Physics by Discovery Standards 2017-18 (2nd Semester)

11. Newton's Law of Universal Gravitation

UG	I can apply the Law of Universal Gravitation	Reason about how doubling distance, masses, etc. affect the force Solve problems involving the Law of Universal Gravitation Use the Law of Universal Gravitation ($F = Gm_1m_2/r^2$) to find the gravitational field strength (g) near different large objects.

12. Central Force Model (Circular Motion)

CFM1	I can explain and apply circular motion concepts analyze uniform circular motion conceptually	Define "uniform circular motion" Identify the direction of acceleration and net force for different situation involving objects moving in a circle or curved path. Draw a qualitatively correct free body diagram for the object at different points along its curved path. Qualitatively compare magnitudes of forces at different points along path Explain the meaning of "centripetal" Explain how acceleration depends on speed and path radius, and how changing either one affect the magnitude of the acceleration
CFM2	I can solve problems involving circular motion	Calculate an object's acceleration Apply Newton's second law along the center, x, and/or y axes Solve problems to find speed, radius of path, acceleration, mass, or forces Solve problems involving satellites in orbit

13. Electric Circuit Models

EC1	Apply and give evidence for the closed loop and charge flow models (Sections 1,2)	Identify on a diagram when bulbs will and will not light Define conductors and insulators, explain how to test for them, give examples Trace the continuous conducting path in circuits and through internal parts of light bulb. Explain direction of charge flow in a circuit and give experimental evidence Explain conventional charge flow and draw on circuit diagram Explain the effect of reversing a battery on the direction of charge flow --- Represent simple circuits with schematic diagrams Explain and draw the structure/parts of a capacitor Draw arrows to indicate direction of conventional charge flow throughout a circuit during capacitor charging and discharging Identify the places in a circuit where mobile charge originates. Compare and contrast the roles of a battery and Genecon in a circuit. Compare and contrast an air capacitor and a capacitor in an electric circuit. State experimental evidence (observations) for key statements in the models

EC2	Apply and give evidence for the Resistance and Incomppressible Fluid models (Sections 3,4)	Explain effect of resistors (including bulb filaments) on charge flow Explain the difference between flow rate and speed Explain effect of series/parallel arrangements on "overall" resistance Explain effect of thickness & length on "overall" resistance Describe the resistance of connecting wires. Use observations to infer resistance, flow rate, electric pressure --- Cite evidence that charge can be compressed Explain why electric pressure is uniform in any wire, and connected wires Explain in terms of electric pressure: capacitor charging, charged capacitor, capacitor discharging, battery, and bulb lighting Color-code circuits to represent electric pressure, and use them to predict which bulbs will light and their relative brightness.
EC3	Determine values for pressure difference & flow rate, and calculate resistance.	Explain what is measured by a "voltmeter" and "ammeter" and cite evidence Describe the resistance of each meter, experimental evidence that it has that resistance, and the reason it is designed to have that resistance
		Apply the relationships between total pressure difference in a circuit and the pressure difference across individual components for series and parallel circuits. Apply the relationships between total current in a circuit and current through individual components for series and parallel circuits.
		Use the definition of resistance to calculate a value (Resistance = $\Delta V/I$) Explain and apply: Ohm's Law, ohmic resistance, and "non-ohmic resistance"
EC4	Quantitatively analyze series, parallel, and combination circuits	Find equivalent resistance for resistors in series and resistors in parallel Find equivalent resistance for combinations of series and parallel connections Determine unknown voltage drop, current, and resistance values at any place in a combination circuit.
EC5	Measure voltage and current	Set the dial and leads of a multi-meter to make it a voltmeter or ammeter Given a schematic diagram and equipment, put together a series, parallel, or combination circuit. Connect and use a meter to measure: - the pressure difference (change in voltage) across a circuit component - the flow rate (current) through a component Calculate values for resistors in the circuit using your measurements

14. Electric Forces and Fields

EF1	Explain **electric charge** & charging processes	Explain how like and opposite charges interact Explain what it means for charge to be "conserved" Explain what it means for charge to be "quantized" Explain the properties of conductors, insulators, semiconductors, superconductors Draw diagrams that show the location of + and - charge in objects at different stages of being charged by methods of conduction and induction Explain "polarization" Explain "grounding" Explain and illustrate why neutral conductors or insulators are attracted to charged objects
EF2	Explain and calculate the **electric force**	Calculate electric force between two point charges using Coulomb's Law ($Fe = kq_1q_2/r^2$) Explain how the electric force depends on the magnitude of each charge and the distance between the charges Include magnitude and direction when stating a force Apply the superposition principle to find net electric force on a particular charge Compare and contrast the electric force with the gravitational force
EF3	Explain, represent, and calculate **electric fields**	Define electric field in terms of the force on a test charge Describe what quantities affect the strength of the electric field Determine the electric field vector at some location due to a point charge Use the principle of superposition to find the net electric field at some point resulting from multiple point charges Draw electric field lines around one or two point charges.

