Content				
Unit	**Topics**	**Labs/Activities**	**Big Ideas**	**Learning Objectives/Science Practices**
1. KINEMATICS [CR2a]	• Kinematics in one-dimension: constant velocity and uniform accelerated motion • Vectors: vector components and resultant • Kinematics in two-dimensions: projectile motion	1.**Match the Graph (GI) [CR6b]** To determine the proper placement of an air track, a glider, and a motion detector to produce a motion that matches a set of given graphs: position, velocity, and acceleration versus time. **2. Free-Fall Investigation** To determine and compare the acceleration of two objects dropped simultaneously. **3. Vector Addition (GI) [CR6b]** To determine the value of a resultant of several vectors, and then compare that value to the values obtained through graphical and analytical methods. **4. Shoot the Target (GI) [CR6b]** To determine the initial velocity of a projectile, the angle at which the maximum range can be attained, and predict where the projectile will land. **5. Chase Scenario (GI) [CR6b]** *Lab Practicum:* Students use a battery cart and a fan cart to recreate a chase scenario (police-thief) to predict the position where the 'thief' will be caught and the final speeds of	3	**Learning Objectives:** 3.A.1.1, 3.A.1.2, 3.A.1.3 **Science Practices** 1.2, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2 **Science Practices** 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2 **Science Practices** 1.1, 1.2, 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4,7.2 **Science Practices** 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4, 7.2 **Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3,5.1, 5.2, 5.3, 6.1, 6.2, 6.4, 7.2

		both cars.		
2. DYNAMICS [CR2b]	• Forces, types, and representation (FBD) • Newton's First Law • Newton's Third Law • Newton's Second Law • Applications of Newton's Second Law • Friction • Interacting objects: ropes and pulleys	**6. Inertial and Gravitational Mass (GI) [CR6b]** To determine the difference (if any) between inertial mass and gravitational mass.	1,2,3, 4	**Learning Objectives:** 1.C.1.1, 1.C.1.3, 2.B.1.1, 3.A.2.1, 3.A.3.1, 3.A.3.2, 3.A.3.3, 3.A.4.1, 3.A.4.2, 3.A.4.3, 3.B.1.1, 3.B.1.2, 3.B.1.3, 3.B.2.1, 3.C.4.1, 3.C.4.2, 4.A.1.1, 4.A.2.1, 4.A.2.2, 4.A.2.3, 4.A.3.1, 4.A.3.2 **Science Practices** 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4, 7.2
		7. Forces Inventory (GI) [CR6b] Qualitative and quantitative investigation on a variety of interactions between objects.		**Science Practices** 1,1, 1.4, 1.5, 2.1, 2.2, 3.3, 4.1, 4.2, 4.3, 5.1, 6.1, 6.2, 6.4, 7.2
		8. **Static Equilibrium Challenge** To determine the mass of a hanging object in a setup with three strings at various angles.		**Science Practices** 1.1, 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4,7.2
		9. Newton's Second Law (OI) [CR6b] To determine the variation of the acceleration of a dynamics cart in two scenarios: (1) the total mass of the system is kept constant while the net force varies, and (2) the net force is kept constant while the total mass of the system varies.		**Science Practices** 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.2, 6.4, 7.2
		10. Coefficient of Friction (GI) [CR6b] To determine the maximum coefficient of static friction between a shoe and a wooden plank.		**Science Practices** 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4,7.2
		11. Atwood's Machine (GI) [CR6b] To determine the acceleration of		**Science Practices** 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4,7.2

