Numerical Answers to Sample 3 Final Exam
Question 1 not released

Question 2
a) A < C < B, b) A < B < C c) i) A = C < B, ii) A = B = C, iii) C < B = A

Question 3a) 89.0 m **Question 3b)** 6.8 m/s

Question 4

a) 0.050 m, b) 1.57 Hz, c) $y(t) = (0.050m)\cos(\sqrt{98}t + \pi)$
d) 0.157 J e) 0.20 m

Question 5a i) L=λ/4 ii) 250, 750, 1250 Hz iii) 11.4 cm
Question 5b) i) 1200 N ii) L=3x(λ/2)

Question 6a i) c ii) λ/(2x1.33)

Question 6b) 360, 1080 Hz

Question 2 – Ranking Questions (12 marks)

Question 2a

Damped harmonic oscillator A has an initial amplitude of 5 cm and a damping constant $b/m = 0.01\ s^{-1}$.

Damped harmonic oscillator B has an initial amplitude of 20 cm and a damping constant $b/m = 0.02\ s^{-1}$.

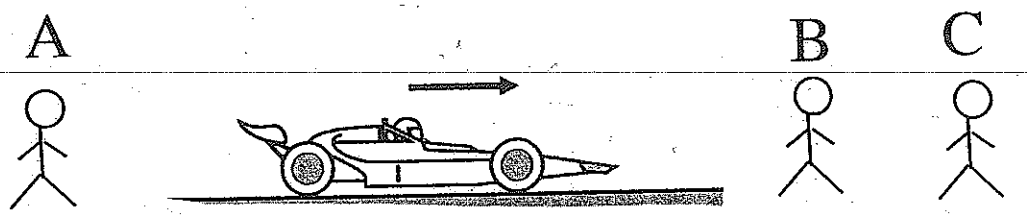
Damped harmonic oscillator C has an initial amplitude of 30 cm and damping constant $b/m = 0.03\ s^{-1}$.

After 100 s their amplitudes are respectively X_A, X_B and X_C. Rank these amplitudes from smallest to largest, indicate any equivalencies by using =.

Smallest _____ _____ _____ Largest

Question 2b

An automobile is traveling at 10.2 m/s and sounding its horn.



Observer A, running at 3.4 m/s in the same direction as the car, but behind it, hears a sound of frequency f_A.

Observer B, running at 3.4 m/s in the same direction as the car, but in front of it, hears frequency f_B.

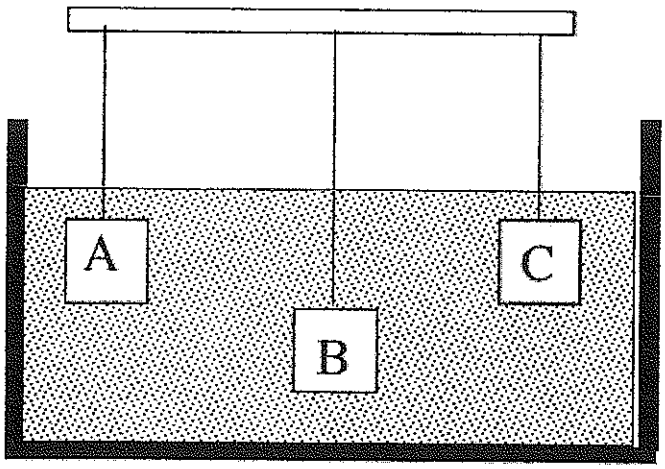
Stationary observer C in front of the car hears frequency f_C.

Rank these frequencies from lowest to highest, indicate any equivalencies by using =
(Take the speed of sound as 340 m/s.)

Lowest _____ _____ _____ Highest

Question 2c.

Three cubical blocks of equal volume, V, are suspended from strings. Blocks A and B have the same mass and block C has less mass. Each block is lowered into a fish tank and they hang at rest. A is at the same level as C and B is at a greater depth.



i) Rank the blocks according to the force (F_A, F_B and F_C) on the top surface of the blocks due to the water, indicate any equivalencies by using =.

Smallest _____ _____ _____. Largest

ii) Rank the blocks according to the buoyant force (B_A, B_B and B_C) acting on the blocks, indicate any equivalencies by using =.

