Systematic errors are one-sided errors, because, in the absence of other types of errors, repeated measurements yield results that differ from the true or accepted value by the same amount. Systematic errors in experimental observations usually come from the measuring instruments. They may occur because there is something wrong with the instrument or its data handling system, or because the instrument is wrongly used by the experimenter. For example, parallax error.

6. **Random errors:** Random errors are errors that affect the precision of a measurement.

They are two-sided errors, because, in the absence of other types of errors, repeated measurements yield results that fluctuate above and below the true or accepted value.

Random errors in experimental measurements are caused by unknown and unpredictable changes in the experiment. These changes may occur in the measuring instruments or in the environmental conditions. For example, the electronic noise in the circuit of an electrical instrument.

SOURCES OF ERROR:

- **How could errors be minimized during an experiment?**

No physical quantity can be measured with perfect certainty. There are always errors in any measurement. So, errors certainly cannot be avoided. However, they can be minimized by taking greater care in our measurements and applying ever more refined experimental methods, thereby, gaining greater confidence that our measurements approximate ever more closely the true value.

Some other steps that can be taken in order to reduce or minimize errors are use of quality equipment, using an updated and precise measuring device that doesn't have any defects while conducting your experiment, and calibrating the equipment properly to avoid inaccurate results.

All measurements in an experiment should occur under controlled conditions to prevent systematic error as changes in external conditions such as humidity, pressure, and temperature can all skew data. Also, to reduce the impact of human error, double-check all observations, recordings, and measurements.

- Errors in this experiment:

There can be many sources that can contribute to the errors while plotting and interpreting of graphs. One error could be the misinterpretation of location of data points. One must eyeball a certain data point accurately and precisely to get the exact location of the data points, however, it is sometimes not possible. There is some uncertainty in the data points. Another error can be using an inconsistent scale across the data represented. This can also effect the accuracy of graph and/or can make the graph cluttered. Other than that, there can be human errors while plotting data points, error while doing calculations, or error while forming equation of the graphs.

CONCLUSION:

In this experiment, we successfully used linear, semi-log, and log-log graphical techniques to plot and analyze different data sets. We calculated the graph equations from the given standard equations for each function. Overall, this experiment was successful as all the graphs were successfully plotted and equations were calculated. Moreover, we went over some key definitions and a thorough discussion over sources of errors to understand how to minimize errors in the future labs and grasp the concept better. Overall, it further strengthened the concepts of graphical analysis discussed in the lecture.

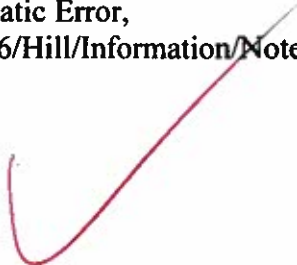
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Carlson, © G.A. Experimental Errors and Uncertainty. 2002,
<http://www2.ece.rochester.edu/courses/erroruncertainty.pdf>.

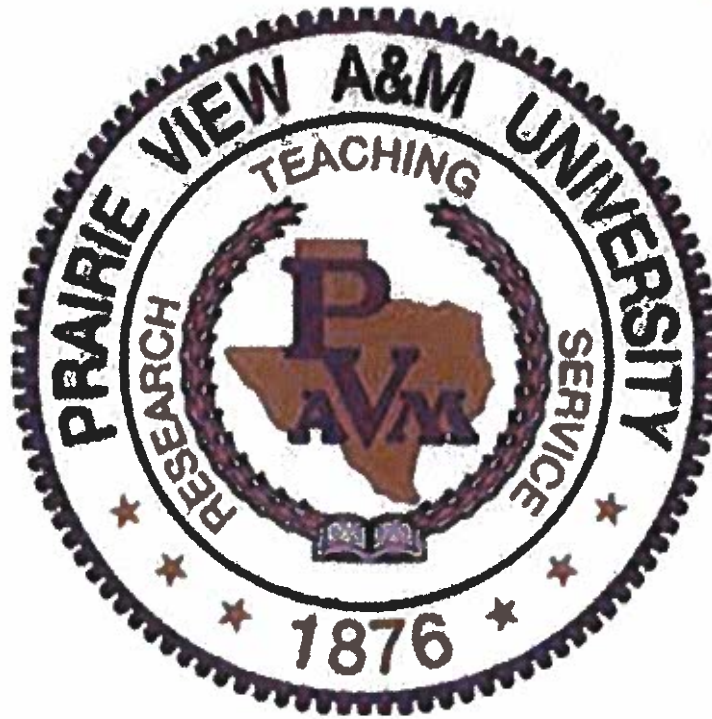
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<https://www.hse.gov.uk/construction/lwit/assets/downloads/human-failure.pdf>.

"Random vs Systematic Error." Random vs. Systematic Error,
<https://www.physics.umd.edu/courses/Phys276/Hill/Information/Notes/ErrorAnalysis.html>.



AVERAGE



610

M

CVEG 3303 P81

Hydraulics Lab

Fall 2021

Laboratory 03 Graphical Analysis of Data

Lab Date: October 21, 2021

Submitted To: Dr. Emmanuel Nzewi

Submitted by: Hunter Rodgers

Date Submitted: November 11, 2021

Group
Group members?

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Data presentation	4-5
Report presentation	6-10
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Objective

The objective of this lab was to develop the ability to ~~correct analyze interpret and clearly~~ communicate the data results of an experiment exercise using graphs. Graphs can facilitate the interpretation and communication of experimental data. The other objective of this lab was to review some essential graphical techniques by plotting / analyzing data which are examples of the types of data students might encounter in completed and or future labs.

Introduction

For this lab we will use empirical formulas to analyze the experimental data collected about the rainfall in Cypress, Texas. The three types of empirical formulas are the Linear Function, Exponential Function, and the Power Function. The Linear function is an expression for a straight line in rectangular coordinates. The Linear Function equations is defined as $y = a+bx$. The Exponential Function will not plot as a straight line on linear paper. We want to linearize the function in order to use graphical techniques to determine the expression, we will take the logarithms of both sides. The data will plot as a straight line on a Semi - Log plot. The Exponential Function equation is defined as $y = ab^x$. The Power Function can be linearized by taking the logarithms of both sides as well. The data will not plot as a straight line on a Log - Log plot.

ab^x

use word
processor
superscript

Procedure

- On a single sheet of linear graph paper, plot the rainfall data for Cypress, TX.
- Plot Cypress, Texas Data Set #4 (0-120 minutes) on Semi - log paper
- Plot Cypress, Texas Data Set #5 (>120 minutes) on Log - Log paper
- Find the equation represented by each of the following data sets assigned (Student Code)

Data presentation

Provided Data

DATA SET #1C

V(ft/s)	Q(cfs)
0.45	49.5
0.9	54.2
1.35	58.5
1.8	63.2
2.25	67.5
2.72	72
3.15	76.5
3.6	81.1
4.05	85.6

DATA SET #2C

h(ft)	Q(cfs)
1	4.5
2	6.71
3	10.12
4.1	15.18
5	22.78
6	34.2
7.2	51.26
8	76.89
9	115.33

DATA SET #3C

R(ft)	V(ft/s)
0.66	0.59
1.32	4.74
2.1	16
2.65	37.93
3.31	74.03
4.1	128.3
4.66	203.26
5.34	303.42
6.01	432.5

DATA SET #4

Time [min]	10 years
5	180.34
10	147.32
15	121.92
20	107.95
30	88.9
40	76.2
50	66.04
60	58.42
120	33.02

DATA SET #5

Time [min]	10 years
180	25.4
240	20.83
300	17.78
360	15.49
420	13.97
480	12.7
540	11.68
600	10.67
720	9.14
1080	6.6
1440	5.33

The image shows two sets of handwritten data plots on graph paper, labeled "2st # 3C" and "2st # 1C".

Experiment 2st # 3C:

- Top Plot:** The y-axis is labeled $y(t)$ and ranges from 0 to 1.5. The x-axis is labeled t and ranges from 0 to 10. The curve starts at (0,0) and increases, leveling off around $y=1.2$.
- Second Plot:** The y-axis is labeled $V(t)$ and ranges from 0 to 400. The x-axis is labeled t and ranges from 0 to 10. The curve starts at (0,0) and increases, leveling off around $V=350$.
- Third Plot:** The y-axis is labeled $R(t)$ and ranges from 0 to 1.5. The x-axis is labeled t and ranges from 0 to 10. The curve starts at (0,0) and increases, leveling off around $R=1.2$.
- Bottom Plot:** The y-axis is labeled $A(t)$ and ranges from 0 to 1.5. The x-axis is labeled t and ranges from 0 to 10. The curve starts at (0,0) and increases, leveling off around $A=1.2$.
- Linear Plot:** The y-axis is labeled $D(t)$ and ranges from 0 to 1.5. The x-axis is labeled t and ranges from 0 to 10. The data points form a straight line passing through the origin.

Experiment 2st # 1C:

- Top Plot:** The y-axis is labeled $y(t)$ and ranges from 0 to 1.5. The x-axis is labeled t and ranges from 0 to 10. The curve starts at (0,0) and increases, leveling off around $y=1.2$.
- Second Plot:** The y-axis is labeled $V(t)$ and ranges from 0 to 400. The x-axis is labeled t and ranges from 0 to 10. The curve starts at (0,0) and increases, leveling off around $V=350$.
- Third Plot:** The y-axis is labeled $R(t)$ and ranges from 0 to 1.5. The x-axis is labeled t and ranges from 0 to 10. The curve starts at (0,0) and increases, leveling off around $R=1.2$.
- Bottom Plot:** The y-axis is labeled $A(t)$ and ranges from 0 to 1.5. The x-axis is labeled t and ranges from 0 to 10. The curve starts at (0,0) and increases, leveling off around $A=1.2$.
- Linear Plot:** The y-axis is labeled $D(t)$ and ranges from 0 to 1.5. The x-axis is labeled t and ranges from 0 to 10. The data points form a straight line passing through the origin.

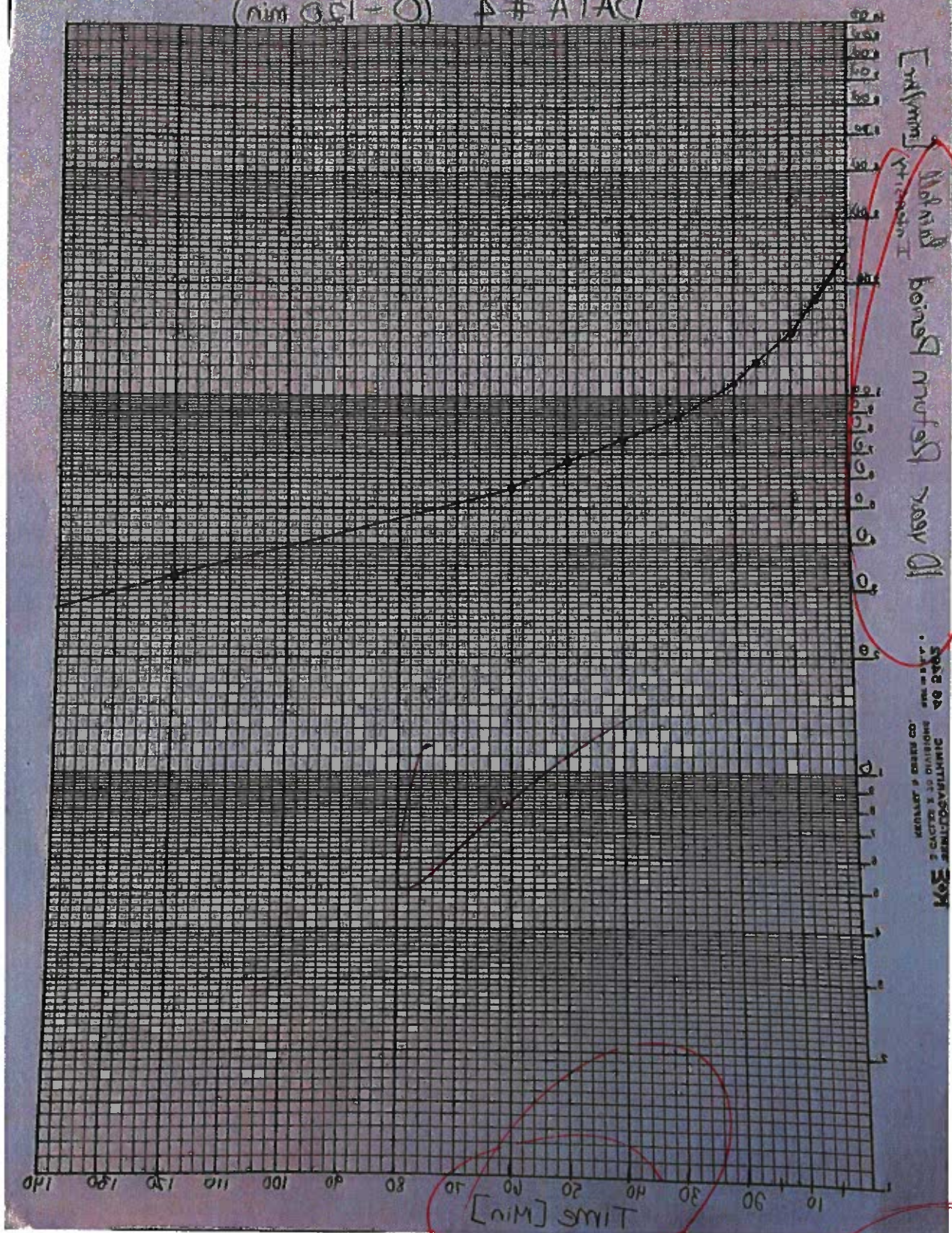
There are red handwritten notes and markings on the page, including "13th Nov 2015" and "13th Nov 2015" written vertically on the right side of the plots.

Perseid

DATA FOR GRAPH 1

Need to be as careful as you scan.

(nim 051-0) 4# ATAC

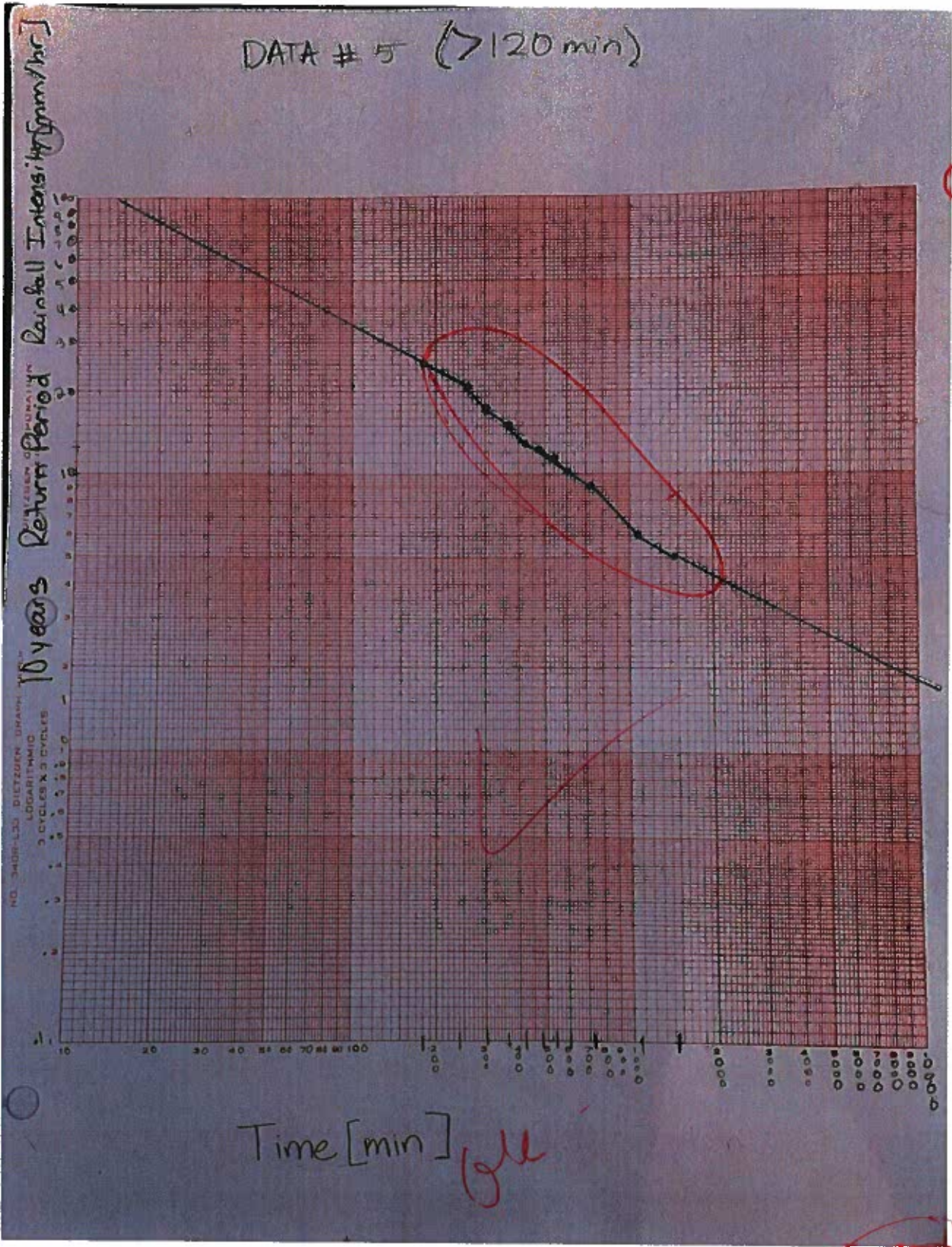


INFLUENCE [mm]

10 100K Before Device

RESEARCH & DESIGN CO.
7 CACTUS 3.10 DIVISION
40 2405
KOE SERVICE/ALPHAC

52



Best fit?

