

# [Science course work : free fall](https://assignbuster.com/science-course-work-free-fall/)

I am going to investigate the effects of changing the spinners speed on the drag. There are several variables that I could investigate to see their effects on the spinners drag.

1. Shape- I could alter the shape of the spinner

2. Size- I could investigate the effects on drag with different sizes of blade

3. Speed- I could change the weight to increase or decrease the speed.

Shape- if I changed the shape of the spinner the air resistance would change. For a ball of paper to accelerate at the same speed as a smaller spinner would require more force (gravity) and hence would need more weight to fall at the same speed. This is because more air is having to be displaced to fall the same distance as on object of similar mass which has a more stream line shape.

Size- Larger blades on the spinner would mean more potential energy would be dissipated acting like a parachute and making it fall slower. The opposite happens with smaller blades.

Speed- By using the fact that at terminal velocity Drag is equal to weight. I can calculate the speed by weighing the spinner with different masses. Doing this I can investigate how terminal velocity is effected by weight.

Another factor that could be considered is air conditions. Aeroplanes/gliders perform differently when it is raining than when it I sunny. Is this also try for spinners? One of the problems when investigating this is that it would be difficult to keep the other variables constant. Rain is not a problem, as I will carry out this experiment indoors. However temperature and movement within the room may effect how the spinner falls and my results. Temperature has an effect because hot air moves to cooler areas usually upwards. Convection currents in the room may give inaccurate results.

Method

To investigate the speed at which a spinner falls I am going to vary the weight by adding paper clips and dropping the spinner from the ceiling each time. I will time how long it takes for the spinner to fall to the floor so I can calculate average speed. Before I drop each spinner I will weigh it so that I can calculate the drag. I am going to take two, time readings.

1. How long it takes to reach the floor.

2. I will time from when it reaches terminal velocity to the floor.

I experimented with a spinner and found that it is fairly easy to observe when a spinner reaches terminal velocity, it should therefore not be difficult to time how long it takes to reach the floor. The reason I am going to take these 2 time readings is so I can calculate the terminal velocity. I researched Formula for finding out velocity/distance/time. Her are the fumula I found and used to work out an equation for terminal velocity.

Where V is final velocity, U is initial velocity, which is often zero, A is acceleration, T is time and S is distance. Here is the final part of the equation, which I worked out after researching any information I needed.

Vt = 2 (h1-Vt T2)

(T1-T2)

Vt (T1-T2) = 2 (H1-Vt T2)

Vt T1-VtT2 = 2H1-2VtT2

VtT1+VtT2 = 2H1

Vt = 2H1

T1+T2

Here is a diagram to show where T1, H1, T2, H2 and H3 are and what I am measuring.

Height from ceiling

to terminal velocity (H3)

From ceiling to

floor (H1) Terminal Velocity

Total time taken From terminal velocity to floor (H1)

to fall from the

ceiling to the floor Time taken to fall to floor when the

(T1) spinner has reached terminal velocity

(T2)

To ensure it is a fair test I will only vary the weight of the spinner and keep the size, shape and conditions in the room constant. One of the reasons I have decided to investigate speed and terminal velocity of a spinner is that it is the easiest variable to change, while keeping the other factors which effect drag constant. I am always going to drop the spinner from the ceiling to ensure that it is falling from the same height each time. I will close the windows in the room and I will work away from the door to try and control conditions in the room as much as possible. I will use the same spinner each time I change the weight, this will ensure that the size and shape remain constant. I will also use the same person each time to judge when the spinner reaches terminal velocity this should make my results as accurate as possible.

I am going to use an electronic weighing machine, to weigh the spinner and the paper clips as well as using two stopwatches. After making and weighing the spinner I will get one person (a) to drop the spinner from the ceiling. Person A will count 1…2…3… then drop the spinner. At this point person B starts timing. Then one of three things will happen depending on the number of people available when I carry out this experiment:

1. Person A will shout NOW when the spinner reaches terminal velocity, and person C starts timing until the spinner reaches the ground or,

2. Person A drops the spinner for a second time but this time person B only times when person A shouts NOW (terminal velocity) to the floor.

3. If there are more the 3 people then two time readings can be taken to get a more accurate set of results.

In this way I can vary the weight of the spinner and find out results for spinners of different weights moving at different speeds. From my results I hope to be able to calculate terminal velocity for the different spinners of different mass using my equations.

