SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

Revisions to General Education Requirements

SDSU	Natural Sciences / Physics	Dennis D. Hedge	3/13/2019
Institution	Division/Department	Institutional Approval Signature	Date
SDSU	Larry Browning	Matt Miller	2/14/2019
Institution	Form Initiator	Dean's Approval Signature	Date

Indicate (X) the component of the General Education Curriculum that the proposal impacts.
X System General Education Requirements

Indicate (X) the revision(s) that is being proposed (more than one may be checked).
___ Revision to an approved course
X Addition of a course to the set of approved courses
___ Deletion of an approved course from the set of approved courses

Section 1. Provide a Concise Description of the Proposed Change
Add PHYS 115-115L to the list of courses approved to meet SGR #6 Natural Sciences requirement.

Section 2. Provide the Effective Date for the Proposed Change
Fall 2019.

Section 3. Provide a Detailed Reason for the Proposed Change
The components of the PHYS 115-115L Physics of Structures and Buildings & Lab course correspond with the SGR #6 objectives, and thus the department seeks approval and inclusion of PHYS 115-115L on the designated list of SGR #6 courses.

Section 4. Provide Clear Evidence that the Proposed Modification will Address the Specified Goals and Student Learning Outcomes
The SGR #6 goal and objectives are detailed below, along with specific means by which this course will address the general education goal and achieve each objective. The course description is provided here for reference:

Course Description: PHYS 115 Physics of Structures and Buildings: Students will learn and apply concepts of physics to buildings and structures using algebra and trigonometry. Principles of Newton and Kirchhoff's laws will be developed into mechanics, oscillations, thermodynamics, fluids, and circuits to explain the stability and failure of structures. Additional applications will focus on infrastructures (heating, wiring, lighting, acoustics, etc.) and energy concerns.

SGR #6 Goal: Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world.

SGR #6 Student Learning Outcomes: As a result of taking courses meeting this goal, students will:

a. *Explain the nature of science including how scientific explanation are formulated, tested, and modified or validated.*
    i. As a result of PHYS 115-115L, students will gather data from demonstrations or activities and use this data to illustrate principles of measurement and scientific reasoning either as a whole class or in small groups or individually. Students will therefore develop an appreciation of peer review, significant figures and error analysis along with the application of the laws of nature to evaluate their data and confirm the physical concepts. It should be noted that the grading method mimics the data collection and analysis used throughout physics and laboratory work. Various technologies may be utilized to facilitate the data collection and analysis (e.g. Vernier's Logger Pro and Video Analysis programs in conjunction with various sensor technologies). Einstein's model of science is used throughout this course (Einstein, Atbert (1934) ***Letters to Solovine 1906-1955***. New York, NY; Philosophical Library. Pages 122-123)
        1. Assessed through classroom activities and the laboratory portion of this course, PHYS 115L, with written lab reports, exams, homework, and quizzes. Technology (e.g. WebAssign, Plickers, D2L, Turning Point Response System, Socrative) is often employed to facilitate this assessment.

b. *Distinguish between scientific and non-scientific evidence and explanations, and use scientific evidence to construct arguments related to contemporary issues.*
    i. Examples of contemporary issues relevant to students' fields of study (construction and architecture) are often used as starting points of lecture discussions and numerical examples. Homework problems are often chosen for assignments because of their relevance to contemporary issues (as well as the physics concepts under development e.g. energy needs and losses in housing). One example is heat loss through a basement wall. Students are also encouraged to do ADA compliance surveys.
        1. Assessed through exams, successful completion of homework, laboratory, and in-class activities related to contemporary issues (R-factors) as well as through extra credit projects chosen by the students (ADA survey).

c. *Apply basic observational, quantitative, or technological methods to gather and analyze data and generate evidence-based conclusions in a laboratory setting.*
    i. Physics 115-115L students will demonstrate the scientific method in a laboratory experience by collecting data, find patterns in data with graphs, tables, or other means; and apply formulas from theories to explain the patterns.
    ii. Each laboratory (typically 9 or 10) in this course is an example of applying scientific methods to apply concepts to physical phenomena. During laboratories, students will observe phenomena, make measurements (take data) and analyze

that data to confirm or discover the connection with basic principles by applying mathematical models to the data.

   1. Assessed though the laboratory portion of the course, PHYS 115L, by writing and submitting laboratory reports for evaluation by a graduate student or faculty member.

d. *Understand and apply foundational knowledge and discipline-specific concepts to address issues, solve problems, or predict natural phenomena.*

   i. Applications of physics will be developed from basic principles and theories (e.g. Newton's Laws, Coulomb's Law/Maxwell's equations, Kirchhoff's Laws) during lecture and in the text. These applications will be applied to problems related to construction and architectural issues such as truss analysis and electrical requirements for buildings. Students will be exposed to appropriate use of physics terminology in all elements of the course (lecture, recitation, lab, text, homework).

      1. Assessed through course examinations (summative), homework (formative), and class activities (formative) with applications of Physics concepts being the primary goal. When possible, other terminology will be introduced (e.g. physics: torque; engineering: moments – same concept but different conventions). Effective communication of concepts will be developed through discussions and evaluated in lab reports and the students' ability to understand and respond correctly to examination questions.

Each course meeting this goal must include the following student learning outcomes: a, b, c and d.

Section 5. Provide a Copy of all Course Syllabi and Other Supporting Documentation
Please see attached.

[See Attachments for Syllabus, schedule, sample final (similar to homework), and sample laboratory.]

SYLLABUS

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CATALOG DESCRIPTION:

PHYS 115/115L Physics of Structures and Buildings and Lab (experimental) [credits: 4] – Concepts of physics will be developed by applying them to buildings and structures using algebra and trigonometry. Newton's laws and mechanics, oscillations, thermodynamics, fluids, and circuit concepts will explain the stability and failure of structures. Additional applications will focus on infrastructures (HVAC, DWV, wiring, etc.) and energy concerns. Prerequisite: MATH 102, 115, 120, 121, 123, 125, 281 or consent. Corequisites: PHYS 115L-PHYS 115. **PHYS 115L Physics of Structures and Buildings Lab** – This laboratory accompanies PHYS 115. [Course meets SGR #6].
Be sure to register for both PHYS 115 and PHYS 115L!

Dates for EXAMS and FINAL:

EXAMS: Sept. 16 (W), Oct.16 (W), Nov. 13 (W), and Dec. 10 (M) [unless noted in class]

Final: Friday, Dec. 18 (?), from 1:45 to 3:45 PM in SCEH 204

INSTRUCTOR: Larry Browning:

Office @SDSU: SDEH 267; phone: (605) 688-4548; after class (MW@5:40 PM), Tuesdays at 10 AM, and by appointment.

e-office @ https://meet.lync.com/jackssdstate-sdstate/larry.browning/NJAXJM7M (?)

E-mail: Larry.Browning@sdstate.edu. Please use this e-mail and include "PHYS 115" in the Subject. Questions about WebAssign problems are best asked by using the "Ask your Teacher" button in WebAssign.

Materials:

D2L and WebAssign are required. You must self-enroll at www.webassign.com using the Class Key: **sdstate 6483 6985 (?).**

Required text: Yehuda Salu, **Physics for Architects (2nd Ed.) -- http://physicsforarchitects.com/ .**

You will also need: a scientific calculator and a device to access the internet in class and lab (e.g. tablet, smartphone), USB/Flash drive (for lab).

