Excellence

NZQA Intended for teacher use only

Purpose of investigation:
To find out how the height at which a muffin case is dropped affects the time taken to reach the ground and how this can be applied to the context of falling from space

Prediction: **I think that....**
I think that the greater the height the muffin case is dropped from, the greater the time taken to reach the ground will be.

Which variable will be changed? (This is the independent variable)
Height at which Muffin Case is Dropped (meters)

How will the independent variable be changed?
By ~~increasing the decreasing~~ increasing the release height (Height at which the Muffin Case is Dropped).

Do some trials to decide on a suitable range of values for this variable (at least 5 values)
~~0.4m, 0.6m, 0.8m, 1m~~
2.
1.2m, 1.4m, 1.6m, 1.8m, 2m

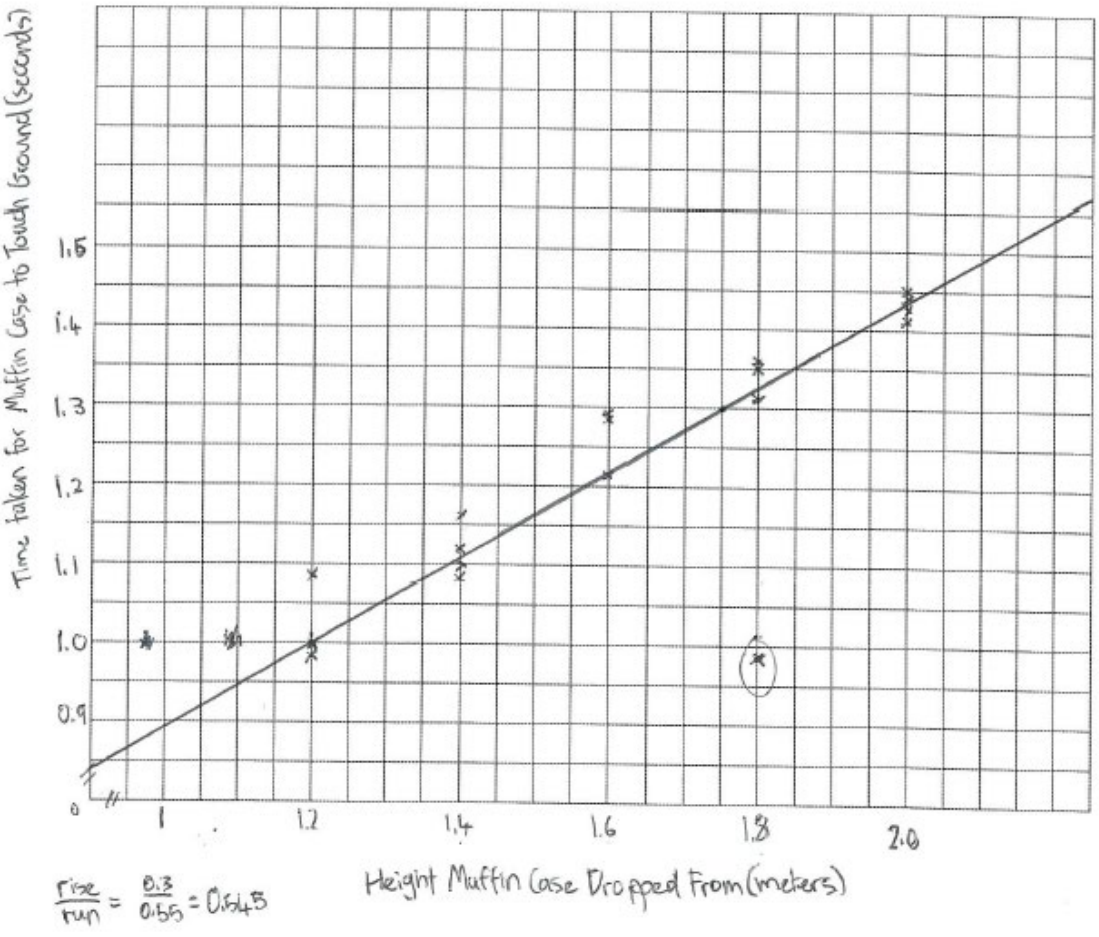
Which variable will have to be measured or observed in order to get some data or information from the investigation? (This is the dependent variable)
Time Taken to Reach the Ground (seconds)

How will the dependent variable be measured or observed – be clear on how you measured and **include units.**
The Time Taken to Reach the Ground will be measured in seconds with a stopwatch. The stopwatch will be started on release and stopped on ground impact of the muffin case.

Method: Now use the information on this planning sheet to write a detailed step-by-step method. A diagram could be used. This should be in your own words and different from others in your group.

Drop Height	Trail 1	Trail 2	Trail 3	Trail 4	Averages	speed
1.2m	1.00 sec	1.00 sec	1.09 sec	0.97 sec	1.015 sec	?
1.4m	1.12 sec	1.10 sec	1.08 sec	1.12 sec	1.105 sec	?
1.6m	1.27 sec	1.28 sec	1.28 sec	1.29 sec	1.2675 sec	?
1.8m	0.97 sec	1.35 sec	1.31 sec	1.36 sec	not including OL 1.34 sec	?
2 m	1.43 sec	1.41 sec	1.44 sec	1.45 sec	1.4325 sec	?