??

50

DATA SET #1C

V(ft/s) Q(cfs)

0.45	49.50
0.90	54.20
1.35	58.50
1.80	63.20
2.25	67.50
2.72	72.00
3.15	76.50
3.60	81.10
4.05	85.60

$$y = ax + b \quad \text{linear}$$

$$b = \frac{y_2 - y_1}{x_2 - x_1} = \frac{67.20 - 63.20}{2.25 - 1.80} = \frac{4}{.45}$$

$$a = y_1 - b \cdot x_1$$

$$a = 49.50 - 8.9(0.54)$$

$$a = 49.50 - 4.806$$

$$a = 44.694$$

$$y = 44.694x + 8.9$$

DATA SET #2C

h(ft) Q(cfs)

1.0	4.50
2.0	6.71
3.0	10.12
4.1	15.18
5.0	22.78
6.0	34.20
7.2	51.26
8.0	76.89
9.0	115.33

$$B = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\log 15.18 - \log 10.12}{4.1 - 3.0}$$

$$B = \frac{.1761}{1.1} = .160$$

$$A = \log\left(\frac{y_1}{b \cdot x_1^B}\right)$$

$$A = \log\left(\frac{4.50}{.160}\right)$$

$$A = 1.449$$

$$y = 1.449 + .160x$$

Semi-log
Result should be
 $y = ab^x$

Same
2 pages

DATA SET #1C

V(ft/s) | Q(cfs)

0.45	49.50
0.90	54.20
1.35	58.50
1.80	63.20
2.25	67.50
2.72	72.00
3.15	76.50
3.60	81.10
4.05	85.60

$$y = ax + b \quad \text{linear}$$

$$b = \frac{y_2 - y_1}{x_2 - x_1} = \frac{67.20 - 63.20}{2.25 - 1.80} = \frac{4}{.45}$$

$$a = y_1 - b x_1$$

$$a = 49.50 - 8.9(0.54)$$

$$a = 49.50 - 4.806$$

$$a = 44.694$$

$$y = 44.694x + 8.9$$

DATA SET #2C

h(ft) | Q(cfs)

1.0	4.50
2.0	6.71
3.0	10.12
4.1	15.18
5.0	22.78
6.0	34.20
7.2	51.26
8.0	76.89
9.0	115.33

$$B = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\log 15.18 - \log 10.12}{4.1 - 3.0}$$

$$B = \frac{-0.1761}{1.1} = -0.160$$

$$A = \log\left(\frac{y_1}{b x_1^B}\right)$$

$$A = \log\left(\frac{4.50}{.160}\right)$$

$$A = 1.449$$

$$y = 1.449 + .160x$$

Sources of error

A source of error for this lab would be in accurate plotting. If the plots are not in the correct spots on the graph the analysis will be incorrect. *ah*

Conclusion

In conclusion, I analyzed the given data and was able to interpret and clearly communicate the data results of an experiment exercise using graph *20*
~~make~~

References

Class Handout *??*

Definitive

180

~~*30*~~
210

BELOW
AVERAGE

CVEG 3303 P81

Hydraulics Lab

Fall 2021

350

L

Laboratory Number 03 - Graphical Analysis of Data

Thursday, 10/21/2021 - 2:00 PM

Group Members (Group #5)

Noah Smith Jr.

Erik Smith

Brennen Wright

Sophie Tuke

Submitted to: Dr. Emmanuel U. Nzewi

Submitted by: Sophie Tuke

Date submitted: 11/10/2021

Objective:

The objective of this experiment is to report graph and analysis by plotting data

Introduction

When graphing, the Empirical equations can never be forgotten in all aspects of academics. In this lab, we applied our graphical techniques to plot the data given and analyze the results in the experiment.

Procedure (per Assignment Sheet)

1. Each graph should have a descriptive title.
2. Each axis should be labeled and the units specified.
3. Data points should be clearly indicated (circles, boxes, triangles, etc.) with a legend if more than one series of data points are plotted together. Each curve drawn should be distinguishable.
4. Data points should "almost always" be connected with a smooth line. Some scatter is to be expected.
5. Unless otherwise noted, the curve is assumed to be fitted by the Least-Squares method and alternatively by "eyeballing".
6. Always try to have a (0,0) origin on the graph if it is practical; however, always choose a scale which represents the data in the best manner

Important!

But this is graphical analysis

Sources of Error

Balancing the water and object correctly is a key part to the entire experiment. Sources of error can easily come from so because they are both being eyeballed in this experiment, and not particularly closely measured.

Another source of error can come from plotting incorrectly when graphing.

return period = 10 yrs, 100 yrs, 7X

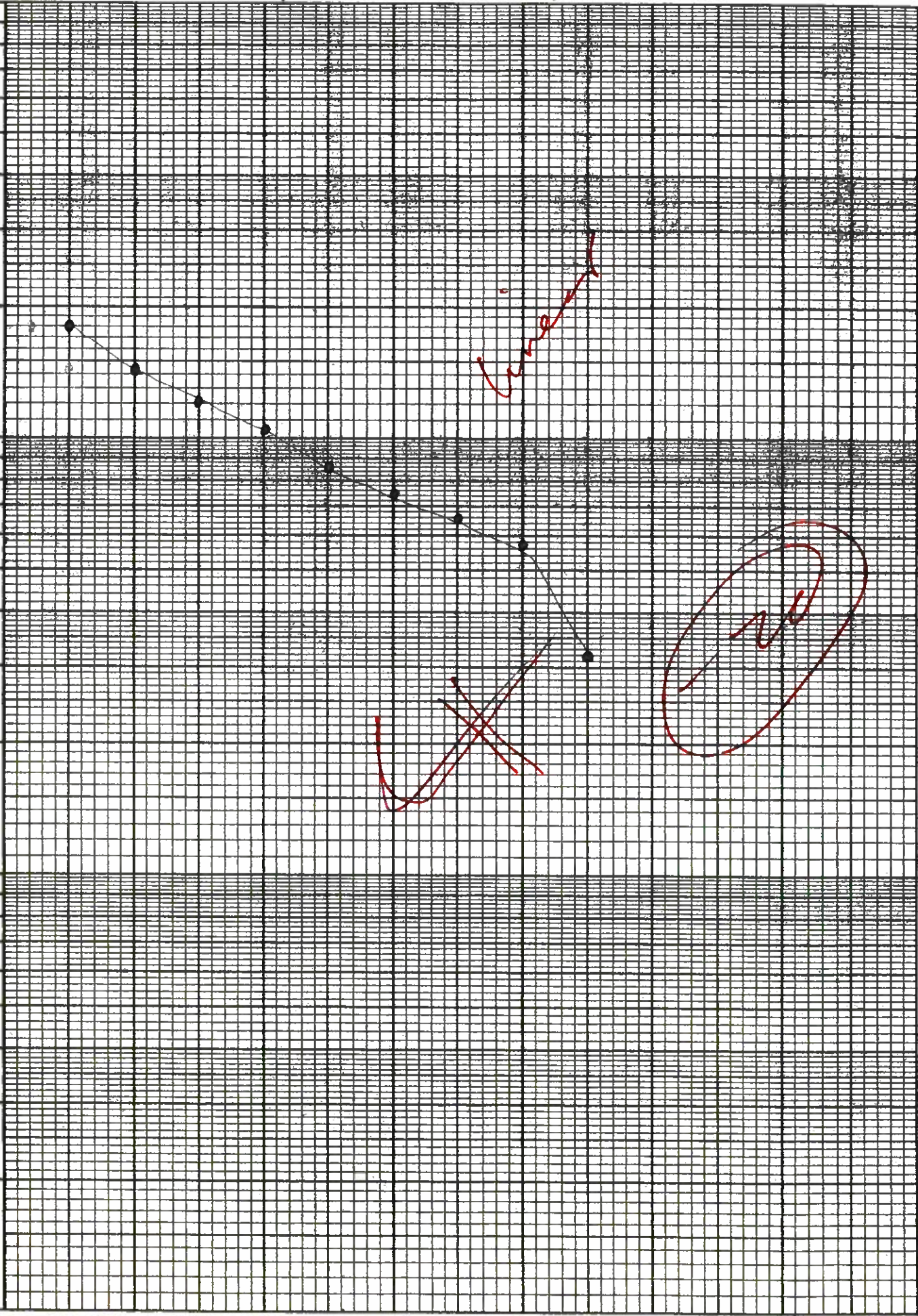
1000

100

9
8
7
6
5
4
3
2
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5
4
3
2
1

K&E SEMI-LOGARITHMIC 46 5492
3 CYCLES X 70 DIVISIONS
MADE IN U.S.A. *
KEUFFEL & ESSER CO.

10



Cymmer, TX, return = 10yrs

15
Where are the
linear plots?
(on regular
scale)

100.0

10.0

LOGARITHMIC
3 CYCLES X 3 CYCLES

1

.1

.2

.5

1

2.0

10.0

20.0

100.0

(24, 5.33)

(25.4, 3)

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\ln 3 - \ln 5.33}{\ln 25.4 - \ln 24} = -10.14$$

Conclusion

This graphing was a little hard to interpret due to its close measure, however, we could closely interpret the relation due to its nature on the graph, and analysis, and this gave us the results of our experiment.

poor scale

what are the relations?

Incomplete works!!

*You DID NOT
Complete the Lab as
required*

References

ASSIGNMENTS FOR ABET OUTCOME 6

An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

**DEPARTMENT OF
CIVIL & ENVIRONMENTAL ENGINEERING
OUTCOME SPECIFIC ASSIGNMENT
COVER SHEET**

**CVEG 3303
Hydraulics
Fall 2021**

Instructor: Dr. Emmanuel U. Nzewi, PE

Title of Assignment

- 1] Lab 02 – Calibration of a Pressure Gage
- 2] Lab 04 –The Bernoulli Equation

Outcome Measured Using this Assignment

Outcome 6

An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions in engineering situations

Brief Description of the suitability of this assignment for the outcome

In these laboratory exercises, the student completes an experiment, collects data and performs the analyses, interprets the results and draws conclusions.

Lab 02

Calibration of Pressure Gage

ABOVE
AVERAGE

CVEG 3303

P81 Hydraulics Lab

Fall 2021

Laboratory Number 02

Pressure Measurement Device
Calibration of a Pressure Gage

Thursday, 10 - 14 - 2021 - 2:00 PM

Group Members

Allyssa Reynolds Student#1

Trinity Scott Student#2

Hunter Rodgers Student#3

Darrell Patterson Student#4

Oluwatimileh Ogunjobi Student#5

Submitted to: Dr. Emmanuel U. Nzewi

Submitted by: Allyssa Reynolds Student#1

Date Submitted: 11/1/2021

Laboratory Number 02 - Pressure Measurement Device Calibration of a Pressure Gage

Objective

The first primary objective of this experiment is to develop an equation that relates the actual pressure to the measured pressure for a given gauge. The second primary objective is to determine the mass of an unknown specimen. The secondary aim is to understand fundamental concepts centered around pressure gage within a hydraulic experimental setting.

Introduction

Calibration is the process of comparing a reference data point with a known error. With proper calibration, the readings provided from the calibrated device should be as accurate as possible. Calibration is essential for Civil Engineers, as the calibration of pressure gauges is essential for obtaining acceptable readings. If the pressure readings provided are incorrect, this can cause the Civil Engineer to design and/or build systems with inaccurate data, often leading to detrimental results. One example of an engineering system is a water heater. This system must operate under specific guidelines in order to provide hot water. If the pressure within this system is not within the specified guidelines, the system will not perform in the manner it was expected to.

Procedure

- I. Obtain an empty gauge, and observe its initial pressure. Pressure reading should initially read "zero."
- II. Pour proper water into the pressure gauge until it is full. Move the piston in a circular motion about 2-3 times to eliminate frictional forces as much as possible. Observe the pressure reading.
 - A. Make sure this reading differs from the initial reading without the water.
- III. Add the first mass and record given pressure for "Pressure Rising."
 - A. Continue this process using masses 200, 700, 1200, 2200, 3200, and 4200 grams in respective order.
- IV. Remove last mass until there is no mass upon the pressure gage, recording respective pressures each time you remove the weight/specimen.
- V. Find an unknown mass by completing steps I through III.
 - A. Masses should be 5000 grams and the unknown mass.