METHODS:

- **Interactive Lecture supported with response systems (e.g. Plickers, Socractive), simulations (e.g. PHeT), and data collection (e.g. PhyPhox, Sensor Kinetics, Physics Toolbox, etc.);**
- **F2F with Electronic support (live chat, recording of lectures, recording of problem solutions, etc.) and made available through WebAssign and D2L/content;**
- **Lab (with electronic submission of reports on D2L – PHYS115L/Assessments/Dropbox).**

Required and Recommended MATERIALS and Software:

- D2L
- WebAssign account (www.webassign.com). Use the Class Key: **sdstate 8768 8521 (?).** WebAssign access cards are available at the SDSU Bookstore. This includes an e-book of the text.
- Text (WebAssign): Yehuda Salu, **Physics for Architects (2nd Ed.) -- http://physicsforarchitects.com/**
- Scientific or Graphic Calculator (permitted/required on exams)
- Device with internet access (uses: submit exams/homework/labs/surveys, view PPTs & recordings, etc.)
- USB drive (AKA "Jump" or "Flash" drive) – bring this to labs to download your data and scans.
- Software:
  - Vernier **Logger *Pro*** program is available for you to download. This will be useful for labs and may be used for special projects for lecture and data collection and analysis in laboratory. Links to download this program are available on D2L.
  - Microsoft **Skype for Business** (https://meet.lync.com/jackssdstate-sdstate/larry.browning/NJAXJM7M) (?) will be used for electronic office hours and to record sessions, which will provide solutions to problems, review for exams, and class material when necessary. Skype for Business may already be on your computer if it is running MS Office. Information concerning Skype/Lync for desk or lap tops is available at: https://support.office.com/en-us/article/Install-Lync-8a0d4da8-9d58-44f9-9759-5c8f340cb3fb. Skype/Lync information for mobile devices is found at: https://support.office.com/en-us/article/Microsoft-Lync-2013-for-Mobile-Clients-6eb97a69-d0dd-4dba-8598-28cf8535ed29?ui=en-US&rs=en-US&ad=US. Skype for Business/Lync training is available at: https://support.office.com/en-us/article/Lync-2013-training-courses-videos-and-tutorials-411f15d5-64ce-4b9e-a3c0-193690d85eb6?ui=en-US&rs=en-US&ad=US
  - Office Lens (lab): https://www.microsoft.com/en-US/store/apps/Office-Lens/9WZDNCRFJ3T8
  - Snipping Tool (Windows): http://windows.microsoft.com/en-us/windows/use-snipping-tool-capture-screen-shots#1TC=windows-7 [Apple laptops have a similar product.]
  - Apps to uses sensors in Smart Device
    - PhyPhox: https://phyphox.org/
    - (The following products work for both platforms but not equally well):

- Android: Physics Toolbox: http://www.vieyrasoftware.net/
- For iOS: Sensor Kinetics: http://rotoview.com/index.htm

  - Vernier's Logger Pro will be provided. See D2L for download instructions.
    - screencasts at: http://www.vernier.com/products/software/lp/

Calculators are permitted during exams. Check your D2L (https://d2l.sdbor.edu/) and WebAssign accounts (http://www.webassign.com/) regularly for announcements, exam results, and reserve materials. You should submit electronic materials (lab and personal point reports) to the "Drop Boxes" in D2L in PHYS 115 and PHYS 115L as appropriate. You will need access to a computer and the internet. Such access is available through the university at various locations if you do not have it at home.

Online Resources:

- Yehuda Salu, **Physics for Architects (2nd Ed.)** -- **http://physicsforarchitects.com/** (also WebAssign)
- PhET Interactive Simulations: http://phet.colorado.edu/
- Hyper Physics: http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
- The Physics Classroom: http://www.physicsclassroom.com/
- A+ Physics: http://www.aplusphysics.com/index.html
- Tracker video analysis and modeling tool: https://physlets.org/tracker/

Specific Course Goals and Objectives:

Primary: the discovery and study of nature's physical rules and the application of those rules in specific situations related to Construction Management and Architecture. Secondary: development of problem solving and mathematical skills. In addition, the derivative nature of physics will be an integral part of the course development. Specifically, PHYS 115 will be a systematic, quantitative, and qualitative study of (in this order, with chapter and mathematical references):

- Introduction: Math (algebra, geometry, trigonometry), Measurements, conversions, scientific notation (Ch 1);
- One-Dimensional Motion: describing motion; reasons for motion (or none) – Newton's laws, forces (i.e. gravity, elastic, normal, friction), statics and dynamics including oscillations [Ch 2; algebra (linear and quadratic equations, reciprocals, and square roots), sines and cosines]
- Two- and Three-Dimensional Motion: Vectors (representations and how to add and subtract them); Newton's Laws expanded for translations and rotations (torques) [Ch 3; trigonometry, products of vectors, simultaneous equations)
- Statics (dead loads): equilibrium; Center of Gravity/Mass; applications to beams, ladders, arches, trusses, and bridges, stress & strain (elastic moduli), hydrostatics [Ch 4; algebra of sums, simultaneous relations, ratios and proportions, trigonometry]
- Lateral Forces (living and dead): Winds loads (living and shape dependent); earthquake loads (living and inertial), hydrostatic (dead and shape dependent) [Ch 5: algebra and geometry]
- Work, Energy, Power, Momentum: kinetic and potential energy, conservation and dissipation of energy, power, and conservation of momentum [Ch 6: algebra, quadratics, vector scalar product]
- Heat and Thermodynamics: Temperature scales (measures of internal kinetic energy), thermal expansion, ideal gas, First and Second laws of Thermodynamics, specific heat, latent heat, humidity, heat transfer (radiation, conduction, convection), R-value and thermal resistance, insulation of

buildings [Ch 7: algebra]

- Electricity: electric forces and charge currents – resistance, current, voltage, energy, and power, DC & AC power generation, series and parallel circuits, house wiring and some safety concerns [Ch 8: algebra, simultaneous equations]
- Optics: nature of light (speed, wavelength, frequency, quantization, energy, generation), perception of light, intensity of light and absorption, reflection, refraction, lenses and mirrors for control [Ch 9: algebra, geometry, trigonometry, exponentials]
- Acoustics: sound waves, Fourier combinations, intensity/loudness (decibels, etc.), absorption, reflection, refraction, transmission, reverberation, interference, resonance, diffraction, diffusion [Ch 10: algebra, geometry, trigonometry, exponential and logarithmic functions]

GRADING:

Course grades will be based on a total of 700 points. Your "Class Points" will be accumulated from regularly scheduled exams, quizzes, homework and recitation assignments, and laboratories. These are the points used to determine the grade cut-offs for the class. Your "Personal Points" are earned from extra credit activities. Class and Personal points will be added together to determine your personal grade after the class statistics have been determined. Maximum cut-offs are listed below and are not statistical. Actual cut-offs may be "curved" using Gaussian distribution statistics, but will not be raised above the maximum levels below.

MAX SCORE		Grade	Max Cut-offs	Curve	Z-Score
Exam 1:	=200	A	644 (92%)	Avg + St Dev	1
Exam 2/Final:	=300	B	588 (84%)	Avg	0
HW/Q:	≅150	C	518 (74%)	Avg - St Dev	-1
Lab:	≅ 50	D	420 (60%)	Avg - 2×St Dev	-2

Total Possible = 700 (+ Extra Credit) Extra Credit $\leq \Delta Z = ½$

That is to say, grade cut-offs are determined before personal points are added to an individual's scores so that grade cut-off are based on "class points" while your individual grade will be calculated on the sum of your "class points" and "personal points."

Class points

Class points are the majority of your points and are the points used for the statistical model discussed below. *Class points* are earned in the following ways:

- Final score (summative),
- In-Class Exam scores (summative),
- Homework and Quiz scores (formative),
- Laboratory scores (formative).

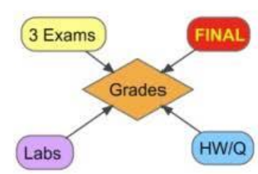


Figure 1: Class points for grade

Personal Points:

Personal or "Extra Credit" ***points*** (limited to half a standard deviation – or half a grade spread – and used to determine borderline cases).
Personal points are less defined. Details of each follow.

FINAL (200 Class Points):

A cumulative FINAL (typically 120 min.) worth 200 points will administered in SCEH 204 on Friday, December 18 (?), starting at 1:45 PM. Expect questions and problems covering all material from this semester, unless announced in class. Scheduling conflicts must be resolved according to the Physics Department "Final Examination Policy" by filling out the required forms.

IN-CLASS EXAMS (400 – 100 = 300 Class Points):

There will be four EXAMS worth 100 points each. Only a student's top three of these will be used to determine their grade. The exams will have Multiple Choice questions, mostly conceptual in nature, as well as free response problems mostly to evaluate your ability to apply principles and to solve problems. Examination dates with expected topics for this semester are indicated below. Review sessions will be conducted the lab before the exam (see lab schedule). Chapters in the text are referenced but in some cases not all of the chapter will be covered and are tentative. Specific topics for exams will be noted in class.

- **Sept. 16 (W) [Math, Vectors, 1-D, 2 & 3-D Motion and Equilibrium] Ch 1, 2, 3**
- **Oct. 16 (W) [Statics and Lateral Forces] Ch 4, 5**
- **Nov. 13 (W) [Work, Energy, Power, Momentum, Electricity, Heat and Thermodynamics] Ch 6, 7, 8**
- **Dec. 10 (M) [Optics and Acoustics] Ch 9, 10**

Exams may be "normalized" so that each exam will count as much as any other exam. An equation sheet will be provided.