I intend to take three reading for each mass of the spinner and use the average of these to calculate the terminal velocity. I predict the range in results for the spinner to fall from ceiling to floor, will be approximately three seconds (for a spinner with one paper clip) to less than 1 second (for a spinner with 6 paper clips.) I tested several spinners with different numbers of paper clips so I could make this prediction. I only timed each spinner once so the range may actually be slightly different when I time several free falling spinners. I will vary the weight from approximately 1 gram (with one paper clip) to 3 grams (with 6 paper clips).

Prediction

I predict that the greater the weight of an object the faster it will fall and the greater the speed at terminal velocity. I think this because when weight = drag an object is no longer accelerating. So if you have a heavier object it will have to fall faster and for longer for the weight to = the drag and the object to have reached terminal velocity. The opposite is true for a spinner weighing less, it will not need to be travelling as quickly or for as long for the drag to = the weight there fore terminal velocity will be slower. I intend to try and prove this theory or to find out what is actually happening to a spinner’s drag.

Results

The know formulae I have used to calculate a formula for terminal velocity relies on the fact that A (acceleration) is constant, meaning that the spinner accelerates at the same rate until it reaches terminal velocity. Constant acceleration requires a constant resultant force, resultant force can be calculated by subtracting the drag of an object when falling from its weight. During acceleration the weight remains constant, however the drag increase until terminal velocity is reached; this means that the resultant force decreases as the spinner gets nearer to terminal velocity. As the resultant force is not constant, I can not presume that acceleration is also constant. The formula I used all assume A as a constant, this means that my equation for Vt and the results I have based my conclusions on are likely to be slightly incorrect. If I had taken into consideration the effect of resultant force on drag in my equations the results would be more reliable.

Weights: 1 paper clip = 0. 41g 1 paper clip with spinner = 1. 09g

2 paper clips = 0. 81g 2 paper clips with spinner = 1. 48g

3 paper clips = 1. 19g 3 paper clips with spinner = 1. 86g

4 paper clips = 1. 58g 4 paper clips with spinner = 2. 25g

5 paper clips = 1. 96g 5 paper clips with spinner = 2. 63g

6 paper clips = 2. 35g 6 paper clips with spinner = 3. 02g

Spinner = 0. 67g Height of ceiling = 2. 75 cm

Mass of spinner No. of From ceiling to From Vt to floor (T2) Average (T1) Average (T2)

paper clips floor (T1)

1 2 3 1 2 3

1. 09g 1 2. 82s 2. 81s 2. 75s 2. 28s 2. 25s 2. 23s 2. 79 2. 25

3

1. 48g 2 2. 16s 2. 22s 2. 22s 1. 4s 1. 16s 1. 5s 2. 2 1. 45

1. 86g 3 1. 96s 1. 93s 1. 78s 1. 31s 1. 47s 1. 47s 1. 89 1. 42

2

2. 25g 4 1. 53s 1. 56s 0. 59s 0. 97s 0. 78s 1. 00s 1. 56 0. 98

1

2. 63g 5 1. 15s 1. 32s 1. 38s 0. 84s 0. 84s 0. 88s 1. 35 0. 85

3. 02g 6 0. 82s 0. 93s 0. 88s 0. 44s 0. 43s 0. 44s 0. 88 0. 44

1, 2, 3 = I redid these as they are probably incorrect because they are so different from the other result and got these instead: 1= 1. 34 2= 0. 97 3= 1. 46 . Both T1 and T2 is measured in seconds (s)

Note concerning the height of the ceiling: I chose to measure the height of the ceiling to the nearest whole centimetre, I felt this was accurate enough because 1cm is only approximately 0. 333% of the height of the ceiling. Measuring to 1 cm leaves a very small margin of error when I work out terminal velocity, which is satisfactory.

