Physics 12 -Year End Review

KEY IDEA: x and y component vectors work independently of each other (kinematics, forces, and momentum)

Uncertainties and Graphing (lab skills):

Keywords: **Accuracy, precision, systematic errors, random errors, absolute uncertainty, relative uncertainty, _______ proportional to**

- Write your final answers in proper significant figures
- Discuss and differentiate between systematic errors and random errors in relation to the accuracy and/or the precision of the data
- Convert between relative and absolute errors
- Error propagation
- Linearizing graphs and Max/min slope
- Tip for analyzing graphs:
    - The **slope** of any graph gives you the value produced from $\frac{y-axis\ value\ (units)}{x-axis\ value\ (units)}$. (ex. The slope of a velocity-time graph gives you $\frac{\Delta velocity\ (m)}{\Delta time\ (s)}$, which is acceleration *a*
    - The **area** of any graph gives you the product of y-axis value (units) × x – axis (units). (ex. The area of a velocity-time graph gives you velocity (m) × time (s), which gives you displacement

Kinematics:

Keywords: **distance, displacement, speed, velocity, acceleration, projectile motion, relative velocity**

- Directions (+/-)s matter!!!
- Vectors in 2D and language used: _____ degrees above/below the horizontal, ____ degrees N/S/W/E of W/E/N/S (the order is the reverse of path you'd follow to get your angle)
- When adding vectors (ex. Navigation and finding relative velocities), you need to add vectors graphically on a 2D plane (tip to tail). You cannot just simply add the magnitudes of the vectors for all cases.
- Kinematics in 2D: Projectile Motion
    - Horizontal (x) and Vertical (y) vector components work independently of each other, so don't mix them up in the same equation (ex. Don't use gravity when calculating for horizontal displacement)

Forces and Newton's Laws:

Keywords: **acceleration, net force, gravity, mass, weight, action/reaction forces, free-body diagram, inertia, mass, net force, coefficient of friction, elastic, force, friction, normal**

- Free Body Diagrams: draw one whenever solving forces problems, represent all forces with arrows proportional to their magnitudes
- F_N NOT ALWAYS EQUALS F_g, it depends if the object is accelerating along F_N's direction and other forces with components acting along F_N's direction as well
- $F_f = \mu F_N$ (μ = coefficient of friction; static and kinetic), direction opposite to the object's motion. This is important when dealing with inclines
- DRAW YOUR FREE BODY DIAGRAMS!!!
- Write **F_{net} = ma** equations for vertical and horizontal forces; they act independently of each other!
- Inclines: you need to adjust your axis so that the x-axis is parallel with your incline, then break your forces into x and y components relative to this **new set of axis.**
- Equilibrium: when an object is at rest or not accelerating, the sum of all forces is zero

$$\Sigma F_x = 0\ and\ \Sigma F_y = 0$$

OR F_{net} = 0 in both the x and y direction

- Rotational equilibrium: when an object is not rotating relative to a pivot/axis/point

$$\Sigma\tau_{cw} = \Sigma\tau_{ccw}$$

And $\tau = F_{\perp} \times d$, where τ is torque, $F_{\perp}$ is the perpendicular force component relative to the lever arm, and d is the distance where this force is applied relative to the pivot

- If a body is not moving, both $\Sigma F_x = 0\ and\ \Sigma F_y = 0$ and $\Sigma\tau_{cw} = \Sigma\tau_{ccw}$ can be applied

Momentum and Energy (most of this should be review):

Keywords: **collisions, explosions, impulse, momentum, conservation of momentum, elastic collision, inelastic collision, efficiency, energy, gravitational potential energy, kinetic energy, power, work, conservation of energy**

- $E_p = mgh$
- $E_k = ½mv^2$
- Law of Conservation of Energy: $\mathbf{E_i = E_f}$ → $E_{ki} + E_{pi} = E_{kf} + E_{pf}$ (for conservation of mechanical energy only, no heat, sound, light, elastic potential, and chemical)
    - If there's energy lost and/or gained: $E_{gained} + E_{ki} + E_{pi} = E_{kf} + E_{pf} + E_{lost}$
- Power = Work/time = ΔEnergy/time, P = Fv (ONLY when force and velocity are constant)
- Efficiency = Energy out/Energy in x 100%
- Momentum: p = mv
    - The idea here is like Newton's 1st Law, all objects moving at constant velocity will stay moving at its constant velocity unless acted upon by a next external force.
    - The larger the mass, the more inertia it has, and also the more momentum it has
- Change in momentum: $\Delta p = m\Delta v = F_{net}t$ = **IMPULSE**
    - This is another way to describe Newton's 2nd Law, $F_{net} = ma$
- Momentum is conserved: $\mathbf{p_i = p_f}$ → $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ (for collisions/explosions involving 2 masses only)
- <u>2D Conservation of momentum: $\mathbf{p_{ix} = p_{fx}}$ and $\mathbf{p_{iy} = p_{fy}}$</u>
- Understand and differentiate between elastic and inelastic collisions

Circular Motion:

Keywords: **centripetal acceleration, geosynchronous orbits/geostationary orbits, escape velocity**

- $F_{net} = mv^2/R$, where $a = v^2/R$ OR $a = 4\pi^2R/T^2$ F_{net} = Forces towards – Forces away from circle's center
- For minimum speed before object leaves vertical circular motion is when $F_N = 0$ (or whatever force is keeping the object moving in a circle).
- Objects in orbit are still "falling" towards the center of their orbit, it's their tangential velocity that causes them to stay in orbit at some distance away. While in orbit, $F_{net} = F_G = GMm/R^2$
- Escape velocity is the minimum velocity needed by an object to completely escape the gravitational influence (separation at infinite distance) of a planet/star. $v_{escape} = \sqrt{\frac{2GM}{R}}$

Electric circuits and Electromagnetism

Keywords: **Series, parallel, terminal voltage, internal resistance, electromotive force, electromagnet, magnetic force, magnetic flux**

- $V = IR$, $P = VI$, $P = V^2/R$, $P = I^2R$
- Series: $V_{total} = V_1 + V_2 + V_3...$, $I_{total} = I_1 = I_2 = I_3...$, and $R_{total} = R_1 = R_2 = R_3$
- Parallel: $V_{total} = V_1 = V_2 = V_3...$, $I_{total} = I_1 + I_2 + I_3...$, $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
- Magnetic field runs north to south: detected with iron fillings and compass (needle points along field)
- Right hand rules: 1st RHR -> thumb is current, fingers are magnetic field; 2nd RHR -> thumb is magnetic field (or N pole), fingers are currents; 3rd RHR -> thumb is charge, index finger is magnetic field, middle finger/palm face is direction of magnetic force
- Faraday's Law: $\varepsilon = -\frac{N\Delta\Phi}{\Delta t}$
- Lenz's Law on electromagnetic induction: induced magnetic field (by induced current) opposes the change in magnetic flux through a loop of wire
- Back EMF: the faster you motor spins, the larger the induced back emf because it opposes the motion of the motor
- Step up transformers: $N_p < N_s$, $V_p < V_s$, and $I_p > I_s$; Step down transformers: $N_p > N_s$, $V_p > V_s$, and $I_p < I_s$