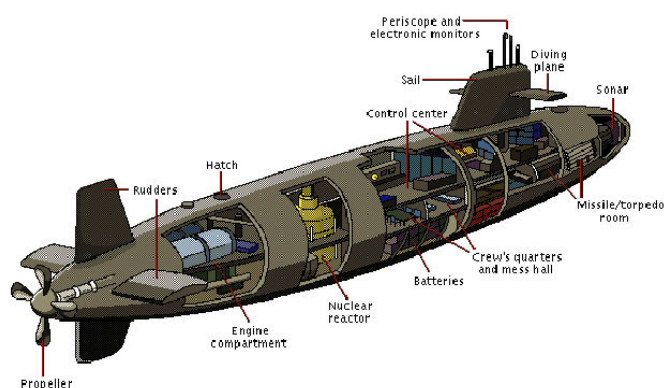


## G8 Science: Class 9 Homework

Read the following excerpt and answer the questions below. Adapted from How Stuff Works (<http://science.howstuffworks.com/transport/engines-equipment/submarine1.htm>)

### HOW SUBMARINES WORK



Submarines are incredible pieces of technology. With the addition of the submarine to the standard naval arsenal, the world below the surface became a battleground as well.

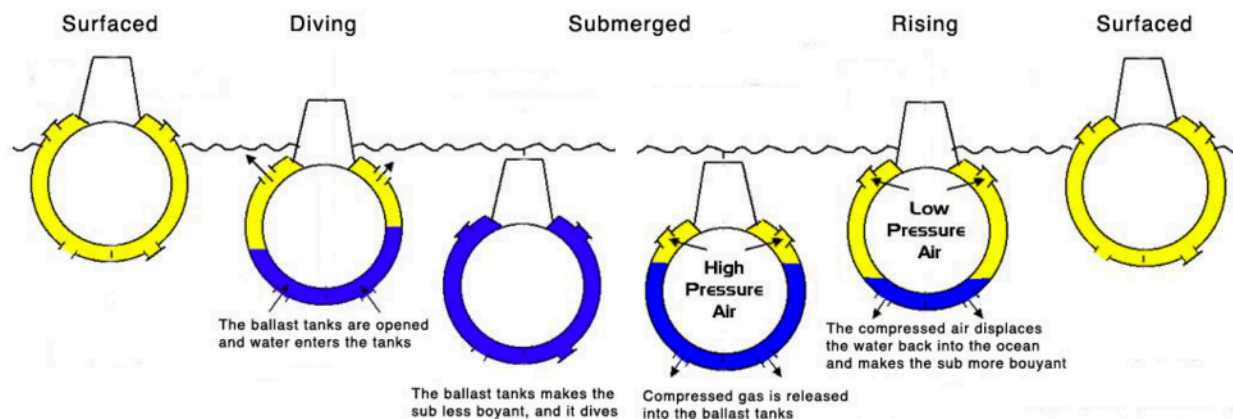
The adaptations and inventions that allow sailors to not only fight a battle, but also live for months or even years underwater are some of the most brilliant developments in military history.

### Diving and Surfacing

A submarine or a ship can float because the weight of water that it displaces is equal to the weight of the ship. This displacement of water creates an upward force called the **buoyant force** and acts opposite to gravity, which would pull the ship down. Unlike a ship, a submarine can control its buoyancy, thus allowing it to sink and surface at will.

To control its buoyancy, the submarine has **ballast tanks** and auxiliary, or **trim tanks**, that can be alternately filled with water or air. When the submarine is on the surface, the ballast tanks are filled with air and the submarine's overall density is less than that of the surrounding water. As the submarine dives, the ballast tanks are flooded with water and the air in the ballast tanks is vented from the submarine until its overall density is greater than the surrounding water and the submarine begins to sink (**negative buoyancy**). A supply of compressed air is maintained aboard the submarine in air flasks for life support and for use with the ballast tanks. In addition, the submarine has movable sets of short "wings" called **hydroplanes** on the stern (back) that help to control the angle of the dive. The hydroplanes are angled so that water moves over the stern, which forces the stern upward; therefore, the submarine is angled downward.

To keep the submarine level at any set depth, the submarine maintains a balance of air and water in the trim tanks so that its overall density is equal to the surrounding water (**neutral buoyancy**).



When the submarine surfaces, compressed air flows from the air flasks into the ballast tanks and the water is forced out of the submarine until its overall density is less than the surrounding water (**positive buoyancy**) and the submarine rises. In an emergency, the ballast tanks can be filled quickly with high-pressure air to take the submarine to the surface very rapidly.

### Life Support in the Submarine

There are three main problems of life support in the closed environment of submarine:



#### 1) Maintaining the air quality

Oxygen is supplied either from pressurized tanks, an oxygen generator or some sort of "oxygen canister" that releases oxygen by a very hot chemical reaction. Oxygen is either released continuously by a computerized system that senses the percentage of oxygen in the air, or it is released in batches periodically through the day.

Carbon dioxide can be removed from the air chemically using soda lime (sodium hydroxide and calcium hydroxide) in devices called **scrubbers**. The carbon dioxide is trapped in the soda lime by a chemical reaction and removed from the air.

#### 2) Maintaining a fresh water supply

Most submarines have a distillation apparatus that can take in seawater and produce fresh water. The distillation plant heats the seawater to water vapor, which removes the salts, and then cools the water vapor into a collecting tank of fresh water. The distillation plant on some submarines can produce 38,000 - 150,000 liters of fresh water per day. This water is used mainly for cooling electronic equipment (such as computers and navigation equipment) and for supporting the crew (for example, drinking, cooking and personal hygiene).

## 3) Maintaining temperature

The temperature of the ocean surrounding the submarine is typically 4 degrees Celsius. The metal of the submarine conducts internal heat to the surrounding water. So, submarines must be electrically heated to maintain a comfortable temperature for the crew. The electrical power for the heaters comes from the nuclear reactor, diesel engine, or batteries (emergency).

**QUESTIONS**1. Define the following terms: **[4 marks]**

- a. Buoyant force
- b. Negative buoyancy
- c. Neutral buoyancy
- d. Positive buoyancy

2. a) What is the density of water? Include all units. **[2 marks]**

b) If something is less dense than water, will it float or sink? **[1 mark]**

c) If something is more dense than water, will it float or sink? **[1 mark]**

3. Explain why a submarine made of metal floats but a metal rod sinks. **[2 marks]**