Data Presentation

Measured Readings			Height
Added Mass (g)	Trial 1	Trial 2	Average Pressure (kPa)
	Pressure Rising (kPa)	Pressure Falling (kPa)	
0	21	0	$\frac{21+0}{2} = 10.5$
200	21	54	$\frac{21+54}{2} = 37.5$
700	25	63	$\frac{25+63}{2} = 44$
1200	35	72	$\frac{35+72}{2} = 53.5$
2200	67	96	$\frac{67+96}{2} = 81.5$
3200	116	122	$\frac{116+122}{2} = 119$
4200	147	147	$\frac{147+147}{2} = 147$

↑ TABLE 14

Actual Readings			
Added Mass (g)	Trial 1	Trial 2	Average Pressure (kPa)
	Pressure Rising (kPa)	Pressure Falling (kPa)	
0	$\frac{1.9-0.0}{0.015} = 31$	0	$\frac{31+0}{2} = 15.5$
200	$\frac{1.102-0.000}{0.015} = 37$	$\frac{1.109-0.011}{0.015} = 81$	$\frac{37+81}{2} = 59$
700	$\frac{1.9-0.000}{0.015} = 59$	$\frac{1.109-0.011}{0.015} = 59$	$\frac{59+59}{2} = 59$
1200	$\frac{2.1-0.000}{0.015} = 97$	$\frac{1.109-0.011}{0.015} = 97$	$\frac{97+97}{2} = 97$
2200	$\frac{2.8-0.000}{0.015} = 165$	$\frac{1.109-0.011}{0.015} = 165$	$\frac{165+165}{2} = 165$
3200	$\frac{3.5-0.000}{0.015} = 265$	$\frac{1.109-0.011}{0.015} = 265$	$\frac{265+265}{2} = 265$
4200	$\frac{4.2-0.000}{0.015} = 396$	$\frac{1.109-0.011}{0.015} = 396$	$\frac{396+396}{2} = 396$

↑ TABLE 24

OK

Average Absolute Gage Error (kPa)	
$ 110.5 - 110.1 = 0$	
$ 113.5 - 371 = 0$	
$ 144 - 591 = 15$	
$ 153.5 - 911 = 43$	
$ 181.5 - 1105 = 84$	
$ 1119 - 2105 = 1110$	
$ 1147 - 3910 = 249$	

Average: $\frac{0+0+15+43+84+1110+249}{7} = 171.8 \text{ kPa} = \text{Average Difference}$

4 TABLE 3.4

Measured Pressure Rise (kPa)	Actual Pressure Rise (kPa)	Percentage Gage Error (%)	Absolute Gage Error (kPa)
21	31	$\frac{ 21-31 }{31} \times 100 = 32$	$ 21-31 = 10$
21	37	$\frac{ 21-37 }{37} \times 100 = 44$	$ 21-37 = 16$
25	59	$\frac{ 25-59 }{59} \times 100 = 58$	$ 25-59 = 34$
35	97	$\frac{ 35-97 }{97} \times 100 = 64$	$ 35-97 = 62$
67	105	$\frac{ 67-105 }{105} \times 100 = 35$	$ 67-105 = 38$
110	2105	$\frac{ 110-2105 }{2105} \times 100 = 51$	$ 110-2105 = 1995$
147	3910	$\frac{ 147-3910 }{3910} \times 100 = 33$	$ 147-3910 = 2763$

4 TABLE 4.4

Percentage Error	Actual Value	Measured Value
$\frac{116 - 105}{105} \times 100 = 10$	$116 - 105 = 11$	$\frac{116 + 105}{2} = 110.5$
$\frac{137.5 - 137}{137} \times 100 = 0$	$137.5 - 137 = 0.5$	$\frac{137.5 + 137}{2} = 137.25$
$\frac{159 - 144}{144} \times 100 = 10.4$	$159 - 144 = 15$	$\frac{159 + 144}{2} = 151.5$
$\frac{197 - 183.5}{183.5} \times 100 = 7.3$	$197 - 183.5 = 13.5$	$\frac{197 + 183.5}{2} = 190.25$
$\frac{1165 - 115}{115} \times 100 = 103$	$1165 - 115 = 1050$	$\frac{1165 + 115}{2} = 1140$
$\frac{1265 - 1191}{1191} \times 100 = 6.1$	$1265 - 1191 = 74$	$\frac{1265 + 1191}{2} = 1228$
$\frac{1396 - 147}{147} \times 100 = 94.6$	$1396 - 147 = 1249$	$\frac{1396 + 147}{2} = 1271.5$

↑ TABLE 7.4

Simple Linear Regression

Slope: $\frac{y_2 - y_1}{x_2 - x_1} = \frac{59 - 20.1}{107 - 21} = 2.9$

Intercept: $y_1 - bx_1 = 21 - 0.29(107) = 105.3$

Unknown Mass:

$$0.03015(\text{mass}) + 20.1 = \frac{59 - 20.1}{0.03015}$$

$$0.03015(\text{mass}) + 20.1 = 1290$$

$$0.03015(\text{mass}) = 1270.12$$

$$\frac{0.03015}{0.03015} \frac{\text{mass}}{\text{mass}} = \frac{1270.12}{0.03015}$$

$$\text{mass} = 1293.53 \text{ grams}$$

Actual Pressure:

$$P = \frac{W}{A} = \frac{m \cdot g}{A} = \frac{9.81(1.27)}{0.315} = 37.33 \text{ kPa}$$

Percentage Error

$$\left| \frac{\text{Actual} - \text{Experimental}}{\text{Experimental}} \right| \times 100 = \left| \frac{0.1843 - 0.2181}{0.2181} \right| \times 100 = 14.57\%$$

Absolute Error

$$|\text{Actual Value} - \text{Measured Value}| = 120 - 21 = 99$$

Added Mass g	Measured Readings		Average kN/m ² /kPa
	Trial 1 Pressure Rising kN/m ² /kPa	Trial 2 Pressure Falling kN/m ² /kPa	
0	21	0	10.5
200	21	54	37.5
700	25	63	44
1200	35	72	53.5
2200	67	96	81.5
3200	116	122	119
4200	147	147	147

Table 1: Measured Pressure Readings per Added Mass, and the Averages of Values for Trials 1 and 2.

quite erratic
behavior

10

	Actual Readings		
	Trial 1	Trial 2	
Added Mass g	Pressure Rising kN/m ² /kPa	Pressure Falling kN/m ² /kPa	Average kN/m ² /kPa
0	31	0	16
200	37	37	37
700	59	59	59
1200	97	97	97
2200	165	165	165
3200	265	265	265
4200	396	396	396

Table 2: Actual Pressure Readings per Added Mass, and the Averages of Values for Trials 1 and 2.

Average Absolute Gage kN/m ² /kPa	
	5
	0
	15
	43
	84
	146
	249
Average	77

Table 3: Average Absolute Error for Trials 1&2.

Unknown Object	
Added Mass g	Pressure Rising kN/m ²
5000	43
X	59

Table 4: Pressure Readings per Added Mass for Unknown Object.

0.500 kg

→ Cannot be 1.32g
then

-25
You cannot read a higher pressure for lower mass

Measured	Actual		
Trial 1	Trial 1	Percentage Gage Error	Absolute Gage Error
Pressure Rising	Pressure Rising		
kN/m ² /kPa	kN/m ² /kPa	%	m
21	31	33	10
21	37	44	16
25	59	58	34
35	97	64	62
67	165	59	98
116	265	56	149
147	396	63	249

Table 5: Percentage Gage Error and Absolute Gage Error for Trial 1.

Measured	Actual		
Trial 2	Trial 2	Percentage Gage Error	Absolute Gage Error
Pressure Falling	Pressure Falling		
kN/m ² /kPa	kN/m ² /kPa	%	m
0	0	0	0
54	37	44	17
63	59	6	4
72	97	25	25
96	165	42	69
122	265	54	143
147	396	63	249

Table 6: Percentage Gage Error and Absolute Gage Error for Trial 2.

Measured	Actual	
Average	Average	Average Gage Reading
kN/m ² /kPa	kN/m ² /kPa	kN/m ² /kPa
10.5	16	13
37.5	37	37
44	59	52
53.5	97	75
81.5	165	123
119	265	192
147	396	271

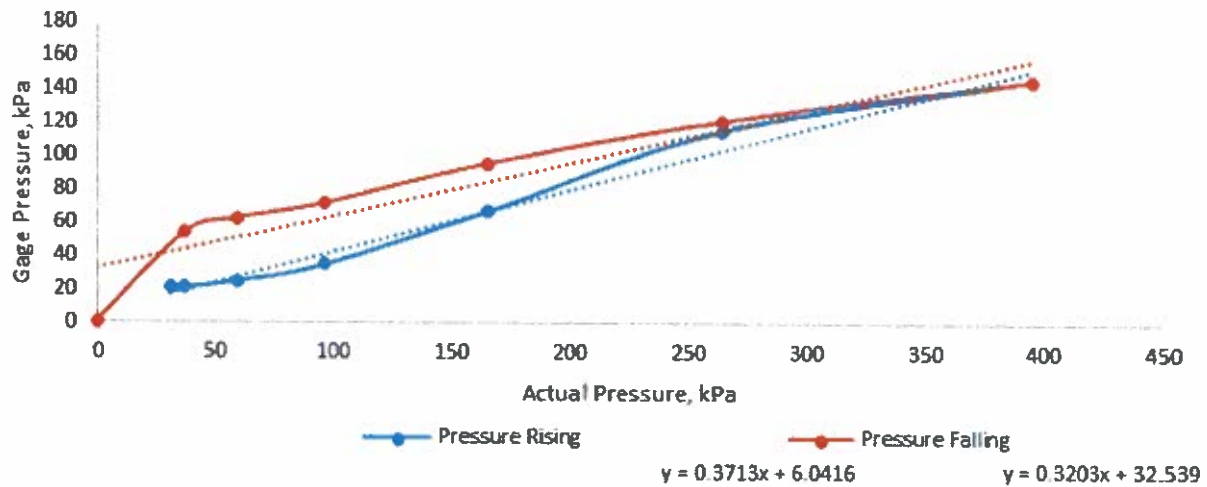
Table 7: Average Difference in Pressure Values Between the Actual and Gage Pressure. Calculations were used to Find Absolute and Measured Errors in **Table 8**.

Percentage Gage Error	Absolute Gage Error	Average Gage Reading
%	m	kN/m ² /kPa
48	5	13
0	0	37
34	15	52
80	43	75
103	84	123
122	146	192
169	249	271

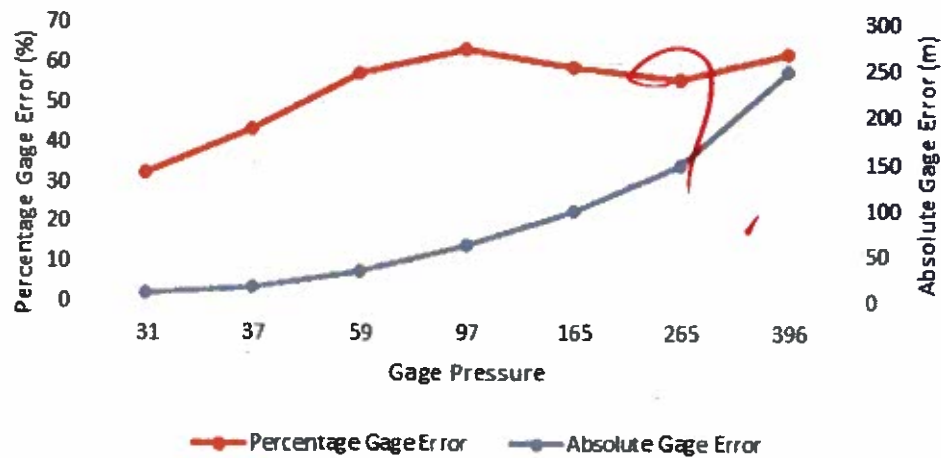
Table 8: Percent Error Averages between Actual and Measured Pressure Readings for Trials 1 and 2.

Report Presentation

Actual Pressure vs. Gage Pressure

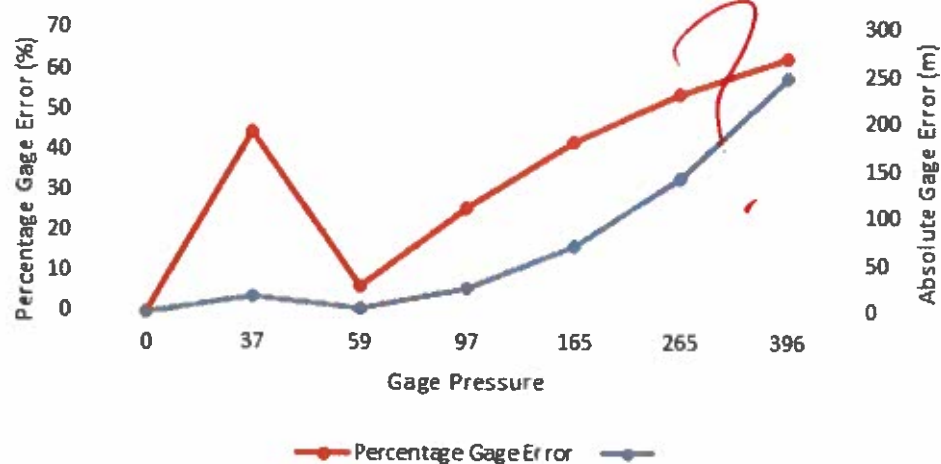


Pressure Reading vs Errors: Trial 1



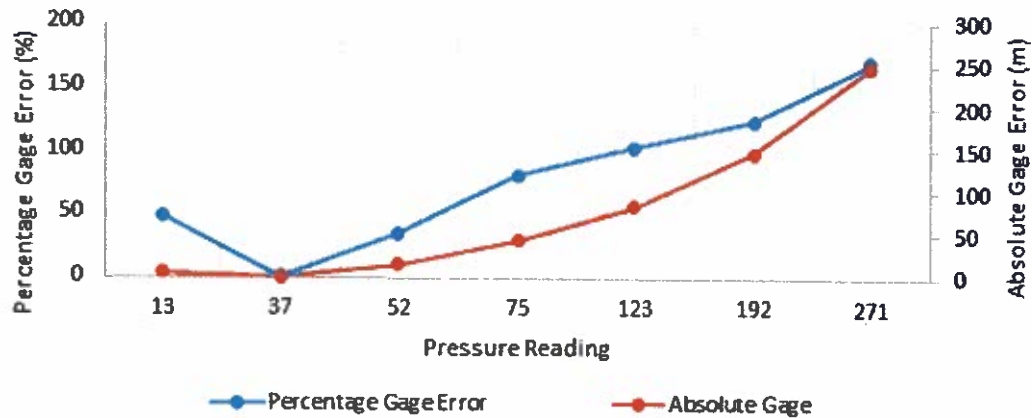
Graph 2 represents the data presented from Table 5 in graphical form for Trial 1. The percentage errors are being compared to the actual gauge readings for Trial 1.

Pressure Reading vs % Errors: Trial 2



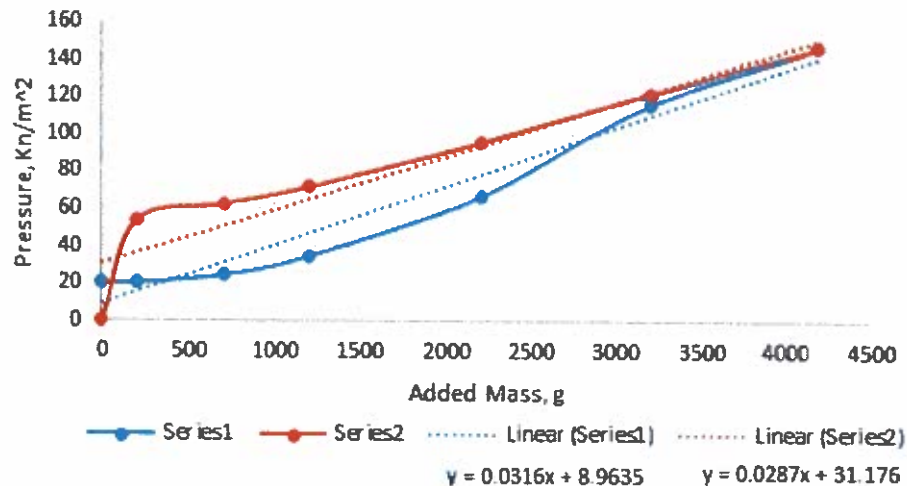
Graph 3 represents the data presented from Table 6 in graphical form for Trial 2. The percentage errors are being compared to the actual gauge readings for Trial 2.

Average Pressure Reading vs % Errors



Graph 4 represents the data presented from Table 8 in graphical form for Trials 1 and 2. The percentage errors are being compared to the actual gauge readings for Trials 1 and 2.

Added Mass vs. Pressure



Graph 5 represents the data presented from Table 1 in graphical form for Trials 1 and 2. The slope equation formed for each trial is located directly under each linear line.