Smallest _____ _____ _____. Largest

iii) Rank the blocks according to the tension (T_A, T_B and T_C) in the strings supporting the blocks, indicate any equivalencies by using =.

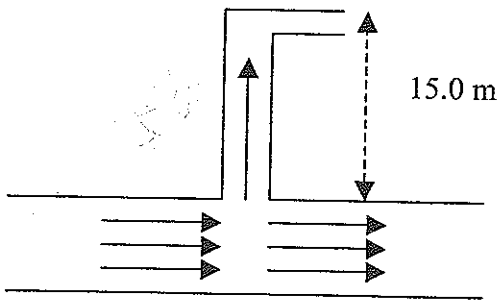
Smallest _____ _____ _____. Largest

Question 3a (4 marks)

Scuba equipment provides the diver with air at the same pressure as the surrounding water. At absolute pressures greater than about 1.0×10^6 Pa, the nitrogen in air becomes dangerously poisonous. At what depth in water does nitrogen become dangerous? (the density of the ocean-water is 1030 kg/m^3).

Question 3b (8 marks)

Water in a main pipe at the street level is at a gauge pressure of 170 kPa and is moving with negligible speed. A pipe connected to the main pipe is used to deliver the water to a kitchen located on the third floor of a building, at a 15-m height from the street level. What is the maximum possible velocity with which the water can emerge from an open kitchen faucet?



Question 4 (12 marks)

A Phys 101 student observes that, when a mass of 2.0 kg is attached to the end of a vertical spring, the spring is stretched by 10.0 cm. The student then pulls the mass down 5.0 cm from its equilibrium position and releases it at time t = 0. Assuming that there are no damping forces,

a) What is the amplitude of the motion?

b) What is the frequency of the motion?

c) Assuming that the upward direction is positive, deduce the equation of motion for the displacement, y, from the point of equilibrium. Evaluate all constants.

d) What is the kinetic energy of the system at y = 3.00 cm?

e) If you took two springs identical to that above and connected them in series and then hung a mass of 2.0 kg on them, how much would you stretch the combined spring?

Question 5a (7 marks)
Consider two tubes, sealed at the bottom end and 34 cm high. You then blow over the top of Tube 1 to produce a note.

i) Draw the displacement diagram showing the nodes and antinodes in the tube for the fundamental frequency.

ii) Using the speed of sound as 340 m/s, determine the three lowest frequencies for Tube 1.

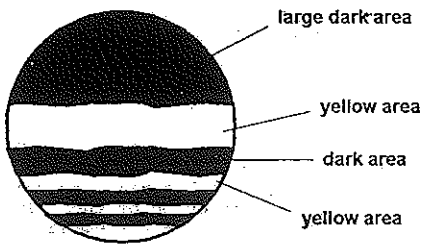
iii) Tube 2 contains some water and has a fundamental frequency of 375 Hz, what is the depth of water in Tube 2?

Question 5b (5 marks)
A piano tuner is working with a wire which she wishes to vibrate with a fundamental frequency of 500 Hz. The string has length, L, of 0.400 m and has a mass, m, of 3.00 g.

i) What must be the tension in the wire to achieve this frequency?

ii) Sketch what the wire would look like if it vibrates at its third harmonic frequency.

Question 6a (6 marks)
Yellow light is viewed by reflection from a thin vertical soap film (n=1.33).

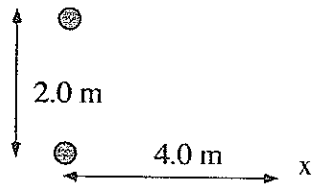


i) Why is there a large dark area at the top of the film? Which of the following is the best explanation?

a) no light is transmitted through this part of the film
b) the film thickness there is $\lambda/4n$
c) the light reflected from one of the film's surfaces undergoes a 180° phase shift
d) the film is too thick in this region for thin film formulae to apply

ii) In terms of λ, by how much does the thickness of the film change in going from the top yellow area to the yellow area below it?

Question 6b (6 marks)
Two speakers are separated by a distance of 2.0 m as shown. The speakers are in phase and you are standing 4.0 m directly in front of one of the speakers. Assume the speed of sound is 340 m/s and the range of hearing is 20 to 20 kHz.



What are the two lowest frequencies that you will hear a minimum signal (destructive interference)?