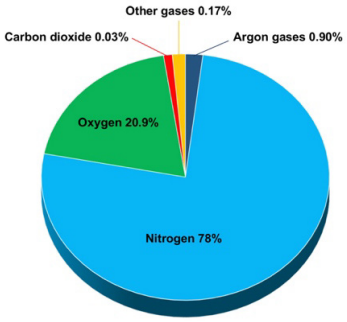
5.2 Composition of air

Basic information and collecting ideas	Oxygen is not only the requirement for life on Earth, but also enables a whole series of technical processes (e.g. combustion engines). The students should know the composition of air and especially the amount of oxygen it contains to understand important biological and technical processes. We use steel wool for this experiment because the iron in the steel binds with the oxygen (21% of air) to form iron oxide (base metal) and the residual volume of air (79%) mostly consists of nitrogen, which we can identify as an “extinguishing agent”. This experiment is also suitable for examining the oxygen content of exhaled air – when a person is at rest or after physical activity.
Setting up and conducting experiments	**Set up:** ▪ 2 syringes 100 ml ▪ glass tube 200/8 mm ▪ 2 pieces of tubing 3 cm ▪ steel wool ▪ gas burner ▪ 2 wooden sticks ▪ aluminium foil  **Conducting the experiment:** 1. Push about 5 cm of steel wool into the glass tube using a wooden stick. 2. Fill one syringe with 100 ml of air. The second syringe is empty and contains no air. 3. Connect both syringes to the glass tube using two pieces of tubing. 4. Check to see that the system is airtight. 5. Heat the steel wool in the glass tube from all sides with the gas burner. 6. Move the air slowly from one syringe to the other. 7. When the steel wool starts to glow, take the glass tube out of the flame (otherwise it will bend too much) and continue to push the air back and forth. 8. When the steel wool has stopped glowing, let the air cool down and determine the remaining volume of gas. 9. Push the steel wool out of the tube onto a piece of aluminium foil and compare it with the original wool. 10. Expel the remaining gas onto a glowing stick. 11. Repeat the last experiment with fresh air and compare.

Setting up and conducting experiments	**Advice:** Let the students assemble the equipment. One syringe contains 100 ml of air, the other syringe is empty. Ask the students to test the tightness of the system of the two syringes by alternately pushing the pistons back and forth. If the volume of 100 ml does not change, the system is tight. For safety reasons, the students should wear eye protection. When the group performs the experiment, the teacher should handle the gas burner to heat the steel wool. Two students hold the syringes by the cylinders and alternately move the pistons back and forth. The flame of the gas burner (about 1300 °C) should heat only the area of the glass tube containing the steel wool. During heating the students rotate the glass tube by rotating the syringes. When the iron heats up and starts to glow, the teacher should remove the gas burner so that an exothermic reaction can be seen in the glass tube. Allow the glass tube with the steel wool to cool down and determine the remaining gas volume. Also refer to the changed colour of the steel wool. Ignite a wooden stick and blow out the flame after a short time. Take the syringe with the remaining gas and expel the air on the glowing stick. Repeat the process, but this time use fresh air. This demonstrates that the residual gas consists of a fire-extinguishing gas (nitrogen), whereas oxygen promotes combustion.  Source: Wikipedia
Observing and documenting	Describe your observations: ▪ How many ml of gas remained? ▪ What percentage of the gas volume was used? ▪ What happened to the steel wool? ▪ Where has the missing volume gone? ▪ What do you call the “used” gas? ▪ What are the properties of the remaining gas? ▪ What do you call the remaining gas?
Analysing and reflecting	Nitrogen is used to extinguish burning oil wells. How does it work? *> Nitrogen prevents the supply of oxygen.* *This prevents the oil from burning*
Doing further research	▪ How would you test the oxygen content of car exhaust? *> While the engine is running fill a plastic bag with exhaust gas. Using a syringe, remove 100 ml of it and examine it.* ▪ How would you test the oxygen content of exhaled air (at rest (1) or after intense exercise (2))? *> At rest (1) or after intense physical activity (2), exhale 100 ml of gas into a syringe and determine the oxygen content.*

Technical and vocational application 	The composition of air under different conditions is common knowledge and vital to all people. All professions where the activities influence the oxygen content (e.g. welding, car repair, agriculture (biogas), etc.)

Space for notes