Impact of inclined plane's angle of inclination on acceleration

Interdisciplinary project - experiment

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What did I need for the experiment?

- An air track set
  - an air track with an air pump
  - a glider

- A piece of sponge to stop the glider and prevent it from crushing

For measurement:

- Angle: a mobile phone with “Angle” app with 1° uncertainty
- Time: a photogate timer system with 1 millisecond uncertainty
- Distance: scale on the air track with 1 millimetre uncertainty

Experiment

Steps

1. Preparing the equipment, attaching the pump to the air track and connecting photogates to the timer

2. Inclining the air track and measuring angle

3. Turning on the timer and placing the glider on the track

4. Letting go of the glider and stopping it with a sponge after it goes past both photogates

5. Reading and writing down the time

6. Repeating with various angles

Results of measurement

Angle [°]	Time [ms]	Time [s]
8	385	0,385
13	311	0,311
15	289	0,289
19,6	250	0,25
23,5	230	0,23
27	222	0,222
37	190	0,19
41	181	0,181
60	158	0,158

Calculations

Methods of calculation

Calculating speed and acceleration

The formula I intended to use:

$$a = 2s/t^2$$

s - distance between the two photogates which is 0,3 m

The tool I have used for calculation is Excel.

An error

I made a significant mistake during the experiment. I hadn't realised how important it was until I made the calculations and noticed that in some cases the acceleration is larger than gravitational acceleration, which is physically impossible.
The reason behind this was that I I left space between the first photogate and the glider when I let it go, while I should have put the glider just by the photogate. The result of this mistake was that the glider elaborated speed before it crossed the sensor.

Solution to the problem

In order to avoid repeating the experiment, I used the potential energy formula and transformed it:

$mgh = mv_o^2/2$

$v_o = \sqrt{(2gh)}$

$h = \sin\alpha * s_o$

s_o is the distance I left between the first sensor and the glider and it equals 16,4 cm, so it is 0,164 m

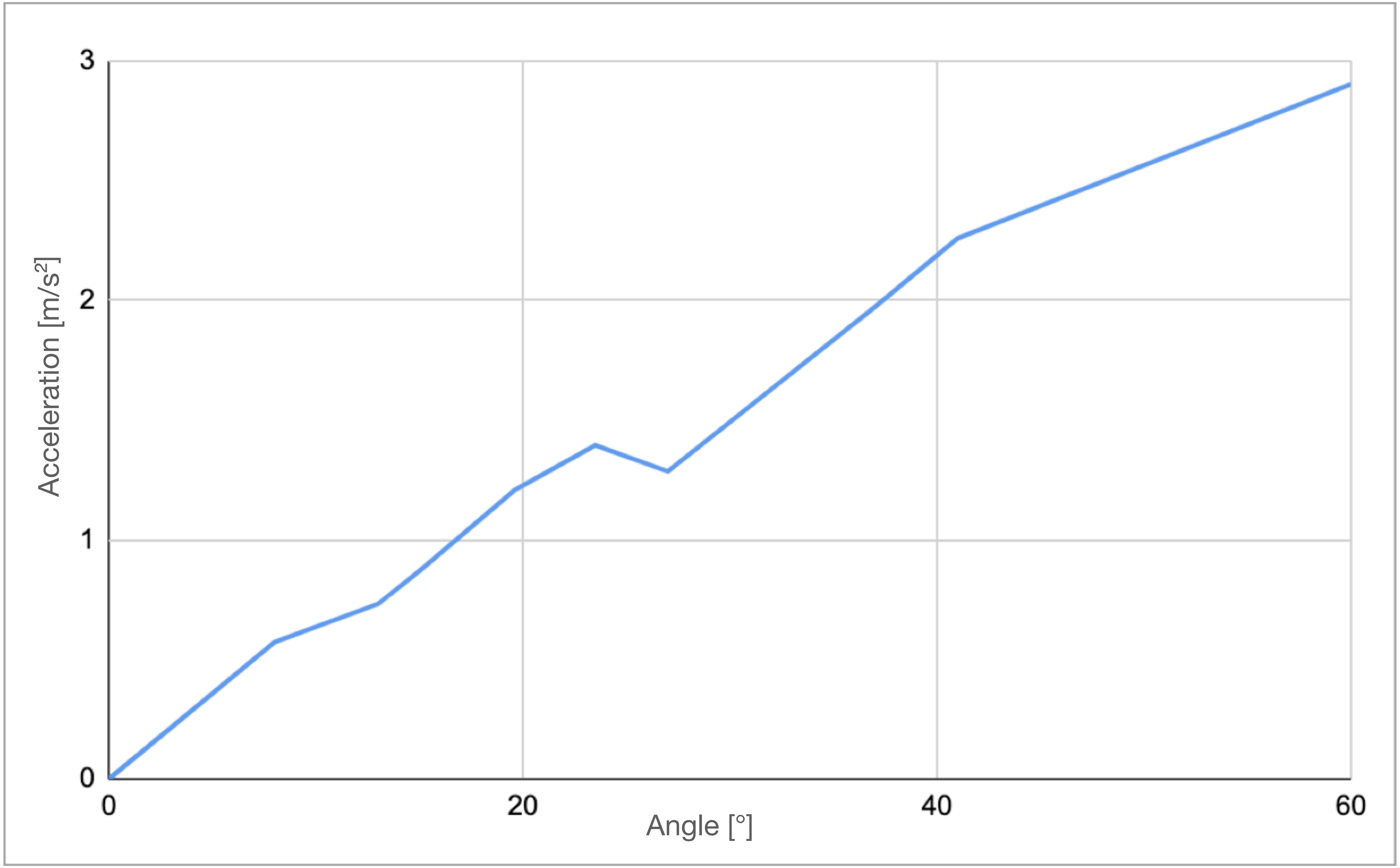
$v_o = \sqrt{(2g * \sin\alpha * s_o)}$

$a = 2s/t^2 - 2v_o / t$

$a = 2s/t^2 - 2 [\sqrt{(2g * \sin\alpha * s_o)}] / t$

angle	sinus	2g [m/s²]	s_o [m]	v_o [m/s]	time [s]	t^2	2s [m]	a
0	0	19,62	0,164	0	0	0	0,6	0
8	0,1392	19,62	0,164	0,669254104	0,385	0,148225	0,6	0,571255455
13	0,225	19,62	0,164	0,850868968	0,311	0,096721	0,6	0,731583649
15	0,2588	19,62	0,164	0,91254347	0,289	0,083521	0,6	0,868642312
19,6	0,342	19,62	0,164	1,049021716	0,25	0,0625	0,6	1,207826274
23,5	0,4067	19,62	0,164	1,14395387	0,23	0,0529	0,6	1,394730056
27	0,454	19,62	0,164	1,208646648	0,222	0,049284	0,6	1,285627957
37	0,6018	19,62	0,164	1,39154584	0,19	0,0361	0,6	1,972647671
41	0,6561	19,62	0,164	1,452969321	0,181	0,032761	0,6	2,25954964
60	0,866	19,62	0,164	1,669284541	0,158	0,024964	0,6	2,90442577

Impact of angle of inclination on acceleration



Conclusion: acceleration increases as rake angle gets larger. I assume it is going to rise until it reaches 9,81 m/s^2, which is gravitational acceleration.

Thank you for your attention