Sample Calculations:

Slope

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{147 - 21}{4200 - 0} = 0.0316 = b$$

Intercept

$$y_1 - bx_1 = y_2 - bx_2 = 21 - (0.0316) \cdot 200 = 14.68$$

Unknown Mass

$$0.03015(\text{mass}) + 20.1 = \text{Pressure} = \frac{59 - 20.1}{0.03015} = 1293.53 \text{ grams}$$

Actual Pressure

$$P = \frac{W}{A} = \frac{m \cdot g}{A} = \frac{9.81 \cdot 1.2}{0.315} = 37.33 \text{ kPa}$$

Percentage Error

$$\left| \frac{\text{Gage} - \text{Experimental}}{\text{Experimental}} \right| \cdot 100 = \left| \frac{0.1863 - 0.2181}{0.2181} \right| \cdot 100 = 14.57\%$$

Absolute Error

$$|\text{Actual Value} - \text{Measured Value}| = |20 - 21| = 1\%$$

Sources of Error

There were multiple sources of error ^{during} within this experiment. The first source of error was human error. The students had trouble identifying when to read the scale throughout the lab, as the pressure pointer continuously changed. This means the pressure within the gauge continued to increase or decrease as mass was added. Since the students never provided enough time for the pressure to settle due to limited time within the lab, gauge readings were most likely inaccurate. } you probably had a faulty setup

Relating to inaccurate gauge pressure readings, an experimental error occurred as the pressure gauge was inconsistent with providing correct readings. There were occurrences when the pressure gauge would sporadically increase and decrease between readings. This caused the recorded data to become inconsistent at times. This may have occurred as the force impacting the reading was experiencing combating factors. For example, since the force at the top of the gage experienced frictional forces, this may have reduced the expected force at the bottom of the deadweight tester. added wt too high?

Conclusion

All objectives were met.

This group found the equation that related actual pressure to the measured pressure. For both trials, the equation derived was $0.3458x + 39$. This was found by taking the average of the slope equations from trials 1 and 2.

The average percent difference between the actual pressure and calculated values for the measured pressure is 80%. Thus, the procedure is technically invalid, as the percentage error found was high. I can infer that the pressure readings were inaccurate, as the percentage error values found were within an unacceptable range. I can also infer that the pressure readings were inaccurate as the measured values between trials 1 and 2 differed greatly, contributing to this high percentage error.

Force, area, and pressure were provided for the top of the gauge. The pressure at the bottom of the gauge can be considered negligible as the length of the deadweight tester and gauge is small, but this value can potentially impact the readings. Additionally, the ideal force affected at the top of the rod could be affected by frictional forces. Thus, the anticipated/theorized hydrostatic pressure could be less than the measured value.

The unknown mass of the object was found due to the manipulation of our equation $0.03015x + 20.069$. This was found by taking the average of the slope equations from trials 1 and 2. The mass found was 1300 grams or 1.3 kilograms.

The average difference in pressure found was 77 kPa.

-35

Something was incorrect with your table

But added mass was 5000 kg → 431 kPa
→ 1.3 kg → 69 kPa

References

“Add or Remove a Secondary Axis in a Chart in Excel.” Microsoft,
support.microsoft.com/en-us/office/add-or-remove-a-secondary-axis-in-a-chart-in-excel-91d1a2e2f-5db1-41e9-8908-e1a2e14dd5a9.

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Visaya. “Pressure Measurement, Pressure Devices, and Pressure Gauge Calibration.” Visaya, 9
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Measured Readings

Added Mass (g)	Trial 1	Trial 2	Average Pressure (kPa)
	Pressure Rising (kPa)	Pressure Falling (kPa)	
0	21	0	$\frac{21+0}{2} = 10.5$
200	21	54	$\frac{21+54}{2} = 37.5$
700	25	63	$\frac{25+63}{2} = 44$
1200	35	72	$\frac{35+72}{2} = 53.5$
2200	67	96	$\frac{67+96}{2} = 81.5$
3200	116	122	$\frac{116+122}{2} = 119$
4200	147	147	$\frac{147+147}{2} = 147$

TABLE 19

Actual Readings

Added Mass (g)	Trial 1	Trial 2	Average Pressure (kPa)
	Pressure Rising (kPa)	Pressure Falling (kPa)	
0	$\frac{(1.0 \times 9.81)}{0.315} = 31$	0	$\frac{31+0}{2} = 15.5$
200	$\frac{(1.2 \times 9.81)}{0.315} = 37$	$\frac{(1.2 \times 9.81)}{0.315} = 37$	$\frac{37+37}{2} = 37$
700	$\frac{(1.9 \times 9.81)}{0.315} = 59$	$\frac{(1.9 \times 9.81)}{0.315} = 59$	$\frac{59+59}{2} = 59$
1200	$\frac{(3.1 \times 9.81)}{0.315} = 97$	$\frac{(3.1 \times 9.81)}{0.315} = 97$	$\frac{97+97}{2} = 97$
2200	$\frac{(5.3 \times 9.81)}{0.315} = 165$	$\frac{(5.3 \times 9.81)}{0.315} = 165$	$\frac{165+165}{2} = 165$
3200	$\frac{(8.5 \times 9.81)}{0.315} = 265$	$\frac{(8.5 \times 9.81)}{0.315} = 265$	$\frac{265+265}{2} = 265$
4200	$\frac{(12.7 \times 9.81)}{0.315} = 396$	$\frac{(12.7 \times 9.81)}{0.315} = 396$	$\frac{396+396}{2} = 396$

TABLE 20

Average Absolute Gage (kPa)

- | 110.5 - 116 | = 5
- | 137.5 - 371 | = 0
- | 144 - 59 | = 15
- | 153.5 - 97 | = 43
- | 181.5 - 165 | = 84
- | 119 - 265 | = 146
- | 147 - 396 | = 249

Average: $\frac{5+0+15+43+84+146+249}{7} = 77 \text{ kPa} = \text{Average Difference}$

TABLE 3.4

Measured Pressure Rise (kPa)	Actual Pressure Rise (kPa)	Percentage Gage Error (%)	Absolute Gage Error (mm)
21	31	$\frac{21-31}{31} \times 100 = -32$	$ 21-31 = 10$
21	37	$\frac{21-37}{37} \times 100 = -44$	$ 21-37 = 16$
25	59	$\frac{25-59}{59} \times 100 = -58$	$ 25-59 = 34$
35	97	$\frac{35-97}{97} \times 100 = -64$	$ 35-97 = 62$
67	165	$\frac{67-165}{165} \times 100 = -59$	$ 67-165 = 98$
116	265	$\frac{116-265}{265} \times 100 = -56$	$ 116-265 = 149$
147	396	$\frac{147-396}{396} \times 100 = -63$	$ 147-396 = 249$

TABLE 4.4

Measured Pressure Fall (kPa)	Actual Pressure Fall (kPa)	Percentage Gage Error %	Absolute Gage Error (m)
0	0	$\frac{10-01}{0} \times 100 = 0$	$10-01 = 0$
54	37	$\frac{154-37}{37} \times 100 = 44$	$154-37 = 117$
65	59	$\frac{163-59}{59} \times 100 = 60$	$163-59 = 104$
72	97	$\frac{172-97}{97} \times 100 = 25$	$172-97 = 75$
96	165	$\frac{196-165}{165} \times 100 = 42$	$196-165 = 31$
122	265	$\frac{1122-265}{265} \times 100 = 84$	$1122-265 = 857$
147	396	$\frac{1147-396}{396} \times 100 = 68$	$1147-396 = 751$

↑ TABLE 5 4

Measured Average (kPa)	Actual Average (kPa)	Average Gage Reading (kPa)
10.5	16	$(10.5+16)/2 = 13$
37.5	37	$(37.5+37)/2 = 37$
44	59	$(44+59)/2 = 52$
53.5	97	$(53.5+97)/2 = 75$
81.5	165	$(81.5+165)/2 = 123$
119	265	$(119+265)/2 = 192$
147	396	$(147+396)/2 = 271$

↑ TABLE 6 4

Percentage Gage Error (%)	Absolute Gage Error (m)	Average Gage Reading (mm)
$\frac{116-105}{105} \times 100 = 10$	$116-105 = 11$	$\frac{105+116}{2} = 110.5$
$\frac{137.5-137}{137} \times 100 = 0$	$137.5-137 = 0$	$\frac{137+137.5}{2} = 137.25$
$\frac{159-144}{144} \times 100 = 10$	$159-144 = 15$	$\frac{144+159}{2} = 151.5$
$\frac{197-183.5}{183.5} \times 100 = 7$	$197-183.5 = 13.5$	$\frac{183.5+197}{2} = 190.25$
$\frac{1165-103}{103} \times 100 = 12$	$1165-103 = 1062$	$\frac{103+1165}{2} = 634$
$\frac{1265-119}{119} \times 100 = 10$	$1265-119 = 1154$	$\frac{119+1265}{2} = 692$
$\frac{1396-147}{147} \times 100 = 9$	$1396-147 = 1249$	$\frac{147+1396}{2} = 771.5$

↑ TABLE 7 ↑

Sample Calculations

$$\text{Slope: } \frac{y_2 - y_1}{x_2 - x_1} = \frac{594 - 31}{147 - 21} = 2.9$$

$$\text{Intercept: } y_1 - bx_1 = y_2 - bx_2 = 21 - (2.9)(147) = -405.3$$

Unknown Mass:

$$0.03015(\text{mass}) + 20.1 = \frac{59 - 20.1}{0.03015}$$

$$0.03015(\text{mass}) + 20.1 = 1290$$

$$\begin{array}{r} 0.03015(\text{mass}) = 1270.12 \\ \hline 0.03015 \quad 0.03015 \\ \text{mass} = 1293.53 \text{ grams} \end{array}$$

Actual Pressure:

$$p = \frac{F}{A} = \frac{m \cdot g}{A} = \frac{9.81(1.2)}{0.315} = 37.33 \text{ kPa}$$

Percentage Error

$$\left| \frac{\text{Gage} - \text{Experimental}}{\text{Experimental}} \right| \times 100 = \left| \frac{0.1863 - 0.2181}{0.2181} \right| \times 100 = 14.57\%$$

Absolute Error

$$|\text{Actual Value} - \text{Measured Value}| = 120 - 211 = 190$$

AVERAGE

Calibrated Pressure gage

Lab 2

Thursday, 11/2/2021 - 5:00 PM

(Group #5)
Noah Smith

type Calibration of Pressure Gage

Lab Group?

Group members

Submitted to: Dr. Emmanuel U. Nzewi
Submitted by: Noah Smith
Date submitted: 10/28/2021

650

M

25

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*No page
numbers*

Where?

Objectives

The objectives were to find out how weighted affected the pressure and of a cylinder or a piston.

The second objective was to figure out the weight of unknown objects as well as their pressure on a water piston cylinder.

Introduction

Barometric is lower on mountains than and higher in valleys (low lying areas).

A water barometer is a device that uses water to measure barometric pressure. The device uses the force of gravity, combined with pressure in the air, to create a vacuum, which in turn gives a reading that indicates the barometric pressure changes that are taking place in a specific area.

Procedure

We used a pressure measurement device and first added water to it. Next, we read the cylinder pressure number of the object before adding any weight. Next, after writing the amount it weighed without weight, we then added 200 pounds to the cylinder which made the water pressure rise. We did this 6 times and added either unknown 0.5 or 1 kg after each measurement. Finally, we added an unknown mass to the cylinder and saw the amount of unknown weight measured.

Better
and
Choice

what
name?

Hand
to follow

50

Data Presentation

Added Mass	Pressure on Gage	units
No Mass	21 kN/m ² =>	21000 N/m ²
200g	26 kN/m ² =>	26000 N/m ²
700 g	39 kN/m ² =>	39000 N/m ²
1200g	56 kN/m ² =>	56000 N/m ²
2200g	87 kN/m ² =>	87000 N/m ²
3200g	120 kN/m ² =>	120000 N/m ²
4200g	150 kN/m ² =>	150000 N/m ²
15000	64 kN/m ² =>	64000 N/m ²

1200g = 56000

Unknown=1000 +500g= 1500g

2200=87000

Could be better

No graph ??
p p

~~105~~

Report Presentation

Incomplete

Absolute gage error

Percentage gage error

$$\text{Force} = 9.81\text{N}$$

$$100 \cdot (X_1 - Y_1) / Y_1$$

$$\text{Pressure} = 9.81\text{N} / (315\text{mm}^2) / 1000 = 31.14285$$

Explain

$$(31.14285 - 21000) = -20968.85715\text{m}^2 \quad 100 \cdot (31.14285 - 21000) / 21000 = -99.85122452$$

$$(31.14285 - 26000) = -25968.85715 \quad 100 \cdot (31.14285 - 26000) / 26000 = -99.87983519$$

$$(31.14285 - 39000) = -38968.8715 \quad 100 \cdot (31.14285 - 39000) / 39000 = -99.91989012$$

$$(31.14285 - 56000) = -55968.85715 \quad 100 \cdot (31.14285 - 56000) / 56000 = -99.94420919$$

$$(31.14285 - 87000) = -86968.85715 \quad 100 \cdot (31.14285 - 87000) / 87000 = -99.96408867$$

$$(31.14285 - 120000) = -119968.85715 \quad 100 \cdot (31.14285 - 120000) / 120000 = -99.97396429$$

$$(31.14285 - 150000) = -149968.85715 \quad 100 \cdot (31.14285 - 150000) / 150000 = -99.97917143$$

$$31.14285 - 64000 = -63968.85715 \quad 100 \cdot (31.14285 - 64000) / 64000 = -99.95118304$$

$$P = a + bG$$

$$31.14285 = a + b(21000)$$

$$\text{Slope} = -1/21000$$

$$a = 31.143$$

$$b = 0.001$$

What graph?

where

100

$$\text{Force} = 9.81 \text{ N}$$

$$A = 315 \text{ mm}$$

$$\text{Pressure} = \left(\frac{9.81 \text{ N}}{315 \text{ mm}} \right) \div 1000$$

mass pressure

$$1200\text{g} = 5000$$

$$2200\text{g} = 87000$$

$$200\text{g} - 2200\text{g}$$

$$= 1000 + 500\text{g}$$

$$= \boxed{1500\text{g}}$$

Percentage Gage pressure

Difficult to follow

$$100 \times \frac{(31.14285 - 21000)}{21000} = -99.85122752$$

$$100 \times \frac{(31.14285 - 26000)}{26000} = -99.87983519$$

$$100 \times \frac{(31.14285 - 39000)}{39000} = -99.9442019$$

$$100 \times \frac{(31.14285 - 56000)}{56000} = -99.9442019$$

Absolute gage error

$$(31.14285 - 21000) = -20968.85715 \text{ m}^2$$

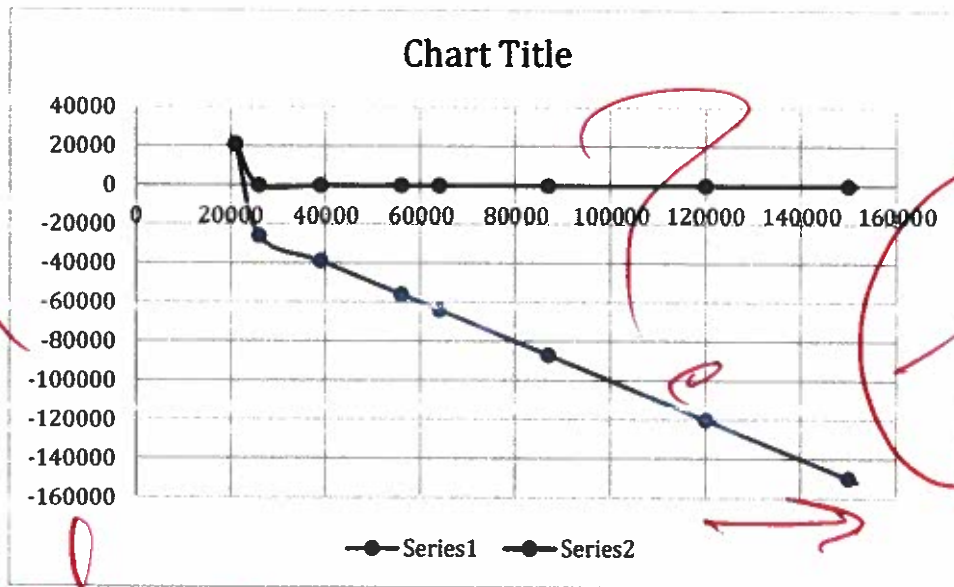
$$(31.14285 - 26000) = -25968.85715 \text{ m}^2$$

$$(31.14285 - 39000) = -38968.85715 \text{ m}^2$$

$$(31.14285 - 56000) = -55968.85715 \text{ m}^2$$

$$(31.14285 - 87000) = -86968.85717 \text{ m}^2$$

Graph



Label

Series 1 – Absolute gage pressure

Series 2- Percentage gage pressure

Absolute gage pressure = $y = -1x + 31.1428$

Percentage gage pressure = $Y = 0.00000572x - 99.73093216$

Report
This report does not have sufficient
Information

References?
Conclusions?

