Physics by Discovery 1st Semester Standards

1. Discovery Process Skills

DP1	Exploration	Brainstorm prior knowledge Make observations: Qualitative and Quantitative (measurements) Identify variables; determine if measurable, independent/dependent Write 6 questions, including 3 that are investigable and involve a quantitative relationship between two variables Make sure that all variables mentioned in the questions were also included in the "Variables" list
DP2	Experiment Design	Thoroughly complete all aspects of designing an experiment: • Research question • Variables • Materials • Procedure • Data table • Analysis plan • Assumptions • Preconceptions
DP3	Quality Graph	Make a quality graph (by hand and with Logger Pro) - Title, axes labels with units, "good" scale, fills more than 1/2 page - Plot data points accurately - Draw best-fit line or curve - Include error bars - Include origin
DP4	Patterns in Data	Know pattern characteristics (linear, direct proportion linear, quadratic, inverse, inverse square) - describe the general mathematical model, what x&y combo is constant, shape of graph, characteristics of slope, how doubling x changes y... Find a pattern in data & writing mathematical model **by hand** - identify the pattern in graphed data, explaining reasoning.. (State a characteristic of the pattern and use numbers from the graph to show that the data has that characteristic) - For lines, find slope using two circled points on line, not data points - Determine value of constant with units - Write mathematical model that best represents the data Find a pattern in data & write mathematical model **with Logger Pro** - Identify the pattern in graphed data - Determine value of constant with units - Write mathematical model that best represents the data
DP5	Conclusion and Discussion	- Write a Conclusion that includes claim, evidence, and mathematical model (if applicable), and makes claim for idealized model if appropriate - Interpret and explain results of experiment, ultimately expressing this thinking by writing a Discussion (see Discovery Process Handbook)

2. HW Preparation

HW	I can complete homework assignments, correct my work, and meet deadlines	Homework assignments are completed, corrected with the solutions, and turned in on time.

3. Position and Displacement

PD	I can explain and apply position and displacement concepts	• Explain and determine position, displacement, and distance traveled • Explain the meaning of specific values for position and displacement • Draw a displacement vector to scale with correct direction • Determine the direction and magnitude of a given displacement vector • Add together several displacement vectors graphically; find resultant displacement

4. Constant Velocity Particle Model

CVPM1	I can explain and apply constant velocity concepts	• Explain constant speed, constant velocity, vectors, scalars • Explain the meaning of specific values for speed, and velocity. • Create and interpret graphs, motion maps, mathematical models, and verbal descriptions of constant velocity motion. • Find velocity from a position-time or velocity-time graph • Find displacement from a position-time or velocity-time graph
CVPM2	I can use multiple representations to solve constant velocity problems	• Use graphical methods and equations to solve problems • For an object moving at constant velocity, write an equation for its position as a function of time. • Determine when and where two objects will meet

5. Constant Acceleration Particle Model

CAPM1	I can explain and apply constant acceleration concepts	• Explain instantaneous velocity and acceleration and how to calculate or find each from a graph. • Explain the meaning of the sign (+ or -) of acceleration in different situations. • Explain speed, velocity, and acceleration during free fall situations • Translate between graphs, verbal descriptions, motion maps. • Given a position time graph, find instantaneous velocities at different times using tangent lines and make a velocity-time graph. • Determine acceleration of an object from its velocity-time graph
CAPM2	I can solve problems involving motion with constant acceleration	• Solve problems using (a) annotated graphs (b) equations. • Identify special cases of motion (when initial velocity, final velocity, or displacement is zero, free fall acceleration, conditions for two objects to meet)

