Acceleration due to gravity example question

- A golf ball and a ping pong ball of equal volume fall form the same height above Earth.
- The gold ball has a larger mass than the ping pong ball.
- Air resistance does act on both objects during fall.

Why does the golf ball reach the ground first?

1. The golf ball **has larger mass** and **so a larger weight** (**greater force acting down**).
2. The **golf ball will reach a higher terminal velocity since it accelerates for a longer period of time** compared to the ping bong ball.
3. This is because **a larger drag force is needed to balance** against **its larger weight**.
4. This means that with a **larger terminal velocity**, the **golf ball will reach the ground first**.

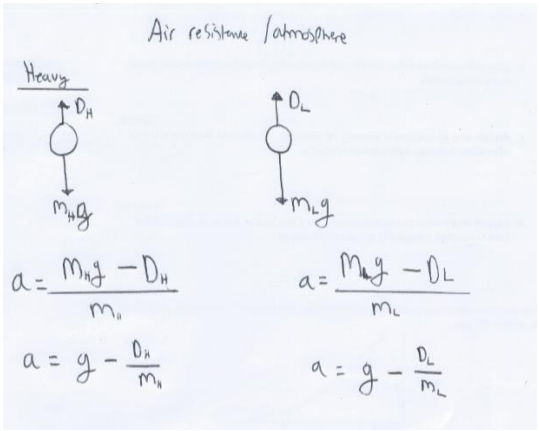
(iii)	The golf ball experiences greater drag (at terminal velocity to equal its larger weight) (AW)	B1
	Drag increases with speed or drag $\propto v^2$ or the golf ball takes longer time to reach its terminal velocity or the golf ball accelerates for longer time	B1
	The golf ball (has greater terminal velocity)	B1

More detailed

1. Both objects have the **same initial acceleration due to gravity (9.81 ms^{-1}). Since to begin with they both have zero velocity so no air resistance.**
2. As objects accelerate/ their speed increases so does the drag force. Speed **directly proportional** drag
3. The weight of an lighter object is less than a heavier object. Therefore the lighter object has a smaller downward force.
4. In a shorter amount of time, the drag force will have balanced against the weight.
5. The **heavier object will accelerate for longer** (acceleration decreases at a slower rate) s**ince a larger drag force is needed to balance a larger weight/downward force.**
6. The **heavier object reaches a greater terminal velocity** than the lighter one so will **reach the ground first.**

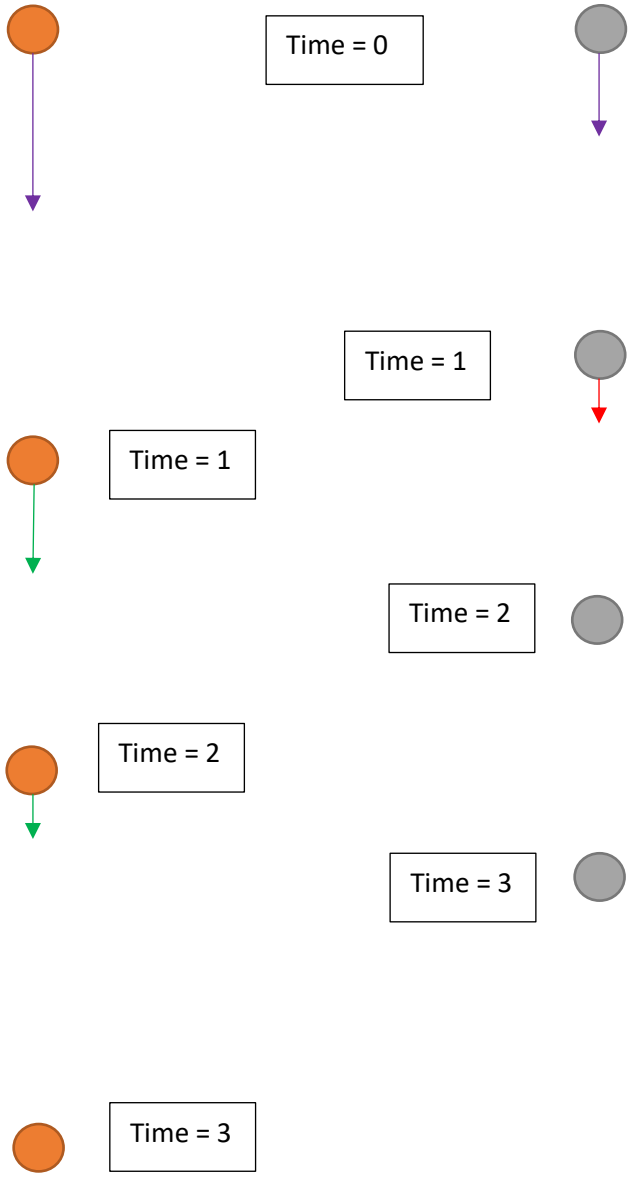
It is best **NOT** to explain it using this method:

"The acceleration of the heavy object is greater" – while this may be true for a particular point in time



Since both objects **begin with same acceleration (9.81 ms^{-1})** and the **drag force increases for both objects as speed increases**. The drag force will increase so the resultant downward force decreases anyway.

It makes it more difficult to visualise.



This diagram shows a heavy (orange) ball and a lighter (grey) ball.

It only shows the **net force acting down**

(weight – air resistance)

To begin with air resistance = 0 and both have same acceleration since even though the orange ball has a larger resultant……

Heavier things have a greater gravitational force BUT ALSO a heavier mass.

The acceleration is directly proportional to the magnitude of the net force AND inversely proportional to the mass of the object.

Hence larger mass has inverse effect so the acceleration ends up being the same for a heavy and a light object in a vacuum or at start of fall when there is no air resistance as no velocity. This is why the first stage in my diagram will have the SAME ACCELERATION even though the larger object has a greater resultant downwards.