150

BELOW
AVERAGE

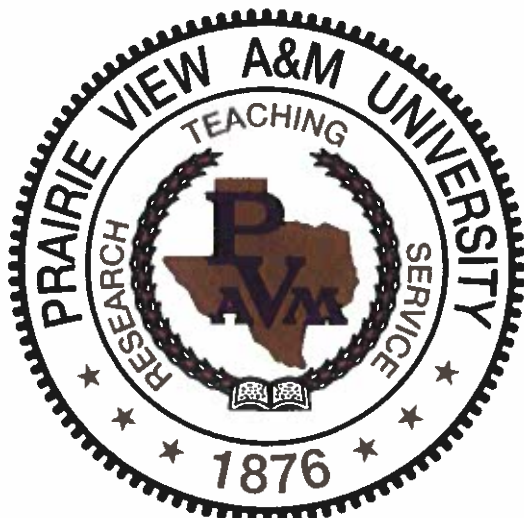
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Prairie View A&M University



CVEG 3301 Hydraulics

Lab Assignment #2

Pressure Measurement Devices (Calibration of a pressure gage)

Due: November, 1 2021

Submitted By: Erik Smith

Submitted to: Dr. Emanuel Nzwei

Cover
Sheet

Group? members?

-15

Abstract:

Objective

For this laboratory experiment we were tasked to measure and analyze the effect of added force on a pressure gage. Each group was to plot the data we obtained for the calibration of the pressure gage. As well as determine an equation which relates the actual pressure (P) to the measured pressure (G) for the gage.

We are to report our answer as an equation $\rightarrow P = a + b \cdot G$, where a and b are coefficients values. We must find the values of the constants a and b. Must plot this on a linear graph sheet and find the equation of the line.

Determine, from the equation of part #2, the average difference [kN/ m²] between the actual (P) and calculated values for the measure pressure (G).

Determine the mass [g] of the unknown specimen [A, B, C, D, E] assigned to my group. Must accomplish this by first adding 0.5 kg to the piston and then adding MY specimen to the piston. Note that the gage pressure in each case and use the information obtained and the calibration equation you found in part #2, calculate the mass of my specimen to the nearest gram.

copying assignment

50

Introduction of theory:

$$P = W/A$$

??

-25

Please provide more information here
Inadequate

Materials and Methods:

- Pitcher of water
- Pressure gage
- Piston
- Unknown Object

method

Procedures:

- Pour water into tube on pressure measurement apparatus.
- Place piston into the tube that was filled with water.
- Place an external forces (added weight) to the piston and record what the pressure gage reads.

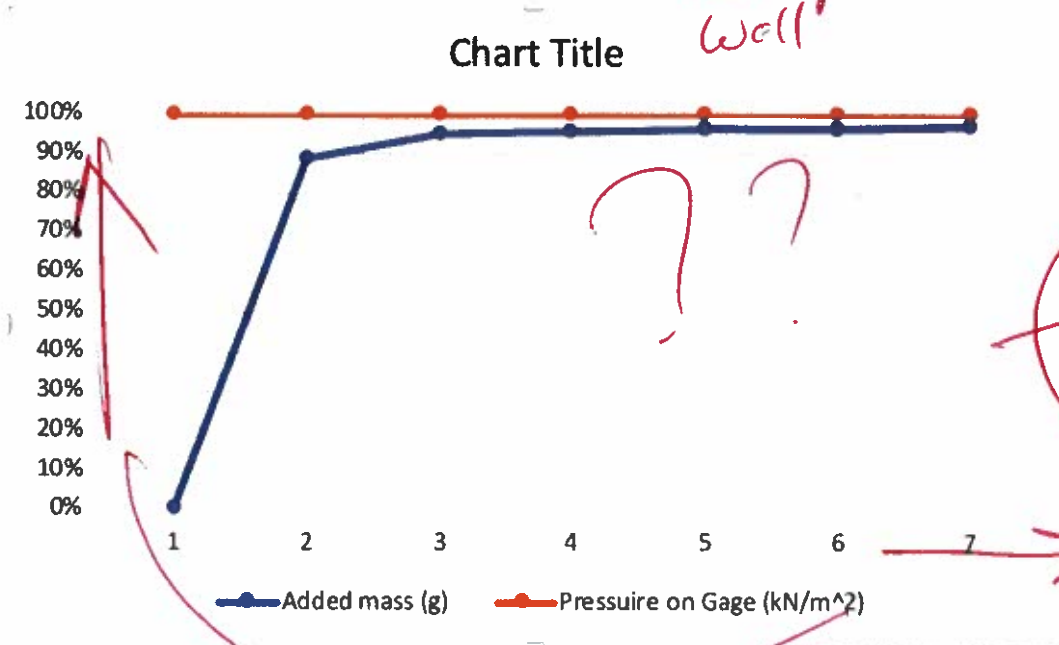
Could be
better
stated

-50

- Continue to add weight and recording the pressure until you have 8 values.

Results & Analysis:

1.



2. $P = W/A$

What does this describe?

label axes

2. Absolute gage error:

- (21-26) = -5
- (21-39) = -18
- (21-56) = -35
- (21-87) = -66
- (21-120) = -129

How did you obtain this?
Please explain

vi. $(21-150) = -129$

vii. $(21-64) = -43$

Percentage gage error:

i. $100*(21-26)/26 = -19.2307$

j. $100*(21-39)/39 = -46.1538$

k. $100*(21-56)/56 = -62.5$

l. $100*(21-87)/87 = -75.8620$

m. $100*(21-120)/120 = -82.5$

n. $100*(21-150)/150 = -86$

o. $100*(21-64)/64 = -67.1875$

Where is
your solution for unknown
mass?

-125

you need to
calculate

4. The mass of the unknown specimen for my group is between 800 g and 1800 g (1.8 kg). I came to this conclusion because of the value it produced on the pressure gage, which was 64 (kN/m²). And that falls in between the values of pressure that were recorded when 1200 g and 2200 g were added to the piston.

Source of Error:

Please realign your text

The downward pressure slowly is diffused as soon as the pressure is applied, so it was difficult to catch the act pressure at the moment the force was placed on the piston. Other than that there were no sources of error in the procedure of this laboratory assignment.

+25

References:

Move to next
page

- Lab assignment sheet

Appendix:

- Raw Data:

What is this table for

Units

Added mass	Pressure on Gage
0 g	21 (KN/m ²)
200 g	26 (KN/m ²)
700 g	39 (KN/m ²)
1200 g	56 (KN/m ²)
2200 g	87 (KN/m ²)
3200 g	120 (KN/m ²)
4200 g	150 (KN/m ²)
Unknown Object + 500 g	64 (KN/m ²)

Conclusion:

After completing this laboratory assignment and analyzing the data, I have come to the conclusion that the pressure increases slightly.

incomplete

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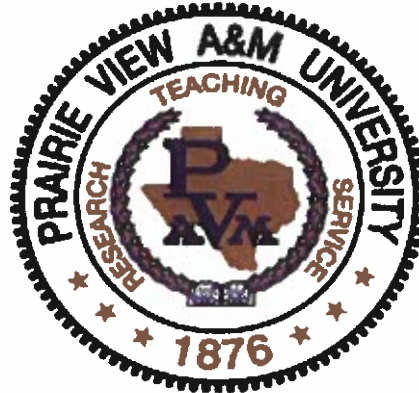
— References ? } — 50
— Discussion ? }

Lab 04

The Bernoulli Equation

ABOVE
AVERAGE

Prairie View A&M University
Roy G. Perry College of Engineering
Civil & Environmental Engineering Department



CVEG 3303 P81 – Hydraulics Laboratory
Fall 2021

Laboratory #4

The Bernoulli Theorem

Date: Thursday, November 11th, 2021 - 2:00 PM

Group Members (Group #1)

Maalvika A.	Student1
Austin B.	Student2
Maurice B.	Student3
Amani F.	Student4

Submitted to: Dr. Emmanuel U. Nzewi
Submitted by: Maalvika Aggarwal, Student1
Date Submitted: Tuesday, November 29th, 2021

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III. Table 4: Piezometric Data Results and Calculations	pg. 12
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9. Conclusion _____ pg. 22

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TITLE:

Laboratory Number 04- The Bernoulli Theorem

OBJECTIVE:

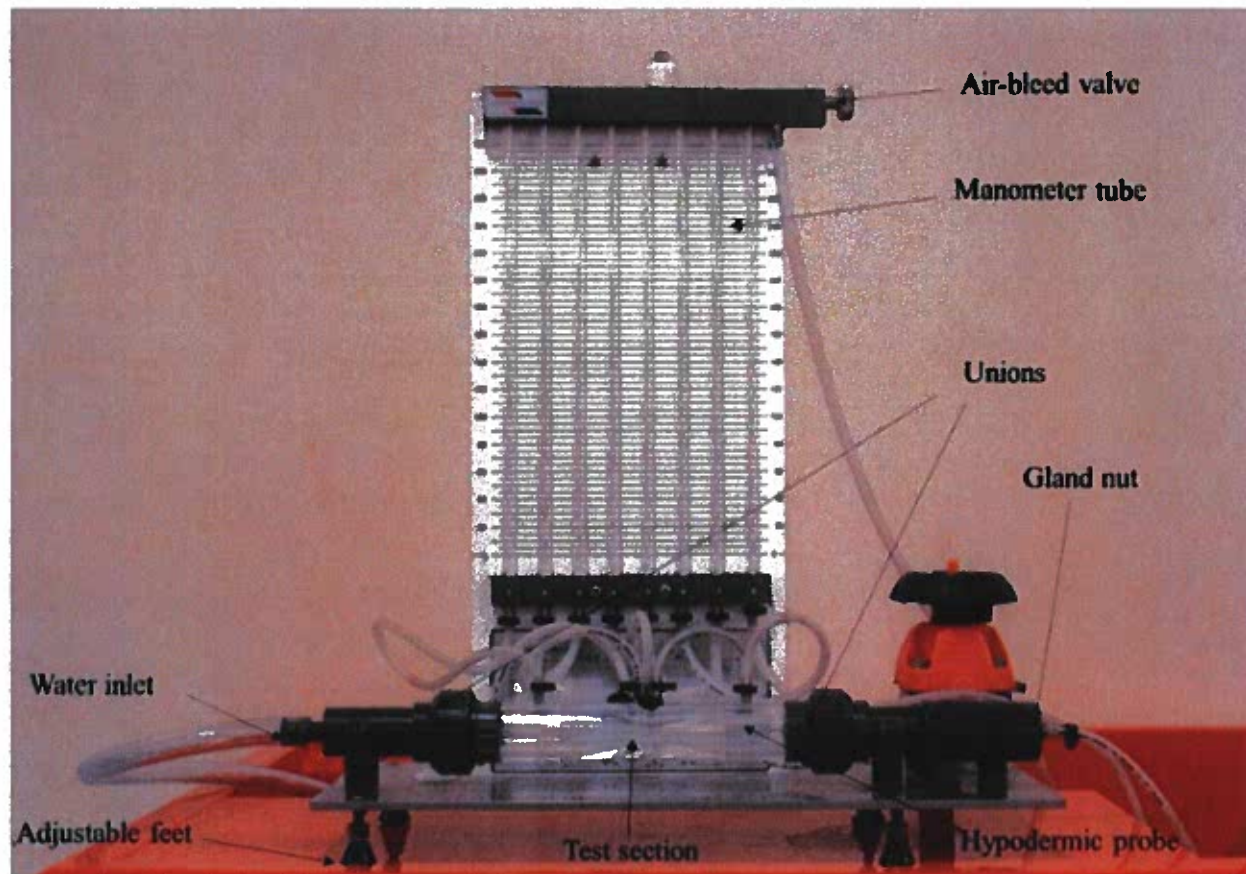
The objective of this experiment is to investigate the validity of Bernoulli's Theorem as applied to the flow of water in a tapering circular conduit, using a Bernoulli's apparatus test equipment.

INTRODUCTION TO THE THEORY:**I. Bernoulli Equation Apparatus:**

The Bernoulli test apparatus consists of a tapered duct (venturi), a series of manometers tapped into the venturi to measure the pressure head, and a hypodermic probe that can be traversed along the center of the test section to measure the total head.

The test section is a circular duct of varying diameter with a 14° inclined angle on one side and a 21° inclined angle on other side. Series of side hole pressure tapings are provided to connect manometers to the test section.

Figure 1: Bernoulli Equation Apparatus



EQUATIONS USED IN THE EXPERIMENT:

1. Volume Flow Rate/ Discharge:

Discharge, Q is the rate at which a fluid with velocity V , flows through a duct of a cross-sectional area A .

$$Q = VA \quad \text{[When velocity is uniform]}$$

$$Q = \int V dA \quad \text{[When velocity is not constant]}$$

2. Mass Flow rate:

Mass flow rate is the rate of mass at which a fluid with given velocity V and density, flows through a duct, with cross-sectional area A .

$$\dot{m} = \rho VA = \rho Q$$

3. Mean Flow Velocity:

Mean Flow Velocity is the velocity of a fluid flowing through a vector field

$$\bar{V} = \frac{Q}{A}$$

4. The Continuity Equation:

$$\rho_1 A_1 V_1 = \rho_2 A_2 V_2 \quad [\text{When flow is steady}]$$

$$A_1 V_1 = Q = A_2 V_2 \quad [\text{For incompressible flow}]$$

5. The Bernoulli Equation:

$$z_1 + \frac{V_1^2}{2g} + \frac{P_1}{\gamma} = z_2 + \frac{V_2^2}{2g} + \frac{P_2}{\gamma}$$

6. Piezometric Head Equation:

$$\text{Piezometric head} = z + \frac{P}{\gamma}$$

7. Velocity Head Equation:

$$\text{Velocity head} = \frac{V^2}{2g}$$

8. Percentage error Equation:

This equation is used to find percentage of error between the actual and theoretical value.

$$\% \text{ error} = \frac{|\text{Actual} - \text{Theoretical}|}{\text{Theoretical}} \times 100$$

✓ Good

EQUIPMENT AND ANALYSIS TOOLS:

- Gravimetric Bench
- Bernoulli Equation Apparatus
- Stopwatch
- 2 kg weights

DESCRIPTION OF PROCEDURE:

1. Record and take note of the diameter and area
2. Switch on the Gravimetric bench motor.
3. Allow an initial discharge of water to measuring tank by regulating the valve.
4. Set the flow to High.
5. Bring the weighing scale down and add the 2-Kg weights.
6. Using a stopwatch, record the time it takes to come back to its starting position.
7. Repeat the procedure for added mass of 4-Kgs.
8. Then, take the piezometric head reading, in mm, of all the taps A through L.
9. Repeat the entire procedure for Low flow.