Correlation between Time Taken for Muffin Case to Touch Ground and Height Muffin Case Dropped From



$\frac{\text{rise}}{\text{run}} = \frac{0.3}{0.55} = 0.545$

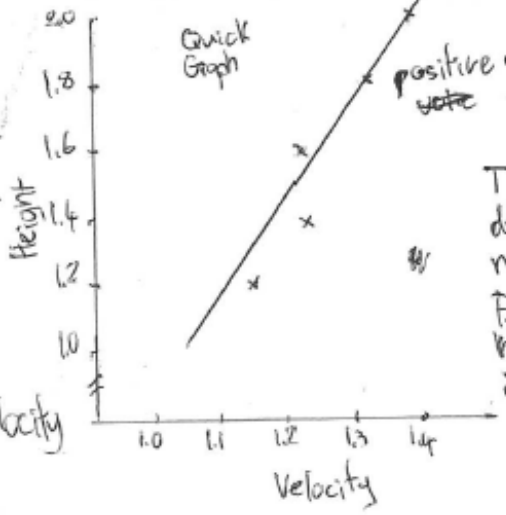
Write a **conclusion** that links to the purpose and to the context. Consider your results, graph, gradient of graph (gradient = rise/run). Do further calculations using the data to double check what the gradient shows. Relevant formula: v=d/t

In conclusion, my prediction was ~~right~~ correct, as the graph shows a positive (0.545) trend towards Time Taken for Muffin Case to Touch Ground in relation to Height Muffin Case Dropped From. This means the greater the Height the Muffin Case Dropped From is, the greater the Time Taken for Muffin Case to Touch Ground will be, which was my prediction.

This would theoretically mean a skydiver such as Felix Baumgartner would take longer to reach the ground if they jumped from a higher altitude.

Height	Velocity d/t
1.2m	1.182m/s
1.4m	1.267m/s
1.6m	1.267m/s
1.8m	1.343m/s
2.0m	1.396m/s

Height Muffin Case Dropped From (m) / Time Taken For Muffin Case to Reach Ground (s)



This higher velocity when dropped from a higher height means a skydiver such as Felix Baumgartner would have a higher average velocity if he jumped from a higher altitude.

Felix Baumgartners maximum ~~terminal~~ velocity was 1357 Km/h.

Science Ideas: Write an explanation of your results in terms of the physics ideas involved (what is the science to explain your observations/results that links to the purpose)
The physics concepts involved are **motion** & **forces**. Explain these concepts and how they have resulted in your conclusion, include terminal velocity concepts, link to your data AND you could do further calculations.

The muffin case takes longer to reach the ground when dropped from a higher height because it encounters more air resistance force in total, ~~meaning~~ although the velocity is relatively the same, ~~more~~ the muffin case has further to fall, which means it will experience more air resistance in total.

Average Velocity only increases with height dropped because it has more time to fall at maximum speed, or terminal velocity. The muffin case takes a set amount of time to accelerate, and then reaches max speed, this time taken to reach terminal velocity and time at terminal velocity are added up and divided by the distance/height. This means the difference in velocity will be smaller and smaller as the height the muffin case is dropped from increases, although ~~it will always~~ velocity will always increase as height increases.

As the muffin case is at the top of the height it will be dropped from, it has maximum gravitational potential, and no force is acting on it, therefore there is no motion. The tension force of the hand and the weight force of the muffin case is equal, therefore the forces are balanced. The net force is 0.

When it is released, the tension force is eliminated and the weight force of the muffin case causes it to move downwards.

As it moves downwards, the surface area of the muffin case causes air resistance force, which increases as speed increases. as more air molecules obstruct it per amount of time as it moves faster. At this point the forces are unbalanced, as the gravitational force is larger than the air resistance force, meaning the net force is not 0 and the muffin case is accelerating.

As it decends further, the air resistance force increases until it equals the weight force, and the forces are balanced again. This is called terminal velocity. Terminal velocity occurs when the air resistance force equals the weight force of an object. It means the object is at maximum speed.

The muffin case then decends at terminal velocity until it contacts the ground. when the muffin case touchs the ground, all gravitational potentional energy has been converted into kinetic energy, and the muffin case is not in motion because the push/surface force of the ground equals the weight force of the muffin case, meaning the net force is 0 and the forces are balanced.

All of these concepts apply to a skydiver such as Felix Baumgarther skydiving, although he jumped at a very high altitude, where the air resistance is much less. This means he would accelerate much faster relative to the air lower down. He would also achieve a higher terminal velocity in the thinner air for the same reason, but as he decends it would decrease, and drastically increase as the surface area was increased with a parachute.

To produce reliable and accurate results, we made sure to keep controlled variables as consistent as possible. The same equipment was used throughout, and the person doing a task did that task the whole time.

The biggest concern was the variation in the shape of the muffin case. As it is held, the sides are compressed, altering the surface area and therefore the resulting air resistance.

The best solution to this would be to use a consistent mechanical dropper. We collected one outlier, which I discarded. It was not necessary to replace this as 3 trials are enough to get an accurate average.