



Additional problem

Soot on a paper card



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Reporter: **Samuil Slavchev**

from Bulgaria (№ **504**)



Problem 24

Place a paper card above the flame of a candle. Describe the dependence of the soot spot on the distance between the flame and the card.



Agenda

1. The chemistry side of the problem
2. Physical part
3. How does the spot appear
4. Intensity of the spot
5. Minimal and maximal distance
6. Graph for diameter of spot/distance
7. Conclusion



Chemistry side

- The candle
 - The candle consists of hydrocarbons which at the **t** of burning of the candle burn not completely in to carbon and evaporated **water**.
- $C_xH_{y(s)} + y/4 O_{2(g)} \rightarrow xC_{(s)} + y/2 H_2O_{(g)} + Q$
- Exothermical process



Physical side

- During the exothermic process heat is emitted which heats up the air.
- The hot air is lighter than the cold air and starts to rise up and carries the burned particles.



How the soot spot appears

- The carbon particles that are obtained are with such small size that they rise up and because they are wet from the water, stick to the card.



The intensity of the spot

- The candle's flame is hotter at its top side and heats up air the most intensively. This causes the center of the spot to be the most intensive.



Experimental set up





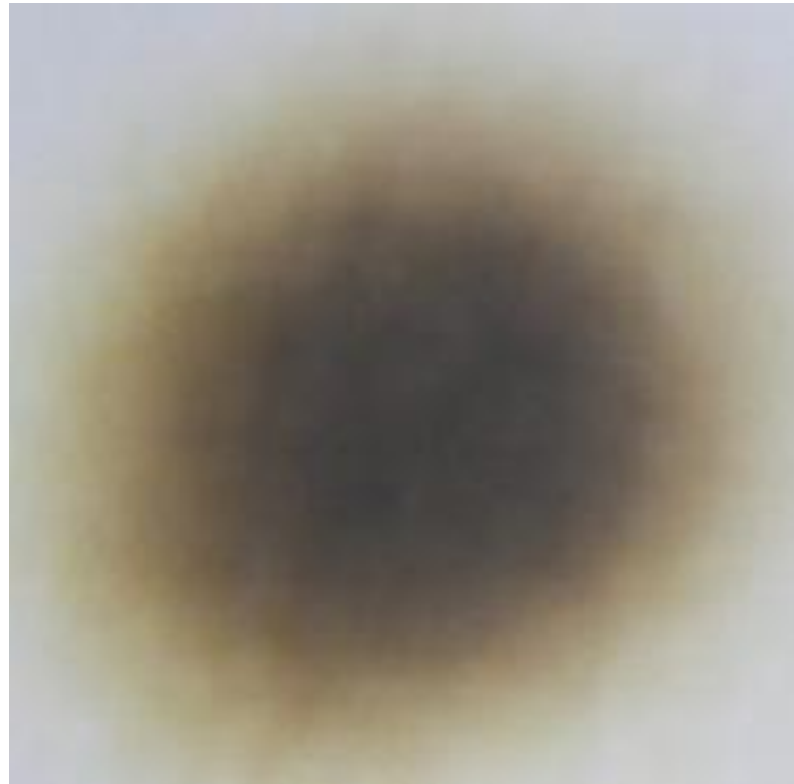
Minimal and maximal distance

- **Minimal:** Our observation showed that at a distance of about 7 mm from the tip of the flame to the card after about 1 s. the card catches on fire.
- **Maximal:** On a distance of 158 mm the spot is not longer visible.



Experimental proof about the intensity

- $L = 12 \text{ mm}$





Factor: *the time of flame exposure*

- The more time the card is exposed the bigger and more intense is the spot.
- **But** it does not effect the diameter of the spot !

