

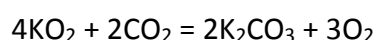
Answer to the Question#47310-Chemistry, Other

Question:

An average human adult takes about 15 breaths per min and exhales 23ml of CO₂ with each breath. If you are trapped in a cave with pressure 0.963atm and 11°C and your only source of oxygen is a breathing device containing 1kg of KO₂, how long do you have to live?

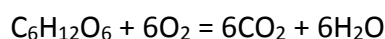
Solution:

KO₂ (potassium superoxide) can be used for rebreathers (CO₂-scrubbers). The KO₂-rebreather units work by converting the exhaled CO₂ to O₂ via the following chemical reaction:



Notice the potassium superoxide consumes CO₂, a product of respiration, and produces O₂, which can be breathed.

To solve our problem, we can describe breathing by simplified chemical equation:



1. Now calculate moles of CO₂ exhales per 1 breath using the ideal gas equation:

$$PV = nRT,$$

Convert all values to standard form:

$$0.963 \text{ atm} = (101325 \text{ Pa/atm}) \times 0.963 \text{ atm} = 97576 \text{ Pa}, 23\text{ml} = 2.3 \times 10^{-5} \text{ m}^3, 11^\circ\text{C} = 284 \text{ K},$$

$$R = 8.314 \text{ Pa} \times \text{m}^3 / \text{mol} \times \text{K}$$

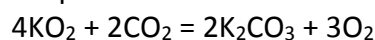
$$\text{Per 1 breath: } n = PV/RT = 97576 \times 2.3 \times 10^{-5} / 8.314 \times 284 = 9.5 \times 10^{-4} \text{ mol}$$

2. How many moles of O₂ is needed to 1 breath?

According to simplified chemical equation of breathing 1 mole of O₂ are equals to 1 mole of CO₂. Thus 9.5×10^{-4} mol of O₂ is needed to 1 breath.

3. How many moles of O₂ can be obtained from 1 kg (1000 g) of KO₂?

KO₂ reacts with CO₂ according to the equation:



As we can see, 1 mole of O₂ is equivalent to 4/3 moles of KO₂

$$M(\text{KO}_2) = 39 + 16 \times 2 = 71 \text{ g/mol},$$

$$4/3 \text{ moles of KO}_2 = 71 \times 4/3 = 94.7 \text{ g/mol O}_2$$

$$1000 \text{ g} / (94.7 \text{ g/mol O}_2) = 10.6 \text{ mol O}_2$$

4. How many breaths you can do with 10.6 mol O₂?

$$10.6 \text{ mol} / 9.5 \times 10^{-4} \text{ mol} = 11157 \text{ breaths}$$

5. How long it will be possible to breathe?

$$11157 \text{ breaths} / (15 \text{ breaths/min}) = 743 \text{ min}$$

Answer: You can to live about 743 minutes.