Experiment 11: Flying Teabag

Change gravity's direction by brewing convection

THE SET UP

1. Summary

A stapled teabag is emptied and opened out into a cylinder shape. The top is lit, the teabag burns down and just before it finishes, the bag lifts off the table and combusts in the air. This very visual effect is unexpected and intriguing for most students.

2. Context

This is perfect to accompany Heat Transfer as convection is demonstrated very effectively. It is also suitable for supporting Forces and Energy transfers.

3. Apparatus

- Teabags – the folded, stapled type with the tea and staple removed
- Splint
- Heatproof mat
- Fire extinguisher, only in case of emergency!

4. Preparation

Try the experiment with different teabags as their performances can vary depending on size and shape. Remove the staple and empty the teabag, open it to make a cylinder, trimming with scissors if the end isn't square. Stand the cylindrical bag on the heat proof mat and set light to the top with a splint. Stand back and watch as the bag burns down and then takes off and combusts in the air. A good teabag will float about a metre into the air.

5. Safety

Use a heatproof mat, wear goggles and have students wear goggles. The bag can fall over when lit so ensure there are no draughts and nothing flammable nearby.

THE DEMONSTRATION

1. Procedure

- Ask the class whether they think teabags can fly
- Remove the staple and tea from the teabag, and set it up as in the preparation
- Discuss with the students what they think might happen
- Light the top of the teabag and explain the acting forces as it burns down
- Watch as it floats into the air and then explain the change in forces and the introduction of convection. Students will probably want to see the effect again so have a few spare teabags close at hand.

2. Suggested Script Ideas

"Today's big question is: Can a tea bag really fly?
I am going to cheat a bit and remove the tea first.
Put your goggles on and stand up, ready to run away if the teabag heads for you!
Now I am going to light the top of it - What do you think will happen?

(Light)

Why did that happen?
Lets see it again…"

THE CONCLUSION

1. Explanation

When we put the teabag on the table the forces are balanced: gravity is the downward force and it is being supported by the bench so there is no movement. When we light it, several things are happening: as the bag burns, its mass decreases, so the downward force due to gravity also decreases. The released heat causes the air to rise due to convection and eventually this air movement is strong enough to create a bigger force upwards than gravity's downwards force, so the teabag takes off.

2. Useful Questions and Answers

Q) Will this experiment work with an ordinary teabag?

A) Probably not, you need some time for the flames to heat the air to create the convection current, however there is only one way to find out…

Q) Will this experiment work with other objects?

A) There are three requirements: they must burn, have a long cylinder shape and have a very low density. Ordinary paper doesn't work because of its density.

Q) Is this the same principle at work as in a hot air balloon?

A) It is similar but the hot air isn't trapped in the tube itself but is moving upwards above the cylinder.

Q) Can I try this at home?

A) Absolutely not!