Name: _____

PHYS 1210-02 Exam 4

Standards 44–55

Calculators of any type are permitted. You may bring your own 8 ½" × 11"notes sheet, which may contain information on both sides, and a hedgehog.

Enter your answer inside the box provided by each question. Include units with all quantitative answers. Do not make stray marks in the box, and do not write your answer outside the box. It is a good idea to write your answers in pencil. If the question asks for a selection from provided options, fill the circle (○) by the most correct answer.

All questions are worth 1 point unless otherwise indicated.

Physical Constants

$G = 6.674 \times 10^{-11}\ \mathrm{N \cdot m^2/kg^2}$

Questions

1. What change in sound intensity corresponds to a 10-decibel change?

   ○ a. 10 watts per square meter

   ○ b. 10^{-6} watts per square meter

   ○ c. a factor of 10

   ○ d. a factor of e

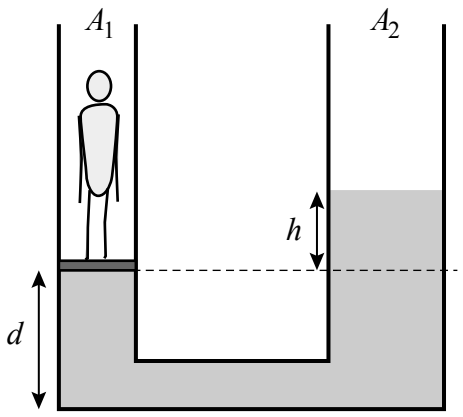
2. At a distance of 2.0 meters from a buzzing fly, the intensity of the fly's annoying buzz is 2.0×10^{-6} watts per square meter. How far away would the fly need to be for its sound intensity to be only 1.0×10^{-7} watts per square meter? (Write your answer in the box. If you show any work, write it outside the box.)

   [ ]

3. The sound intensity at a distance of 1.0 meter from the explosion of a small firecracker is reportedly 150 decibels. How far away would one need to retreat from the firecracker to reach a safe sound level of 85 decibels? (Write your answer in the box. If you show any work, write it outside the box.)

4. A cyclist traveling at a speed of 4.0 meters per second hears the whistle of an approaching train at a frequency of 344 hertz. The train's whistle produces the sound at a frequency of 320 hertz, and the speed of sound in air is 342 meters per second. What is the speed of the train? (Write your answer in the box. If you show any work, write it outside the box.)

5. The piston assembly illustrated at right consists of two connected cylinders of cross-sectional areas A_1 and A_2. The cylinders and the connection between them contain hydraulic fluid of density ρ. One cylinder is capped by a piston on which a person stands; the combined mass of the person and the piston is m. The other cylinder is open to the ambient atmosphere. At equilibrium, the top of the fluid in the open cylinder is a height h above the level of the piston, and the piston is a height d above the bottom of the chamber.



A. What is the pressure of the fluid pushing up on the piston?

○ a. mg/A_1 ○ b. ρg ○ c. mgh ○ d. $\rho gh/A_1$ ○ d. $\rho g/A_2$

B. What is the pressure of the fluid pushing down on the bottom of the chamber?

○ a. $(m + \rho)g$ ○ b. $\rho gh(A_1/A_2)$ ○ d. $mg/A_1 + \rho gd$ ○ d. $\rho g(h+d)/A_2$

C. (0.1 point) How do you expect the area of cylinder 1 to affect the fluid height h?

○ a. The larger the area A_1, the higher h will be.

○ b. The smaller the area A_1, the higher h will be.

○ c. A_1 should have no effect on h.

D. (0.1 point) How do you expect the area of cylinder 2 to affect the fluid height h?

○ a. The larger the area A_2, the higher h will be.

○ b. The smaller the area A_2, the higher h will be.

○ c. Area A_2 should have no effect on h.

E. (0.1 point) How do you expect the fluid density ρ to affect the fluid height h?

○ a. The greater the density ρ, the higher h will be.

○ b. The lower the density ρ, the higher h will be.

○ c. Density ρ should have no effect on h.

F. (0.1 point) How do you expect the gravitational field g to affect the fluid height h?

○ a. The greater the gravity g, the higher h will be.

○ b. The lower the density g, the higher h will be.

○ c. Gravitational field g should have no effect on h.

G. (0.1 point) How do you expect the total volume of hydraulic fluid in the apparatus to affect the fluid height h?

○ a. The greater the volume, the higher h will be.

○ b. The smaller the volume, the higher h will be.

○ c. The volume of fluid should have no effect on h.

H. What is the height h? Express it in terms of some or all of the other given variables m, ρ, A_1, A_2, and d, and any other necessary constants. (Write your answer in the box. If you show any work, write it outside the box.)

6. Rose sits on a wooden door adrift in the chilly North Atlantic ocean. The door has mass m_1 = 105 kg and density $\rho_1 = 700$ kg/m^3. Rose has mass $m_2 = 45.0$ kg and density $\rho_2 = 985$ kg/m^3. Sea water has a density $\rho_3 = 1025$ kg/m^3.

A. What is the volume of the door, in cubic meters? (Write your answer in the box. If you show any work, write it outside the box.)

B. Does the door float Rose completely above the water, or is she partly submerged?

○ a. Rose is above the water.

○ b. Rose is partially submerged.

C. What is the least mass that the door could have to keep Rose completely above the water? (Write your answer in the box. If you show any work, write it outside the box.)

7. In high-performance liquid chromatography, or HPLC, a solution of a substance to be purified is passed through a solid sorbent with a large volume of solvent. High pressures are needed to force the solvent through the tightly-packed sorbent. In a particular HPLC, the solvent methanol, density 792 kg/m^3, is pressurized to 300 bar (1 bar = 100,000 Pa). The tubing develops a pinhole leak, with a diameter of 0.10 millimeter (much less than the diameter of the tubing), so that methanol escapes through the pinhole. What is the speed of the methanol leaving the tubing? (Write your answer in the box. If you show any work, write it outside the box.)

8. The Moon, mass 7.35×10^{22} kilograms, orbits the Earth, mass 5.97×10^{24} kilograms, at a distance of 3.84×10^{8} meters. (We shall approximate all orbits as circular.) The Earth-Moon system, in turn, orbits the Sun, mass 1.99×10^{30} kilograms, at a distance of 1.50×10^{11} meters. *G* is given on the first page of the exam. The orbits are both in the same angular direction.

(Objects and distances not to scale.)

A. What is the magnitude of the gravitational attraction between the Earth and Moon? (Write your answer in the box. If you show any work, write it outside the box.)

B. What is the gravitational potential energy of the Earth-Moon system in the "gravitational well" of the Sun? (Write your answer in the box. If you show any work, write it outside the box.)

C. What is the tangential speed of the center of mass of the Earth-Moon system in its orbit around the Sun? (Write your answer in the box. If you show any work, write it outside the box.)

D. When the Moon is between the Earth and the Sun in its orbit, its kinetic energy is less than average. How is the mechanical energy of the Earth-Moon-Sun system conserved?

○ a. The Moon's gravitational potential energy is higher at that time.

○ b. The Earth's kinetic energy is higher at that time.

○ c. Mechanical energy averages out over the course of an orbit.

○ d. Mechanical energy is not conserved, because this is not a closed system.