Formative Assignment (FA) (150 Class points):

Assessments worth 150 points total will be due throughout the semester. These assessments will be "WebAssign" problems (http://www.webassign.com/) which are often quantitative in nature and "formative" in purpose (having many submissions) to help you "form" your knowledge, skills and mathematical reasoning. These will be similar to the "free response" part of the exams. Questions may also be posed in class with the use of "clickers" or the Socrative program (http://m.socrative.com). **All WebAssign exercises will be due at about 6 PM the day before the exam**. After the due date and time, answers for your problems (they are customized to individual students) will be available for your review. Assignments completed 48 hours before the deadline will receive a 10% bonus to encourage students to keep up with the material. Additional "Self-Study Questions" may be available on WebAssign, but these will not count toward class or personal points.

In the end, the total of the FA assessments will be adjusted to 150 points or one and a half exams.

LABS (Normalized to 50 Class Points):

Because of the empirical nature of Physics, the Physics Department requires that every student in PHYS 115 enroll in, and attend, a laboratory section (PHYS 115L). Students are expected to complete labs worth 50 normalized points, total. Each lab will be scored out of 10 points for the write-up. Your total lab score will be normalized (see below) to your lab instructor's average and standard deviation to produce an Evaluation Ratio (ER) which is the ratio of your score's difference from your lab instructor's overall average to your instructor's overall standard deviation [ER = (Score – Average) / (Std. Dev.)]. The Evaluation Ratio is the same as the parameter "z" mentioned under "***Normalization***" below and is sometimes referred to as a "Z-Score."

Normalizing in this way minimizes differences in lab sections and instructors. The last lab may be taken to substitute for a missed lab or for extra credit if no previous labs have been missed. Some questions from the labs may be used on exams and quizzes. **Missing 3 or more of the required labs (without make-up) is an automatic failure** for PHYS 115/115L, regardless of other scores. Please note that missing just one laboratory may have significant grade consequences. If you are repeating this course, see your lecture instructor. Labs must be completed by **Dec. 6 for any credit**.

NOTE: To complete a lab you must:

- Attend,
- Take data,
- Write-up, and
- Turn-in a complete report in a timely manner as specified by your laboratory instructor.

Please note for LABORATORYS: This is the student's chance to actually experience how the abstract ideas apply to a physical situation. Although these laboratories are closely directed, it is hoped that the student will come away with an appreciation of the connection between theory and experience, between mathematical abstraction and instrumental measurements and the limitations and usefulness of each.

Personal Point Details and Opportunities:

PERSONAL POINTS or "Extra Credit" (limited to half a standard deviation of final total class points): Additional points for your personal score may be earned in a number of ways. This is a way of documenting your interest and effort in this class. It is not a substitute for comprehension but may assist it. It is also an impartial way of deciding borderline cases. One-half letter (i.e. half a standard deviation) is the most these points may raise your course grade. For full credit, all activities should be completed by **December 6** unless special arrangements are made. Some activities may have an earlier deadline. Recommended activities include:

*VISITS: A *trip* to a science museum and an *analysis* of at least three exhibits will earn extra credit. Some places to visit include: in *Pierre*, The South Dakota Discovery Center (http://www.sd-discovery.com/); in *Sioux Falls*, Washington Pavilion's Kirby Science Discovery Center (367-7397, ≈$5, http://www.washingtonpavilion.org/). Some proof of attendance (e.g. a short report and ticket) must be provided with your physics analysis of the experience/exhibit before the extra credit can be awarded. Spooky Science Nights (Oct. 14 at the Kirby Science and Discovery Center) are additional ways to earn Personal Points. Points depend on analysis and the link you make with principles of physics but will usually range from 2 to 7 points.

*DEMONSTRATIONS: Designing and constructing a physics demonstration suitable for use during a lecture will be worth extra credit depending on ingenuity, labor (and number of participants), understanding, and execution. Be sure to check with your instructor before beginning and include in your report/instructions, which physics principles are demonstrated and how, and what problems may arise with the apparatus. Points will depend on ingenuity, complexity of design, effort and finish, and analysis. Points will range from 2 to 20 points.

*EVENTS:

- The *Kirby Science Center* at the Washington Pavilion in Sioux Falls will present its "Spooky Science Night" **Saturday, October 19 (?) (10am- 7pm)** [https://www.washingtonpavilion.org/special-events/spooky-science]. There is an entrance fee, but it is a lot of fun with science. Write a report for extra credit.
- The College of Engineering *Senior Design Conference* on Tuesday, **November 26 (?),** will have several projects on display at the University Student Union with the student/designers explaining their projects throughout the day (8:00 – 4:00 PM). Report on how physics principles play a part in a device or project for extra credit.
- Also attending a career fair for a career you are interested in and ask questions will be worth Personal Points. The maximum points for these events are 10.
- Other events may be announced in class.

*REPORTS: Reports on good or bad usage of physical principles in literature also gain extra credit. Sources for analysis include: manuals for tools and equipment, magazine articles, novels, short stories (especially science fiction), movies, and even cartoons. Be sure to explain WHY (with mathematics and perhaps graphs) a drawing, descriptive passage, etc. can or cannot be correct. Support your thesis by referring to the text in your report. Some books suitable for this project are available from your instructor. A clearly written or typed report, which includes a direct quote of the referenced passage (a scan or photocopy will do), would be appreciated. Good models for this type of report are the books -- L. Krauss and L. M. Krauss: **The Physics of Star Trek**; and J. Kakalois: **The Physics of Superheroes** as well as the books of Michio Kaku [http://mkaku.org/] . Points range from 0 to 5 points.

*QUESTIONS: Authoring multiple choice questions suitable for this course will be worth one-quarter point each. Each question should have one correct answer and at least three incorrect answers all with explanations. Maximum score is 10 points for this activity – or 40 questions.

*Extra Homework points: If you earn more than the maximum number of points for early submission of Formative Assignments on WebAssign, the points above the maximum will be added to your over-all score as Personal Points. This will not affect the class statistics.

*Pre and Post Content Surveys: Personal Points may be awarded for completion of content surveys. These are usually administered on WebAssign or D2L and final survey point may be designed to reward improved performance.

*OTHER: Please feel free to suggest your own extra credit project, but be sure to check with your instructor before beginning. Such projects could include computer programming or making a video. All projects must include a mathematical analysis based on physics principles.

Assumptions and guidelines used for grading: Each semester's class is treated as being about the same as any other semester (exams and other scores may vary but the students probably have about the same ability and motivation). Each TA's set of lab students is also treated as being about as good as any other lab TA's students (lab report scores may vary by TA – "hard grader" vs. "easy grader" – but the students and their efforts are probably about the same). Each exam is worth about as much as any other exam. Exam averages may vary because questions and problems may be harder or easier on a particular exam, but the students' comprehension and mastery should be about the same from exam to exam). Because of the first assumption, grades are based on how well you do relative to your classmates this semester and not historical averages. This last guideline may be relaxed if over-all class averages are so high that it is fairly certain that most students understood most of the material. This is reflected in the "Max Cut-offs" listed. In addition, some students are better at taking tests than others so that it seems reasonable to assume that the assessments used could be inaccurate by half a letter grade (think of this as the "uncertainty of measurement" in grading). The extra credit points (i.e. "personal points") are used to allow a student to use their own initiative to make up for such a situation.

NORMALIZATION: Mathematics used to assess progress and assign grades

As in all classes, someone is required to measure and evaluate how well you understand and can apply the material of the course or have mastered the skills being taught. Measurements in the laboratory often follow a particular statistical pattern called a Normal or Gaussian distribution (sometimes called the "Bell-Shaped curve"). To reflect these measurements, most physics courses at SDSU assume that measurements of your performance on assessment materials will follow the same pattern. This pattern is characterized by an "Average" value ($\bar{s}$) and a "Standard Deviation" (σ). The quantity $z = (s - \bar{s})/\sigma$ is used to characterize the probability of obtaining a specific value (s) for a continuous distribution of values by the function:
$f(s) = \left(\frac{1}{\sqrt{2\pi\sigma^2}}\right) e^{\left(-\frac{1}{2}\left(\frac{s-\bar{s}}{\sigma}\right)^2\right)} = \left(\frac{1}{\sqrt{2\pi\sigma^2}}\right) e^{\left(-\frac{z^2}{2}\right)}$ where f(s) is adjusted or "normalized" such that $\int_{-\infty}^{+\infty} f(s)ds = 1$. Some modifications have to be made for discrete values such as grades, but these are encoded into MS Excel and are similar to the discussion in Appendix B (particularly pages 96 to 100) of the

SDSU Physics 111 lab manual. Grades in PHYS 115 are based on this statistical model with the exception that you will also have opportunities to show the instructor that you have made additional efforts that may not be reflected in your statistical grade. To facilitate this there are two types of points you can accumulate during this course: class points (which are used in the statistics) and personal points (which are not used in the statistics). Individual elements of your score such as an exam score or a Teaching Assistant's lab scores may be "Normalized" by using an average and a standard deviation of an appropriate data set to convert a raw score to a "normalized" score based on the Gaussian distribution.

