PHYS 0215 - PRINCIPLES OF PHYSICS: HEAT, WAVES AND MODERN PHYSICS

Catalog Description

Formerly known as PHYS 4C (PHYS 215 and 215L, combined)
Prerequisite: Completion of PHYS 205, PHYS 205L, and MATH 31 with grades of "C" or better
Corequisite: Concurrent enrollment in PHYS 215L
Hours: 54 lecture
Description: Thermodynamics, kinetic theory of gases, waves, geometrical and physical optics, sound, and modern physics. The 205-210-215 series presents general principles and analytical methods used in physics for physical science and engineering majors. (combined with PHYS 215L, C-ID PHYS 215) (CSU, UC-with unit limitation)

Course Student Learning Outcomes

- CSLO #1: Solve problems associated with thermodynamics and waves using calculus, trigonometry, and algebra.
- CSLO #2: Identify which physical concepts associated with thermodynamics or waves explain physical phenomena.
- CSLO #3: Develop an overlying and rigorous process to evaluate the behavior of physical systems obeying wave properties and the laws of thermodynamics.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

54

Outside of Class Hours

108

Total Student Learning Hours

162

Course Objectives

It should be noted that a thorough understanding of physics requires the student to evaluate data and synthesize ideas to solve conceptual and numerical problems. The list of objectives below is intended to help the student in this endeavor. Thus students in Physics 215 are expected to:
1. Describe and explain Hooke's Law, oscillatory motion, period, amplitude of oscillation, simple harmonic motion, the simple pendulum, the physical pendulum, and conservation of energy.
2. Apply principles of kinematics and dynamics to spring-mass systems as they pertain to conceptual and numerical problems.
3. Apply principles of kinematics and dynamics to simple and physical pendulum systems as they pertain to conceptual and numerical problems.
4. Evaluate whether or not a system (e.g. simple pendulum, physical pendulum, Lennard-Jones Potential, ball rolling in a a bowl etc.) will exhibit simple harmonic motion or some other form of oscillatory motion.
5. Describe, and explain damped harmonic motion, driven damped harmonic motion, and resonance.
6. Describe and explain wave motion, wavelength, wave number, wave speed, nodes, antinodes, and wave function.
7. Explain what is required to produce mechanical waves.
8. Distinguish between transverse, longitudinal, and torsional waves.
9. Describe the dependence of the speed of a wave in terms of the general properties of the medium.
10. Explain the physical meaning of the wave equation for mechanical waves along with its solutions.
11. Determine whether or not a given function can represent a wave from a simple application of the wave equation.
12. Determine the position, speed, and acceleration of a particle in a harmonic wave.
13. Describe the dependence of the energy and power in any mechanical wave in terms of its amplitude, the elastic and inertial properties of the medium, and angular frequency.
14. Apply the concepts of power and intensity to conceptual and numerical problems involving waves that originate from point sources.
15. Describe what happens to the energy and amplitude of a wave as a result of its transmission and reflection at a boundary.
16. Describe and explain the concepts of constructive and destructive interference, phase shift, path difference, standing waves, normal modes, fundamental frequency, harmonics, overtones, harmonic content, timbre, pitch, and the principle of linear superposition for any mechanical wave.
17. Describe the characteristics of sound waves (e.g., longitudinal mechanical wave, speed, etc.) the audible range of hearing, infrasonic sound waves, and ultrasonic sound waves.
18. Explain the relationship between pressure fluctuation and displacement of particles in a sound wave.
19. Apply the concepts of sound intensity, intensity level, and decibel scale to solve conceptual and numerical problems.
20. Apply relevant concepts on the properties and behavior of mechanical waves (items 6-16 above) to solve conceptual and numerical problems involving standing sound waves and standing waves on a string.
21. Apply the concepts of interference, path difference, and phase shift to conceptual and numerical problems involving the superposition of two traveling waves.
22. Apply the concept of beats to conceptual and numerical problems.
23. Distinguish between group velocity and phase velocity.
24. Explain how the concepts of mechanical waves allows one to understand music produced by various instruments.
25. Solve problems involving the Doppler effect for sound waves.
26. Describe and explain the concept of thermal equilibrium and its relationship to the concept of temperature.
27. Explain the physical characteristics of thermometers (e.g., liquid thermometers, gas thermometers, etc.).
28. Convert between the Celsius, Fahrenheit, and Kelvin temperature scales.
29. Solve conceptual and numerical problems involving linear, area and volume expansion, and thermal stress.
30. Explain the relationship between heat and thermal energy.
31. Describe the energetics involved in phase changes (melting, freezing, vaporization, condensation, sublimation, and deposition).
32. Apply the concept of conservation of energy to solve conceptual and numerical calorimetry problems.
33. Describe and explain the heat transfer mechanisms of conduction, convection, and radiation.

