How Surface Area Of Vanes Effect The Rate At Which A Weight Drops

Aim – To see if the surface area of a wind vane affects the rate at which a weight drops from it.

Hypothesis – I predict that by increasing the surface area of the vanes on the wind vane, I will increase the air resistance therefore slowing the rate at which the weight will drop.

Primary Work – If a piece of paper and a marble are in free fall, they will fall at the same speed, so they should hit the ground at the same time. If you test this by just dropping a marble and a piece of paper you will find it is not true. This is because the objects are not in free fall. To be in free fall, gravity has to be the only force acting on the objects. When you just drop something, there is also air resistance. Air resistance is a type of fluid friction. Because friction acts in the opposite direction of the object's motion, air resistance of an object falling downward is an upward force. This is because a falling object is coming down, so the opposite direction is up. If air resistance were equal for every object, objects would still fall at the same rate. Since we know they do not fall at the same rate, we know air resistance is different for different objects. The amount of air resistance acting on an object depends on the object's surface area. If an object has a small surface area, it will have little air resistance. Because the piece of paper has a larger surface area than the marble, the marble will have less air resistance than the piece of paper and the paper will fall slower. This is what I expect to happen with a wind vane. As the wind vane turns, air resistance will act on each of the separate vanes. By increasing the surface area of the vanes, I will increase the air resistance therefore making the rate at which the weight drops slower, because there is more opposing force.

Theory – Newton's law of gravity and Galileo's freefall theory state that objects of any mass will fall to the ground at the same time if in a complete vacuum i.e. space, if not in a complete vacuum i.e. earth, *they will fall at different times because of air resistance* (and weight). The air resistance depends on the surface area of the object, the larger the surface area, the more amount of air resistance. In the case of a wind vane, the objects dropping are the separate vanes.

Plan Of Experiment – I will drop a 15g weight from a piece of string; this string will be attached to an axel which is further attached to a wind vane. Firstly the string will be coiled around the axel then when let go, the weight will drop and the wind vane will turn to create opposing force. I will time the rate at which it falls. My dependant factor will be the time the weight takes to hit the table. My independent factor will be the surface area of the vanes. To ensure a fair test, my controls will be the distance from the table and the weight of the falling object.

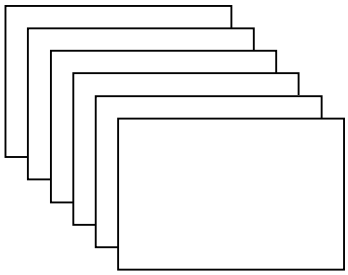
Apparatus –

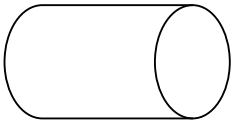
- Stand
- Clamp
- 20g Weight
- 55cm of String
- Axel
- Cork With Equal Slits For Vanes
- Card For Vanes
- Stopwatch

Method –

1. I will set up the equipment as shown below.

2. I will cut out 6 vanes with a certain surface area and put them into their corresponding slits in the cork.





3. I will coil the string attached to the weight around the axel and then drop it. I will time the time it takes for the weight to hit the table and record my results.