ATTENDANCE:

Students will be held responsible for material covered in lecture and lab and are expected to be in attendance during all scheduled exams and quizzes. Lectures will explain, illustrate, demonstrate, highlight, summarize, and define subjects and areas of importance. Your presence is always welcomed and important, however many factors may prevent you from always being in attendance. The university has a number of guidelines published in the catalog. These are reproduced below. Attendance is particularly critical for the exams and labs so if you have to miss, make plans with your instructor if at all possible. The following is from the SDSU Catalog:

Attendance

Policy: Student attendance in all classes is expected. Teaching and learning is a reciprocal process involving faculty and students. Faculty members have an expectation of meeting classes on a regular basis and students have an obligation to attend classes on a regular basis. Faculty determine the specific attendance policy for courses under their direct supervision and instruction. Attendance procedures must be stated in written form and distributed to students at the beginning of each semester. If attendance is required and will impact grading, this expectation will be included in the syllabus.

Absence due to personal reasons

Any exceptions to the faculty member's written attendance policy due to **verified medical** reasons, **death** of family member or significant other, or **verified extenuating circumstances** judged acceptable by the instructor or the institution, will be honored. Such exceptions must be communicated and negotiated between the student and faculty member prior to the absence whenever possible.

Absence due to approved university-sponsored trips

Faculty and administration **will honor officially approved** absences where individuals are absent in the interest of officially representing the University. These are considered officially "excused absences." A single trip cannot keep students away from classes more than five (5) consecutive class days. Requests for excused absences must be submitted one week prior to the trip. Students **must** present the **completed approved** trip absence card to the faculty member **prior** to the trip to have an official "excused absence." Faculty members are not required to honor incomplete cards.

Students with official "excused absences"

Students with excused absences will be given appropriate make up work and **equivalent** opportunities for obtaining grades as students who were in attendance. Students with official "excused absences" are not to be penalized in course progress or evaluation. However, should excused absences be excessive, the faculty member may recommend withdrawal from the courses or a grade of incomplete.

Mediation on absence

Arrangements should be negotiated with the faculty member. If this is not possible the student goes to the department head and dean in that order. The student may contact the Office of the Vice President for Academic Affairs if conflict is not resolved at these levels.

Waiting Policy

Please wait 15 minutes after the start of class or lab for your instructor. After 10 minutes, if your instructor has not arrived please call the Physics Department office at (605) 688-5428 to inform them of the situation and see if there is any news. If convenient, you might also check WebAssign and D2L for announcements.

Academic Success

To support student success in this course, any academic performance concerns will be communicated through ConnectState. ConnectState will also alert those dedicated to supporting every student's success. Notifications will be sent to your jacks email account and can be reviewed in the ConnectState platform. If you receive a notification, please come see your instructor, laboratory Teaching Assistant, or seek assistance from your advisor, the Student Success Center, or other campus resources.

Access to ConnectState is found on the MyState dashboard page and uses the same login credentials as MyState.

Expectations:
Students are expected to keep up with reading the text for chapters outlined in the "Objectives" above in a timeframe appropriate for "In-Class Exams" and the Laboratory Schedule.

- Make an honest attempt to understand the reading and solve assigned problems.
- Ask a question when something does not make sense. The sooner, the better.
- Read any assigned laboratories beforehand or review the lecture beforehand.

You should be familiar with graphing, geometry (including surface areas and volumes of spheres, cylinders and parallelepipeds), algebraic manipulations (including quadratic equations and their solution, exponential and logarithm functions), trigonometric functions and identities (e.g. sine, cosine, and tangent). Vector algebra (e.g. multiplication by a scalar, "dot" products, and "cross" products) will be developed and used in PHYS 115. It is the students' responsibility to communicate to the instructor if they do not understand a topic whether it is a mathematical formalism or a physical concept that the mathematics is being used to describe.

Rule of thumb for time management: On average, for every credit taken you should expect to spend about three hours outside of class per week. This will vary a lot from week to week, from course to course, and from student to student, but it's not a bad way of estimating how much time you should spend on a course. So, for a 4-credit course, you should expect to spend about 12 hours outside of class each week. Remember though, time does not guarantee comprehension, and you are graded on comprehension.

General Policies and Statements

NOTE: Students are advised to take note of departmentally posted policies regarding academic dishonesty, course repetition, and laboratory policies, which will be adhered to in this class (see below).

The SDSU catalog also lists a number of general policies at the following link:
http://catalog.sdstate.edu/content.php?catoid=22&navoid=2110

Remaining syllabus information containing SDSU Physics Departmental policies and some catalog information can be found at http://www.sdstate.edu/phys/for-undergrad/policies/index.cfm .

Accommodations: Any student who feels s/he may need an accommodation based on the impact of a disability should contact your instructor privately to discuss your specific needs as early as possible in the semester. If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and the Office of Disability Services at (605) 688-4504 in room 065, at the SDSU Student Union, to coordinate reasonable accommodations for students with documented disabilities. To privately discuss your situation, please contact:

Nancy Hartenhoff-Crooks, Coordinator of Disability Services

Ph: 605-688-4504 Fax: 605-688-4987 E-mail: sdsu.disability@sdstate.edu

Web site: http://www.sdstate.edu/campus/disability/index.cfm)

Diversity and Inclusion: Over the course of the semester, please honor the uniqueness of your fellow classmates and refrain from personal attacks or demeaning comments of any kind. If you feel your differences may in some way isolate you from South Dakota State University's community or if you have any specific accommodations, please speak with your instructor about your concerns and what can be done to help you become an active and engaged member of our class and community.

Department of Physics **Academic Dishonesty Policy** **SDSU: College of Arts and Sciences**

From: http://www.sdstate.edu/phys/for-undergrad/policies/upload/Academic-Dishonesty-Policy-August-2011.pdf

It is unethical and unprofessional to present the work done by others in a manner that indicates that an individual is presenting the material as his/her original ideas or work. The following definitions of violations of academic integrity appear in the Student Policies Manual, Student Code, Ch. 1:

1. Cheating, which is defined as, but not limited to, the following: use of or giving of any unauthorized assistance in taking quizzes, tests, or examination; use of sources beyond those authorized by the instructor in writing papers, preparing reports, solving problems, or carrying out other assignments; or acquisition, without permission of tests or other academic material belonging to a member of the institutional faculty or staff.

2. Plagiarism, which is defined as, but is not limited to, the following: The use, by paraphrase or direct quotation of the published or unpublished work of another person (words, ideas or arguments) without full and clear acknowledgment consistent with accepted practices of the discipline; the unacknowledged use of materials prepared by another person or agency engaged in the selling of term papers or other academic materials.

3. Fabrication is intentional and unauthorized falsification or invention of any information or citation in an academic exercise.

4. Facilitating academic dishonesty is intentionally or knowingly helping or attempting to help another to commit an act of academic dishonesty.

5. Claiming to represent or act on behalf of the institution when not authorized to so represent or so act.

Cheating, unauthorized assisting of others, or plagiarizing on tests, quizzes, problems, research papers, or other assignments will result in written notification to the student involved, the academic advisor and the Physics Department. The penalty for such dishonesty within the academic confine of the Physics Department may be one or more of the following, at the discretion of the instructor, and based on the seriousness of the situation:

1. a grade of zero on the test, quiz, homework, problem or other assignment for the student(s) involved.

2. a grade of F for the course.

3. referral of the matter to the Division of Student Affairs for disciplinary action. (The minimum sanction is disciplinary probation.)

Students have the right to appeal an academic dishonesty charge as outlined in the procedures below [see link under this section heading]. No final course grades will be given until all avenues of appeal have been completed or the case resolved.

If repeated offenses occur in either a specific Physics class or in 2 or more different Physics classes, the matter will be automatically referred to the Student Conduct Committee.