15. Electrical Energy and Electric Potential

EE1	Apply electric potential energy and electric potential concepts	Qualitatively compare electrical potential energy of a charge at different locations Define and explain "electric potential" and "electric potential difference" Solve problems involving electric potential, electric potential energy, and charge. <u>For special case of oppositely-charged parallel plates</u>: Define a system and set "zero" electric potential energy at negative plate Calculate electric potential energy of charged particle between plates Calculate changes in electric potential energy of charged particle between plates Apply conservation of energy to analyze the motion of charged particle Compare electric potential at different locations; identify equipotentials Calculate electric potential and changes in electric potential Relate electric potential to the electric field between the plates
EE2	Determine energy and power for circuit components	Explain the meaning of power Starting with "Power = energy transferred/time", derive an expression for electric power in terms of current and potential difference For resistors in an electric circuit, calculate power, energy transferred in some amount of time, cost of that energy

16. Magnetism (Ch 19, 20)

M1	Explain properties of magnets and magnetic fields	Explain magnetic poles and how they interact Explain what a magnetic field line communicates Draw magnetic fields: permanent magnet, earth, current-carrying wire, loop, and coil Explain cause of magnetism; why some materials are magnetic Explain domains and draw domain diagrams for magnets, materials attracted/not attracted to magnets Explain why some non-magnets are attracted to magnets Explain how different materiasl inserted into an electromagnet affect its strength. Explain operation of buzzer & circuit breaker
M2	Determine magnitude and direction of magnetic force.	Determine the force (direction only) of a current's magnetic field on a magnet (such as a compass) Determine the force (magnitude and direction) of a magnetic field on a current-carrying wire. Explain the operation of a simple motor and speaker. Determine the force (magnitude and direction) of a magnetic field on a free moving electric charge and analyze the resulting motion.
M3	Apply principles of electromagnetic induction	Explain when a potential difference and current will be induced Calculate the magnetic flux through a loop Determine the direction of the induced current in a loop (Lenz's Law) Sketch a graph of magnetic flux vs time and rate of change of flux vs. time for a bar magnet moving through a loop Explain what affects the magnitude of the induced potential difference Calculate the induced potential difference and current (Faraday's Law)

17. Lab Report

LR	Write a complete, clear, and thorough report of an experiment	• Lab report includes the following sections: Purpose, Variables, Assumptions, Expectations, Method, Data, Analysis, Conclusion, and Discussion • See the "Guidelines for Writing a Lab Report" for information

18. Light: Ray Nature

L1	**Reflection** Explain and apply the ray nature of light and the law of reflection	Explain what is necessary to see Draw light rays showing how an observer can see an object, how light rays reflect from different surfaces, how pinhole cameras form images Explain why we don't normally see laser light in air Explain how our brain locates the position of the object it is seeing Apply the law of reflection by drawing incident and reflected rays Draw light rays to locate images in plane mirrors Describe the characteristics of the image formed by plane mirrors Draw light rays and explain how a rear-view mirror and periscope work
L2	**Refraction** Apply principles of refraction and total internal reflection	Apply Snell's Law to solve for unknowns (ni, θi, nr, θr) Given a diagram showing incoming and outgoing light rays at a boundary, qualitatively identify which medium has the higher index of refraction. Relate the index of refraction to the speed of light in a medium. Determine which direction light must travel at a boundary for there to be a possibility of total internal reflection Define the critical angle, and calculate it for a given boundary

		Determine the future path of a light ray at a boundary (reflect and refract -or-total internal reflection) Explain how fiber optic cables work
L3	**Lenses** Use diagrams and equations to analyze convex lens situations.	Draw a ray diagram and locate the image Use incoming parallel light rays to locate the focal point of a lens Use thin lens equation to calculate focal length, image distance, object distance Describe the difference between virtual and real images Describe characteristics of the image: size(larger, smaller, same size), type (real/virtual), orientation (upright/inverted) Calculate and interpret "magnification"

19. Waves and Sound *(This standard is only assessed on the final)*

WS	Waves and Sound	Describe particle motion in transverse and longitudinal waves Identify amplitude, crest, trough, period, wavelength, frequency, and period from time and position graphs. Identify factors that do and don't affect the speed of a wave Relate period and frequency ($f = 1/T$) Calculate the speed of a wave in air using the equation ($v = 331$ m/s $+ 0.6T$) Solve problems involving wavelength, frequency, speed, and period Define constructive interference and destructive interference; draw pulses that would demonstrate each type of interference; apply superposition to draw resultant wave For standing wave patterns on a string • Draw fundamental, 1st overtone, 2nd overtone, 3rd overtone. • Write an expression that relates the length of the string to the wavelength of the wave • Solve problems that relate speed of wave, length, wavelength, and frequency for the different vibrational modes.