The effect of force and mass on the acceleration of an object

The aim of the experiment

The aim of this experiment is to investigate the effect of force and mass on the acceleration of an object, in this case a trolley.

You will need

* Air track trolley,
* Air track,
* a pulley,
* thread,
* twelve 10 g masses and a holder
* tape measure
* Motion sensor and datalogger

What to do

Set up your apparatus and draw diagram.

The trolley should be able to run for 0.6 m.

This is the length over which the trolley accelerates.

Start with ten of your twelve washers on the trolley and the other two on the thread hanging down.

The mass to be accelerated is the mass of the trolley and twelve washers while the accelerating force is the weight of the two suspended washers (0.2 N).

Allow the trolley to accelerate down the track and record the acceleration from the data logger take two repeats and take an average.

Repeat the procedure by taking one washer off the trolley and adding it to the suspended washers – the accelerating force is now 0.3N (same total mass).

Carry on until you have only two washers left on the trolley.

Draw up a table with the following headings:

|  |  |  |
| --- | --- | --- |
| Accelerating force (N) | Total mass (kg) | acceleration  (m s-2 ) |
|  |
|  |  |  |
|  |  |  |

Plot a graph of acceleration (x – axis) against force (y- axis).

Use the graph to answer the following questions:

1 From Newton’s 2nd Law you would expect the graph of acceleration against force to be a straight line which passes through the origin.

2 Explain why you would expect this to be the case.

3 Explain what the gradient of the graph represents.

4 Calculate the gradient of the graph and explain whether it agrees with your answer to question (3).

5 Your results may show some scatter. Explain why this might be and the causes of any inaccuracy.

6 Does the experimental result support Newton’s Second Law of Motion?

Practical advice

The friction changes with different slope angles. It is best to try the experiment out first and decide if it is worth tilting the slope to friction compensate.

The acceleration could be measured directly with a motion sensor attached to a computer

External references

This activity is taken from Resourceful Physics <http://resourcefulphysics.org/>

Newton’s second law

Simple calculations and a little thinking.

An 80 kg skier has a force of 200 N exerted on him down the slope.

1. Calculate his acceleration down the slope.

2. Is the slope less than or more than 45? Explain your answer.

An ice hockey player has a sudden impact force of 2000 N exerted on him due to unexpected collision with the wall. The mass of the player is 100 kg.

3. Find his acceleration.

4. Compare this with the acceleration when he free falls.

Coming out of a dive, 75 kg astronauts in training experience an acceleration of 40 m s–2.

5. Calculate the force acting on them.

6. Compare this with the force which normally acts on them when stationary on Earth.

7. Why is it important that they are seated and strapped in before the dive ends?

A 50 g tennis ball may be accelerated at 1000 m s–2 to reach a service speed of 130 mph.

8. Calculate the force required to accelerate the ball.

9. Is your answer reasonable? Comment.

When a force of 200 N is exerted on an asteroid it accelerates at 0.002 m s–2.

10. Find the mass of the asteroid.