Physics Summative Exam Solutions

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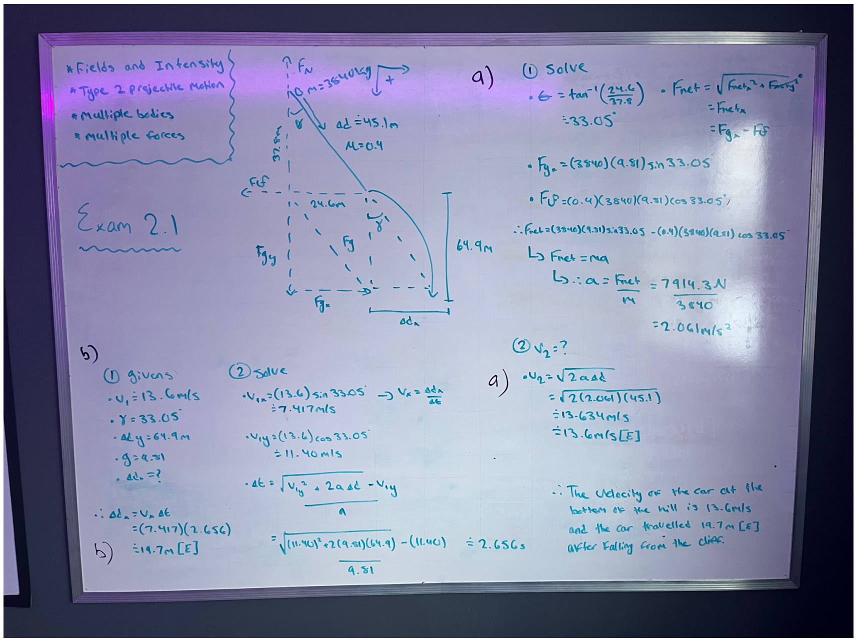
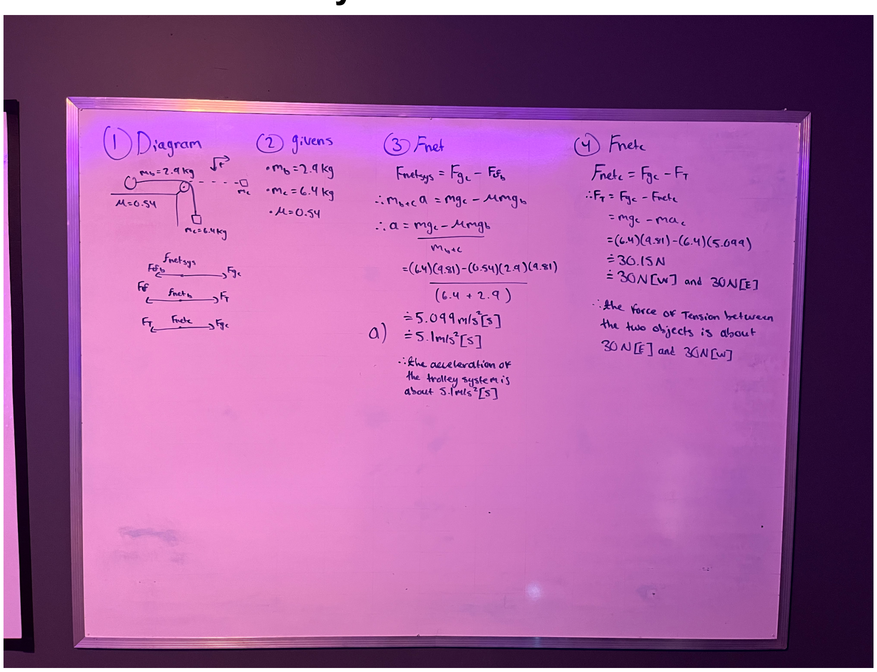
2. Unit 1 Dynamics and Motion

2.1: Incline Plane + Projectile Motion:



2.2: Fletcher's Trolley



2.3.1: Which of the following are a part of Newton’s Laws of Motion?
Answer: b)

2.3.2: Which of the following are a part of Newton’s Laws of Motion?
Answer: a)

