PHYS 1431 SECOND TEST SOLUTIONS

27. 3. 2018

1. If you want to construct a barometer using water instead of mercury to measure atmospheric pressure how long does the tube need to be?

A) 5m
B) 1m
C) 11m
D) 9m
E) 8m

$\rho_w g h = P_{atmos.}$

$1000 * 9.8 * h = 101 \times 10^3 \text{ Pa}$

$h = \frac{101 \times 10^3}{1000 * 9.8} = 10.3 \text{ m} = \text{average height of column of water}$

We must use a longer tube to allow for vacuum at top $\Rightarrow L = 11$ m

2. The systolic blood pressure is measured in the normal way and is found to be 120 mmHg. What is the systolic pressure in a leg artery 82 cm below the heart? ($\rho_{blood} = 1060 \text{ kg m}^{-3}$)

A) 126 mmHg
B) 185 mmHg
C) 55 mmHg
D) 120 mmHg
E) 150 mmHg

$P_{leg} = P_{heart\ level} + \rho_{blood} g h$

$\rho_{blood} g h = (1060)(9.8)(0.82) = 8500 \text{ Pa} * \frac{760 \text{ mmHg}}{10^5 \text{ Pa}} = 65 \text{ mm Hg}$

$\therefore P_{leg\ level} = 120 + 65 \text{ mmHg} = 185 \text{ mmHg}$

3. What is the atmospheric pressure at a height of 3100 m above sea level? Assume an average air density of 1 kg/m^3.

A) 30 kPa
B) 130 kPa
C) 70 kPa
D) 100 kPa
E) 120 kPa

$P(\text{at } y = 3100 \text{ m}) = P(\text{sea level}) - \rho g h$

$= 100{,}000 - 1(9.8)(3100)$

$= 100{,}000 - 30{,}000 = 70{,}000 \text{ Pa}$

$= 70 \text{ kPa}$

4. A lead cube of side 20 cm is placed on a horizontal surface. What is the pressure exerted by the cube on the surface? ($\rho_{lead} = 11\,300 \text{ kg m}^{-3}$)

A) 60 kPa
B) 44 kPa
C) 78 kPa
D) 11 kPa
E) 22 kPa

$P = \frac{Mg}{Area} = \frac{\rho_{lead} (L^3) g}{L^2} = \rho_{lead} L g$

$= (11300)(0.2 \text{ m})(9.8 \text{ m/s}^2) = 22 \text{ kPa}$

5. A string has a length of 45 cm and a mass of 2 grams. It is under a tension of 40N. What is its fundamental frequency?

A) 53 Hz
B) 106 Hz
C) 26 Hz
D) 33 Hz
E) 78 Hz

$\mu = \frac{M}{L} = \frac{0.002}{0.45} \text{ kg/m}$, $c = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{40 * 0.45}{0.002}} = 95 \text{ m/s}$

$\lambda_1 = 2L = 0.9 \text{ m}$

$f_1 = \frac{c}{\lambda_1} = \frac{95 \text{ m/s}}{0.9 \text{ m}} = 106 \text{ Hz}$

6. What is the intensity of a 70 dB sound wave?

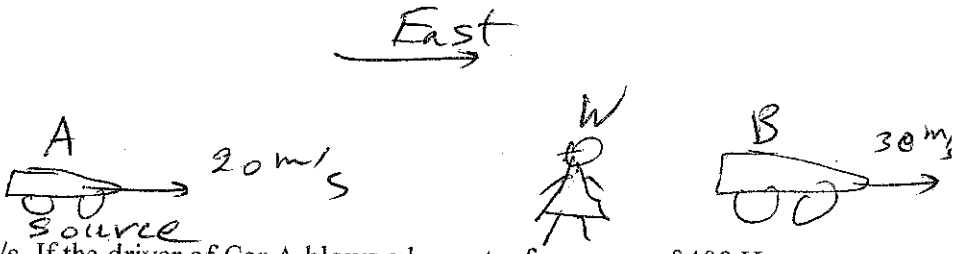
A) 10^{-7} W/m^2
B) 10^{7} W/m^2
C) 10^{5} W/m^2
D) 10^{-5} W/m^2
E) 10^{-70} W/m^2

$L = 10 \log_{10} \frac{I}{10^{-12} \text{ W/m}^2} = 70$

$\log_{10} \frac{I}{10^{-12} \text{ W/m}^2} = 7 \Rightarrow \frac{I}{10^{-12} \text{ W/m}^2} = 10^7$

$\therefore I = 10^7 * 10^{-12} \text{ W/m}^2 = 10^{-5} \text{ W/m}^2$

Use g = 9.8 m/s^2. Speed of sound in air = 343 m/s



7. Car A is traveling East at 20 m/s. If the driver of Car A blows a horn at a frequency of 400 Hz, what frequency is heard by a woman standing 200 m in front of the approaching car?

A) 378 Hz
(B) 425 Hz
C) 400 Hz
D) 450 Hz
E) 356 Hz

The source is moving towards the observer (W)

$$f' = f\frac{c}{c - v_s} = 400\,\frac{343}{343-20} = 425\ \text{Hz}$$

8. What frequency is heard by the driver of Car B which is traveling East at 30 m/s in front of Car A in problem 7 when the horn of Car A is blown at a frequency of 400 Hz?