Freedom in learning. *Under Board of Regents and University policy student academic performance may be evaluated solely on an academic basis, not on opinions or conduct in matters unrelated to academic standards. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. A student who believes that an academic evaluation reflects prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards should first contact the instructor of the course to initiate a review of the evaluation. If the student remains unsatisfied, the student may contact the department head and/ or dean of the college which offers the class to initiate a review of the evaluation.*

System General Education Goals and Student Learning Outcomes (SGR-SLO)

SGR 6 -- Fulfills

Physics 115-115L **FULFILLS** the SD Board of Regents System General Education Goal #6, Natural Sciences*: Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world.*

Student Learning Outcomes [all four below are required]: As a result of taking this course, students will:

a. Explain the nature of science including how scientific explanation are formulated, tested, and modified or validated.
   i. Students will gather data from demonstrations or activities and use this data to illustrate principles of measurement and scientific reasoning either as a whole class or in small groups or individually. Students will therefore develop an appreciation of peer review, significant figures and error analysis along with the application of the laws of nature to evaluate their data and confirm the physical concepts. It should be noted that the grading method mimics the data collection and analysis used throughout physics and laboratory work. Various technologies may be utilized to facilitate the data collection and analysis (e.g. Vernier's Logger Pro and Video Analysis programs in conjunction with various sensor technologies). Einstein's model of science is used throughout this course (Einstein, Albert (1934) ***Letters to Solovine 1906-1955***. New York, NY; Philosophical Library. Pages 122-123)
      1. Assessed through classroom activities and the laboratory portion of this course, PHYS 115L, with written lab reports, exams, homework, and quizzes. Technology (e.g. WebAssign, Plickers, D2L, Turning Point Response System, Socrative) is often employed to facilitate this assessment.

b. Distinguish between scientific and non-scientific evidence and explanations, and use scientific evidence to construct arguments related to contemporary issues.
   i. Examples of contemporary issues relevant to students' fields of study (construction and architecture) are often used

as starting points of lecture discussions and numerical examples. Homework problems are often chosen for assignments because of their relevance to contemporary issues (as well as the physics concepts under development e.g. energy needs and losses in housing). One example is heat loss through a basement wall. Students are also encouraged to do ADA compliance surveys.

1. Assessed through exams, successful completion of homework, laboratory, and in-class activities related to contemporary issues (R-factors) as well as through extra credit projects chosen by the students (ADA survey).

c. Apply basic observational, quantitative, or technological methods to gather and analyze data and generate evidence-based conclusions in a laboratory setting.
   i. Physics 115/115L students will demonstrate the scientific method in a laboratory experience by collecting data, find patterns in data with graphs, tables, or other means; and apply formulas from theories to explain the patterns.
   ii. Each laboratory (typically 9 or 10) in this course is an example of applying scientific methods to apply concepts to physical phenomena. During laboratories, students will observe phenomena, make measurements (take data) and analyze that data to confirm or discover the connection with basic principles by applying mathematical models to the data.
      1. Assessed though the laboratory portion of the course, PHYS 115L, by writing and submitting laboratory reports for evaluation by a graduate student or faculty member.

d. Understand and apply foundational knowledge and discipline-specific concepts to address issues, solve problems, or predict natural phenomena.
   i. Applications of physics will be developed from basic principles and theories (e.g. Newton's Laws, Coulomb's Law/Maxwell's equations, Kirchhoff's Laws) during lecture and in the text. These applications will be applied to problems related to construction and architectural issues such as truss analysis and electrical requirements for buildings. Students will be exposed to appropriate use of physics terminology in all elements of the course (lecture, recitation, lab, text, homework).
      1. Assessed through course examinations (summative), homework (formative), and class activities (formative) with applications of Physics concepts being the primary goal. When possible, other terminology will be introduced (e.g. physics: torque; engineering: moments – same concept but different conventions). Effective communication of concepts will be developed through discussions and evaluated in lab reports and the students' ability to understand and respond correctly to examination questions.

SGR 5 – Support and Alignment

In addition, Physics 115-115L **builds on** the SD Board of Regents System General Education Goal #5; Students will understand and apply fundamental mathematical processes and reasoning. [As a mathematically derivative science, this entire course is an exercise in the use of this goal and its outcomes.]

Student Learning Outcomes: As a result of taking this course, students will:

a. Use mathematical symbols and mathematical structure to model and solve real world problems:
   i. Every example in lecture, every homework problem, every lab report is an example of this outcome.
      1. Physics reasoning depends on mathematical structures and models which are assessed in exams, home work, and laboratory reports.

b. Demonstrate appropriate communication skills related to mathematical terms and concepts:
   i. Use of mathematical terms to explain laboratory results is essential for a well written lab report or to discuss assigned problems.
      1. Assessed through exam components where students must communicate mathematical steps in problem solutions.

Laboratory/Class Schedule (Revised)

PHYS 199/199L -- Fall 2018;

Lab in SDEH 262 on Tu or W: Lecture in SCEH 204 on M & W @ 4 PM

(Chapter references refer to the text by Yehuda Salu: **Physics for Architects**)

	Month	M/Tu/W	Lab	Lab Description
1	Aug.	20/21/22	1	Measurements, Math and Apps (bring your devices – Ch1)
2	Aug.	27/28/29	2	1-D motion: Atwood's Machine (Ch 2)
3	Sept.	~~~3~~/4/5	3	Vectors and Forces in 2-D: Equilibrium (Ch 3)
4	***$Sept.$***	***10/11/12***		Ch 1, 2, &3 Exam/Problem Review and Preparation
5	Sept.	17/18/19	4	Statics: Ladders, Trusses and CoM (Blue Boards) (Ch 4)
6	Sept.	24/25/26	5	Voussoirs ~~Hydrostatics and Dynamic Loads~~ (Ch 4)
7	Oct.	1/2/3	6	Springs and Hydrostatics ~~Momentum, Work & Energy~~ (Ch 5)
8	***$Oct.$***	***~~~8~~/9/10***		Ch 4 & 5 Exam/Problem Review and Preparation
9	Oct.	15/16/17+	7	Work, Energy, Friction, Impulse (Ch 6)
10	Oct.	22/23/24	8	Thermal Expansion and Heat (Ch 7)
11	Oct./Nov	29/20/31	9	Resistance: Electrical and Thermal (Ch 8)
12	***$Nov.$***	***~5/6/7***		Ch 6, 7,& 8 Exam/Problem Review and Preparation
13	Nov.	~~12~~/13/14	10	Make-up/Extra-Credit Lab: Acoustics and Illumination from points and lines (Ch 9)
14	Nov.	*~19/20/~~21~~*		**Thanksgiving Break – No Labs**
15	Nov.	26/27/28		Ch 9, & 10 Exam/Problem Review and Preparation
16	***Dec. $***	***3/4/~~5~~~***		**No Labs – Finals Begin this week**
	Dec.$$	***7 (Friday)***		**FINAL at 1:45 PM in SCEH 204**

Chapters (in parentheses) refer to the text: Yehuda Salu: **Physics for Architects**, 2th Ed.

$ Exam weeks (highlighted in green).

~ Holiday – Labor Day: Sept. 3 (M); Native American Day: Oct. 8 (M); Veterans' Day: Nov. 12 (M)); Reading Day for FinalsDec. 5

+ Event – Spooky Science (Saturday, Oct. 20); Senior Design Conference (Nov. 20) – be alert for others.

Note: The 10th Lab (#10) is the make-up lab. Only one lab may be made up, the last lab is only for those who had to miss one (or more) of the other 9 labs or want extra credit. Lab scores are based on 9 lab scores so completing fewer that 9 will severely impact your grade. WARNING: you must complete 7 of these labs to pass PHYS 199, or put another way, if you miss three labs of the required 9, without a make-up, you fail PHYS 199. To complete a lab you must: **attend and *collect data*, write a report and **turn it in** to your lab instructor. Labs are submitted to the appropriate D2L Dropbox (under the "Assessments" dropdown menu).

Lab	Tuesday times	Lab	Wednesday time		
1	8:00-9:50 am LB	5	8:00-9:50 am LB		
		2	10:00-11:50 am LB		
~~3~~	~~Noon – 1:50 pm~~				
~~4~~	~~3:00-4:50 pm BC~~				

Sample Final for PHYS 115

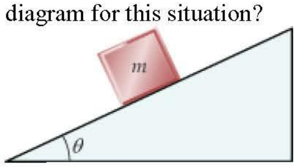
Due:

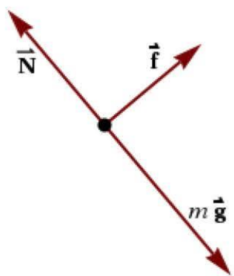
Sat Dec 8 2018 06:00 PM CST

Question
1 2 3 4 5 6 7 **8 9 10 11 12 13 14 15 16 17 18 19 20 21 22**

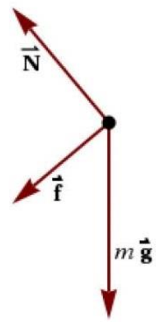
Description
Now we are at the end of this first course of Physics specifically designed for Architecture and Construction. Thanks for being a part of this experiment. There is one last opportunity beyond this exam to share your insights about the course, that is a "Final Survey" in D2L (PHYS 199/Assessments/Survey). Please complete it before the weekend is over. Once again, thanks for being a part of this experiment, and best of luck with your future. Larry B .