2.4.1: Projectile Motion Lab Procedure
1. The metal ramp was attached to the table using a clamp.
2. The carbon paper was placed under the regular paper and taped to the ground.
3. The distance from the table to the papers was measured with a meter stick.
4. The marble was held at the top of the ramp.
5. The marble was released and the timers were started.
6. The timers were stopped when the marble hit the ground.
7. The above steps were repeated an additional five times.
8. The distance from the table to the closest point on the carbon paper was measured
9. The marble's initial velocity was solved for using kinematic equations

2.4.2: Fletcher’s Trolley Lab Procedure
1. The toy car was attached to one end of the string.
2. The 200g weight was attached to the other end of the string.
3. Using a meterstick, an appropriate distance for the toy car was measured.
4. The toy car was placed at the decided distance.
5. The car was let go, and the timers were started.
6. The timers were stopped once the 200g weight had reached the ground.
7. The above steps were repeated an additional five times.

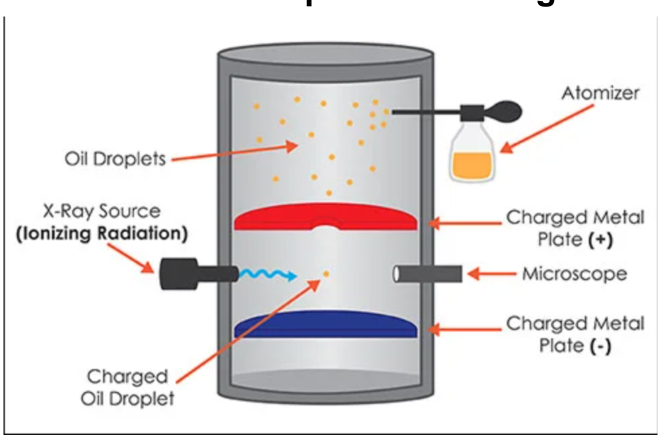
3. Unit 2 Fields
3.1.1: Millikan's Experiment - Diagram


Diagram source attached to image

3.1.2: Millikan's Experiment - Significance
The significance of Millikan's Experiment is that from this experiment, Millikan was able to determine the charge of a single electron. He did this by putting a charged oil particle between two electric plates and matching its force with the force of gravity.

3.2 Electrostatic Forces and Electric Field Intensity
https://drive.google.com/file/d/105DLNqmzShPcAYi12kDIdCv0GDTEK-0z/view?usp=drivesdk

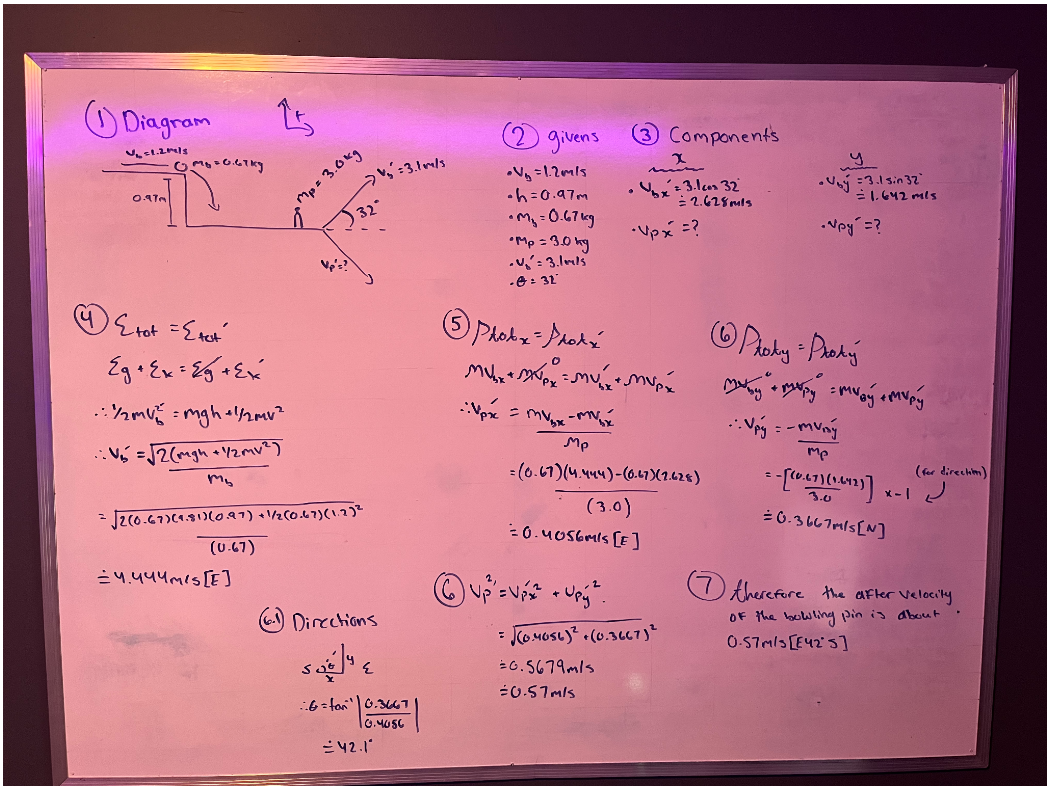
4. Unit 3 Momentum and Energy
4.1.1 Describe how Banked Curves work
When a curve is banked, the components F_N (normal force) and F_f (friction) provide the required centripetal force whereas without a banked curve, only F_f (friction) provides the required centripetal force.