6. Introduction to Forces

IF1	I can diagram forces and find net force	• Draw system schema diagram and identify force pairs • Draw a Free Body Diagram showing all forces with appropriate directions and names • Calculate the force of gravity on an object near the earth's surface • Apply the definition of gravitational field strength (g = Fg/mass) • Add forces graphically to determine the net force (sum of the forces) • Determine if forces are balanced or unbalanced.
IF2	I can explain and apply Newton's 3rd Law	• Explain Newton's 3rd Law (N3L): How many forces are involved in an interaction? How do these forces compare in magnitude? direction? Do these forces act on the same object or different objects? • When given one force, identify its Newton's 3rd Law pair • Apply to figure out unknown forces and solve problems. • Explain experimental evidence for Newton's 3rd Law
IF3	I can explain and apply the friction model	• Explain meaning of static friction, kinetic friction, coefficients of static and kinetic friction, and how these variables are related. • Solve problems involving the static and kinetic friction relationships

7. Forces Particle Models: Balanced and Unbalanced

FPM1	I can explain and apply force model concepts	• Explain Newton's 1st Law (N1L):
		  o Explain experimental evidence for this law.
		  o How does an object's motion model relate to its forces model?
		  o Explain some situations/motions in terms of Newton's 1st Law.
		• Explain Newton's 2nd Law (N2L):
		  o What is the relationship between net force on an object and its acceleration?
		  o What is the relationship between the mass of an object and its acceleration (when there is a net force on it)?
		  o Describe the experimental evidence for Newton's 2nd Law
		  o Reason about how doubling mass or force affects acceleration
		• When given a motion model, draw a qualitatively-correct FBD
		• When given all forces or a FBD, determine the motion model
		• Reason about how changing a certain force in a given situation will change other forces or change which force & motion models apply.

FPM2	I can solve problems using the force models	• Apply Fnet = ma in various situations to find unknowns.
		  o Object at rest
		  o Object moving horizontally or vertically with constant velocity
		  o Object moving horizontally or vertically with constant accel.
		• Resolve angled forces into components; apply Fnet = ma for x and y directions separately.
		• Solve multi-step problems involving connections to Δx, vi, vf, and Δt.

8. Momentum Model

MM1	I can apply impulse and momentum relationships	Calculate the momentum and change in momentum of a system Draw a momentum bar chart to represent initial and final momentum Identify external forces on a system; determine net external force Explain the conditions under which a system's momentum will change Determine the impulse from force and time graph or values. Relate change in momentum to forces applied to a system over time
MM2	I can apply conservation of momentum	Define a system in such a way that the system's momentum is constant Identify the system with a dashed line boundary Draw a free body diagram of each object during the event Write the momentum conservation equation for the system Solve for unknowns

9. Energy Storage and Transfer Model

EM1	Qualitatively identify energy storage and transfers; Calculate energy transferred by work.	• Draw system schema diagram and define system • Identify energy storage modes at different moments • Draw qualitative energy pie charts to represent the total system energy and amounts of energy in different storage modes at different times. • Draw qualitative energy bar charts to represent energy storage modes at an initial and final time and transfers in or out of the system. • Write a qualitative energy conservation equation that includes initial and final energy storage modes, and indication of energy transfers. • Calculate the work done by a force over a displacement • Relate the "work done by an external force" to the "change in energy of a system".
EM2	I can apply conservation of energy	• Define a system • Use equations for each storage mode to calculate kinetic energy, gravitational potential energy, elastic potential energy, and internal energy • Identify initial and final moments that will yield a useful energy equation for finding an unknown. • Write an energy conservation equation and solve for unknowns.

10. Projectile Application *(These standards are assessed only on the final)*

PA1	Explain key concepts for projectile motion	Describe the vertical motion of a projectile Describe the horizontal motion of a projectile Explain experimental evidence for the characteristics of a projectile's motion Sketch velocity vectors at various points along the trajectory, including at the maximum height. Explain how you can find the velocity of the projectile at some time t. Answer qualitative questions about projectile motion
PA2	Solve problems involving projectile motion	Set up an appropriate coordinate system Work with horizontal and vertical components separately Solve problems to find unknown values involving projectiles launched from any height with an initial velocity that is horizontal or at an angle. Calculate components of final velocity and combine to find the final velocity.