Introduction and Materials

In this lab report, we explore Newton's Second Law of Motion using the PhET Interactive Simulations tool, specifically the Forces and Motion: Basics module. We find the relationship between force, mass and acceleration using the online simulator. The materials required for this experiment included a mobile learning device, access to the online simulation, and a digital stopwatch.

Methods

The experiment consisted of two main parts. In Part A, we investigated the effect of applied force on the motion of an object. After accessing the simulation and selecting the "Motion" module, we ensured that all relevant items (forces, values, masses, speed) were ticked. We then chose an object, such as a crate, and placed it on the skateboard. By setting the applied force to 50 N, we observed the object's motion for 10-15 seconds and noted the changes in speed. We repeated this procedure, incrementally increasing the applied force to 100 N, 150 N, and 200 N, and observed that as the applied force increased, the object's speed increased more rapidly. This confirmed the direct relationship between applied force and acceleration.

In Part B, we measured the acceleration of different masses under a constant force of 50 N. After resetting the simulation, we removed the default crate and positioned a 40-kg child on the skateboard. We set the applied force to 50 N, measured the speed after 5 seconds using a digital stopwatch, and recorded the final velocity. We calculated the acceleration using the formula: Acceleration= (final velocity - Initial velocity)/ Time. This process was repeated for other items, including a crate, a man, a metal trash bin, and a refrigerator, with their masses and final velocities recorded.

Results

The results showed that the acceleration values decreased as the mass of the objects increased, and the acceleration increased as the mass decreased illustrating the inverse relationship between mass and acceleration when a constant force is applied. For example, the 40-kg child had an acceleration of 1.3 m/s^2, while the 200-kg refrigerator had an acceleration of 0.26 m/s^2. This demonstrates Newton's Second Law, expressed as

$F=ma$, where the force (F) applied to an object is equal to its mass (m) multiplied by its acceleration (a).

Conclusion

In conclusion, the experiments validated Newton's Second Law of Motion, showing that an object's acceleration is directly proportional to the net force acting on it and inversely proportional to its mass. As more force was applied, the objects accelerated faster. Conversely, heavier objects experienced less acceleration under the same applied force compared to lighter ones. Adjusting the applied force based on the mass of the objects can achieve consistent acceleration values across different masses, a principle crucial in fields requiring precise motion control, such as engineering and physics.

Screenshots from the simulation, included in the other word file, provide us visual references for the initial setup, force application, and observed velocities for different masses. This comprehensive investigation into Newton's Second Law of Motion, verified through virtual simulation, offers a clear understanding of the relationship between force, mass, and acceleration to us.