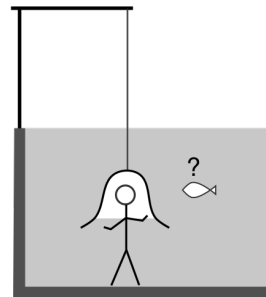


Prelude: The exact date and identity of the person that invented the dive bell is unknown. Seizing this opportunity, you plan to travel back in time to take credit for yourself. However, this requires your CHEM 161 skills to design and use one.



1. An average person consumes 31 g of O₂ per hour through the following balanced chemical equation:



- a) What volume of air (at STP) is required for a 30.0-minute-long dive?
Note that air is 21% O₂ by volume.
- b) To show off your “new invention,” you decide to take the dive bell 30 m below the surface of water. Using the ideal gas law, what is the predicted volume of air in the bell if there is a 1.0 atm increase in pressure for every 10.0 m of depth and you start with 52 L of air?
(Assume temperature remains constant.)
- c) As you go even lower, you notice that the actual measured volume at great depths is greater than the values you calculated. What are some possible explanations for this?
2. After losing track of time, you realize you don’t have enough oxygen to make it back to the surface. Luckily, you notice a box labeled “IN CASE OF EMERGENCY” containing solid sodium peroxide, which is used in submarines to “scrub” CO₂ back into O₂ via the following balanced chemical equation:
- $$2\text{Na}_2\text{O}_2 (s) + 2\text{CO}_2 (g) \rightarrow 2\text{Na}_2\text{CO}_3 (s) + \text{O}_2 (g)$$
- a) If there is 0.10 atm of CO₂ in the bell at 30 m, how many grams of sodium peroxide do you need to consume (“scrub”) all the CO₂? Again, assume temperature remains constant.
- b) As the CO₂ is converted to O₂, does the volume of gas inside the bell increase, decrease, or remain the same?

3. Your arch-nemesis wants to take credit for your precious stolen work, and he has a tank of gas that he figures might be poisonous Cl_2 , so he bubbles it into your dive bell.
- a) The gas tank has a volume of 32 L, a temperature of 27 °C, a pressure of 2125 psi, and contains 748 g of the unknown gas. Determine the identity of the gas being bubbled into your dive bell.
(14.7 psi = 1 atm)



- b) How would inhaling this gas change your voice?
4. After failing to poison you, your arch-nemesis pokes a tiny hole into your dive bell. Which gas in your dive bell is expected to escape the bell most rapidly?
5. Remembering that you have fingers, you use one to plug up the hole. Your arch-nemesis agrees not to steal your stolen work if you can predict the future.
- a) It is foreshadowed that when Venus attains its greatest heliocentric latitude south, a football star will deflate footballs to gain an advantage in the NFL. On this day (known as Deflategate), the player will claim the footballs have lower pressures outdoors because of the cold (9 °C outdoors vs. 24 °C indoors).

If the football's pressure is 12.5 psig indoors, what would its pressure be outdoors?

Note: $P_{\text{psi}} = P_{\text{psig}} + 14.7$ psi (similar to °C to K conversion)

- b) The ball's pressure will be 10.6 psig on the day in question. Is the football player innocent?