

(2)

Tittle: Pharaoh's serpent

Work instructions

Task: The thermal decomposition of potassium dichromate and potassium nitrate, coupled with the subsequent caramelization of the sugar, produces a creeping mixture imitating a snake.

Theory

The thermal decomposition of these chemicals produces oxygen:

$$4 K_2 Cr_2 O_7 \to 4 K_2 Cr O_4 + 2 Cr_2 O_3 + 3 O_2$$
(1)

$$\mathbf{2} \text{ KNO}_3 \rightarrow \text{ KNO}_2 + \text{ O}_2$$

Some of the oxygen produced oxidises the sugar to caramel and therefore the "snake" is brown in colour and some of the oxygen remains with the products in the resulting mixture, giving the resulting mixture a much higher volume which causes the "snake to slither".

Equipment: mortar, plastic syringe (20 ml), wire gauze, tripod, burner, spoon, annealing dish **Chemicals:** potassium dichromate, potassium nitrate, sugar

Procedures:

- 1. Put 2 g of potassium dichromate, 1 g of potassium nitrate and 3 g of sugar in a mortar.
- 2. Grind and mix everything thoroughly so that the mixture has an overall yellow colour.
- 3. Push the mixture thus prepared into the syringe and give it a good push with the plunger so that the mixture is very hard.
- 4. Transfer the syringe to the fume hood where you have prepared the annealing dish. Cut the end off the syringe and squeeze the mixture into the annealing dish. Light the resulting cylinder in the annealing dish with the match and observe the "snake" coming out. If the mixture cannot be ignited, you can add a few drops of ethanol for faster ignition.

Name of the	Digitization of chemistry experiments to improve the quality and
project:	support chemistry teaching in secondary schools
Acronym:	ChemIQSoc
Project	2021-1-SK01-KA220-VET-000027995
number:	



Management of chemical substances

Chemicals	Form	H-statements	P-statements
K ₂ Cr ₂ O ₇	Solid	H350, H340, H360, H272, H330, H301, H312, H372, H314, H334, H317, H410	P201, P280, P301 + P330 + P331, P305 + P351 + P338, P304 + P341, P308 + P313
KNO3	Solid	H272	P220
Saccharose, commercial	Solid		

Sources of risk and assessment of risk severity

Possibility of skin burns and eye damage.

Waste management method

Certified chemical waste disposal company.

Risk reduction measures

Lab coat, goggles, gloves.

Name of the	Digitization of chemistry experiments to improve the quality and
project:	support chemistry teaching in secondary schools
Acronym:	ChemIQSoc
Project	2021-1-SK01-KA220-VET-000027995
number:	



Worksheet

Calculations

- 1. 2.0 g of potassium dichromate was thermally decomposed. Calculate:
 - a. the volume of oxygen released at 20°C and pressure 101.3 kPa

b. the weight of chromium (III) oxide.

Reaction: $4 \text{ K}_2 \text{Cr}_2 \text{O}_7 \rightarrow 4 \text{ K}_2 \text{Cr}_2 \text{O}_4 + 2 \text{ Cr}_2 \text{O}_3 + 3 \text{ O}_2$

 $M(K_2Cr_2O_7) = \dots g.mol^{-1}, M(Cr_2O_3) = \dots g.mol^{-1}$

The volume of released oxygen

b. the weight of chromium (III) oxide

Observation

1. Describe the course of the Pharaoh's serpent experiment.



Questions

- 1. Write the state reaction for the thermal decomposition of $K_2Cr_2O_7$.
- 2. Write the state reaction for the thermal decomposition of potassium nitrate.
- 3. Explain what happens during the experiment, why the "serpent" is formed.
- 4. Explain why the serpentine shape is formed.
- 5. Try to suggest how you could modify this experiment to get "serpents" of different colours. Give specific examples.



Conclusion

Instructions to elaborate conclusions:

- 1. Briefly summarise the aim of the demonstration experiment. What was the experiment trying to find out or prove??
- 2. Describe what you observed during the experiment. What were the most important results and what connections did you notice?
- 3. Explain the results using theory. How do the results confirm or refute the assumed principles?
- 4. Think about the practical meaning. How can the findings from the experiment be used in real life or in further study?

Disclaimer

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Slovak Academic Association for International Cooperation, National Agency for the Erasmus+ Programme for Education and Training Sectors. Neither the European Union nor the granting authority can be held responsible for them.