INVESTIGATION OF NEWTON'S SECOND LAW

Specification reference: **AS Unit 1.3 - Dynamics**

Theory:

The gravitational force of the slotted masses attached via the pulley causes the entire mass of the system to accelerate. That is the mass of the rider, M, and the total mass of the slotted masses, m. Newton's second law, therefore, can be written as:

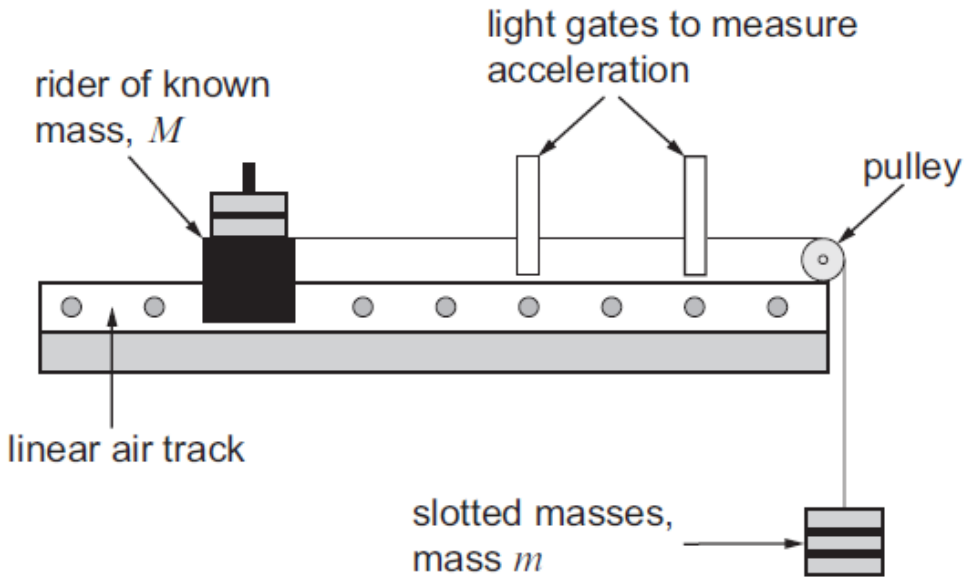
$$mg = (M + m)a$$

and so the acceleration of the system is:

$$a = \frac{mg}{(M + m)}$$

We can use this to test Newton's second law. If the total mass of the system $(M + m)$ remains constant then the acceleration, a, should be proportional to the gravitational force, mg.

Apparatus:



Further guidance for technicians:

It is possible to use just one light gate set to measure the final velocity, v, if two are not available. If the starting velocity is taken to be zero then the acceleration, $a = \frac{v^2}{2s}$. Where s is the distance measured from the starting point of the rider to the light gate.

Experimental Method:

Fix the thread to the rider and attach five slotted 5 gram masses to the other end as shown in the diagram. Set the light gates to record the acceleration and allow the slotted masses to fall to the ground. Record the gravitational force, mg and the acceleration, a. Remove one of the slotted masses and place it on the rider (so keeping the total mass of the system constant).

Repeat the experiment until all the different accelerating masses have been removed. Plot a graph of acceleration (y-axis) against gravitational force, mg (x-axis). This should be a straight line through the origin.

Extension:

By finding the gradient of the graph it is possible to get a value for the mass of the rider, M.

$$\text{gradient} = \frac{1}{(M+m)}$$

Where m = 25 grams - the total mass of the slotted masses.
This set up can also be used to investigate many collision and momentum problems.

Practical Techniques:

- Use appropriate analogue apparatus to record a range of measurements (to include length/distance, temperature, pressure, force, angles, volume) and to interpolate between scale markings.
- Use appropriate digital instruments, including electrical multimeters, to obtain a range of measurements (to include time, current, voltage, resistance, mass).
- Use stopwatch or light gates for timing.
- Use ICT such as computer modelling, or data logger with a variety of sensors to collect data, or use of software to process data.