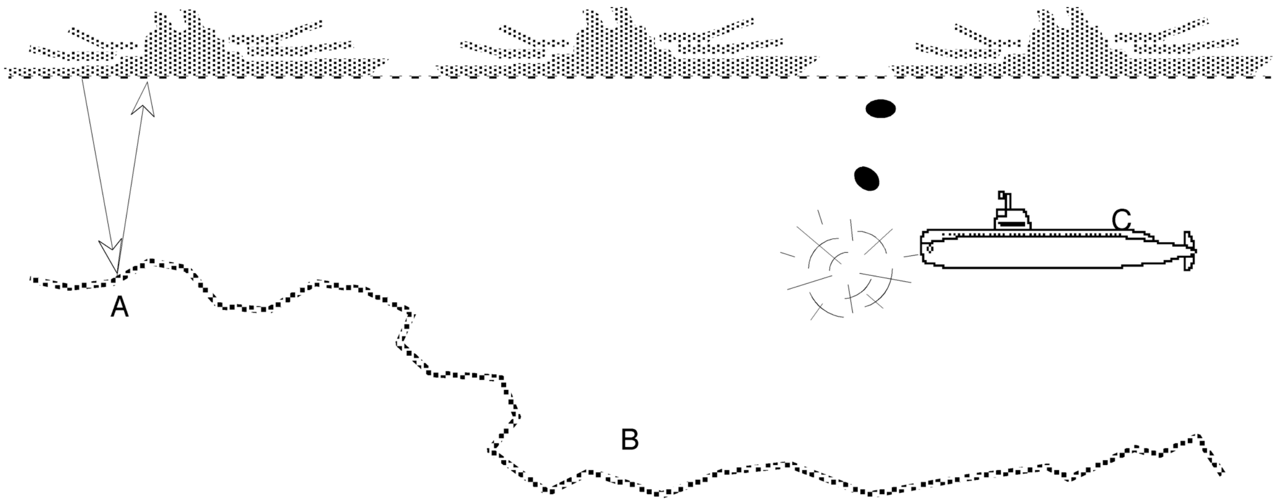
Felix



1. One application of wave behavior is **sonar** (SOund NAvigation Ranging). The depth of water beneath a ship can be determined by sonar by the following technique. A sound is generated at the bottom of a ship. That sound is reflected by the sea bed and returns to the ship. The time it took for the sound to travel from the ship back to the ship indicates the depth of the water.

a. If the depth of water at point A is d and the speed of sound in sea water is v, how long (t_1) does it take for the sound to get from the ship to the sea bed?

$$t_1 = d/v$$

b. How long (t_2) does it take the reflected wave to get from the sea bed back to the ship?

$$t_2 = d/v$$

c. What is the total time t_{TOT} in terms of v and d?

$$t_{TOT} = t_1 + t_2 = 2d/v$$

d. What is the depth of the water d in terms of v and t_{TOT}?

$$d = v \cdot t_{TOT} / 2$$

e. The speed of sound in sea water is __1531__ m/s. If t_{TOT} = 2.0 s, what is the depth of water at A?

$$d = 1531 \text{ m/s} \cdot 2.0 \text{ s} / 2$$
$$d = 153\,1\text{m}$$

2. At point B, the sound takes 1.4 s to return to the ship. What is the depth of the water at B?

$$d = 1531 \text{ m/s} \cdot 1.4 \text{ s} / 2$$
$$d = 1072 \text{ m}$$

3. At point C, a faint echo returns to the ship in 0.9 s. The captain orders depth-charges to be dropped to "neutralize" (as they say in the military) the suspected sub. The depth charges can be set at 10 m intervals; at what depth should the charges be set to explode?

$$d = 1531 \text{ m/s} \cdot 0.9 \text{ s} / 2$$
$$d = 690 \text{ m}$$