4.1.2 What are two ways to reduce the force of a collision?
By taking a look at the Impulse equations, it can be determined that increasing the time in an equation is monumental to decrease the force exerted by the collision. For example, airbags (1) and crumple zones (2) inside a vehicle increase the time (Δt) in the impulse equations. This in return reduces the reaction force.

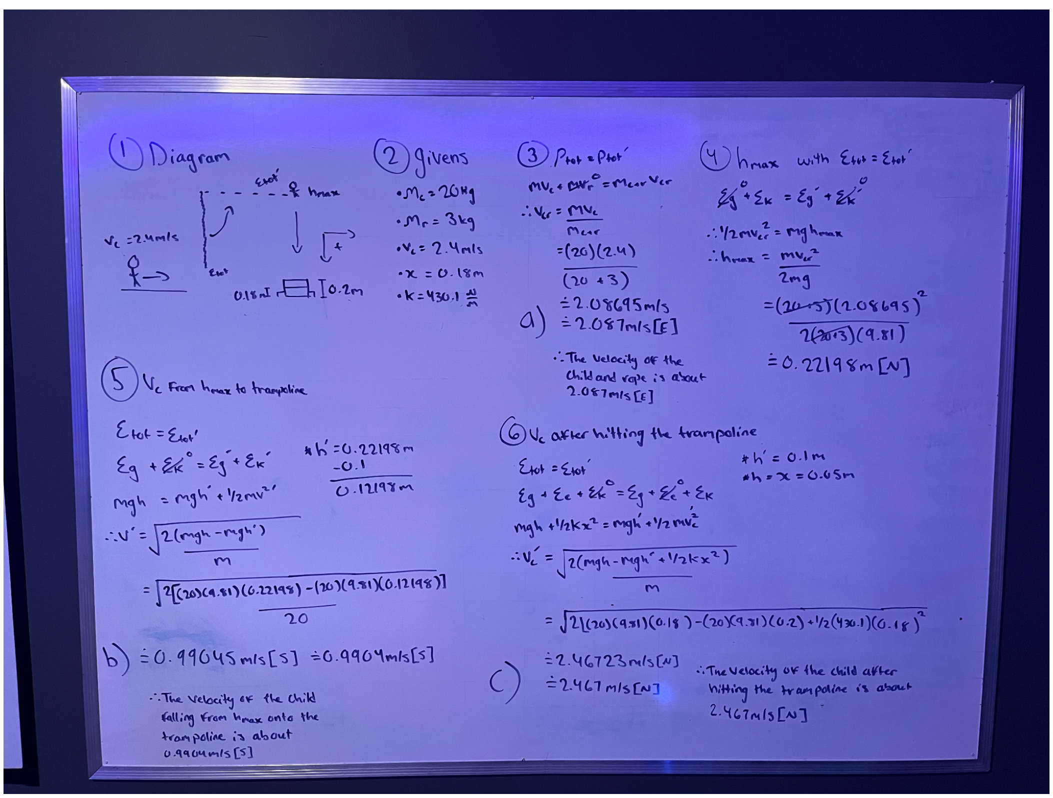
4.2.1 2D Momentum Lab Procedure
Part 1:
1. The metal ramp was clamped to the edge of the desk.
2. Both the regular and carbon paper were positioned on the ground, straight in front of the ramp.
3. The two papers were taped to fortify their position, with the carbon paper on top of the regular paper.
4. The marble was dropped from the ramp. It hit the paper on the ground.
5. The distance from the table to this point was noted.
6. The above steps were repeated an additional five times.

