Chapter 8 Project: Under Pressure

Beginning the Chapter Project

Modern scuba-diving equipment allows divers to stay under water for long periods of time. You will use mathematics to explore safety issues related to scuba diving. Then, you will design a poster or brochure about scuba-diving safety.

Activities

Activity 1: Graphing

Scuba divers must learn about pressure under water. At the water’s surface, air exerts 1 atmosphere (atm) of pressure. Under water, the pressure increases. The pressure $P$ (atm) varies with depth $d$ (ft) according to the equation $P = \frac{d}{33} + 1$.

Boyle’s law states that the volume $V$ of air varies inversely with the pressure $P$. If you hold your breath, the volume of air in your lungs increases as you ascend. If you have 4 qt of air in your lungs at a depth of 66 ft ($P = 3$ atm), the air will expand to 6 qt when you reach 33 ft, where $P = 2$ atm.

- Using the data in the example above, make a table and graph to show how the volume of air in your lungs varies with depth.
- Make a table and graph to show how the volume of air in your lungs varies with pressure.

Activity 2: Writing

The volume of air in a diver’s lungs could more than double as the diver resurfaces. This expansion can cause the membranes of the lungs to rupture.

- If you fill your lungs with 4 qt of air at a depth of 66 ft, how many quarts of air will you need to exhale during your ascent to still have 4 qt of air in your lungs when you reach the surface?
- Write an explanation of why beginning divers are told “Don’t hold your breath!” Refer to your tables and graphs.
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Activity 3: Solving
A popular size of scuba-diving tank holds the amount of compressed air that would occupy 71.2 ft³ at a normal surface pressure of 1 atm. The air in the tank is at a pressure of about 2250 lb/in.², so the tank itself can have a volume much less than 71.2 ft³. How large does the tank need to be to hold 71.2 ft³? (Hint: Use Boyle’s Law: \( PV = k \). Remember that 1 atm = 14.7 lb/in.².)

Activity 4: Solving
The rate at which a scuba diver uses air in the tank depends on many factors, like the diver’s age and lung capacity. Another important factor is the depth of the dive.

At greater depths, a diver uses the air in the tank more quickly. Assume that the amount of time the air will last is inversely proportional to the pressure at the depth of the dive.

- Suppose a tank has enough air to last 60 min at the surface. How long will it last at a depth of 99 ft? (The pressure is 4 atm, or 4 times as great.)
- Make a table showing how long the air will last at 0 ft, 20 ft, 33 ft, 40 ft, 50 ft, 66 ft and 99 ft.

Finishing the Project
Design a poster or brochure explaining what you learned about scuba-diving safety in this chapter. Use graphs, tables, and examples to support your conclusions.

Reflect and Revise
Work with a classmate to review your poster or brochure. Check that your graphs and examples are correct and that your explanations are clear. If necessary, refer to a book on scuba diving. Discuss your poster or brochure with an adult who works in the area of sports safety, such as a lifeguard, coach, physical education teacher, or recreation director. Ask for their suggestions for improvements.

Extending the Project
What other safety issues must scuba divers consider? Ask a scuba diver or refer to a book to find other things a scuba diver must consider to dive safely.