DATA AND TEST RESULTS:

- Density of Water = 1000 Kg/m^3

Table 1: Measurement of Flowrate-Data obtained from Gravimetric Bench method:

Trials		Mass Added (M) (Kg)	Time (t) (s)
HIGH FLOW	1	2.00	9.71
	2	4.00	26.57
LOW FLOW	1	2.00	23.71
	2	4.00	53.60

Table 2: Piezometric Data Readings:

Trial #	Tap # or Section location (mm)	Diameter at section D (mm)	Piezometric head h (mm)	Piezometric head h (m)	Area A $A=3.14/4(D)^2$ (mm ²)	Area A (m ²)
1 (High Flow)	A	26.00	258	0.258	530.9	5.309×10^{-4}
	B	23.20	248	0.248	422.7	4.227×10^{-4}
	C	18.40	166	0.166	265.9	2.659×10^{-4}
	D	16.00	34	0.034	201.1	2.011×10^{-4}
	E	16.79	66	0.066	221.4	2.214×10^{-4}
	F	18.47	128	0.128	267.9	2.679×10^{-4}
	G	20.16	162	0.162	319.2	3.192×10^{-4}
	H	21.84	188	0.188	374.6	3.746×10^{-4}
	J	23.53	202	0.202	434.8	4.348×10^{-4}
	K	25.21	214	0.214	499.2	4.992×10^{-4}
	L	26.00	220	0.22	530.9	5.309×10^{-4}
2 (Low Flow)	A	26.00	242	0.242	530.9	5.309×10^{-4}
	B	23.20	232	0.232	422.7	4.227×10^{-4}
	C	18.40	200	0.2	265.9	2.659×10^{-4}
	D	16.00	144	0.144	201.1	2.011×10^{-4}
	E	16.79	156	0.156	221.4	2.214×10^{-4}
	F	18.47	184	0.184	267.9	2.679×10^{-4}

	G	20.16	198	0.198	319.2	3.192×10^{-4}
	H	21.84	210	0.21	374.6	3.746×10^{-4}
	J	23.53	216	0.216	434.8	4.348×10^{-4}
	K	25.21	220	0.22	499.2	4.992×10^{-4}
	L	26.00	224	0.224	530.9	5.309×10^{-4}

REPORT PRESENTATION:

Table 3: Measurement of Flowrate-Results and Calculations for Gravimetric Bench method:

Trials		Mass Added (M) (Kg)	Mass Added (M2) (M x 3) (Kg)	Volume (m ³) (M2/ρ)	Time (t) (s)	Flowrate (Q) (m ³ /s) (Volume/Time)
HIGH FLOW	1	2.00	6.00	0.006	9.71	6.179×10^{-4}
	2	4.00	12.00	0.012	26.57	4.516×10^{-4}
	Average					5.348×10^{-4}
LOW FLOW	1	2.00	6.00	0.006	23.71	2.531×10^{-4}
	2	4.00	12.00	0.012	53.60	2.239×10^{-4}
	Average					2.385×10^{-4}

Sample calculations for Table 5 - Measurement of Flowrate

High flow:

Trial # 1, Mass added = 2 kg

$$M_2 = (2)(3)$$

$$= 6 \text{ kg}$$

Density of water = 1000 kg/m^3

$$\text{So, Volume} = \frac{M_2}{\rho_{\text{water}}} = \frac{6}{1000} = 0.006 \text{ m}^3$$

$$\text{Time (t) (measured)} = 9.71 \text{ sec}$$

$$\text{Flowrate, } Q = \frac{\text{Vol}}{\text{Time}} = \frac{0.006}{9.71} = \boxed{6.179 \times 10^{-4} \text{ m}^3/\text{s}}$$

$$\text{So, average } Q = \frac{6.179 \times 10^{-4} + 4.516 \times 10^{-4}}{2} = \boxed{5.348 \times 10^{-4} \text{ m}^3/\text{s}}$$

low flow:

Trial # 1, Mass added = 2 kg

$$M_2 = (2)(3) = 6 \text{ kg}$$

Density of water = 1000 kg/m^3

$$\text{So, volume} = \frac{M_2}{\rho_{\text{water}}} = \frac{6}{1000} = 0.006 \text{ m}^3$$

$$\text{Time (t)} = 23.71 \text{ sec}$$

$$\text{Flowrate, } Q = \frac{\text{Vol}}{\text{Time}} = \frac{0.006}{23.71} = \boxed{2.531 \times 10^{-4} \text{ m}^3/\text{s}}$$

$$\text{So, average } Q = \frac{2.531 \times 10^{-4} + 2.239 \times 10^{-4}}{2}$$

$$= \boxed{2.385 \times 10^{-4} \text{ m}^3/\text{s}}$$

Table 4: Piezometric Results and calculations:

Trial #	Tap # or Section location (mm)	Piezo metric head h (m)	Area A (m²)	Actual Velocity V_a (Q/A) (m/s)	Theoretical Velocity V_t (Sqrt (1.007-(h*9810/810)*2g) (m/s)	Actual Velocity Head V_{H_a} (V_a²/2g) (m)	Actual Total Head TH_a (V_{H_a}+h) (m)	Percent Difference Of TH from Tap# A (%)
1	A	0.258	5.309 x 10 ⁻⁴	1.007	1.007	0.0517	0.3097	
	B	0.248	4.227 x 10 ⁻⁴	1.265	3.860	0.0816	0.3296	27.7442
	C	0.166	2.659 X 10 ⁻⁴	2.011	4.063	0.2062	0.3722	
	D	0.034	2.011 X 10 ⁻⁴	2.659	4.370	0.3604	0.3944	
	E	0.066	2.214 X 10 ⁻⁴	2.415	4.297	0.2974	0.3634	
	F	0.128	2.679 X 10 ⁻⁴	1.996	4.154	0.2031	0.3311	
	G	0.162	3.192 X 10 ⁻⁴	1.675	4.072	0.1431	0.3051	
	H	0.188	3.746 X 10 ⁻⁴	1.428	4.009	0.1039	0.2919	
	J	0.202	4.348 X 10 ⁻⁴	1.230	3.975	0.0771	0.2791	
	K	0.214	4.992 X 10 ⁻⁴	1.071	3.945	0.0585	0.2725	
	L	0.220	5.309 X 10 ⁻⁴	1.007	3.930	0.0517	0.2717	
2	A	0.242	5.309 X 10 ⁻⁴	0.449	2.016	0.0103	0.2523	
	B	0.232	4.227 X 10 ⁻⁴	0.564	3.900	0.0162	0.2482	2.5710
	C	0.200	2.659 X 10 ⁻⁴	0.897	3.980	0.0410	0.2410	
	D	0.144	2.011 X 10 ⁻⁴	1.186	4.116	0.0717	0.2157	

	E	0.156	2.214 X 10⁻⁴	1.077	4.087	0.0591	0.2151	
	F	0.184	2.679 X 10⁻⁴	0.890	4.019	0.0404	0.2244	
	G	0.198	3.192 X 10⁻⁴	0.747	3.985	0.0284	0.2264	
	H	0.210	3.746 X 10⁻⁴	0.637	3.955	0.0207	0.2307	
	J	0.258	4.348 X 10⁻⁴	0.548	3.940	0.0153	0.2313	
	K	0.248	4.992 X 10⁻⁴	0.478	3.930	0.0116	0.2316	
	L	0.166	5.309 X 10⁻⁴	0.449	3.920	0.0103	0.2343	

Sample Calculations for Table 4- Piezometric Results

Trial #1, Tap # B

Piezometric head, $h = 248 \text{ mm} = 0.248 \text{ m}$

Diameter = ~~28.20~~ mm

$$\text{Area} = \frac{3.14 (D)^2}{4} = \frac{3.14 (28.20)^2}{4} = 622.7 \text{ mm}^2$$

$$= \boxed{4.227 \times 10^{-4} \text{ m}^2}$$

From table B, Q for trial 1 = $5.384 \times 10^{-4} \text{ m}^3/\text{s}$

So, Actual Velocity, $V_a = \frac{Q}{A} = \frac{5.384 \times 10^{-4}}{4.227 \times 10^{-4}} = \boxed{1.265 \text{ m/s}}$

Assuming, $V_a = V_t$ at Tap # A (V_t = Theoretical velocity)

At Tap # A, $V_a = V_t = \underline{1.007 \text{ m/s}}$

So, Theoretical velocity, $V_t = \sqrt{\left(1.007 - \left(\frac{h (9810)}{9810}\right)\right) \times 2g}$

(Bernoulli equation)

$$\text{So, } V_t = \sqrt{\left(1.007 - \left(\frac{0.248 \times 9810}{9810}\right)\right) \times 2 \times 9.81}$$

$$\boxed{V_t = 3.860 \text{ m/s}}$$

Actual Velocity head, $V_{Ha} = \frac{V_a^2}{2g} = \frac{1.265^2}{2 \times 9.81} = \boxed{0.0816 \text{ m}}$

Actual Total Head = $\frac{V_a^2}{2g} + h$ or $V_{Ha} + h$

$$= \frac{1.265^2}{2 \times 9.81} + 0.248 = \boxed{0.3296 \text{ m}}$$

% difference from Tap # A = $\left[\frac{\text{Actual TH} - \text{theo TH at Tap # A}}{\text{theo TH at Tap # A}} \right] \times 100$

$$= \frac{0.3296 - 0.258}{0.258} \times 100$$

$$= \boxed{27.744\%}$$

Table 5: Data used for Graph 1-Trial 1: Pressure head and Velocity head against the pressure tap Distance:

Tap #	Pressure Tap Distance (m)	Pressure Head (m)	Velocity Head (m)
A	0	0.258	0.0517
B	0.02	0.248	0.0816
C	0.032	0.166	0.2062
D	0.046	0.034	0.3604
E	0.061	0.066	0.2974
F	0.083	0.128	0.2031
G	0.12	0.162	0.1431
H	0.172	0.188	0.1039
J	0.239	0.202	0.0771
K	0.321	0.214	0.0585
L	0.423	0.220	0.0517

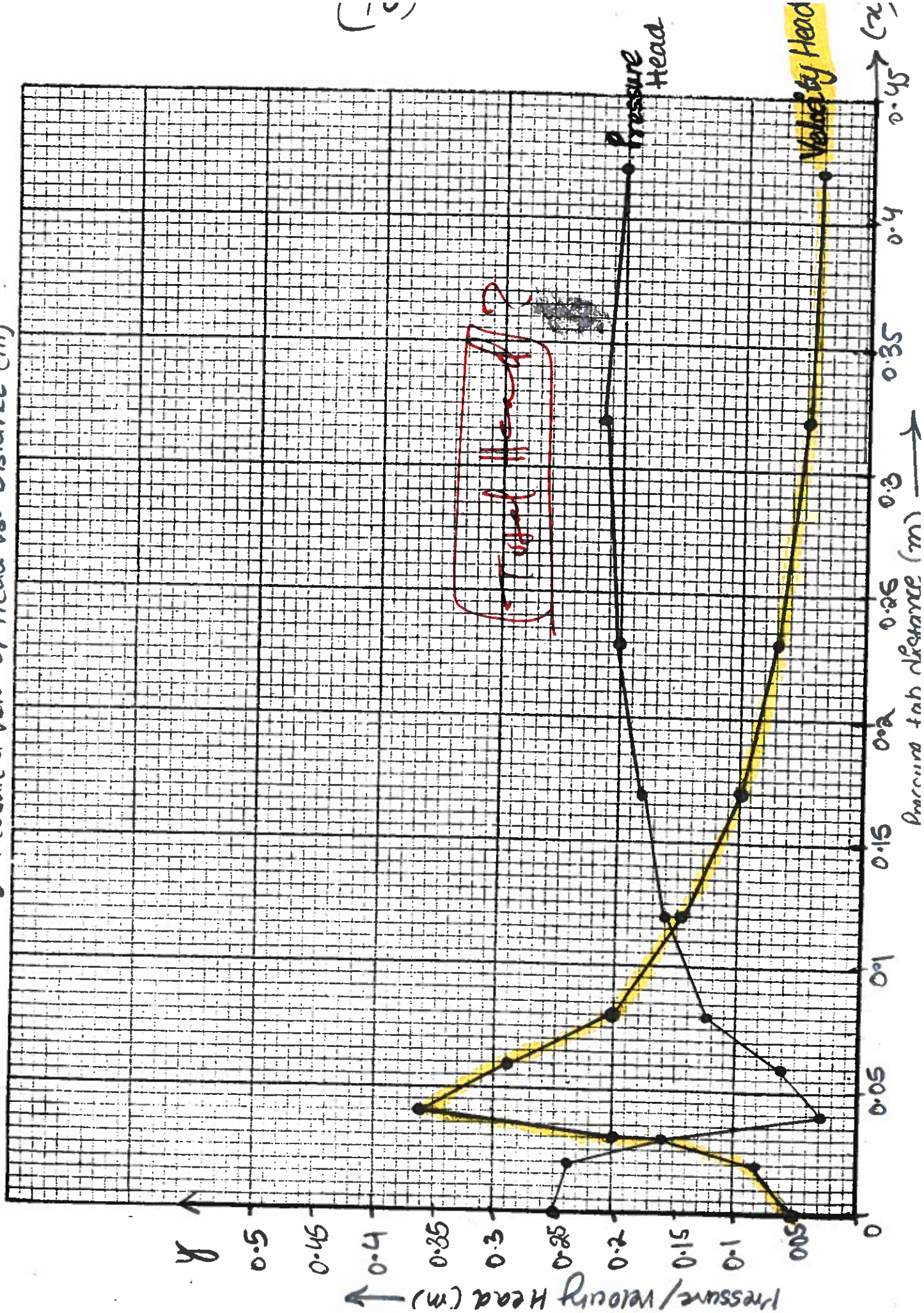
Pressure Tap Distance-Sample Calculation:

Point A (Reference): 54 mm = 0.054 m (0 m from A)

Point B: 34 mm

Distance from point A to Point B: 54-34 = 22 mm = 0.02 m

GRAPH 1: TRIAL 1- Pressure & Velocity Head vs. Distance (m)



Graph 2: Digital Representation of Trial 1-Pressure head (m) and Velocity head (m) against the pressure tap Distance (m)

