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**Problems set # 5** **Physics 131** October 23, 2018

**1.** *(i)* If your heart is beating at 76.0 beats per minute, what is the frequency of your heart's oscillations in hertz? *(i)* What is the oscillating period of your heart when the frequency increases by a factor of 1.3? *(iii)* A sewing machine needle moves in simple harmonic motion with a frequency of 2.5 Hz and an amplitude of 1.27 cm; how long does it take the tip of the needle to move from the highest point to the lowest point in its travel? *(iv)* How long does it take the needle tip to travel a total distance of 11.43 cm?

**2.** Astronaut Harry has landed on Pluto and conducts an experiment to determine the acceleration due to gravity on the dwarf planet. He uses a simple pendulum that is 0.640 m long and measures 10 complete oscillations in 63.8 s. What is the acceleration of gravity on Pluto?

**3.** If you drop a stone into a mineshaft that is 122.5 m deep, how soon after you drop the stone do you hear it hit the bottom of the shaft? The temperature in the mineshaft is 10°C.

**4.** Two submarines are underwater and approaching each other head-on as shown in Fig. 1. Sub $A$ has a speed of 10 knots and sub $B$ has a speed of 30 knots. Commander Harry on Sub $A$ is pinging on $B$ with an active sonar frequency of 10 kHz. The speed of sound underwater is $2,912$ knots, that is roughly 4.3 times as fast as in air. *(i)* What frequency will receive Sally on submarine $B$ from Harry's sonar? *(ii)* What is the frequency of the echo Harry receives from Sally's submarine?

**5.** The security alarm on a parked car goes off and produces a frequency of 960 Hz. The speed of sound is 343 m/s. As you drive toward this parked car, pass it, and drive away, you observe the frequency to change by 95 Hz. At what speed are you driving?


Figure 1: The situation in question 4.