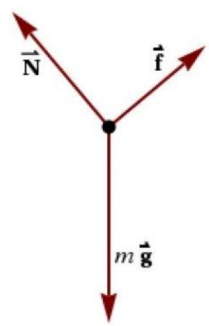
1. - **Question Details** SaluPhysArch2 3.2.WA.018. [3644540]
A block of mass *m* rests on a rough incline plane. Which of the following is the correct free-body diagram for this situation?

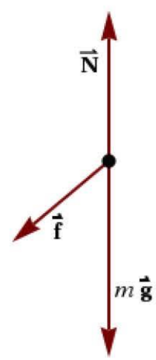




Sample Final for PHYS 115


$\vec{N}$
$\vec{f}$
$m\vec{g}$


$\vec{N}$
$\vec{f}$
$m\vec{g}$

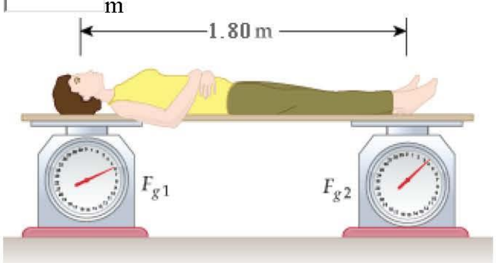


2. - **Question Details** SaluPhysArch2 4.4.WA.001. [3644698]
Calculate the force (in N) a piano tuner applies to stretch a steel piano wire 7.50 mm, if the wire is originally 0.880 mm in diameter and 1.30 m long. Young's modulus for steel is 210×10^9 N/m^2.

N

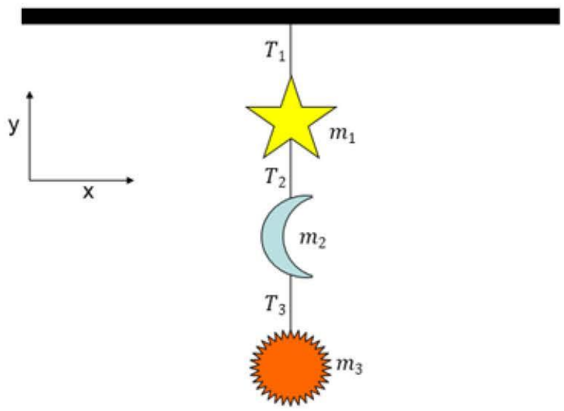
3. - **Question Details** SaluPhysArch2 4.2.WA.005. [3644649]
The center of mass of a person may be determined by an arrangement such as the one shown in the figure below. A light plank rests on two scales separated by a distance of
$d = 1.80$ m
and reading
$F_{g1} = 470$ N
and
$F_{g2} = 360$ N.
Determine the distance of the girl's center of mass from her feet.

m

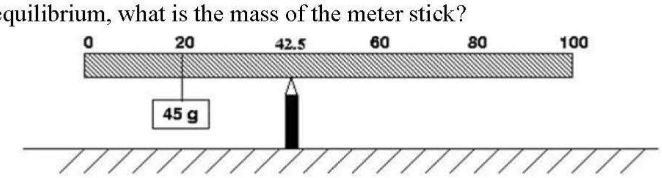


4. - **Question Details** SinghPhysTut1 3.P.001. [3734715]
A mobile hangs from a ceiling. There are three pieces ($m_1 = 2.2$ kg, $m_2 = 3.7$ kg, $m_3 = 4.6$ kg) hanging by massless strings as shown below. Find the tension (in N) in each string.

Sample Final for PHYS 115



T_1= [ ] N T_2= [ ] N T_3= [ ] N
†
5. - **Question Details** PBE1 2008.MC.37. [1056704]
A uniform meter stick has a 45.0 g mass placed at the 20 cm mark as shown in the figure below. If a pivot is placed at the 42.5 cm mark and the meter stick remains horizontal in static equilibrium, what is the mass of the meter stick?



○ 18.0 g ○ 45.0 g ○ 72.0 g ○ 120.0 g ○ 135.0 g

6. - **Question Details** SaluPhysArch2 3.1.WA.002. [3644542]
A cheetah is running at a speed of 18.0 m/s in a direction of 72° north of west. Find the components of the cheetah's velocity along the following directions.
(a) the velocity component due north
[ ] m/s

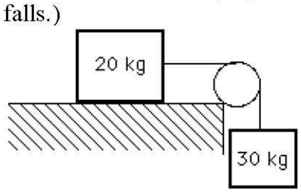
(b) the velocity component due west
[ ] m/s

7. - **Question Details** WACalcPhysMC 5.7.022. [3015078]
A boy of mass 50 kg is standing on a spring scale in an elevator that registers in newtons (N). He looks down and sees a reading of 540 N on the scale. What is the correct conclusion to be drawn from this data?

○ The boy and elevator are accelerating downward with a magnitude of 21 m/s^2. ○ The boy and elevator are accelerating upward with a magnitude of 1.0 m/s^2. ○ The boy and elevator are accelerating upward with a magnitude of 11 m/s^2. ○ The boy and elevator are accelerating downward with a magnitude of 11 m/s^2. ○ The boy and elevator are accelerating upward with a magnitude of 21 m/s^2.

8. - **Question Details** WACalcPhysMC 5.7.018. [3006474]
A 20 kg block slides on a frictionless horizontal table when connected by a string to a 30 kg mass hanging vertically, as shown. The string slides over a frictionless fixed pulley which

doesn't rotate. Using a for acceleration and T for tension, which of the equations below describes the motion of the hanging mass? (Choose acceleration to be positive when the hanging mass falls.)



- 294 N − T = (30 kg)a
- T = (30 kg)a
- 294 N + T = (30 kg)a
- 490 N = (50 kg)a
- T − 196 N = (20 kg)a

9. - **Question Details** SaluPhysArch2 6.4.WA.004. [3644851]
A 70 kg baseball player slides into third base. He starts his slide at a speed of 4.0 m/s, and his speed is zero just as he reaches the base. If the coefficient of friction between his clothes and the surface of the baseball infield is 0.60, determine the following.
(a)
the mechanical energy lost (in J) due to friction acting on the player
J
(b)
the distance (in m) he slides
m

10. - **Question Details** SaluPhysArch2 7.3.WA.005. [3644915]
To sterilize a 25.0-g glass baby bottle, we must raise its temperature from 21.5°C to 95.0°C. How much heat transfer is required? The specific heat of glass is 840 J/(kg · °C).
J

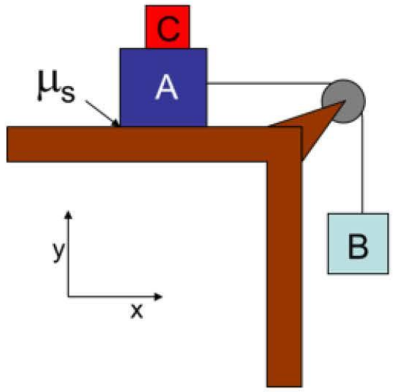
11. - **Question Details** SaluPhysArch2 8.2.WA.037. [3644780]
(a) What is the equivalent resistance of five resistors connected in series with a 14.0-V battery if each resistor has a value of 19.0 Ω?
Ω

(b) Determine the current flowing through each of the five resistors.
A

(c) If the five resistors were instead connected in parallel across the battery, what would be the equivalent resistance?
Ω

(d) Determine the current through each resistor for this parallel connection.
A

12. - **Question Details** SinghPhysTut1 4.B.001. [3734710]
A set of blocks is connected to a pulley in the manner depicted below. (The pulley and rope are to be considered massless.)



Find the minimum mass (in kg) that block C must have in order to keep block A from sliding on the table top.

m_A = 7 kg

m_B = 5 kg

μ_s = 0.20 (coefficient of static friction)

[ ] kg

†

13. - **Question Details** WACalcPhysMC 16.2.015. [2523755]

A sinusoidal wave on a stretched string has its amplitude given by $y = (0.010\text{ m})\sin[(2\pi\text{ m}^{-1})x - (100\pi\text{ s}^{-1})t]$. What is the wavelength and frequency of this wave?