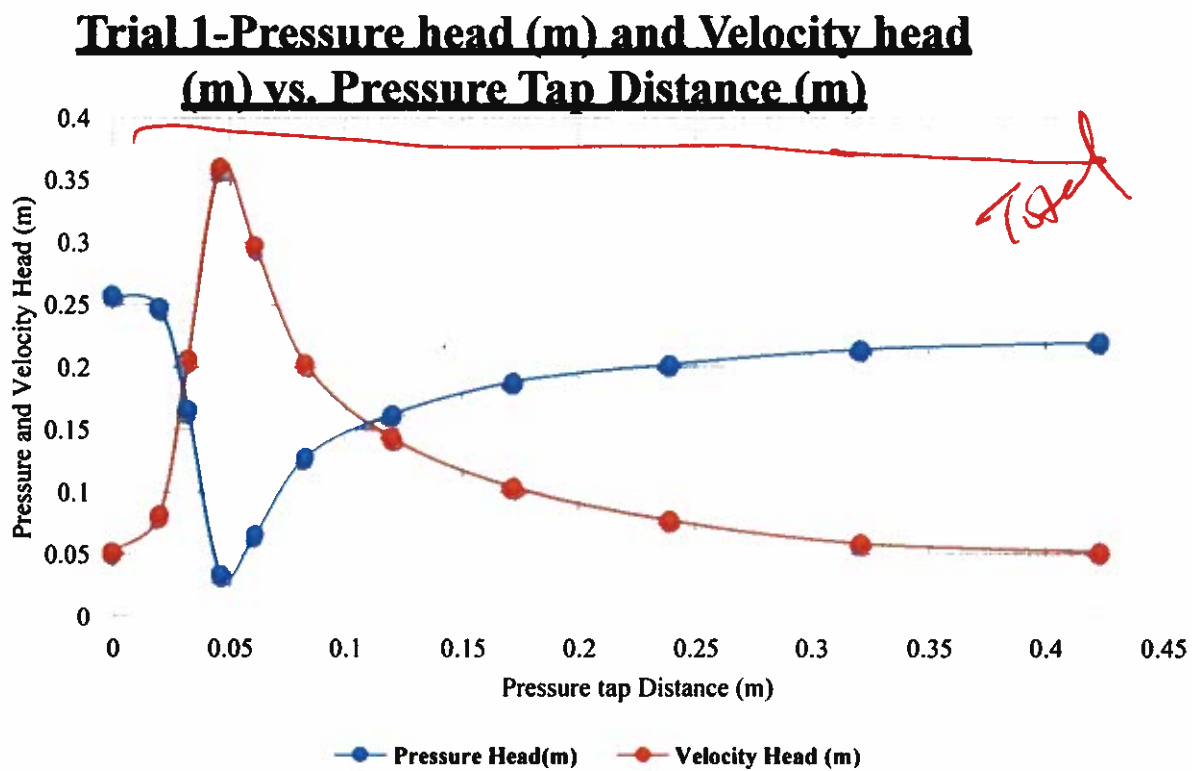
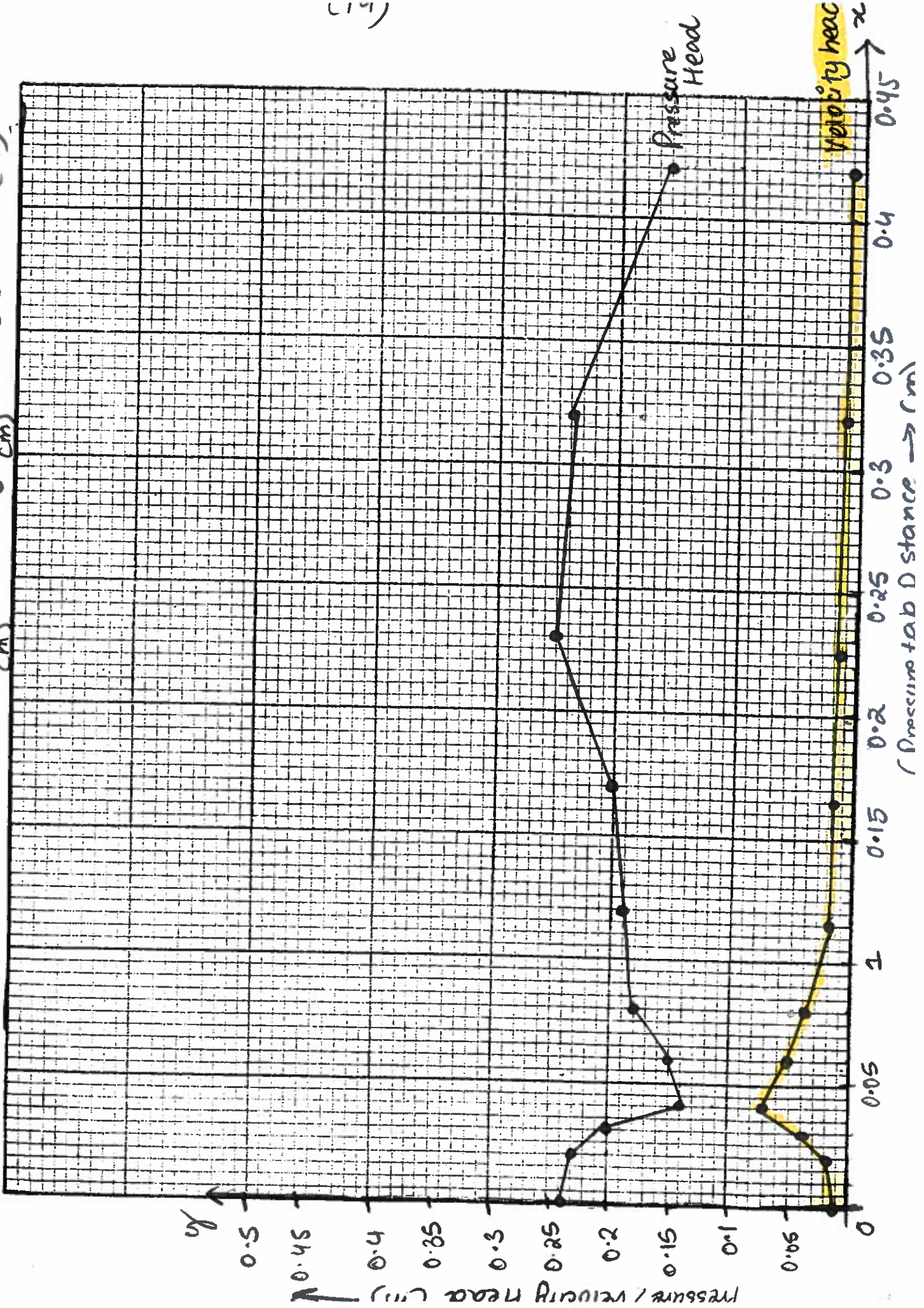


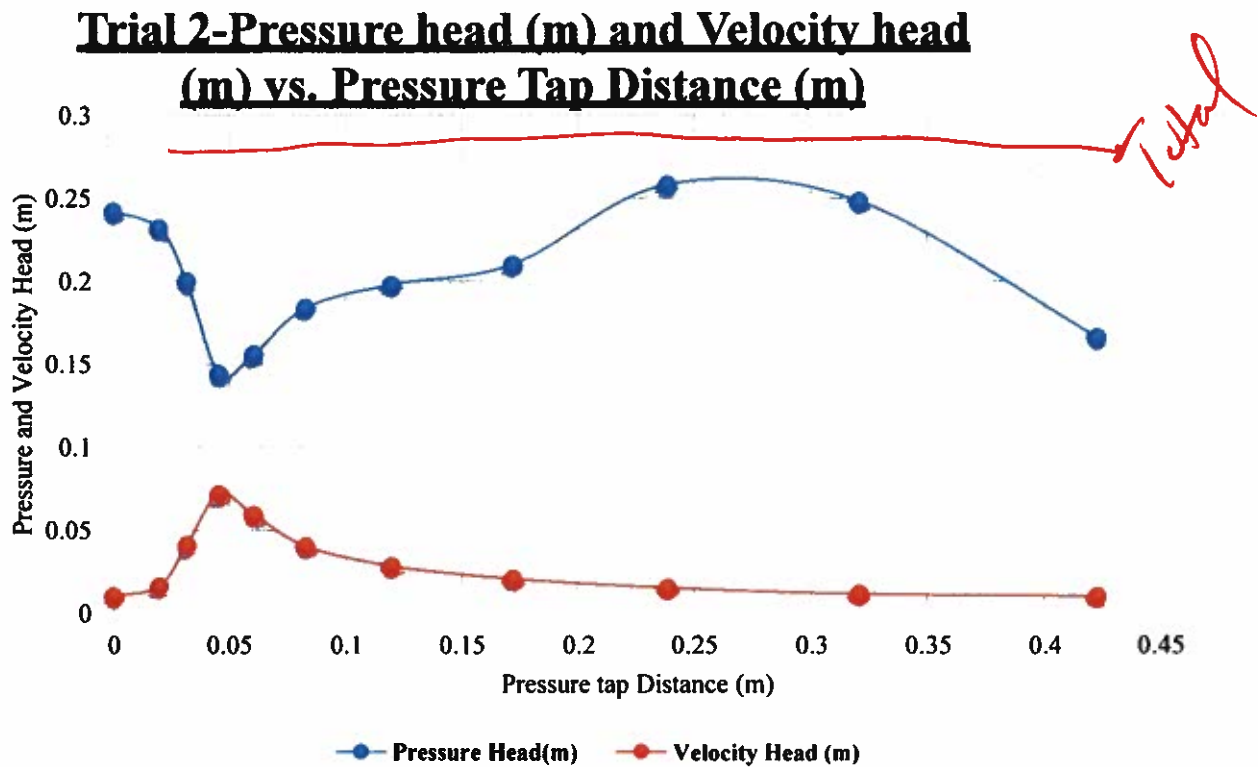
Table 6: Data used for Graph 3-Trial 2: Pressure head and Velocity head against the pressure tap Distance:

Tap #	Pressure Tap Distance (m)	Pressure Head (m)	Velocity Head (m)
A	0	0.242	0.0103
B	0.02	0.232	0.0162
C	0.032	0.200	0.0410
D	0.046	0.144	0.0717
E	0.061	0.156	0.0591
F	0.083	0.184	0.0404
G	0.12	0.198	0.0284
H	0.172	0.210	0.0207
J	0.239	0.258	0.0153
K	0.321	0.248	0.0116
L	0.423	0.166	0.0103

GRAPH 2: TRIAL 2 - Pressure head & Velocity head vs. Distance (m)



Graph 4: Digital Representation of Trial 2-Pressure head (m) and Velocity head (m) against the pressure tap Distance (m)



SOURCES OF ERROR:

There can be many sources of ~~error~~^{errors} that could have contributed to the percentage of error in the experiment. One error analyzed was human or personal error, while recording the piezometric head readings. This is because, the reading must be accurate, and the observer's eyes must be perpendicular to the scale to ensure the readings are precise. The readings could have been misinterpreted. Also, another error could have occurred while recoding the time for the weight scale to come back to its position. The stopwatch could either have started or stopped, either earlier than expected or could have been delayed. These account for personal errors.

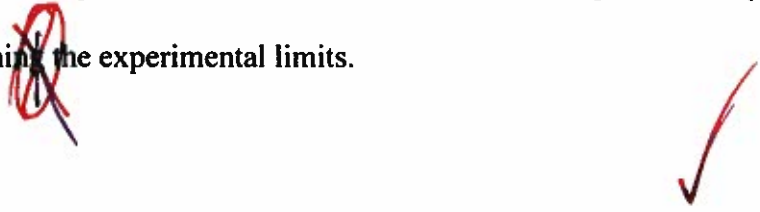
Another error encountered was that the group members were not familiar with the equipment during the first couple of trials. This can also negatively affect the efficiency of the experiment and contribute to the amount of error in the experiment. The group performed only 2 trials for each flow, and so if there were more than 2 trials taken, it might have reduced the percentage of error.

CONCLUSION:

In this experiment, a gravimetric bench and a Bernoulli apparatus was used to verify the validity of Bernoulli's Theorem. The results in the experiment verify and agree with the Bernoulli Theorem as it can be clearly seen from the data tables that as the pressure decreases, velocity increases. Same is true for the Bernoulli theorem, according to which the relation of pressure and velocity is inversely proportional.

According to table 4-Piezometric Results and calculations, percent difference of TH from Tap# A was calculated, assuming Tap# A to be the reference point. The percentage errors obtained were 27.74% for high flow and 2.57% low flow. As explained in sources of error section, there could be numerous reasons for this error, and they could have been minimized if more trials were performed.

Nonetheless, this experiment was successful the Bernoulli equation was put to test and was validated within the experimental limits.



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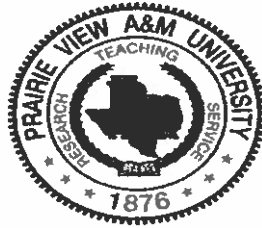
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AVERAGE

Department of Civil & Environmental Engineering



CVEG 3303 P81 Hydraulics Lab Fall 2021

Laboratory Number 04

BERNOULLI EQUATION

Thursday, 11-11-2021 – 02:00 pm

Group Members (Group 2)

Jason Garza. Student 1

Luis Guzman. Student 2

Markus Hartfield. Student 3

Omar Hunter. Student 4

Submitted to: Dr. Emmanuel U. Nzewi

Submitted by: Luis Guzman. Student 2

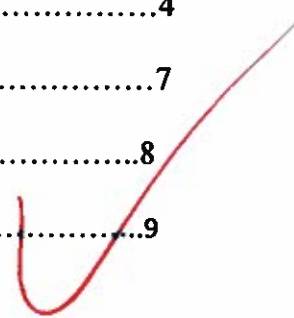
Date Submitted: 11/29/2021

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1. Objective:

To check how is Bernoulli equation valid for the flow of water in a venturi which is the tapering circular conduct.

2. Overview:

When the fluid is moving through a duct with a velocity V and in a uniform area A , then the volume flow rate is defined as:

$$Q = A \cdot V, \text{ and the mass flow rate can be defined as: } m = \rho A V$$

When The area isn't uniform we should integrate the area where the fluid is passing:

$$Q = \int V dA$$

In this case, we assume that the area is uniform and deal with the mean velocity, where this assumption can't be taken as a real state it is just the ideal case.

The continuity equation:

For steady state flow:

$$\rho_{in} V_{in} A_{in} = \rho_{out} V_{out} A_{out}$$

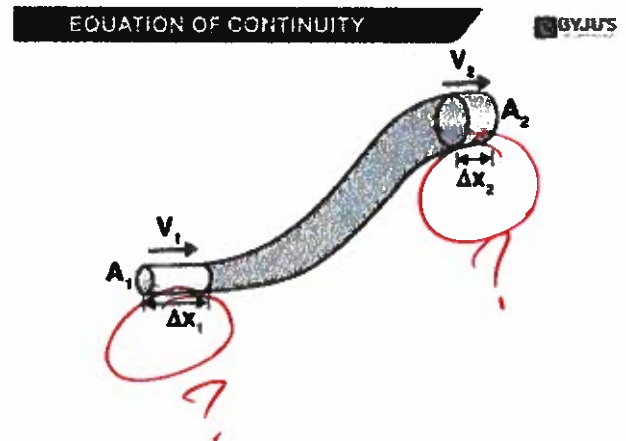
For incompressible flow (constant ρ):

$$V_{in} A_{in} = V_{out} A_{out}$$

The Bernoulli Equation:

$$Z_1 + \frac{p_1}{\gamma} + \frac{v_1^2}{2g} = Z_2 + \frac{p_2}{\gamma} + \frac{v_2^2}{2g}$$

v_1^2



3. Apparatus:

- Hydraulics Bench
- Bernoulli Equation Apparatus

4. Procedures:

- Open the valve at certain openings
- Record the reading of the flow rates at high and low rates with the volume-time method
- Take the reading of piezometer head at all sections

5. Data and Report presentation:

- Table 1 flowrates measurements

Trials	Mass added	time (sec)	mass flow rate (kg/sec)	flow rate (m ³ /sec)
high flow 1	2	15.2	0.131578947	0.000131579
high flow 2	2	16.72	0.119617225	0.000119617
Average			0.125598086	0.000125598
low flow 1	2	16.01	0.124921924	0.000124922
low flow 2	4	27.6	0.072463768	0.000072463768
Average			0.098692846	0.000065360546

Where the working fluid is water with a density of 1000 kg/m³

Using continuity equation, $m = \rho Q$, $Q = \frac{m}{\rho}$

Getting the velocity at the first tap using continuity, so:

For high flow rater $Q = 0.000125598 = AV$, Area of tap $A = 0.0005309 \text{ m}^2$

So, $V = 0.2365 \text{ m/sec}$ assuming that the actual and theoretical velocity at this section is

the same

For low rate by the same concept, $V = 0.185 \text{ m/sec}$

- Getting the theoretical velocity at the rest of the section using the Bernoulli equation by taking tap A as reference.