34. Solve numerical and conceptual problems involving the conduction of heat in a thin rod (the temp variation is uniform) or several thin rods.
35. Solve numerical and conceptual problems involving heat transfer by radiation.
36. Solve conceptual problems involving heat transfer by convection.
37. Describe the ideal gas law, its limitations, and how it's related to Charles' Law, Boyle's Law, Gay-Lussac's Law, and Avogadro's Law.
38. Solve numerical and conceptual problems involving the ideal gas law.
39. Describe the molecular model of a gas (kinetic theory of a gas), including the molecular interpretation of pressure and temperature.
40. Describe and explain the heat capacity of an monatomic, diatomic and polyatomic ideal gases for constant volume processes.
41. Describe and explain the PV-diagram along with the isometric, isobaric, adiabatic, and isothermal thermodynamic processes.
42. Solve numerical and conceptual problems involving the work done on or by an ideal gas for isometric, isobaric, adiabatic, isothermal, and adiabatic free expansion thermodynamic processes.
43. Describe and explain the internal energy of an ideal gas.
44. Explain the first law of thermodynamics.
45. Describe and explain the heat capacity of an monatomic, diatomic and polyatomic ideal gases for constant pressure processes.
46. Solve numerical and conceptual problems involving the first law of thermodynamics for isometric, isobaric, adiabatic, isothermal, and adiabatic free expansion thermodynamic processes.
47. Describe and explain reversible and irreversible processes, heat reservoir, the heat engine, the refrigerator, and the heat pump.
48. Explain the concepts of the efficiency of a heat engine and the coefficient of performance of heat pumps and refrigerators.
49. Describe and explain the Kelvin-Planck and the Clausius forms of the second law of thermodynamics.
50. Describe and explain the Carnot Engine, the Carnot Cycle, Carnot's Theorem, and the Theorem's implications to real heat engines.
51. Solve numerical and conceptual problems involving heat engines and the laws of thermodynamics (items 47 through 50 above).
52. Describe and explain the concepts of entropy, entropy change in reversible cycles, and entropy change in irreversible cycles.
53. Solve numerical problems involving entropy change for various processes.
54. Explain the statistical interpretation of entropy.
55. Describe and explain the nature of electromagnetic waves in terms of wave fronts and rays.
56. Compare and contrast the subjects of geometric optics and physical optics.
57. Explain the wave and particle aspects of electromagnetic radiation.
58. Describe and explain Huygen's Principle, specular reflection, diffuse reflection, refraction, index of refraction, Snell's law, the law of reflection, critical angle, total internal reflection, and dispersion.
59. Solve numerical and conceptual problems involving concepts in geometrical optics (item 58).
60. Describe and explain the concepts of unpolarized light (natural light), polarization, polarization by reflection, Brewester's law, polarization by scattering, polarization by absorption, dichroism, Malus's law, and polarization by birefringence.
61. Solve numerical and conceptual problems involving concepts in polarization (item 60).
62. Describe and explain the relevant physics of image formation by reflection due to plane and spherical surfaces.
63. Describe and explain principal rays, paraxial rays, paraxial approximation, lateral magnification, and spherical aberration.
64. Solve problems involving image formation by reflection using mathematical formulas and ray-tracing.
65. Describe and explain the relevant physics of image formation by refraction due to plane surfaces, spherical surfaces, and thin lenses.
66. Solve problems involving image formation by refraction with single-lens, two lens, and lens-mirror systems using mathematical formulas and ray-tracing.
67. Describe and explain the application of lenses and mirrors in various optical instruments such as the eye and the telescope.
68. Describe and explain the concepts of coherence, Young's double-slit experiment, intensity in interference patterns, thin film interference, Newton's rings, and the Michelson interferometer.
69. Solve numerical and conceptual problems involving concepts in optical interference (item 68).
70. Describe and explain the concepts diffraction; compare and contrast Fresnel diffraction and Fraunhofer diffraction.
71. Describe and explain single slit diffraction (Fraunhofer), intensity in a single slit pattern, interference and diffraction effects in multiple slit intensity patterns, and the diffraction grating, grating spectrometers, and x-ray diffraction.
72. Solve numerical and conceptual problems involving concepts in diffraction (item 71).
73. Describe and explain resolving power and Rayleigh criterion.
74. Solve numerical and conceptual problems involving concepts in optical resolution (item 73).
75. Describe and explain the physics of the emission and absorption of light, the photoelectric effect, atomic line spectra, atomic energy levels, nucleus of the atom, the Bohr atom, x-ray production and scattering, Compton scattering, Compton experiment, spectral emittance of radiation, the Stefan-Boltzmann law for a blackbody, Wien displacement law, Planck's radiation law, and the wave-particle duality of electromagnetic radiation.
76. Solve numerical and conceptual problems involving concepts in modern physics (item 75 at the introductory level).
77. Describe and explain De Broglie waves, electron diffraction (Davisson-Germer experiment), probability and uncertainty in quantum mechanics, Heisenberg uncertainty principle, the Schrodinger equation, stationary states, wave functions, wave packets, and the wave-particle duality of particles.
78. Solve numerical and conceptual problems involving concepts in (quantum mechanics (item 77) at the introductory level.

