LAST NAME: **STUDENT # :**

FIRST LETTER OF LAST NAME: **FIRST NAME:**

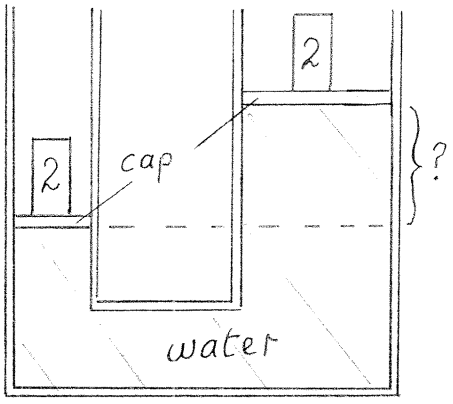
Phys. 101 Section 203 Mid-term exam.
Thurs. March 1, 2007. Hebb Theatre 9:30 am – 10:40 am
Instructor : J. E. Eldridge

ANSWER ALL 5 QUESTIONS. PART MARKS ARE SHOWN IN THE MARGIN.

Question	#1	#2	#3	#4	#5	TOTAL
Mark						

Part marks

Question 1. A U-tube is filled with water, and the two arms are capped. 2.0 kg masses are then placed on the caps, and the equilibrium configuration is shown in the figure. The tube is cylindrical, and the right arm has twice the radius of the left arm. The caps have negligible mass, are watertight, and can freely slide up and down the tube. The dashed line represents the level of the water in the left arm. What is the mass of the water in the right arm between the dashed line and the right cap? Explain your answer.



Pressure is equal on both sides of the U-Tube at the dashed line.

$\frac{2\,kg}{A_{left}} = \frac{m_{right}}{A_{right}}$ $A_{right} = 4\,A_{left}$

$\therefore m_{right} = 8\,kg$ and $m_{WATER} = 8\,kg - 2\,kg = 6\,kg$.

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Question 2. A large helium balloon has a volume of 20.0 m^3. The density of air is 1.29 kg/m^3 and the density of helium is 0.179 kg/m^3. The mass of the balloon material is 5.0 kg.

10 What is the buoyancy mass acting on the balloon?

$M_{BUOY} = \rho_{AIR} * V_{BALLOON} = 1.29 * 20 = 25.8\,kg$

$(252.8\,N$ for $F_{BUOY})$

Question 2 (continued)

10 What is the maximum payload that can be lifted by the balloon?

$$\text{Payload} = M_{\text{lift}} - M_{\text{balloon}} - M_{He}$$
$$= 25.8 - 5 - 20 * 0.179$$
$$= 25.8 - 5 - 3.58$$
$$= 17.22 \text{ kg} \quad (\text{or } 168.8 \text{ N})$$

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Question 3. Blood with density 1050 kg/m^3 flows with a velocity of 0.140 m/s in an artery. In one section the artery is 90% blocked.

5 What is the velocity of the blood as it flows in the blocked section?

$$A_1 V_1 = A_2 V_2 \qquad V_2 = 0.14 * \frac{A_1}{A_2} = 0.14 * \frac{A_1}{0.1 A_1} = 1.4 \text{ m/s}$$

15 What is the change in blood pressure (magnitude and direction) in the blocked section?

$$\Delta P = \tfrac{1}{2} \rho (V_2^2 - V_1^2) = \frac{1050}{2} (1.4^2 - 0.14^2)$$
$$= 525 (1.96 - 0.0196)$$
$$= 1018.7 \text{ Pa} \quad \text{REDUCTION}$$

$$(P_2 - P_1 = \tfrac{1}{2} \rho (V_1^2 - V_2^2) = -1018.7 \text{ Pa})$$

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Question 4. A mass is attached to a spring on a horizontal frictionless surface. It is stretched a distance x_0 from equilibrium and released. At what distance from equilibrium will it have

10 velocity equal to half of its maximum velocity?

$x = A\cos\omega t \quad \therefore V = -A\omega \sin\omega t \qquad V = -0.5 A\omega$ when $\sin\omega t = 0.5$

or $\omega t = 30° \quad \therefore x = A\cos 30 = 0.866\, x_0$

OR use energy $K.E = \frac{1}{4} E_{TOTAL}$ when $V = V_{MAX}/2$. $\therefore P.E. = \frac{3}{4} E_{TOTAL}$

$\therefore \frac{1}{2}kx^2 = \frac{3}{4}\cdot\frac{1}{2}kx_0^2$ and $x = \frac{\sqrt{3}}{2} x_0 = 0.866 x_0$

10 acceleration equal to half of its maximum acceleration?

Force = mass * accel $= -kx$

$\therefore$ accel $= 0.5$ max accel when $x = 0.5 x_0$

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Question 5. A simple harmonic oscillator has a frequency of 0.50 Hz. It is released from rest at time t = 0 with a displacement of 10.0 cm.

10 What is the velocity (magnitude and sign) at time t = 1.5 seconds?

$f = 0.5$ Hz $\therefore T = 2$ sec. At $t = 1.5$ sec, vel will be $= \omega x = A\omega = 0.1 * 2\pi * 0.5$

$= +0.1\pi$ m/s

OR $x = A\cos\omega t$ gives $V = -A\omega\sin\omega t \qquad \omega = 2\pi f = \pi$ rad/s

$\therefore V = -0.1\pi \sin(\pi * 1.5) = -0.1\pi * -1 = +0.1\pi$ m/s

10 If instead, it was released at time t = 0.2 seconds, what would be the phase constant φ_0, (magnitude and sign) in the solution x = A cosine ($\omega t + \varphi_0$)?

$x = A\cos(\omega t + \phi_0) \qquad \cos(\omega t + \phi_0) = 1$ at $t = 0.2$ sec

$\therefore \omega t + \phi_0 = 0$ at $t = 0.2$ sec

$\therefore (0.2 * \pi) + \phi_0 = 0$

$\phi_0 = -0.2\pi$

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