List of chapter-specific learning goals and tentative correspondence with class modules & practicals (PRA)

Note: These goals are in addition to the overall learning goals in the syllabus.

Ch.	#	Goal	Class Module	PRA
URC	1	Identify areas of subjectivity in physics.	0	
URC	2	Analyze statistics about who participates in physics.		1
22	1	Explain what is needed for us to see things.	1	
22	2	Draw ray diagrams to represent how an extended source emits light.	1	
22	3	Design an observational experiment to determine patterns in the behavior of a narrow beam of light (laser beam) incident on a mirror.	1	
22	4	Use an observational experiment to determine patterns in the behavior of a laser beam incident on a tank of water.	1	
22	5	Apply the law of reflection to solve problems.	1	
22	6	Apply the law of refraction to solve problems.	1	
22	7	Design two independent experiments to determine the refractive index of a transparent material (one should involve total internal reflection).		2
22	8	Explain how a pinhole camera works.	1	
22	9	Draw ray diagrams for light rays in complex situations (including prisms).	1	
URC	3	Justify the need for racial equity (inclusion and access) in physics.	0	
23	1a	"Read and write" with ray diagrams for *plane mirrors*. Use ray diagrams to represent the problem situation and to evaluate the solution.	2	
23	1b	"Read and write" with ray diagrams for *curved mirrors*. Use ray diagrams to represent the problem situation and to evaluate the solution. Explain the role of three rays and the role of a focal plane. Provide examples.	2	
23	1c	"Read and write" with ray diagrams for *lenses*. Use ray diagrams to represent the problem situation and to evaluate the solution. Explain the role of three rays and the role of a focal plane. Provide examples.	2	
23	2	Explain the difference between a real and a virtual image.	2	

23	3	Use ray diagrams, the curved mirror equation, and the magnification equation to solve quantitative mirror problems. Translate between ray diagrams and equations.	2	
23	4	Use ray diagrams, the thin lens equation, and the magnification equation to solve quantitative lens problems. Translate between ray diagrams and equations.	2	
23	8	Design an experiment to determine the focal distance of a concave mirror.	2	
23	9	Design an experiment to determine the focal distance of a convex lens.		2
URC	4	Describe what and how obstacles such as implicit bias, stereotype threat, etc. can influence who participates in the physics field and classroom, creating inequity.	0	
24	1	"Read and write" with wave fronts and rays.	3	
24	2	Use Huygens' principle to explain interference and diffraction phenomena.	3	
24	3	Apply the superposition principle to explain interference effects.	3	
24	4a	Analyze qualitatively and quantitatively situations involving laser light passing through two slits, one slit, multiple slits, and gratings. Identify path length difference and phase difference.	3	
24	4b	Analyze qualitatively and quantitatively situations involving light passing through thin films.		4
24	7	Conduct an observation experiment to determine quantitatively how the slit width affects the pattern on the screen in a single-slit experiment.	3	
24	6	Conduct an observation experiment to determine quantitatively how the slit separation affects the pattern on the screen in a double-slit experiment.	3	
24	10	Apply knowledge of wave optics to explain and analyze technological or biological applications.	3	4
17	1	Design an experiment to test a hypothesis: electric and magnetic interactions are the same.		1
17	2	Explain how we know that there are only two types of electric charge; how to charge and discharge objects.		1
17	4	Explain interactions of charged objects, and charged and neutral objects, using microscopic pictures of charge distribution.	4	
17	3	Explain macroscopic and microscopic differences between conductors and dielectrics.	4	