General Education Information

- Approved College Associate Degree GE Applicability
    - AA/AS - Physical Sciences
- CSU GE Applicability (Recommended-requires CSU approval)
    - CSUGE - B1 Physical Science
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)
    - IGETC - 5A Physical Science

Articulation Information

- CSU Transferable
- UC Transferable

Methods of Evaluation

- Classroom Discussions
    - Example: 1. Example for Classroom Discussion Assessment or Objective Exam: As you know, projectors are used to display a magnified image of an object on a screen. This can be accomplished by placing an object in front of a converging lens. What should the object distance, p, be in terms of the focal

length, f, of the lens? A. fB. p>2f C. pD. p2f For the Discussion assessment, Individual students will be graded based on the following two criteria: 1. Is the student participating in the discussion? 2. Did the student get the correct response? Based on how well the class responds to the question, the instructor will ask additional questions on this topic, review this topic, or move on to the next topic.

- Objective Examinations
  - Example: 1. Example for Classroom Discussion Assessment or Objective Exam: As you know, projectors are used to display a magnified image of an object on a screen. This can be accomplished by placing an object in front of a converging lens. What should the object distance, p, be in terms of the focal length, f, of the lens? A. fB. p>2f C. pD. p2f For the Discussion assessment, Individual students will be graded based on the following two criteria: 1. Is the student participating in the discussion? 2. Did the student get the correct response? Based on how well the class responds to the question, the instructor will ask additional questions on this topic, review this topic, or move on to the next topic.
- Problem Solving Examinations
  - Example: Chapter quizzes and unit exams along with a comprehensive final examination are used to measure student performance in terms of the stated student performance objectives. 1. Exam problem (problem solving with rubric grading):One mole of an ideal diatomic (rigid rotator) ideal gas has initial temperature of 300K and pressure 1atm (labeled state A). It undergoes an isochoric process to a new state labeled B with temperature 600K. It then expands adiabatically to C and returns to A via an isobaric process. a. Sketch a PV-diagram of the process, indicating states A, B, and C, and the direction of each process (5pts). b. What is the volume of gas at A (3pts)? c. What are the volume and temperature at C (10pts)? d. How much heat is transferred in the isochoric process (5pts)? e. What is the net work done in one cycle (10pts)? f. If this were an engine, what would its efficiency be (5pts)? g. What is the change in entropy of the gas during the isobaric process (10pts)? 2. Quiz problem (problem solving with rubric grading): A jackhammer operated continuously at a construction site behaves as a source of spherical waves. A construction supervisor 50m due east of the source begins to walk east. How far must she walk (in m) to decrease the sound level by 2.0dB (10pts)?

Repeatable

No

Methods of Instruction

- Lecture/Discussion
- Distance Learning

Lecture:

1. (In Class or Distance Learning)
2. A multimedia presentation is used to discuss interference of light. The presentation includes graphics and video clips for emphasis and clarity. The instructor solves example problems in great detail at appropriate times throughout the lecture. Students are always encouraged to ask questions in class or in the LMS discussion board throughout the presentation.. (In Class or Distance Learning)
3. Demonstrations illustrating interference of light are used at appropriate times to elucidate this topic. Students are always encouraged to ask questions throughout the presentation.

Distance Learning

1. (In Class or Distance Learning)
2. An audience response system is used to ask questions on the interference of light in order to assess the level of student understanding during lecture. Based on how well students respond to the questions, the instructor will ask additional questions on this topic, review this topic, or move on to the next topic

Typical Out of Class Assignments
Reading Assignments

1.Read textbook chapter on Interference of Light in preparation for class discussion. 2.Read the lecture slide notes on Standing Waves on a String in preparation for class discussion.

Writing, Problem Solving or Performance

1. Complete the online homework assignment. Sample Problem: A typical coal-fired power plant generates 1000MW of usable power at an overall thermal efficiency of 41%. a. What is the rate of heat input to the plant? b. The plant burns anthracite coal, which has a heat of combustion of 2.65x10^7 J/kg. How much coal does the plant use per day, if it operates continuously? c. At what rate is heat ejected into the cool reservoir, which is a nearby river? d. The river's temperature is 291.2 K before it reaches the power plant and 291.6 K it has received the plants waste heat. Calculate the river's flow rate in cubic meters per second. e. By how much does the river's entropy increase each second? 2.Complete the problem solving worksheet on the cyclical thermodynamic processes.

Other (Term projects, research papers, portfolios, etc.)
Required Materials

- University Physics
  - Author: Young and Freedman
  - Publisher: Pearson
  - Publication Date: 2020
  - Text Edition: 15th
  - Classic Textbook?:
  - OER Link:
  - OER:
- Physics for Scientists and Engineers, Technology Update
  - Author: Serway and Jewitt
  - Publisher: Cengage
  - Publication Date: 2019
  - Text Edition: 10th
  - Classic Textbook?:
  - OER Link:
  - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.