Speed of a Falling Object

Aim
The aim of this investigation is to find the factors affecting the rate of fall of a body through the air.

Fair Test
The variables that will need to be the same to make this a fair test are:
- The shape paper cases that are used :-

The shape of the paper case affects the air resistance acting upon it.
- The weight of the paper cases that are used :-

The weight affects the speed of fall and would therefore end up in incorrect results.

Theory
Gravity is the force which pulls objects together. It depends on the mass of both objects, an object with a large mass will have a large gravitational force compared to an object with a smaller mass which will have a smaller gravitational force. This can be shown using the moon and the Earth as the Earth has a larger mass it has larger gravitational field strength. Gravitational forces between objects decrease if they have less mass or are further apart. Gravity acts on objects and pulls them down towards the Earth.

Resistive forces act on any object moving through a fluid (i.e. a gas or a liquid). When moving through air, air resistance acts upon an object. Air resistance occurs because the object must move air particles out of the way and this will cause resistive or drag forces.

Air resistance increases as the object is dropped and accelerates and will continue until it equals the downward force of gravity. The object will then fall at terminal velocity until it hits the ground.

Prediction
I think that as the weight of the paper case increases, the time taken to fall will decrease. This is due to the fact that an object with a larger weight can push air particles out of the way easier than an object with a smaller weight, as it is falling with more velocity.

Apparatus
- Stand
- Stop Watch
- Paper case X2
- Clamp X2
- Paper Case X2
- Metre Rule X3

Diagram

Method
Set up apparatus as shown above. Hold the paper case at 0.5m and drop it the time must be measured while it is falling from when it starts to fall to when it hits the ground. Then record the time. Do this four times to ensure accuracy of the experiment. From these four measurements the average time must be calculated and recorded. Repeat this experiment on the distance of 0.5m for 1, 1 ¼, 1 ½, 1 ¾ and 2 paper cases (actual weights are recorded below). The experiment just completed (including with different weight paper cases) should be repeated for the heights of 1.0m, 1.5m, 2.0m and 2.5m.

Weights of paper cases:

- 1 = 0.31g
- 1 ¼ = 0.34g
- 1 ½ = 0.44g
- 1 ¾ = 0.50g
- 2 = 0.56g

Results

0.5m

Weight of Paper Case	1st Time Taken (s)	2nd Time Taken (s)	3rd Time Taken (s)	4th Time Taken (s)	Average Time Taken (s)
1	0.36	0.44	0.37	0.37	0.39
1 ¼	0.37	0.43	0.31	0.33	0.36
1 ½	0.33	0.33	0.27	0.29	0.30
1 ¾	0.27	0.29	0.29	0.28	0.28
2	0.24	0.27	0.29	0.27	0.24

1.0m

Weight of Paper Case	1st Time Taken (s)	2nd Time Taken (s)	3rd Time Taken (s)	4th Time Taken (s)	Average Time Taken (s)
1	0.57	0.71	0.65	0.72	0.62
1 ¼	0.64	0.66	0.65	0.58	0.63
1 ½	0.54	0.57	0.52	0.66	0.57
1 ¾	0.54	0.47	0.53	0.53	0.51
2	0.48	0.49	0.51	0.50	0.50

1.5m

Weight of Paper Case	1st Time Taken (s)	2nd Time Taken (s)	3rd Time Taken (s)	4th Time Taken (s)	Average Time Taken (s)
1	0.98	0.95	1.03	0.95	0.98
1 ¼	0.97	0.92	0.96	0.80	0.91
1 ½	0.90	0.85	0.83	0.81	0.85
1 ¾	0.75	0.80	0.75	0.78	0.77
2	0.67	0.75	0.78	0.67	0.72

2.0m

Weight of Paper Case	1st Time Taken (s)	2nd Time Taken (s)	3rd Time Taken (s)	4th Time Taken (s)	Average Time Taken (s)
1	1.31	1.28	1.37	1.28	1.31
1 ¼	1.25	1.19	1.19	1.20	1.21
1 ½	0.97	1.12	1.06	1.09	1.06
1 ¾	1.00	1.03	1.00	1.06	1.02
2	0.97	0.97	1.00	1.00	0.99

2.5m

Weight of Paper Case	1st Time Taken (s)	2nd Time Taken (s)	3rd Time Taken (s)	4th Time Taken (s)	Average Time Taken (s)
1	1.53	1.51	1.54	1.47	1.51
1 ¼	1.36	1.30	1.37	1.30	1.33
1 ½	1.23	1.26	1.27	1.25	1.25
1 ¾	1.19	1.19	1.20	1.17	1.19
2	1.15	1.17	1.14	1.07	1.13

Conclusion

From the results and the graph I can make the judgement that, as the weight of the paper case is increased, the time taken to fall increases. All of the lines on the graph are very similar shapes and this shows that this conclusion is reliable. It seems that this trend would probably continue for other weights if they were tested. It would be possible to test larger weights of paper case but these would be less accurate as it would take a shorter time for the paper case to fall to the ground and human error could influence the experiment more than it already does.

Evaluation

The time taken is measured as accurately as possible with the apparatus available. The main factor affecting the accuracy of the result is human error. Human error is caused by the reaction time of the person timing the experiment and accounts for about 0.3 seconds, on average.

Human error can be eradicated by setting up a computer system to measure the time. Writing a timing program for the computer and setting up motion sensors can achieve this and therefore get more accurate results.

As mentioned above the results are very accurate with the apparatus available. This is shown by the graphs the lines fit the trend of Distance/time graphs and

they are all similar shapes. Also the four results for every test are similar and by doing this they back each other up.

Improvements for the future include the point mentioned above about using a computer to time rather than a person, to increase the accuracy. Another improvement could be to get a larger measuring device as I used three 1m rules held up by a clamp and this is not as accurate as one straight measuring device (e.g. rule) that is 2.5m long.

Ways to extend the experiment are to ask the questions, "What would happen if other objects are used?" "What would happen if the air pressure was changed?" and "What would happen if there was a different gravitational force?"