



Bunny Can Combustion

Wake the Nesquik Bunny up!



If there is one question all science teachers constantly face then it is this one:

"Please, can we blow up something?"

Why do students ask? Well most students love to experience a bang but probably also as this is the way 'science' is portrayed in all 'MythBuster' type TV programs! Well - here we have a great idea for you to fulfill your students' dreams and teach them some valuable chemistry along the way!



Before we start, just the fine print to keep the guys in the black suits happy:

INDEMNITY: The author has made every reasonable effort to ensure that the activities described are safe when conducted as instructed but assumes no responsibility for any damage caused or sustained while performing the activities. The author does not intend to explain all dangers known or unknown that may exist in the execution of the procedures.

The Science behind the Combustion

Let's have a look at the chemistry of butane combustion:



The spark ignites the combustion mixture, causing an increase in pressure because

- the lid is still in place and the volume is fixed
- the mole change from 15 to 18 tries to increase the volume
- the exothermic (heat producing) nature of the reaction.

The hot gaseous reaction products push against the can lid & walls until the pressure is high enough to blow the lid off. The bang you hear is the pressure wave reaching your ears just like that from a popped balloon. Because the lid releases when the burning is still in progress, a flash of flame can be seen.

It is incorrectly assumed by many that a bullet gathers speed as it flies toward the target. The highest speed during the flight is that of the lid (or bullet) as it leaves the muzzle ("muzzle velocity"). It would have travelled forever, if it weren't for the air resistance, gravity and in our case the fishing line that brings it to rest.

The above balanced equation is very important as it gives us the ratios in which reactants react. It also tells us there is no use in adding more fuel, if you do not add oxygen too. The equation states that 2 moles of butane react with 13 moles of oxygen. Or 0.154 moles butane will react with 1 mole oxygen. This is known as the stoichiometric combustion ratio.

As the Ideal Gas Law is closely obeyed by nearly all gases at room temperature, the ratio of 0.154 : 1 should thus apply to the volumes of the gases too.

The amount of oxygen is set in the can. 21% of the atmosphere's volume is made up of oxygen. So 21% of the volume of the can is oxygen: $0.21 \times 500 \text{ cm}^3 = 105 \text{ cm}^3$
We therefore require: $105 \times 0.154 = 16.2 \text{ cm}^3$ butane.

Volume ratio: butane volume : can volume
16.2 : 500
1 : 31

So you may simply divide your can's volume by 31 to calculate the volume of butane required.

Now let's get on with the preparations. We will use a simple approach so that the device can be made in minutes. We are after a demonstration that is reliable, safe and easy to produce.

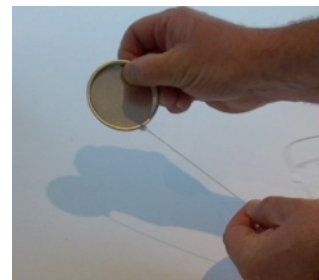
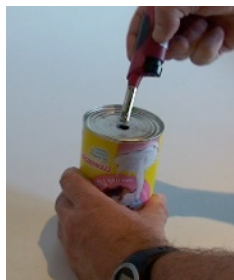
Components required

- ✦ One 250g Nesquik can
- ✦ Measuring cylinder / jug
- ✦ Gas lighter with round shaft
- ✦ Drill and drill bit with diameter of gas lighter shaft
- ✦ Butane refill can (used for refilling hand gas lighters. From tobacconist shop)
- ✦ Plastic syringe (20 ml)
- ✦ Fishing line (strong!) approx. 1 meter. This is a safety measure and should stop the flying lid.
- ✦ Cable tie that will fit around the can.
- ✦ Poking tool or nail



Preparation

1. Clean a Nesquik can (or similar metal can with a press-lid metal lid).
2. Measure the volume of the can using water and a measuring cylinder / jug. Ours takes 500 ml.
3. Poke a hole in the centre of the bottom of the can with the poking tool or a nail.
4. Enlarge this hole to the diameter of the gas lighter shaft with the hand drill. The lighter shaft should fit tightly through this hole.
5. Remove all burrs from the hole with a fine file or sand paper. Careful!



6. Cut a length of strong fishing line. We suggest around 1m.
7. Poke or drill a small hole in the rim of the **metal lid** and tie the fishing line securely to the lid.



8. Position the cable tie close to the bottom end of the can but do not pull it taught.
9. Now, tie the other end of the line securely to the cable tie and then pull it taught.

Testing the System

- Calculate the amount of butane gas required for combustion: $\text{Volume of can} \div 31 = x \text{ ml butane}$.
- Place the metal lid securely on the can.
- Hold the butane refill can upright and position the syringe tip on the butane can nozzle and simply press the syringe down. The syringe plunger should shoot up to the required volume. Fill to x ml.
- Now inject the butane into the can through the hole. Then cover the hole with your finger. The gas should diffuse through the can but you may want to give it a gentle shake.
- Important: Aim away or well above your spectators.
- Insert the gas lighter, do the countdown and squeeze the trigger . . . bang!
- If it does not fire then retry the lighter twice or open the lid and blow into the can to refresh the air supply and then repeat the procedure. It is very important (and educational) to emphasize the result of an over supply or under supply of butane.



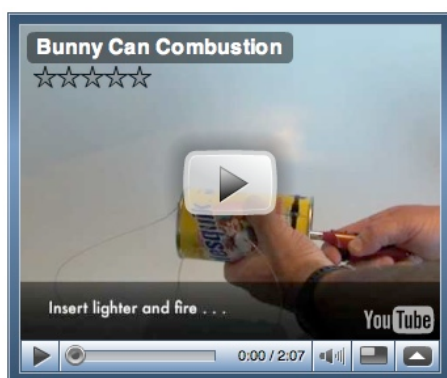
Extending the experience . . .

Here are a few things to ponder on or apply in your classroom or backyard research:

- Why did the lid fly off and (luckily) not the lighter? *Start with the definition of pressure (P): $P = F/A$ where F is the force and A the surface area. Focus on the surface areas of the lid and lighter and remember that the applied force inside the can is equal in all directions.*
- Replace the butane with hair spray or deodorant spray. *You will now have a mixture of butane and propane plus some impurities you did not have before.*

Acknowledgements

I have been tinkering with many combustion systems for years but would like to mention the valuable ideas & comments shared with me by my friend, prof Jeff Bindon of the Department of Mechanical Engineering at the University of KwaZulu-Natal in Durban, South Africa.



See the Bunny Can in action on video. Follow the Video link on our [website](#).

Have fun but please play it safe!
Carl