Part 2:
7. The other sheets of carbon and regular paper were placed on the left and right sides of the first sheet.
8. These other sheets were positioned for the colliding marbles to hit them.
9. The ramp was angled slightly to the right.
10. The second marble was placed at the front of the ramp on a screw.
11. The first marble was released.
12. After the marbles collided and hit the ground paper, the distance between the desk and the points were noted. (both x and y)
13. The above steps were repeated an additional five times.

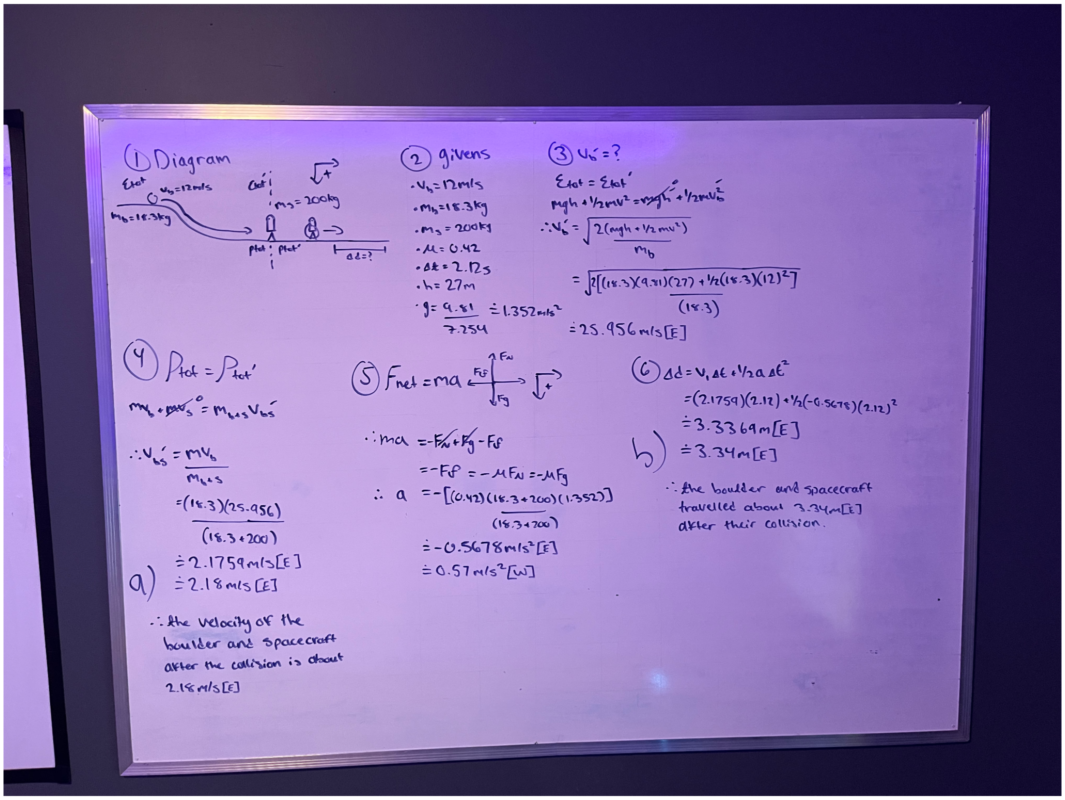
4.3 Energy + 2D Momentum



4.4 Spring Energy + Inelastic Momentum



4.5 Momentum + Energy + Kinematics + Forces



5. Unit 4 Light as a Wave

5.1.1 Why does an interference pattern appear for single slits?

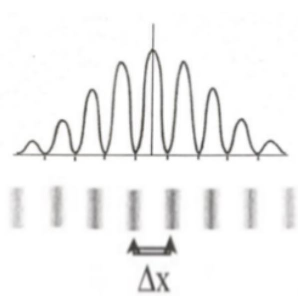
An interference pattern appears for single slits because of Christiaan Huygens's theory of wavelets. Wavelets are small waves inside bigger waves that interfere with each other.