17	5	Describe the experiment from which Coulomb's law can be inferred, describe how Coulomb found proportionality of the force to the magnitude of the charges, and apply Coulomb's law to situations using force diagrams and Newton's laws.	4	
17	6	Construct and evaluate energy bar charts for situations involving static electricity.	4	
17	7	Explain why the electric potential energy of a system of two oppositely charged objects is negative and of two like-charged objects is positive.	4	
17	8	Apply knowledge of forces, momentum, and energy to solve problems combining mechanics and electrostatics.	4	
18	1	Explain the difference between the concept of a field as a medium for interactions and physical quantities characterizing it: E and V fields.	4	
18	2	Compare and contrast the physical quantities of E and V fields.	4	
18	3	Compare and contrast operational definitions of E and V fields and cause-effect relationships for the same quantities.	4	
18	4	"Read and write" with different representations of electric field such as E field vectors, E field lines, and equipotential surfaces.	4	
18	5	Apply the superposition principle to calculate E and V fields for situations involving multiple charged objects, including infinitely large metal plates.	4	
18	6	Explain grounding and shielding qualitatively and grounding quantitatively through electric potential.	4	
18	8	Apply knowledge of electric fields and work/energy to explain how a capacitor works.	5	
19	1a	Explain why only a closed circuit loop will light a bulb.	5	
19	1b	Be able to troubleshoot wrongly connected circuits.		5
19	1c	Build simple circuits involving series and parallel connections and measure current through and potential difference across circuit elements.		5
19	2a	Compare and contrast the physical quantities of electric current, potential difference, resistance, and electric power.	5	
19	2b	Make predictions concerning potential difference, current, and resistance in DC circuits.	5	
19	3	Reason qualitatively about series and parallel circuits using the concept of potential difference and resistance. Apply	5	

		this reasoning to home wiring.		
19	4a	Explain why the slope of the current-versus-voltage curve is not equal to the inverse of the resistance of an element (except when the graph is a straight line that goes through the origin).	5	
19	4b	Compare and contrast the operational definition of resistance with the cause-effect relationship.	5	
19	6	Compare and contrast resistors, incandescent light bulbs, LEDs, and capacitors in DC circuits.	5	
19	9	Design an experiment to test which model for a regular battery is better: a source of constant current or source of constant voltage.		5
19	10	Design an experiment to estimate the internal resistance of a battery and opening voltage of an LED.		5
19	7	Use Kirchhoff's rules to reason about circuits quantitatively.	5	
20	1a	Describe the sources of magnetic fields. Explain how magnetic fields are created.	6	
20	1b	"Read and write" with B field line representations.	6	
20	2	Explain how to use a compass to determine the direction and relative magnitude of the B field at a particular location.	6	
20	3	Determine the directions of B field vectors when the magnetic field is created by a bar magnet, horseshoe magnet, and by a current-carrying wire, loop, and a solenoid.	6	
20	4	Apply the right-hand rule for the fields and the right-hand rule for forces to analyze situations involving magnetic fields when magnetic fields are created by current-carrying wires.	6	
20	5	Compare and contrast electric fields and magnetic fields.	6	
20	6	Determine the magnitude of a magnetic force exerted on a current-carrying wire or a moving charged particle in a uniform magnetic field.	6	
20	7	Apply knowledge of magnetic forces, electric forces and Newton's laws to solve problems. Use force diagrams to analyze situations.	6	
20	8	Explain how an electric motor works using knowledge of torques.	6	
20	10	Design an experiment to determine the magnitude and direction of the B field produced by a current-carrying wire, current-carrying solenoid and(/or) by an unmarked magnet.	6	4

21	1	Design an experiment to create current in a coil that is not connected to a battery using two different methods.	6	4
25	6	Explain what light phenomena can be explained using a particle-bullet model, wave model, and electromagnetic wave model.	6	
25	4	Explain how electromagnetic waves are emitted and detected.	6	
25	8	Describe the scientific steps of the investigations/reasoning that led to the discovery of electromagnetic waves.	6	
URC	5	Feel empowered to take action towards creating a more equitable community.	0	
26	2	State Einstein’s postulates and the reasons for proposing them.	7	
26	3	Analyze situations using Einstein’s postulates.	7	
26	4	Apply the concepts of time dilation and length contraction to explain relevant phenomena, including magnetism.	7	