Weight in Newtons/Drag

For 1 paper clip w = 1. 09g = 0. 0109 N

100

For 2 paper clips w = 1. 48g = 0. 0148 N

100

For 3 paper clips w = 1. 86g = 0. 0186N

100

N = Newtons

For 4 paper clips w = 2. 25g = 0. 0222 N

100

For 5 paper clips w = 1. 86g = 0. 0263 N

100

For 6 paper clips w = 3. 02g = 0. 0302N

100

Terminal Velocity

1. For one paper clip Vt = (2 x 2. 75) 2. For two paper clips Vt = (2 x 2. 75)

(2. 79 + 2. 25) (2. 2 + 1. 45)

Vt = 5. 5 Vt = 5. 5

5. 04 3. 65

Vt = 1. 091 m/sec Vt = 1. 507 m/sec

3. For three paper clips Vt = (2 x 2. 75) 4. For four paper clips Vt = (2 x 2. 75)

(1. 89 + 1. 42) (1. 56 + 0. 98)

Vt = 5. 5 Vt = 5. 5

3. 31 2. 54

Vt = 1. 662 m/sec Vt = 2. 165 m/sec

5. For five paper clips Vt = (2 x 2. 75) 6. For six paper clips Vt = (2 x 2. 75)

(1. 35 + 0. 85) (0. 88 = 0. 44) Vt = 5. 5 Vt = 5. 5

2. 2 1. 32

Vt = 2. 5 m/sec Vt = 4. 167 m/sec

Average Speed.

1 paper clip 2. 75 m 2 paper clips 2. 75 m

2. 79 s = 0. 986 m/s 2. 2 s = 1. 25 m/s

3 paper clips 2. 75 m 4 paper clips 2. 75 m

1. 89 s = 1. 455 m/s 1. 56 s = 1. 763m/s

5 paper clips 2. 75 m 6 paper clips 2. 75 m

1. 35 s = 2. 037 m/s 0. 88 s = 3. 125m/s

m = meters s = seconds

I decided that six results was not enough to draw an accurate graph and decided to take more results. I used a pin, with the same number of paper clips; as it is almost half the weight of one paper clip. This would mean I had about eleven results with which to draw a graph. However I found that the spinner was no longer strong enough to fall accurately, each time we dropped the spinner it fell at a different speed. This led to results which were nothing like the first set which we recorded and I decided not to continue with the second table of results and therefore only used the first table of results (see above) to draw the graphs.

Analysis

I can see from my graphs that both the average speed and terminal velocity is not directly proportional to the drag. As the speed increases the drag also increases. The graphs shows a steady increase in speed at terminal velocity/the average speed and drag until the spinners mass is 2. 25 grams; after this the speed (terminal velocity and average speed) continue to increase with very little change to the amount of drag. This is because the nature of the way the spinner falls changes at this point. The blades can no longer dissipate the potential energy and the spinner gains kinetic energy. This is shown on my graph when the line of best fit plateaus out. Terminal velocity is still reached but because there is less air resistance there is less drag. If I continued to add weight to the spinner I might find that the spinner could fall faster before terminal velocity is reached, as it is more aero-dynamic, and there is less drag. The spinner does not fall like other simple objects as it is falling and rotating at the same time, more simple objects usually have a graph which would look similar to this, where drag is proportional to speed2 . X axis = speed Y axis = drag.

My prediction was correct “ the greater the weight of an object the faster it will fall and the greater the speed at terminal velocity. I think this because when weight = drag an object is no longer accelerating. So if you have a heavier object it will have to fall faster and for longer for the weight to = the drag and the object to have reached terminal velocity. The opposite is true for a spinner weighing less, it will not need to be travelling as quickly or for as long for the drag to = the weight there fore terminal velocity will be slower.” To complete this investigation I need to investigate one more thing (the parts in red), to test whether all of my prediction is correct.

Evaluation

I am fairly confident that my results are accurate as I did them several times and used a balance that calculates mass to one hundredth of a gram. I also made sure we used the same make of stopwatch each time. A factor, which could have effected the accuracy of my results, is human reaction times and human error. This will mean that the results are slightly out however as this was the same for each of the different masses of the spinner I feel I can still draw some accurate conclusions.

We identified anomalous results as we went along, repeating the drop and using these new results to work out the averages not the anomalous readings. I would think these anomalous readings were due to human error. As a result of identifying anomalous readings as I went along my final graphs have no points which are not on or very close to the line of best fit.

My results are fairly consistent, there is not a lot of variation. I feel that with more evidence to support my prediction I could be 100 % sure that my conclusions are accurate, however we only used six different masses of spinner so I can not be altogether certain that the conclusions I have drawn are correct. I believe my results back up the predictions I made adding evidence to my theories.

I think that to improve the validity of my conclusion I should have found a way of tacking more times and points to plot on my graph. This would make me more confident that my conclusion is as accurate as possible.