2. DYNAMICS [CR2b]	• Forces, types, and representation (FBD) • Newton's First Law • Newton's Third Law • Newton's Second Law • Applications of Newton's Second Law • Friction • Interacting objects: ropes and pulleys	**6. Inertial and Gravitational Mass (GI) [CR6b]** To determine the difference (if any) between inertial mass and gravitational mass.	1,2,3, 4	**Learning Objectives:** 1.C.1.1, 1.C.1.3, 2.B.1.1, 3.A.2.1, 3.A.3.1, 3.A.3.2, 3.A.3.3, 3.A.4.1, 3.A.4.2, 3.A.4.3, 3.B.1.1, 3.B.1.2, 3.B.1.3, 3.B.2.1, 3.C.4.1, 3.C.4.2, 4.A.1.1, 4.A.2.1, 4.A.2.2, 4.A.2.3, 4.A.3.1, 4.A.3.2 **Science Practices** 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4, 7.2
		7. Forces Inventory (GI) [CR6b] Qualitative and quantitative investigation on a variety of interactions between objects.		**Science Practices** 1,1, 1.4, 1.5, 2.1, 2.2, 3.3, 4.1, 4.2, 4.3, 5.1, 6.1, 6.2, 6.4, 7.2
		8. **Static Equilibrium Challenge** To determine the mass of a hanging object in a setup with three strings at various angles.		**Science Practices** 1.1, 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4,7.2
		9. Newton's Second Law (OI) [CR6b] To determine the variation of the acceleration of a dynamics cart in two scenarios: (1) the total mass of the system is kept constant while the net force varies, and (2) the net force is kept constant while the total mass of the system varies.		**Science Practices** 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.2, 6.4, 7.2
		10. Coefficient of Friction (GI) [CR6b] To determine the maximum coefficient of static friction between a shoe and a wooden plank.		**Science Practices** 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4,7.2
		11. Atwood's Machine (GI) [CR6b] To determine the acceleration of a hanging mass and the tension in the string.		**Science Practices** 1.1, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4,7.2

5. MOMENTUM [CR2e]	• Impulse • Momentum • Conservation of momentum • Elastic and inelastic collisions		3,4,5	**Learning Objectives:** 3.D.1.1, 3.D.2.1, 3.D.2.2, 3.D.2.3, 3.D.2.4, 4.B.1.1, 4.B.1.2, 4.B.2.1, 4.B.2.2, 5.A.2.1, 5.D.1.1, 5.D.1.2, 5.D.1.3, 5.D.1.4, 5.D.1.5, 5.D.2.1, 5.D.2.2, 5.D.2.3, 5.D.2.4 , 5.D.2.5, 5.D.3.1
		16. Bumper Design (GI) [CR6b] To design a paper bumper that will soften the impact of the colli- sion between a cart and a fixed block of wood. Their designs are evaluated by the shape of an acceleration-versus-time graph of the collision.		**Science Practices** 1.4, 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1,6.2, 6.4, 7.2
		17. Impulse and Change in Momentum (GI) [CR6b] To measure the change in momentum of a dynamics cart and compare it to the impulse received.		**Science Practices** 1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1,5.3, 6.1, 6.4, 7.2
		18. Elastic and Inelastic Collisions (OI) [CR6b] To investigate conservation of momentum and conservation of energy using a ballistic pendulum to determine the type of collision.		**Science Practices** 1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1,5.2, 5.3, 6.1, 6.2, 6.4, 7.2
		19. Forensic Investigation (OI) [CR6b] *Lab Practicum:* Apply principles of conservation of energy, conservation of momentum, the work-energy theorem, and a linear model of friction to find the coefficient of kinetic friction.		**Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.2, 6.4, 7.2
6. SIMPLE HARMONIC MOTION [CR2d]	• Linear restoring forces and simple harmonic motion • Simple harmonic motion graphs • Simple pendulum • Mass-spring systems	**20. Finding the Spring Constant (GI) [CR6b]**	3,5	**Learning Objectives:** 3.B.3.1, 3.B.3.2, 3.B.3.3, 3.B.3.4, 5.B.2.1, 5.B.3.1, 5.B.3.2, 5.B.3.3, 5.B.4.1, 5.B.4.2 **Science Practices** 1.1, 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4, 7.2

		To design two independent experiments to determine the spring constants of various springs of equal length. **21. Graphs of an Oscillating System (GI) [CR6b]** To analyze graphs of position, velocity, and acceleration versus time for an oscillating system to determine how velocity and acceleration vary at the equilibrium position and at the endpoints. **22. Simple Pendulum Investigation (GI) [CR6b]** To investigate the factors that affect the period of a simple pendu- lum and test whether the period is proportional to the pendulum's length, the square of its length, or the square root of its length.		**Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3,6.1, 6.4, 7.2 **Science Practices** 1.2, 1.4, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1,5.3, 6.1, 6.4, 7.2
7.ROTATIONAL MOTION[CR2g]	• Torque • Center of mass • Rotational kinematics • Rotational dynamics and rotational inertia • Rotational energy • Angular momentum • Conservation of angular momentum	**23. Torque and the Human Arm (OI) [CR6b]** To design and build an apparatus that replicates the forearm and biceps muscle system to determine the biceps tension when holding an object in a lifted position. **24. Rotational Inertia (GI) [CR6b]** To determine the rotational inertia of a cylinder from the slope of a graph of an applied torque versus angular	3,4,5	**Learning Objectives:** 3.F.1.1, 3.F.1.2, 3.F.1.3, 3.F.1.4, 3.F.1.5, 3.F.2.1, 3.F.2.2, 3.F.3.1, 3.F.3.2, 3.F.3.3, 4.A.1.1, 4.D.1.1, 4.D.1.2, 4.D.2.1, 4.D.2.2, 4.D.3.1, 4.D.3.2, 5.E.1.1, 5.E.1.2, 5.E.2.1 **Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.2, 6.4, 7.1, 7.2 **Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3,6.1, 6.4, 7.2