Neglecting the potential head

$$\frac{PA}{\gamma} + \frac{V^2 A}{2g} = \frac{p}{\gamma} + \frac{V^2}{2g}$$

Therefore:

$$\text{High flow } \frac{p}{\gamma} + \frac{V^2}{2g} = 0.3178555$$

$$\text{Low flow } \frac{p}{\gamma} + \frac{V^2}{2g} = 0.3167631523$$

By substituting with the head of pressure

We get the velocity at each section the theoretical velocity

Getting the actual velocity using the continuity equation since the Q is constant

- For high flow, $0.000125598 = AV$
- For low flow, $0.000065360546 = AV$

By this, we get the actual velocity at each section

6. Results:

difference

Trial	Tap	H(m)	d	A(mm)	A(m ²)	Va (m/sec)	Vth (m/sec)	Vha (m)	Tha (m)	difference of total head from tap %
1	A	0.315	26	530.9	0.0005309	0.236575789	0.236575789	0.002855515	0.317855515	0
	B	0.31	23.2	422.7	0.0004227	0.297132718	0.392387697	0.004504482	0.314504482	1.453058793
	C	0.25	18.4	265.9	0.0002659	0.472350508	1.153242431	0.011383418	0.261383418	4.55336739
	D	0.162	16	201.1	0.0002011	0.624554948	1.747789491	0.019901474	0.181901474	12.28486025
	E	0.18	16.79	221.4	0.0002214	0.567289973	1.643766439	0.016419281	0.196419281	9.121822941
	F	0.236	15.47	267.9	0.0002679	0.468824188	1.266636532	0.011214088	0.247214088	4.751732086
	G	0.252	20.16	319.2	0.0003192	0.393477444	1.136119758	0.007899209	0.259899209	3.134606791
	H	0.268	21.84	374.6	0.0003746	0.335285638	0.988518136	0.005735534	0.273735534	2.140124487
	I	0.278	23.53	434.8	0.0004348	0.288863845	0.883837148	0.004257261	0.282257261	1.531388952
	K	0.286	25.21	499.2	0.0004992	0.251598558	0.790169668	0.003229685	0.289229685	1.129260636
	L	0.29	26.9	530.9	0.0005309	0.236575626	0.738896545	0.002855512	0.292855512	0.984659165
2									0	
	A	0.325	26	530.9	0.0005309	0.185897242	0.185897242	0.001763152	0.326763152	0
	B	0.315	23.2	422.7	0.0004227	0.233481159	0.480164342	0.002781299	0.317781299	0.882951923
	C	0.245	18.4	265.9	0.0002659	0.371163919	1.265921718	0.007028707	0.252028707	2.868859946
	D	0.125	16	201.1	0.0002011	0.490763232	1.988606999	0.012288191	0.137288191	9.830553065
	E	0.155	16.79	221.4	0.0002214	0.445765519	1.834818191	0.010138107	0.165138107	6.54071423
	F	0.21	15.47	267.9	0.0002679	0.368393005	1.512798002	0.006924153	0.216924153	3.29721589
	G	0.24	20.16	319.2	0.0003192	0.309186986	1.304054368	0.004877377	0.244877377	2.032240486
	H	0.26	21.84	374.6	0.0003746	0.263460988	1.14392211	0.003541413	0.263541413	1.362081869
	J	0.275	23.53	434.8	0.0004348	0.226983638	1.007252597	0.002628652	0.277628652	0.955873323
	K	0.285	25.21	499.2	0.0004992	0.197701294	0.904741839	0.001994174	0.286994174	0.699710019
	L	0.29	26.9	530.9	0.0005309	0.185896564	0.848856758	0.001763139	0.291763139	0.60797911

7. Graph:

(shown on paper)

8. Source of error

- Mainly the Bernoulli equation in this form doesn't include the friction in the duct, so these affect the results making these small deviations
- Also, the assumption that the area is uniform, and the area isn't uniform
- Some errors that may exist in pressure measuring and flow rate measuring, may affect the results too

So this is a source of error?

No really
why?
meaning?

Piezometric head?

way?
explain?

20

high flow

1: Mass added 2kg $2(3) = 6 \text{ kg}$

2: 2kg $2(3) = 6 \text{ kg}$

Low flow

1 2kg $2(3) = 6 \text{ kg}$

2, 4kg $4(3) = 12 \text{ kg}$

High flow $\frac{P}{\rho} + \frac{V^2}{2g} = 0.317$

low flow $\frac{P}{\rho} + \frac{V^2}{2g} = 0.316$

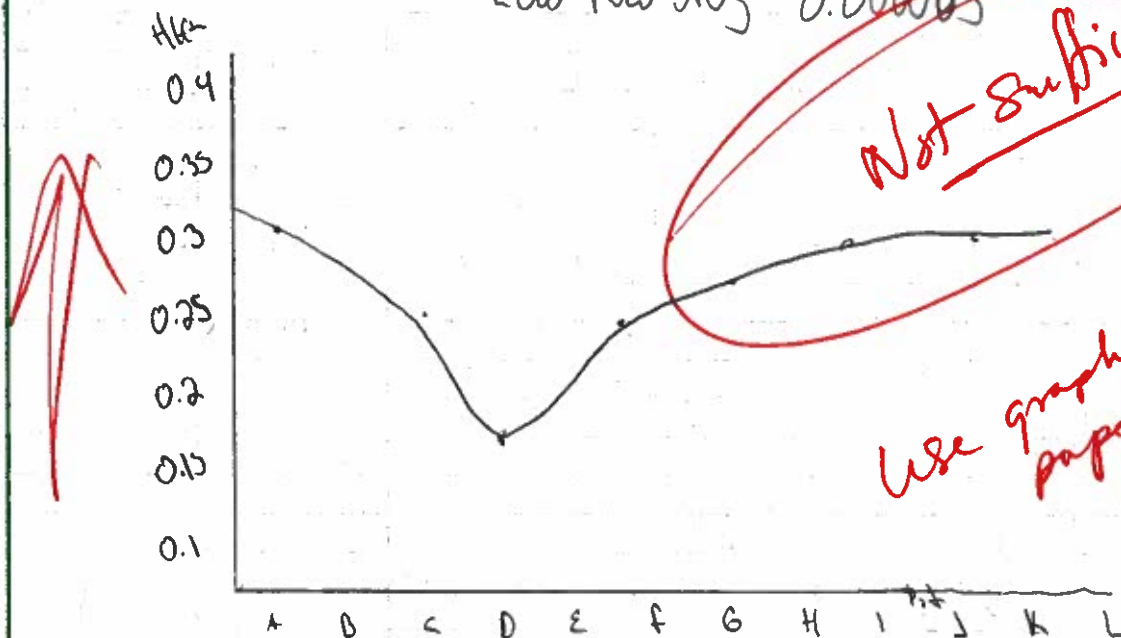
High flow Avg = 0.00012

Low flow Avg 0.000065

MORE
graphs are
required

Not sufficient

Use graph
paper



Label.

150

9. Conclusions:

Based on the results, an error estimate was made to determine the Bernoulli reliability; in the table above, the maximum error is less than 5%, indicating that the Bernoulli equation is reliable.

Bernoulli's equation is valid for ideal fluids that are incompressible, irrotational, non-viscous, and subjected to conservative forces.

Since airflow is compressible and it is not possible to follow density changes to quantify the actual pressure change, Bernoulli's equation cannot be used to predict the amount of curvature of the ball.

The Bernoulli equation should only be applied when ALL of the following conditions are met: The Bernoulli equation can only be applied along a flow line, i.e. between points on the SAME flow line. mixed jets, pumps, motors, and other areas where turbulent or mixing fluids are present

-70

10. References

The Trustees of Princeton University. (n.d.). *Bernoulli's equation*. Princeton University. Retrieved November 29, 2021, from https://www.princeton.edu/~asmits/Bicycle_web/Bernoulli.html.

***Bernoulli equation*. Pressure. (n.d.). Retrieved November 29, 2021, from <http://hyperphysics.phy-astr.gsu.edu/hbase/pber.html>.**

Laboratory 04 manual .

BELOW
AVERAGE

1
CVEG 3303 P81

Hydraulics Lab

Fall 2021

Laboratory Number 04 - **Bernoulli Equation**

Thursday, 11/18/2021 - 2:00 PM

Group Members (Group #5)

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Date submitted: **11/30/2021**

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numbered*

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Objective

1. Use the apparatus to study the effect of area of the flow velocity and fluid pressure
2. Use the Bernoulli's equation to compare the behavior of ideal and real fluid

See
expt.
obj

Introduction

In a fluid system, with factors such as airflow and current, and the increase in flow velocity, the pressure produced by fluid will likely decrease. Daniel Bernoulli discovered this principle in 1738, and thus, is called the Bernoulli's Principle. The content of Bernoulli's principle states that when an incompressible fluid flows steadily in a duct, with the increase in flow velocity, the static pressure of the fluid will decrease. Inversely, with the decrease of flow velocity, the static pressure of fluid will increase. However, the total magnitude of static pressure and kinetic pressure of fluid is constant.

Considering flow at any two positions on the central streamline of the tube (Fig. 1), Bernoulli's equation may be written as

$$z_1 + \frac{v_1^2}{2g} + \frac{p_1}{\gamma} = z_2 + \frac{v_2^2}{2g} + \frac{p_2}{\gamma}$$

Bernoulli's equation proves that the sum of the velocity head ($V^2/2g$), pressure head (p/γ), and elevation (z) are constant along the central streamline. In the case of this lab, the tube is horizontal so $z_1 = z_2$, and the pressure heads ($h_1 = p_1/\gamma$) and ($h_2 = p_2/\gamma$) can be measured from common data so that Bernoulli's Equation simplifies as well.

Where?

12/28

Handwritten signature or initials.

Equipment

- Hydraulic bench with Bernoulli apparatus
- Stopwatch

Procedure

1. Attach the apparatus with the power supply but keep the supply off
2. Turn on the power supply to run the pump and adjust the flow rate control valve until water level in all the manometers is at readable range.
3. Place stop plug in basin
4. Note the time required to fill the basin with specific amount of water
5. Remove the stop plug to drain out all the water from the water
6. Place the dynamic pressure probe with the static pressure port and measure the manometer data from both of the probes
9. Now place the dynamic pressure probe with next static pressure probe and measure the manometer data from the probes
10. Repeats the above steps for measuring data from all the manometer probes
11. Determine which set of data is higher flow and lower flow by analyzing probes
12. Turn off the pump and set off the power supply

which are not the Bernoulli apparatus

??
NO

-30

Data



TABLE 1. MEASUREMENT OF FLOWRATE [TECQ - VENTURI APPARATUS] & GRAVIMETRIC BENCH

Trial	Mass Added [M] [kg]	Mass X3 [M2] [kg]	Volume Vol [m ³]	Time [t] [s]	Flowrate [Q] [m ³ /s]
HIGH FLOW 1	2 kg	6 kg	0.006 m ³	13.9	0.0004
2	4 kg	12 kg	0.012 m ³	28.5	0.0004
				Average (HIGH)	0.0004
LOW FLOW 1	2 kg	6 kg	0.006 m ³	22.4	0.0003
2	4 kg	12 kg	0.012 m ³	45.3	0.0003
				Average (LOW)	0.0003

TABLE 2. PIEZOMETER READING AND RESULTS

Trial #	Tap # or Section (location (mm))	Diameter at Section [mm]	Piezometric Head h [mm]	Piezometric Head h [m]	Area A [mm ²]	Area A [m ²]	Actual Velocity V _a [m/s]	Theoretical Velocity V _t [m/s]	Actual Velocity Head V _h [m]	Actual Total Head TH _a [m]	Percent Difference of TH from Tap #A [%]
1 high rate	A [-54.0]	26.00	252	0.252	530.9	5.309 × 10 ⁻⁴	0.753		0.819	-49.08	9.17%
	B [-34.0]	23.20	245	0.245	421.7	4.217 × 10 ⁻⁴	0.796		1.14	-31.016	8.1%
	C [-22.0]	18.40	170	0.17	267.9	2.679 × 10 ⁻⁴	1.509		2.43	-20.262	7.9%
	D [-08.0]	16.00	64	0.064	201.1	2.011 × 10 ⁻⁴	1.609		4.02	-7.76	3%
	E [07.0]	16.79	88	0.088	221.4	2.214 × 10 ⁻⁴	1.801		3.33	-6.79	3%
	F [22.0]	18.47	142	0.142	267.0	2.670 × 10 ⁻⁴	1.493		2.311	-10.46	2%
	G [37.0]	20.16	170	0.170	318.2	3.182 × 10 ⁻⁴	1.253		1.74	-34.336	7.2%
	H [52.0]	21.84	192	0.192	374.0	3.740 × 10 ⁻⁴	1.068		1.33	-48.464	6.5%
	J [67.0]	23.53	202	0.202	434.8	4.348 × 10 ⁻⁴	0.919		1.05	-62.511	6.7%
	K [82.0]	25.21	214	0.214	499.2	4.992 × 10 ⁻⁴	0.801		0.856	-76.67	6.5%
	L [102.0]	26.00	223	0.223	530.9	5.309 × 10 ⁻⁴	0.753		0.792	-94.758	7.1%
2 low rate	A [-54.0]	26.00	244	0.244	530.9	5.309 × 10 ⁻⁴	49.323		1.88 × 10 ³	-44.14	9%
	B [-34.0]	23.20	238	0.238	421.7	4.217 × 10 ⁻⁴	54.412		2.96 × 10 ³	-31.28	8%
	C [-22.0]	18.40	195	0.195	267.9	2.679 × 10 ⁻⁴	66.499		7.48 × 10 ³	-20.31	7.7%
	D [-08.0]	16.00	146	0.146	201.1	2.011 × 10 ⁻⁴	84.371		1.31 × 10 ⁴	-7.73	3.4%
	E [07.0]	16.79	158	0.158	221.4	2.214 × 10 ⁻⁴	103.536		1.07 × 10 ⁴	-6.74	3.7%
	F [22.0]	18.47	180	0.18	267.0	2.670 × 10 ⁻⁴	85.413		7.77 × 10 ³	-10.42	7.2%
	G [37.0]	20.16	200	0.2	318.2	3.182 × 10 ⁻⁴	72.155		5.21 × 10 ³	-34.48	6.8%
	H [52.0]	21.84	210	0.21	374.0	3.740 × 10 ⁻⁴	61.399		2.77 × 10 ³	-48.57	6.6%
	J [67.0]	23.53	218	0.218	434.8	4.348 × 10 ⁻⁴	52.898		2.0 × 10 ³	-62.78	6.3%
	K [82.0]	25.21	222	0.222	499.2	4.992 × 10 ⁻⁴	46.074		2.12 × 10 ³	-76.99	6.1%
	L [102.0]	26.00	218	0.218	530.9	5.309 × 10 ⁻⁴	49.323		1.88 × 10 ³	-94.47	6.9%

480

OK but data needs to be analyzed
4/5

Calculations and Analysis

Calculations:

- piezometric head $\rightarrow$ mm to m $= \times 10^{-2}$

- area $\rightarrow$ given $\rightarrow$ convert mm^2 to $\text{m} = \times 10^{-6}$

- Actual velocity $= \bar{V} = \frac{Q}{A} = \frac{0.0041 (\text{m}^3/\text{s})}{\text{Area} (\text{m}^2)} \leftarrow$ found Q for high rate previously

$$= \frac{0.023 (\text{m}^3/\text{s})}{\text{Area} (\text{m}^2)} \rightarrow \text{for low rates}$$

- $V_{HA} \rightarrow$ found using Bernoulli's equation:

$$\left(\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 \right) = \left(\frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 \right)$$

$\underbrace{\left(\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 \right)}_{\text{piezometric head}} = \underbrace{\left(\frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 \right)}_{\text{velocity head}}$

$$\rightarrow \text{ex: } 0.252 + \frac{V_1^2}{2g} = \left(\frac{V_2^2}{2g} \right)$$

The Bernoulli's Equations proved the results of the experiment and its calculations

Sources of Error

$\rightarrow$ Calculated in Percentage Difference from THa (m) from given Tap #, due to different variations and calculations from readings

lacking much analysis

-100

How?

Discussion of results

Experimental error?

more

-60

-110

Conclusion

In this experiment, with the measurement of the static head, the relationship between the static head and the kinetic head is existing according to Bernoulli's equation.

The aim of this experiment was to discuss the behavior of ideal and real fluid and on the basis of the test result it can be concluded that the experiment was successful because there is difference in measured and theoretical values. This is because of the friction losses in the real fluid; ideal fluid does not have friction losses. From the experiment it can be concluded that with decrease in area of flow there is an increase in velocity and decrease in the flow pressure of the fluid.

Ref ?
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