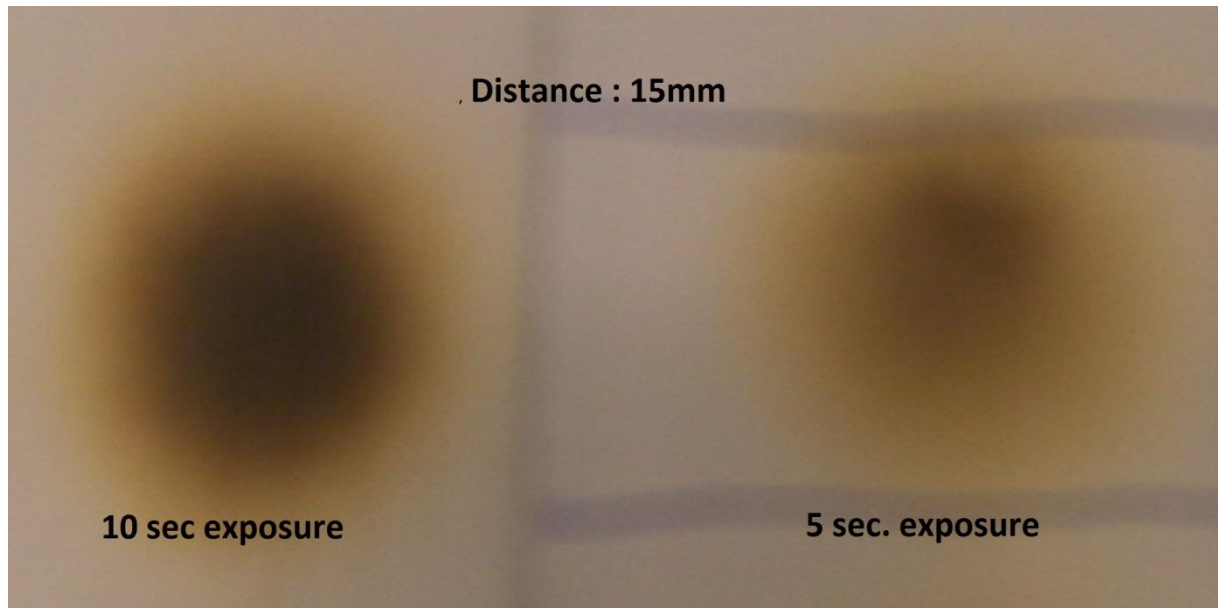


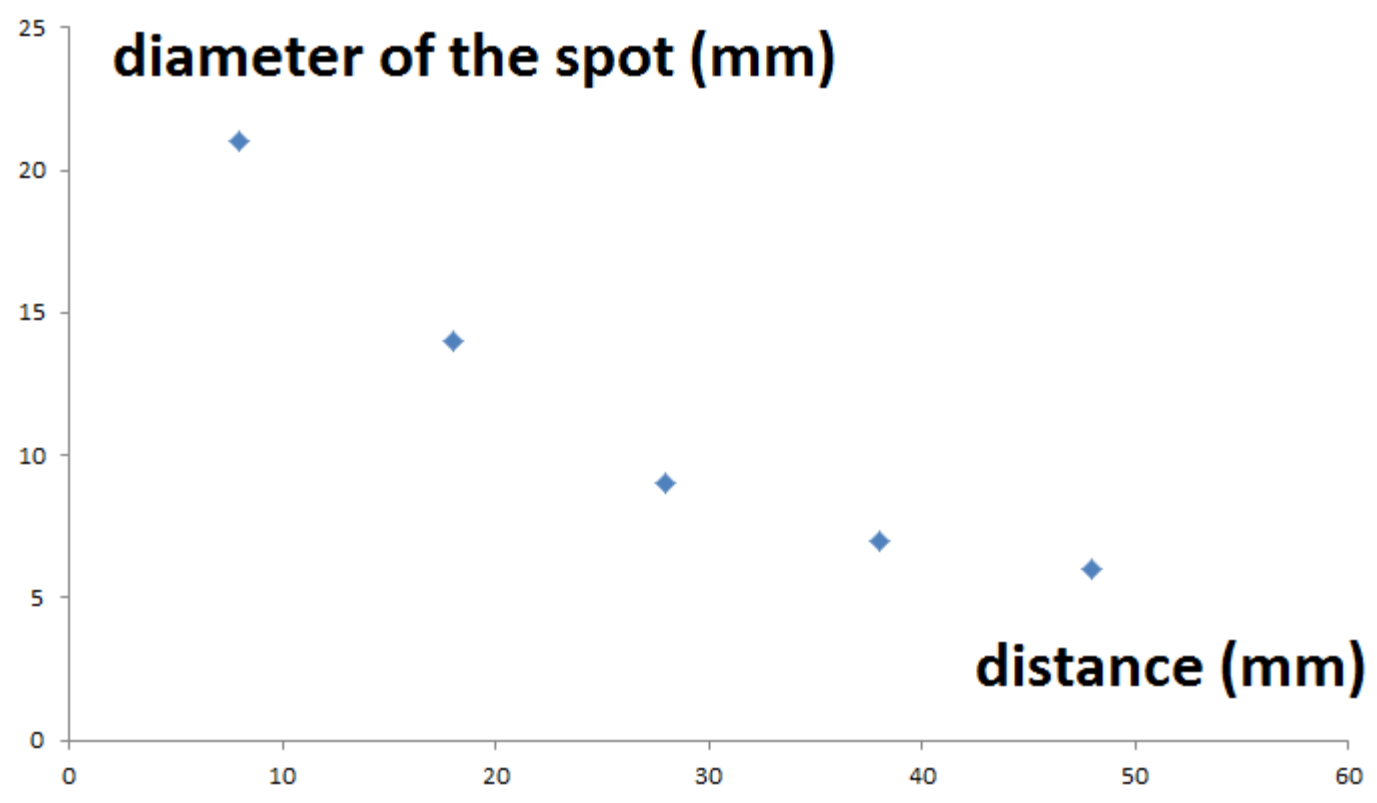


Table for distance/diameter

Distance (mm)	Diameter (mm)
8	21
18	14
28	9
38	7
48	6



Graph for diameter of spot/distance





Analysis of the graph

- I. Because of air resistance with increase of the distance the hot air stream's diameter increases.
- II. When the stream hits the card at short distance, it splashes. It depends on the velocity of the stream (distance).

The results from the graph show that the second factor is more influential.(at short distances)



Conclusion

- The distance affects the diameter of the soot spot. When we increase the distance the diameter gets smaller and vice versa.
- The diameter of the spot drastically decreases when the distance get shorter.
- The time of flame exposure affects the intensity of the soot spot, but doesn't affect the diameter.



Thank you for your attention!