		acceleration. **25. Conservation of Angular Momentum (GI) [CR6b]** To investigate how the angular momentum of a rotating system responds to changes in the rotational inertia.		**Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3,6.1, 6.4, 7.2
8.MECHANICAL WAVES[CR2j]	• Traveling waves • Wave characteristics • Sound • Superposition • Standing waves on a string • Standing sound waves	**26. Mechanical Waves (GI) [CR6b]** To model the two types of mechanical waves with a spring toy to test whether or not these characteristics affect the speed of a pulse: frequency, wavelength, and amplitude. **27. Speed of Sound (GI) [CR6b]** Design two different procedures to determine the speed of sound in air. **28. Wave Boundary Behavior (GI) [CR6b]** To compare what happens to the phase of a transverse wave on a spring toy when a pulse is reflected from a boundary and when it is reflected and transmitted from various boundaries (spring to string). **29. Standing Waves (GI) [CR6b]** Given a specified tension, students predict the length of the string necessary to generate the first two harmonics of a	6	**Learning Objectives:** 6.A.1.1, 6.A.1.2, 6.A.1.3, 6.A.2.1, 6.A.3.1, 6.A.4.1, 6.B.1.1, 6.B.2.1, 6.B.4.1, 6.B.5.1, 6.D.1.1, 6.D.1.2, 6.D.1.3, 6.D.2.1, 6.D.3.1, 6.D.3.2, 6.D.3.3, 6.D.3.4, 6.D.4.1, 6.D.4.2, 6.D.5.1 **Science Practices** 1.2, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.2, 6.4,7.2 **Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1,6.4, 7.2 **Science Practices** 1.4, 3.1, 4.1, 4.2, 4.3, 5.1, 6.1, 6.4, 7.2 **Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3,6.1, 6.4, 7.2

		standing wave on the string. Then they perform the experiment and compare the outcome with their prediction.		
9.ELECTROSTATICS [CR2h]	• Electric charge and conservation of charge • Electric force: Coulomb's Law	**30. Static Electricity Interactions (GI) [CR6b]** Students use sticky tape and a variety of objects to make qualitative observations of the interactions when objects are charged, discharged, and recharged. **31. Coulomb's Law (GI) [CR6b]** To estimate the charge on two identical, equally charged spherical pith balls of known mass.	1,3,5	**Learning Objectives:** 1.B.1.1, 1.B.1.2, 1.B.2.1, 1.B.3.1, 3.C.2.1, 3.C.2.2, 5.A.2.1 **Science Practices** 1.2, 3.1, 4.1, 4.2, 5.1, 6.2, 7.2 **Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 6.4, 7.2
10.DC CIRCUITS [CR2i]	• Electric resistance • Ohm's Law • DC circuits • Series and parallel connections • Kirchhoff's Laws	**32. Brightness Investigation (GI) [CR6b]** To make predictions about the brightness of light bulbs in a variety of series and parallel circuits when some of the bulbs are removed. **33. Voltage and Current (GI) [CR6b]** To determine the relationship between the current through a resistor and the voltage across the resistor. **34. Resistance and Resistivity**	1,5	**Learning Objectives:** 1.B.1.1, 1.B.1.2, 1.E.2.1, 5.B.9.1, 5.B.9.2, 5.B.9.3, 5.C.3.1, 5.C.3.2, 5.C.3.3 **Science Practices** 1.2, 3.1, 4.1, 4.2, 4.3, 5.3, 6.1, 6.4, 7.2 **Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.3,6.1, 6.4, 7.2 **Science Practices** 1.4, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1,5.3,

		(GI) [CR6b] To investigate the effects of cross-sectional area and length on the flow of current through a roll of Play-Doh. **35. Series and Parallel Circuits (GI) [CR6b]** To investigate the behavior of resistors in series, parallel, and series-parallel circuits. The lab should include measurements of voltage and current.		6.1, 6.4, 7.2 **Science Practices** 1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3, 5.1, 5.2,5.3, 6.1, 6.4, 7.2