5.1.2 Why does an interference pattern appear for double slits?

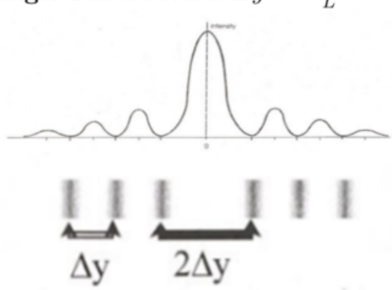
An interference pattern appears for double slits because the two light waves that are shone through the slits both constructively and destructively interfere with each other.

5.1.3 Draw the intensity chart for both double and single slits

Double Slit Pattern $\Delta x = \frac{(\lambda)(d)}{L}$



Single Slit Pattern $\Delta y = \frac{(\lambda)(d)}{L}$



5.1.4 Briefly summarize each of the following

Minimum of 100 characters for each

a) **Diffraction Gratings**
   Diffraction Gratings were used as multiple slits (instead of just a single or double slit). Diffraction Gratings were made by cutting very tiny slits into a sheet of paper with glass.

b) **Polarization**
   Polarization is the elimination of either the vertical or horizontal components of a light wave. Polarization is most recognized for its usage in filming 3D movies.

c) **Red Light vs Green Light**
   Because the color of light is dependent on its wavelength, red light has a greater wavelength than green light.

5.2 Double Slit Solve

Givens:

- $d = 4.0 \times 10^{-4}$
- $L = d \times 5 \times 10^{3} = 2m$
- $\Delta x = 0.2m$
- $\lambda = ?$

Solve:

a) $\lambda = \frac{\Delta x\, d}{L} = \frac{(0.2)\,(4\times10^{-4})}{2} \approx 4.0 \times 10^{-5}$ m

   $Therefore\ the\ wavelength\ of\ the\ light\ is\ approximately\ 4.0 \times 10^{-5}\ m$

b) Therefore since the wavelength is approximately 400 nanometers, the light color would be violet.

5.3 Single Slit Solve

Givens:

- $d = ?$
- $\lambda = 4.7 \times 10^{-7} m$
- $L = 1.2m$
- $\Delta y = 3 \times 10^{-2} m = 0.03m$

Solve:

- $d = \frac{\lambda L}{\Delta y} = \frac{(4.7\times10^{-7})\,(1.2)}{0.03} \approx 1.88 \times 10^{-5}\ m$

  $Therefore\ the\ width\ of\ the\ slit\ is\ approximately\ 1.9 \times 10^{-5}\ m$

6. Bonus - Unit 5 Quantum

6.1 Describe Wave-Particle Duality

Wave-Particle Duality is the Quantum theory that almost all matter, light, particles, etc. oscillate like a wave. This theory was derived by performing the Double Slit Experiment performed with electrons. It was determined that electrons (a particle) move like a wave. It was first theorized by Albert Einstein that the movement of electrons acts as a wave, though the electrons themselves are still particles.

6.2 Elaborate on one of the following

Minimum of 100 characters

a) **Schrödinger's Cat**
Schrödinger's Cat is a hypothetical experiment that explains the paradox of particle superposition. The experiment visualizes a cat inside a closed box. The cat has a 50% chance of dying and a 50% chance of surviving inside this box. After a certain amount of time, the cat is both alive and dead at the same time. It's only when we open the box that we see which one that is. (alive or dead)

b) **Superposition**
Superposition is the state of matter in which it exists at different places at the same time. Superposition was proved by the Double Slit Experiment performed with electrons. As the electron was shot at the double slits, it was expected that it would only go through one. But instead, it went through both. This means that the electron was in multiple positions at the same time whilst it was traveling between the slits.

c) **Heisenberg Uncertainty Principle**
The Heisenberg Uncertainty Principle states that we cannot know both the position and speed of a particle (protons, electrons, etc.) with perfect accuracy, though we can estimate their whereabouts.