- wavelength = 0.020 m; frequency = 50 Hz
- wavelength = 0.010 m; frequency = 50 Hz
- wavelength = 1.0 m; frequency = 50 Hz
- wavelength = 0.010 m; frequency = 100 Hz
- wavelength = 1.0 m; frequency = 100π Hz

14. - **Question Details** SaluPhysArch2 10.3.WA.002. [3644462]

After your school's team wins the regional championship, students go to the dorm roof and start setting off fireworks rockets. The rockets explode high in the air and the sound travels out uniformly in all directions. If the sound intensity is 1.52×10^{-6} W/m^2 at a distance of 213 m from the explosion, at what distance from the explosion is the sound intensity half this value?

[ ] m

15. - **Question Details** WACalcPhysMC 35.2.001. [2866003]

A pulsed laser beam is sent to the moon, a distance of 3.8×10^8 m, where it is reflected back to earth. What is the elapsed time between the sending of the pulse and the reception of its reflection back on earth?

- 2.5 s
- 5.1 s
- 3.8 s
- 6.3 s
- 1.3 s

16. - **Question Details** SaluPhysArch2 10.3.WA.004. [3644618]

Sound is emitted by a point source. You wish to compare the sound intensity and sound intensity level from this source at two different sites. If the distance to the second site is a factor of 5 greater than the distance to the first, determine the following.

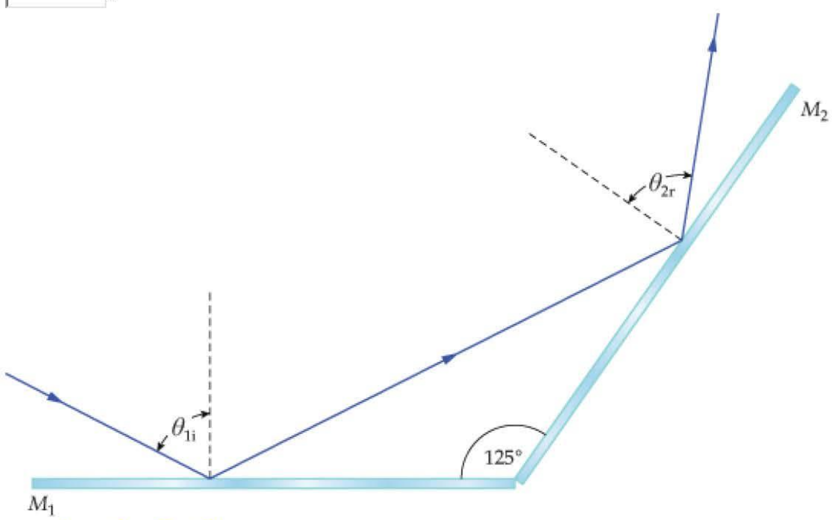
(a) Determine the multiplicative factor by which the sound intensity decreases as you go from the first to the second site. (Assume the intensities at the first and second sites are I_1 and I_2, respectively.)

I_1

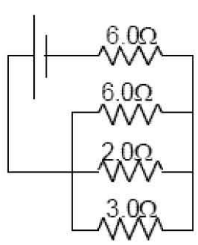
I_2
=

(b) Determine the additive amount by which the sound level intensity decreases as you go from the first to the second site. (Assume the sound level intensities at the first and second sites are β_1 and β_2, respectively.)
$\beta_1 - \beta_2 =$
dB

17. - **Question Details** SaluPhysArch2 9.5.WA.003. [3644937]
As shown in the figure, the angle between two plane mirrors (M_1 and M_2) is 125°. If the incident ray strikes mirror M_1 with an angle of incidence θ_{1i} = 59°, determine the angle of reflection θ_{2r} for mirror M_2.
°



18. - **Question Details** POE1 1998.MC.27. [1066384]
In the electric circuit shown below, the current through the 2.0 Ω resistor is 3.0 A. About what is the emf of the battery?



○ 51 V ○ 42 V ○ 36 V ○ 24 V ○ 21 V

19. - **Question Details** POE1 1998.MC.19. [1066362]

One end of a metal rod of length L and cross-sectional area A is held at a constant temperature T_1. The other end is held at a constant T_2. Which of the statements about the amount of heat transferred through the rod per unit time are true?

I. The rate of heat transfer is proportional to $1/(T_1 - T_2)$.

II. The rate of heat transfer is proportional to A.

III. The rate of heat transfer is proportional to L.

○ II only ○ III only ○ I and II only ○ I and III only ○ II and III only

20. - **Question Details** POE1 1998.MC.10. [1066374]

Air track car Z of mass 1.5 kg approaches and collides with air track car R of mass 2.0 kg. See the diagram below. Car R has a spring attached to it and is initially at rest. When the separation between the cars has reached a minimum, which of the following is correct?

○ Car R is still at rest. ○ Car Z has come to rest. ○ Both cars have the same kinetic energy. ○ Both cars have the same momentum. ○ The kinetic energy of the system has reached a minimum.

21. - **Question Details** SaluPhysArch2 9.5.WA.009. [3644950]

Light enters a liquid (from air) at an angle of 42° with respect to the normal and is refracted into the liquid at an angle of 29° with respect to the normal. Determine the index of refraction of the liquid.

22. - **Question Details** POE1 1998.MC.13. [1066367]

Consider the motion of two blocks along a frictionless level track. Block #1 (mass m_1) is initially moving with speed v_0. It collides with and sticks to an initially stationary block (#2) of mass $m_2 = 9\ m_1$. What is the speed of the two blocks after the collision?

○ v_0

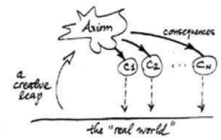
○ $\frac{9}{10}v_0$

○ $\frac{8}{9}v_0$

○ $\frac{1}{9}v_0$

○ $\frac{1}{10}v_0$

PHYS 199L Lab 8: Heat Capacity and Linear Expansion
Team Members: ____ Instructor: ______________



Introduction:

Materials will change temperature as heat energy is added or removed from them. The amount of energy (in joules (J) or calories (cal) required to raise or lower the temperature of an object will depend on how much and what type of material is involved. We will investigate this phenomena along with how the temperature/heat change affects the physical size of certain metals. Metals are chosen because they quickly come to a uniform temperature and are easy to work with, but keep in mind that all materials (concrete, wood, steel, etc.) exhibit similar properties.

Specific Heat Capacity: c

Because the amount and type of material will determine how much heat will be necessary to change the temperature of an object, both factors much be taken into account. Our approach here will be to measure the temperature change in an amount of water, which is a standard to which most materials can be compared. The convention is that one gram of pure water will change its Celsius (or Kelvin) temperature by one degree if one calorie = 4.186 Joules of energy is added (increase) or removed (decrease). In equation form:

$$1\, calorie = 4.186 J = (1\, gram) \cdot \left(1\, \frac{cal}{gram - {}^\circ\mathrm{C}}\right) \cdot (1^\circ\mathrm{C})$$

Of course, two calories would be required to change the temperature of two grams by one degree. Also, two calories would also be required to change the temperature of one gram of water by two degrees Celsius. For any other material, we could generalize this relation to:

$$Q = m \cdot c \cdot \Delta T$$

Here "Q" represents the heat energy exchanged, "m" the mass of the material, ΔT is the change in temperature, and "c" is called the specific heat capacity (or just specific heat) of the material. Of course, it is always important to keep the units consistent so if Q were measured in Joules, and "c" in Joules per (kilogram x degree Celsius) then mass should be in kilograms and the temperature difference should be in Celsius degrees. There are several standards, so be careful which is being used.

Here we will find the heat capacities of several metals by measuring their initial and final temperatures as they go from heated water and change the temperature of a measured amount of water. For an insulated amount of water the temperature change (ΔT) and the mass (m) will be measured. Since the specific heat of water $c = \left(1\, \frac{cal}{gram - {}^\circ\mathrm{C}}\right) = \left(4.186 \frac{kJ}{kg \cdot {}^\circ\mathrm{C}}\right)$ the heat involved in the measured amount of water can be calculated. Assuming the heat is completely transferred from the hot metal to the cooler water without losses, this will allow us to estimate the specific heat of the metal. In equation form:

$$Q = m_{H2O} \cdot c_{H2O} \cdot \Delta T_{H2O} = m_{Metal} \cdot c_{Metal} \cdot \Delta T_{metal}$$

Using this, the specific heat of the metal can be determined and compared with standards.