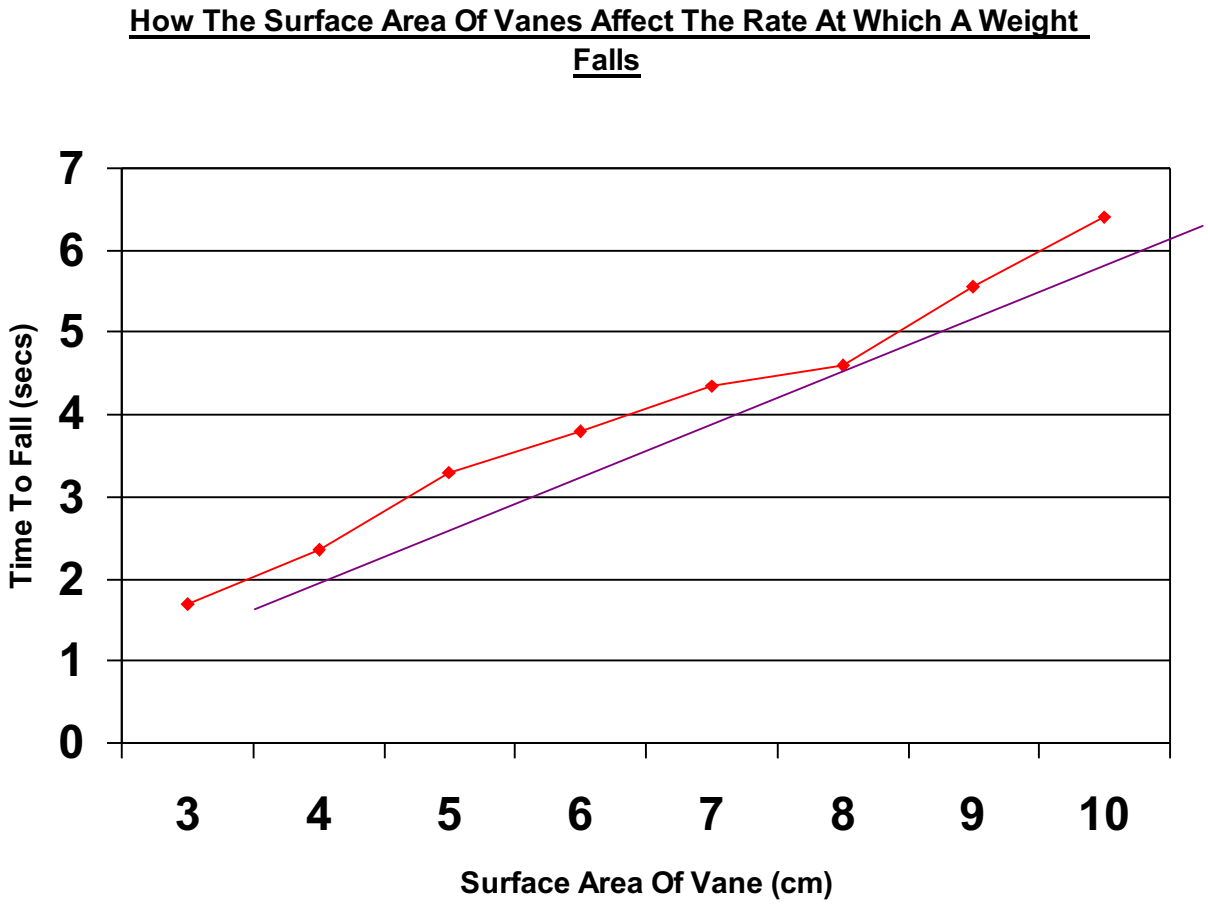
4. I will repeat the experiment for accuracy of results

Results –

Surface Area (cm)	1st Try (secs)	2nd Try (secs)	Average (2.d.p)
3	1.8	1.6	1.7
4	2.4	2.3	2.35
5	3.2	3.4	3.3
6	3.9	3.7	3.8
7	4.4	4.3	4.35
8	4.7	4.5	4.6
9	5.4	5.7	5.55
10	6.3	6.5	6.4

Graph Of Averages –

= Line Of Best Fit



Conclusion – I have found that I was right in my hypothesis in thinking that the larger the surface area of the vanes on a wind vane, the more time it takes for a weight attached to it by means of an axel to fall. This was because, as stated in my theory and primary work, the surface area increased the amount of air resistance and this force opposed gravity which was pulling the weight down, therefore making it travel slower. This is shown in my graph as a positive correlation.

Evaluation – I had no major anomalous results, this was down to accurate measuring and because I kept my experiment fair. After doing this experiment I would like to be able to calculate the actual amount of air resistance created by a wind vane and see if there is any relationship between surface area and amount of air resistance.