(A) 388 Hz
B) 462 Hz
C) 345 Hz
D) 411 Hz
E) 450 Hz

The Source (A) is moving towards the observer (B)
But the observer (B) is moving away from (A)

$$\therefore f' = f\,\frac{c - v_B}{c - v_s} = 400\,\frac{343-30}{343-20} = 388\ \text{Hz}$$

9. Calculate the bulk modulus B of water given that the speed of sound in water is 1440m/s:

A) 2.1×10^9 kg.m/s
B) 1.4×10^6 kg.m/s
C) 1.4×10^6 N/m^2
D) 2.1×10^6 kg.m/s^2
(E) 2.1×10^9 N/m^2

$$c = \sqrt{\frac{B}{\rho}} \Rightarrow B = c^2\rho = (1440)^2 \times 1000 = 2.1 \times 10^9\ \frac{\text{kg}}{\text{m s}^2}$$

$$(\text{m/s})^2\ \text{kg/m}^3$$

$1\text{N} = 1\text{kg}\cdot\text{m/s}^2$, $F = (m)(a)$

$$\Rightarrow \frac{1\text{kg}}{\text{s}^2} = 1\text{N/m}$$

$$= 2.1 \times 10^9\ \frac{\text{N}}{\text{m}^2}$$

10. What is the approximate wavelength of a 1 kHz sound wave traveling through the cochlea?

(A) 1.4 m
B) 1.9 m
C) 0.7 m
D) 0.35 m
E) 0.19 m

The cochlea is filled with salty water
$\therefore c_{sound}$ in the cochlea is $\simeq c_{sound}$ in water ~ 1440 m/s

$$\therefore \lambda = \frac{c}{f} = \frac{1440\ \text{m/s}}{1000} \simeq 1.4\ \text{m}$$

11. If you hear the thunder رعد 3 seconds after you see the lightning برق, how far are the clouds?

(A) 1 km
B) 3 km
C) 0.3 km
D) 2 km
E) 10 km

The lightning travels very fast $\Rightarrow \Delta t \simeq 0$ for light

$$\therefore d = (c_{sound}) * 3\,s$$
$$= 343 * 3 \simeq 1000\ \text{m} = 1\ \text{km}$$

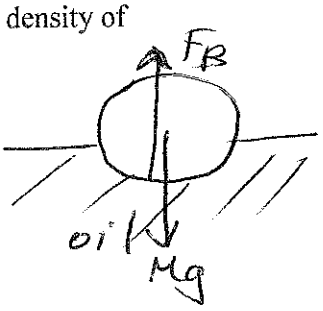
12. Which of the following statements is true?

A) The middle ear compensates for the loss in sound intensity during the transmission from the ear canal to the cochlea. True
B) The loss in sound intensity during the transmission from the ear canal to the cochlea is due to the difference between the acoustic impedences of the ear canal and the cochlea. True
C) The cochlea is filled with a sea-water-like fluid. True
(D) All of the above statements are true. True
E) Only statements B and C are true. False

Use g = 9.8 m/s^2. Speed of sound in air = 343 m/s

13. Which of the following statements is true?
A) The pressure of any volume of gas is constant everywhere. False
B) The pressure of a small volume of gas is constant everywhere. True
C) Atmospheric pressure does not vary with elevation الارتفاع because air is a gas. False
D) Atmospheric pressure does not change with time. False
E) All of the above are true. False

14. A wooden sphere of radius 2 cm is floating in oil. If $\rho_{oil} = 1500\ kg\ m^{-3}$, and the density of wood is 600 kg/m^3, what percentage of its volume lies above the oil surface?



A) 30%
B) 40%
C) 60%
D) 70%
E) 50%

$Mg = F_B$

$\rho_{wood} V_{sphere} g = \rho_{oil} V_{disp} g$

$\therefore \frac{V_{disp}}{V_{sphere}} = \frac{\rho_{wood}}{\rho_{oil}} = \frac{600}{1500} = 40\%$

$\therefore$ 60% is above the oil surface

15. If we hold the wooden sphere mentioned in Problem 14 so that it is completely under the oil surface then the buoyant force on it is:
A) 0.2 N downwards
B) 0.2 N upwards
C) 0.5 N downwards
D) 0.5 N upwards
E) We cannot give an answer unless we know the force with which we hold the sphere.

$F_B = \rho_{oil} \frac{4\pi}{3} R^3 g = 1500 \frac{4\pi}{3} (0.02)^3 9.8$

$\approx 0.5\ N$ upwards

The Buyont force is always directed upwards

16. The apparent weight of a 0.010 kg coin when immersed completely in water is 0.080 N. Its volume is:
A) 8.1 cm^3
B) 1.0 cm^3
C) 2.7 cm^3
D) 1.2 cm^3
E) 1.8 cm^3

Actual Weight $= 0.01 * 9.8 = 0.098\ N$

$F_{Buoyant}$ = Actual Weight − Apparent Weight

$= 0.098 - 0.080 = 0.018 = \rho_w g V$

$\therefore V = \frac{0.018}{1000 * 9.8} = 1.8 \times 10^{-6}\ m^3 = 1.8\ cm^3$

17. Which of the following statements is false?
A) Our blood pressure when doing physical work differs from its value when we are at rest. True
B) Our blood pressure varies with time throughout each cardiac cycle. True
C) Our blood pressure should be measured at the heart's level. True
D) Our blood pressure is the same anywhere in our body. False
E) High blood pressure can cause many health problems. True

Use g = 9.8 m/s^2. Speed of sound in air = 343 m/s