Additionally, these materials will have a unique density that should correspond to the material's specific heat. Recall that the density (ρ) is the ratio of mass to volume ($\rho = \frac{m}{V}$) and that the volume, in cm^3, is the same as the buoyant force, in grams (units are important here), you can determine the metal's volume and density by weighing the metal when it is submerged under water. Since the buoyant force is the difference in the mass in air and in water, the result (using grams and cm^3) is: $\rho = \frac{m_{air}}{m_{air} - m_{water}}$.

Linear Expansion Coefficient: α

As heat is added to a material, its atoms become more energetic and collide with each other more often and with more impulse. The consequence of this is that the material usually expands (there are some exceptions if the structure of the material changes as in the case of ice melting, but these are rare and usually only occur near a phase transition). This effect is small, but can be significant for large objects and can have devastating consequences if they are not taken into consideration (i.e. expansion of rails road rails or the deck of a bridge). To understand this effect, three metal tubes will be heated and cooled and their length changes will be measured and analyzed.

Length changes will be measured with a dial micrometer. Each tick mark on the dial represents a length change of 0.01 mm with every 10 tick marks being indicated and each revolution represents 100 tick marks. This means one revolution of the dial will represent a length of 1.0 mm and up to 10 mm can be measured using the small dial (which keeps track of revolutions) and the large dial. Please note that the main dial can be rotated to have the indicator-needle point to zero when you begin, so the reading will be the change in length directly. When you begin, the foot of the dial should be under a bit of pressure when it is placed against the clip ring on the tube.

To determine the **temperature** of the tube, a thermistor is in contact with the tube and its resistance can be measured with an ohmmeter. The resistance is related to the temperature with a table of equivalents, which is provided. Every degree Celsius has an equivalent resistance, but to refine the temperature measurement, you should do a linear extrapolation if the resistance is not exactly listed on the table. For example, if the resistance is 57,000 Ω, then the temperature is between 37°C (where the resistance is 58,138 Ω) and 38°C (where the resistance is 55,658 Ω). Assuming the temperature is approximately a linear function of resistance, then 57,000 Ω is 58,138 – 57,000 = 1,138 Ω out of 58,138 – 55,658 = 2480 Ω or 1138/2480 = 46% of the way to the next degree. This means the temperature should be 37.46°C. Note that the lower the resistance the greater the temperature, in general. Expressing this mathematically:

$$T = T_L + \left|\frac{R_L - R}{R_L - R_H}\right| \cdot 1\frac{^\circ\mathrm{C}}{\Omega}$$

Here T_L is the lower temperature where the resistance is R_L and the resistance one degree higher is R_H. The measured resistance is R. The measured resistance, R, should be between R_L and R_H.

Similar to Young's Modulus, the coefficient of expansion (α) is defined in terms of fractional changes of length. Mathematically α is defined as:

$$\alpha = \frac{\Delta L}{L \cdot \Delta T} \quad or \quad \Delta L = \alpha L \cdot \Delta T$$

Once the three values: the total length between retaining rings; ΔL from the dial micrometer and ΔT from the thermistor then the coefficient of thermal expansion can be determined and compared with accepted values.

PHYS 199L Lab 8: Heat Capacity and Linear Expansion

Team Members: ______________________ Instructor: ______________

Specific Heat Capacity: $c = \frac{Q}{m \cdot \Delta T}$ $from\ Q = m \cdot c \cdot \Delta T$

Sample Mass	Metal's Mass in Water	Metal Volume	Metal's T_i	Water's Mass	Water's T_i	Final T	Q	c	Density	Metal

Sample Calculations for Q from water (1 pt):

Sample Calculation for $c = \frac{Q}{m \cdot \Delta T}$ (1 pt.):

Table of Specific Heats & Densities (https://www.engineeringtoolbox.com/specific-heat-metals-d_152.html)							
Material	$cal/(g \cdot °C)$	$kJ/(kg \cdot °C)$	Density	Material	$cal/(g \cdot °C)$	$kJ/(kg \cdot °C)$	Density
Water	1.00	4.186	1.0 g/cc	Magnesium	0.243	1.05	1.74 g/cc
Aluminum	0.215	0.900	2.7 g/cc	Lead	0.128	0.0305	11.34 g/cc
Brass/Copper	0.092	0.38	8.96 g/cc	Tin	0.054	0.21	7.31 g/cc
Iron/Steel	0.108	0.450	7.87 g/cc	Zinc	0.387	0.0925	7.13 g/cc

Coefficient of linear expansion: $\alpha = \frac{\Delta L}{L \cdot \Delta T}$ or $\Delta L = \alpha L \cdot \Delta T$

Metal	Length L (mm)	Resistance Cold (Ω)	ΔL (mm)	Resistance Hot (Ω)	T_{cold}	T_{hot}	ΔT	α $10^{-6} \cdot °C^{-1}$	α $(10^{-6} \cdot °C^{-1}$	% error
Al									23	
Brass									19	
Copper									17	

Sample calculation for temperature (1 pt): $T = T_L + \left|\frac{R_L - R}{R_L - R_H}\right| \cdot 1\frac{°C}{\Omega}$

Sample calculation for linear coefficient of thermal expansion (1 pt): $\alpha = \frac{\Delta L}{L \cdot \Delta T}$

PHYS 199L Lab 8: Heat Capacity and Linear Expansion

Team Members: ______________________ Instructor: ______________

PHYS 199L Lab 8: [redacted]

Team Members: [redacted] Instructor: Dr. Browning

Cup = 7g

ZMB Oct. 24, 2018

Specific Heat Capacity: $c = \frac{Q}{m \cdot \Delta T}$ $from\ Q = m \cdot c \cdot \Delta T$

Sample	Metal's Mass	Metal's T_i	Water's Mass	Water's T_i	Final T	Q	c	Metal
	358 g	93 °C	242g	22 °C	30 °C	1936 J	.086 cal/g·°C	Copper
	141 g	97 °C	291g	22.1 °C	24.6 °C	727.5 J	.189 cal/g·°C	Aluminum
	219g	96 °C	328 g	23.5 °C	28.5	1640 J	.131 cal/g·°C	Lead

Sample Calculations for Q from water (1 pt):

$(FT_w - IT_w)$(Waters mass)$(1\frac{cal}{g\,°C}) = (30°C - 22°C) \cdot (242g)(1\frac{cal}{g\,°C}) = 1936J$

Sample Calculation for $c = \frac{Q}{m \cdot \Delta T}$ (1 pt.):

$C = \frac{Q}{m_m (FT_m - IT_m)}$

$\frac{1936J}{358g \cdot (30°C - 93°C)} = .086\ cal/g \cdot °C$

Table of Specific Heats (https://www.engineeringtoolbox.com/specific-heat-metals-d_152.html)					
Material	$cal/(g \cdot °C)$	$kJ/(kg \cdot °C)$	Material	$cal/(g \cdot °C)$	$kJ/(kg \cdot °C)$
Water	1.00	4.186	Magnesium	0.243	1.05
Aluminum	0.215	0.900	Lead	0.128	0.0305
Brass/Copper	0.092	0.38	Tin	0.054	0.21
Iron/Steel	0.108	0.450	Zinc	0.387	0.0925

Coefficient of linear expansion: $\alpha = \frac{\Delta L}{L \cdot \Delta T}$ or $\Delta L = \alpha L \cdot \Delta T$

Metal	Length L (mm)	Resistance Cold (Ω)	ΔL (mm)	Resistance Hot (Ω)	T_{cold}	T_{hot}	ΔT	α $10^{-6} \cdot °C^{-1}$	α $(10^{-6} \cdot °C^{-1}$	% error
Al	350	104.7	.62	6.8	24 °C	94 °C	70 °C	25	23	4.17%
Brass	350	98.1	.515	8	26 °C	88 °C	62 °C	23	19	9.52%
Copper	350	91.4	.455	7.6	27 °C	90 °C	63 °C	20	17	8.1%

Sample calculation for temperature (1 pt): $T = T_L + \left|\frac{R_L - R}{R_L - R_H}\right| \cdot 1\frac{°C}{\Omega}$

$T = 24°C + \left|\frac{104,800\Omega - 104,700\Omega}{104,800\Omega - 100,000\Omega}\right| \cdot 1 °C/\Omega$

$24°C + \left|\frac{100}{4,800}\right| \cdot 1 °C/\Omega =$

Sample calculation for linear coefficient of thermal expansion (1 pt): $\alpha = \frac{\Delta L}{L \cdot \Delta T}$

$a = \frac{.62mm}{350mm \cdot 70°C} = .000025300$